RADical Shifts

A Futurist's Guide to Ecological Transformation and Biodiversity Stewardship

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RADical Shifts: A Futurist's Guide to Ecological Transformation and Biodiversity Stewardship

Coastal delta on Kodiak Island, Alaska. Photo by Steve Hillebrand, USFWS.

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A note about audience:

The Guidebook uses "us" and "we" because it was written by and for people interested in adaptation implementation. No one person will have the answer for how to steward biodiversity and other ecosystem services through this era of rapid change and transformation. Each of our unique jobs and perspectives create the collective genius that will be necessary to respond to ecological change in a meaningful way.

This Guidebook is intended for people who are interested or involved in implementing climate change adaptation.

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American Avocets in North Carolina. Photo by Eve Turek, USFWS.

EXECUTIVE SUMMARY

Natural resource managers and biodiversity conservationists have a proud history of identifying and responding to urgent and novel challenges. Today, the unprecedented threat of climate change requires us to rise to the challenge once again, as species distributions shift, novel species assemblages develop, and ecological transformation accelerates. In the 20th century, the conservation field depended on historical condition to guide management actions. We have since departed from that climate regime and are now entering a new era of conservation that will require us to prepare for and navigate ecological transformation.

Resist—Accept—Direct

The resist—accept—direct (RAD) framework can help to navigate change in this new era. RAD defines the full spectrum of management responses that can be used to steward biodiversity and other ecosystem services as change unfolds. We can create pathways to future conditions in three ways:

- by resisting ecological change
- by accepting ecological change
- by directing ecological change

RAD is a simple framework that can help us explore options beyond restoring and maintaining historical conditions. RAD implementation is facilitated by investment in practices and capacity that will allow us to manage toward a future that may be very different than what was experienced in the past.

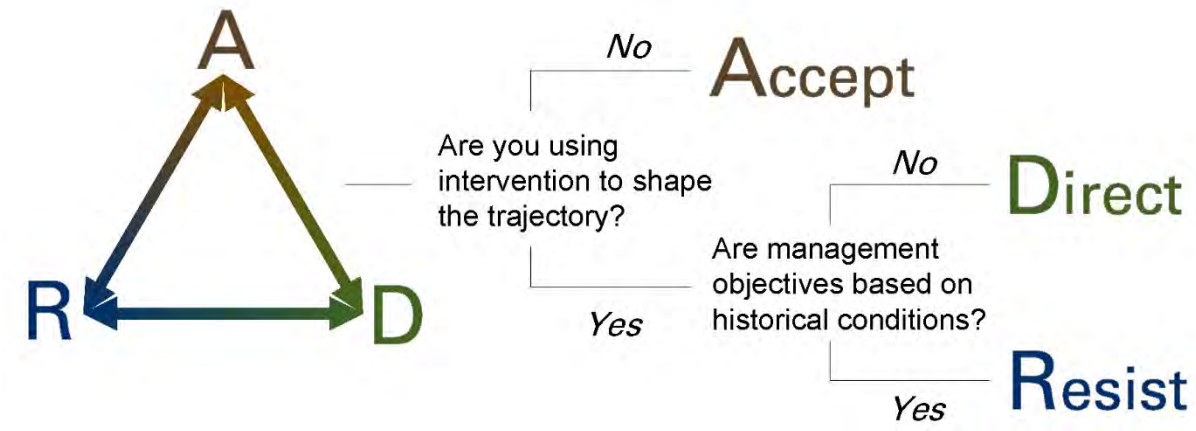


Figure 1. The resist—accept—direct (RAD) framework envisioned as a triangle. Overlapping colors indicate the fuzzy boundaries among the RAD actions. This RAD framework helps us distinguish RAD categories based on whether we are intervening and whether we are using a historical baseline (including a current condition) to envision and communicate management objectives. Figure adapted from Schuurman et al. (2020) and Wilkening et al. (2023).

RAD Implementation

This Guidebook identifies three conceptual starting points for RAD implementation: menus, portfolios, and decision contexts. The implementation chapters are not meant to be interpreted as a linear process. Rather, they support our capacity to implement adaptation actions. The Guidebook identifies information and capacities that allow climate change to be meaningfully addressed in any planning process used and for actions to be implemented on the ground.

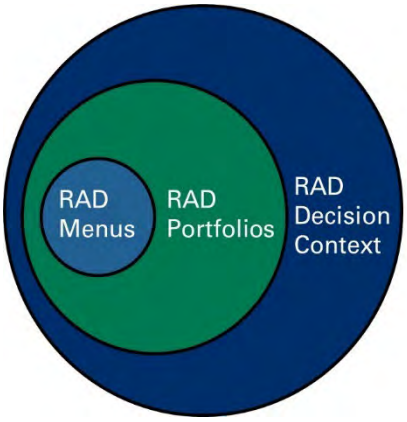


Figure 2. Three starting points for implementing RAD that expand in terms of their scope.

RAD Menus

We are already making climate-smart decisions, but more innovative approaches are needed. RAD is a powerful facilitation tool for exploring a wider range of management responses given scenarios of climate futures and plausible ecological trajectories. Brainstorming RAD options creates a menu of adaptation actions. RAD menus identify and document what we *could* do, not what we *should* do.

RAD Portfolios

To be prepared to navigate transformation, we can plan why, when, where, and how to change RAD actions. These strategic decisions can be implemented using adaptive management strategies and tracked in a portfolio. The portfolio approach in conservation draws from financial risk management. Creating a portfolio of RAD actions minimizes the risk of over-investing in strategies that do not perform, facilitates learning, and provides a structure to track reallocations of our efforts. Actions can include monitoring that scans for change, experimentation to better understand ***the range of plausible ecological trajectories***, and pilots to test RAD actions. Two planning approaches are useful for managing a portfolio:

- **Spatial planning:** Mapping the likelihood of transformation communicates where different RAD strategies may be most effective and contextualizes decisions for each management unit. Landscape conservation design can be used to coordinate RAD responses and share information across jurisdictions.
- **Pathway (temporal) planning:** Pathway planning helps us navigate RAD strategies through time depending on how change unfolds. Learning from changes occurring across an ecoregion can help us identify influential events that may trigger a change in RAD strategy. Pathway planning communicates these management triggers linked to RAD response options. It facilitates the consideration of tradeoffs among current and future decisions and the feasibility of each pathway.

RAD Decision Context

Ecosystem transformation can create situations where the values, rules, and knowledge bases that were previously useful for guiding our management become maladaptive. ***Upstream, deliberative engagement*** entails working with others to adapt our decision context, so we can codevelop effective and meaningful solutions. It builds the trust and collaboration needed to implement RAD actions. Deliberative engagement involves careful consideration and discussion by a group. It creates opportunities to explore collectively and plan more holistically.

Implementing the Strategies

Ideally, RAD implementation would be strategic, collaborative, and coordinated. This ideal would include a collaboratively designed, dynamic, spatial portfolio, which is accompanied by a menu and within a decision context that adapts to changing conditions. However, the Guidebook is designed to support implementation in the real world where people may only be responsible for or interested in pieces of the larger implementation problem. For example, a manager could use portfolio concepts without a formal menu or in the absence of deliberative engagement. For example, they could choose a trigger point for shifting the management strategy from resisting to accepting without understanding the full range of options that might be defined in a menu or a clear understanding about what others are doing. While not ideal, this situation may become necessary given our need to respond in real time to the rapid pace of change.

We encourage Guidebook users to consider these implementation concepts as various starting points, somewhat like different entrances to a park or wildlife refuge. You can start with a RAD menu, a portfolio, or the decision context, depending on the information you have most readily available and nearest at hand. Eventually, your exploration will take you across the entire landscape of RAD implementation strategies, and along the way you will have the opportunity to revisit your previous strategies. We encourage you to embrace the journey as well as the result, as a reminder of the changing conditions under which we work and our continual need to revisit strategies.

Eastern collared lizard in Wichita Mountains National Wildlife Refuge, Oklahoma. Photo by Randy Jones, USFWS.

CHAPTER 1.
RESIST—ACCEPT—DIRECT

Great Blue Heron at Alligator National Wildlife Refuge, North Carolina. Photo by Eve Turek, USFWS.

Key Messages

- Natural resource management and biodiversity conservation face a paradigm shift because we have used historical conditions and the concept of naturalness to guide our management, a strategy that assumes we can maintain current or restore past conditions. This assumption is now being challenged by the rapid pace of climate change.
- The RAD framework helps us be more creative and innovative by exploring a wider range of options. Resist actions align with historical baselines. Accept actions recognize the continuous nature of change. Direct actions permit interventions at strategic moments.
- The RAD framework is a facilitation tool that can help people move forward under conditions of rapid change and uncertainty. The framework is not a decision process. It works within any decision process you already use by helping you identify possible responses and coordinate a strategic response.
- Implementing the RAD framework is an adaptive challenge, so it will never be a cookie-cutter approach. This guidebook provides three options for conceptualizing RAD implementation (Chapters 2–4) that can be selected given the diversity of contexts and needs. These options are not intended to be interpreted as a linear process; you don't need to do the first action before the third. They simply provide three possible starting points.

What is RAD?

The resist—accept—direct (RAD) framework is a facilitation tool that was developed to help people creatively explore the entire range of adaptation options for shaping ecosystem change and transformation (see Appendix A, Ecological Transformation Primer). Traditionally, we have managed habitats, ecosystems, and landscapes using a historical baseline as our point of reference. However, the rapidly accelerating pace of climate change renders this approach no longer feasible or desirable in many places. The RAD framework helps natural resource managers implement climate change adaptation in a way that meaningfully addresses the reality of ecological transformation.

The RAD framework orients us toward a future that will likely be very different than what we have experienced in the past. Intensifying change is propelling many ecosystems globally toward transformations that will be difficult or impossible to reverse (Nolan et al. 2018). Climate change is a directional driver, meaning the way we manage our habitats can no longer be cyclical or based upon a return to the past. Ecosystems will experience disturbance events and conditions that fall outside the historical range of "natural" variability (Schuurman et al. 2022). From the landscapes and species that we manage to the values and demographics of the communities we serve, the 21st-century world continues to shift and evolve. We face the complex task of conserving and stewarding ecosystems and biodiversity under novel conditions and expanding degrees of uncertainty. There are many different worldviews surrounding whether and how exactly that management within the context of climate change should occur. The RAD framework was developed within a North American land management context (Schuurman et al. 2022) and may differ from the norms and practices within other cultural contexts, including those of Indigenous peoples (Shultz et al. 2022).

Resist, accept, and direct are simple categories designed to encompass the continuum of potential management responses to transformation or the potential for transformation (Lynch et al. 2021, Thompson et al. 2021). We do not intend to imply that RAD strategies are reactive as opposed to proactive. Management options are categorized as resist, accept, or direct actions based on whether they are used to shape outcomes and, if so, the period used to envision the goals and objectives of the intervention (Figure 1). We distinguish between the term "intervention" and the more generic use of the term "management." Intervention specifically applies to management actions that are used consciously to alter, change, or influence the ecological trajectory (Schuurman et al. 2022).

The RAD categories are defined as follows:

- ***Resist*** actions are developed based on known (or knowable) current or historical conditions. To resist, intervention is used to maintain a current or to restore a historical ecosystem structure, function, or species composition (or some combination thereof). Resist is not always the RAD option with the lowest risk. In some cases, resist might be an expensive and risky option, requiring chronic intervention as the climate shifts further away from historical conditions.

- ***Accept*** actions are conscious decisions not to interfere with ongoing ecosystem transformation processes. Accept strategies allow species and ecosystems to respond autonomously while humans adapt to accommodate ecological transformations. For example, if sea level rise is accepted, actions to accommodate the rise could require moving a visitor center away from the coast. Accept actions are choices not to intervene but to allow the ecosystem structure and function as well as the species composition to emerge from ongoing transformations. Accept actions recognize that doing nothing is doing something and that consequences still result from inaction requiring decisions.
- ***Direct*** actions use interventions to guide transformations actively toward a desired ecosystem structure, function, or species composition (or any combination thereof). Direct actions may entail greater inherent uncertainty than resist or accept actions because the management goals and objectives are aimed toward the currently emerging or future climate reality. Without a known and measurable reference point, people may not share the same mental model or agree about which, how, when, and where transformations will occur. Direct actions do not necessarily require chronic or more intense interventions. Direct actions may be needed only for short periods of time or at key but highly influential moments.

Where an individual RAD action sits in the continuum can be classified differently by different people. Ultimately, the goal is not to have everyone categorize a particular RAD option in the same way. Instead, the goal is to create more space for innovation and to initiate conversations about the full spectrum of management responses (Stein et al. 2024). Some people may take issue with the words resist, accept, and direct, as these terms can have different meanings to different people. We encourage you to make space for exploring how different people conceptualize and prioritize the range of adaptation strategies and options. Choosing different words or using classifications other than RAD, for example Resistance – Resilience – Transition (RRT), can also provide clear frameworks for exploring a wider range of adaptation options (Millar et al. 2007, Peterson St-Laurent et al. 2021).

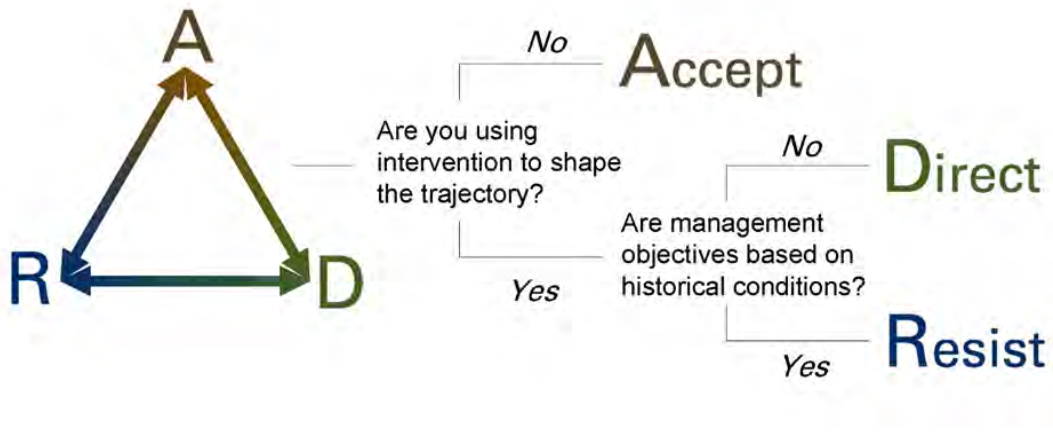


Figure 1. The resist—accept—direct (RAD) framework envisioned as a triangle. This RAD framework helps us distinguish RAD categories based on whether intervention is used and whether historical baseline (including current conditions) are used to envision management objectives. Figure adapted from Schuurman et al. (2020) and Wilkening et al. (2023).

The RAD framework is not intended to be prescriptive. Neither the framework nor this Guidebook orders, values, or ranks the options identified. Instead, each option should be considered within a decision process that considers the landscape's unique context, its various projected transformations, and the community's values and goals.

Similarly, the RAD framework is not a decision process. It is a facilitation tool that helps us explore adaptation options more comprehensively. You have decision processes in place for which you have been trained and which you are currently using successfully. The RAD framework supplements your decision process; it does not replace it.

Finally, the RAD framework is iterative. Decisions made under the framework are not final but require continual revisiting. Ecosystem transformation is not a one-time occurrence after which point systems will stabilize at an alternative, stationary state. We need to work through decision processes continually to select new RAD strategies when thresholds or tipping points trigger management decisions (Lynch et al. 2022).

Why Do We Need RAD for Natural Resource Management and Conservation?

Our world is changing, and it's doing so faster than we've ever known. Increasing uncertainty underpins every decision. Both ecologically and societally, the "new normal" is that there is no normal. Although it is daunting, this reality also presents great opportunity, if we choose to view it as such. Gardner and Bullock (2021) describe this challenge well: "The only options are to continue as normal with conservation mindsets developed in the climatically-stable world we have left behind, or to adapt our approaches and develop solutions explicitly designed to overcome the problems at hand." Which option will we choose?

The RAD framework provides a means to take hold of our future. With RADical thinking, we can shift the ways we navigate our changing ecosystems, proactively planning for adaptation instead of reactively responding to change. We can invite historically overlooked voices to the decision-making table, ensuring that our decision contexts and landscapes of influence are understood holistically. We can invest in relationship building and foster collaboration even when values may differ or rules impede progress. Whether we are outlining our plausible futures, brainstorming decision alternatives, identifying trigger points for adaptation, or integrating local decisions within the larger landscape, we can tap into the wealth of knowledge within our professions as well as across the diverse communities we serve. This is our collective genius (Hill et al. 2014), and we can use it to navigate ecological transformation and design a future for all.

A paradigm shift is needed. Rather than emphasizing only preservation of species and habitats in place, we can expand our focus to include safeguarding the evolutionary processes necessary for life to thrive on our planet now and into the future (Figure 3). This approach can be facilitated by maintaining, restoring, and fostering ecosystems that allow the biosphere to change and adapt as a whole (Gardner and Bullock 2021). We can strive to promote well-functioning and resilient ecosystems rather than act to preserve only components of those systems (i.e., specific species or habitats). When

we choose to focus holistically on conserving ecological and evolutionary functions or processes, we maintain those conditions that allow systems to thrive (Thomas 2020). This reframing provides a platform for embracing unavoidable change and shaping our desirable ecological present and future.

We are not suggesting that we completely abandon past conservation actions, such as establishing protected areas or facilitating habitat connectivity. We still intend to preserve as much existing biodiversity as possible. The RAD framework facilitates this effort as it provides opportunities to refocus conservation objectives and prioritize scarce resources. We recognize that rapid transformation challenges existing conservation actions and that conservation theory, goals, and practice may need fundamental changes in perspectives to embrace options that accept or direct, rather than merely resist, change.

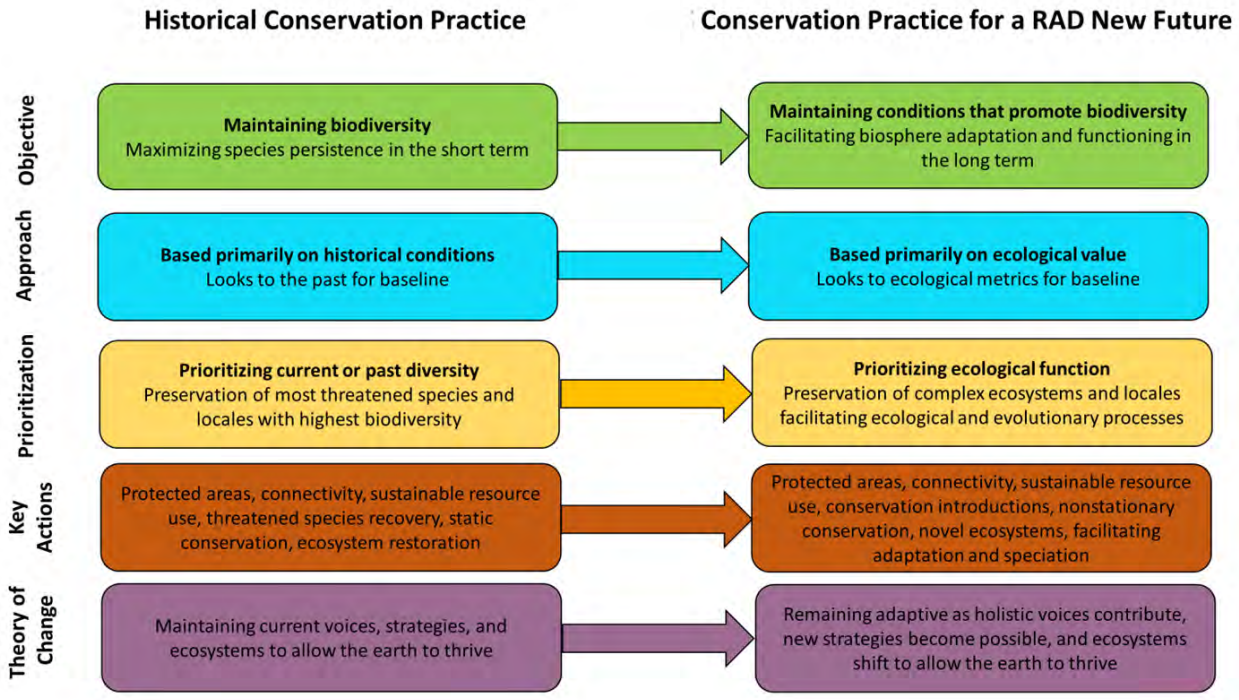


Figure 3. The transition from traditional conservation practices to a new paradigm better suited for our current and future world. Adapted from Gardner and Bullock 2021.

For example, attitudes around nonnative species may need to be adjusted as species ranges increasingly change. This is not to say that we endorse global biological homogenization. Instead, we are suggesting that efforts to eradicate nonnative species may be reduced in some areas to maximize biodiversity and overall global species persistence (Davis et al. 2011). Likewise, we may need to embrace novel ecosystems, as new species combinations can form successful biological communities (Kennedy et al. 2018), and novel ecosystems have been shown to facilitate evolution and speciation, which maintains biological complexity (Hendry et al. 2017). Finally, large-scale conservation introductions (e.g., assisted migration) may need to be considered more frequently as species may require them to persist (Butt et al. 2021). Relatedly, we need to give managers and conservation practitioners the permission and support they need to experiment and possibly fail.

Processing Emotion as Part of Navigating Ecological Transformation

Inherent in ecological transformation is the loss of one system as it is replaced by another. This loss can be multifaceted, as in that of a well-functioning ecosystem, of the preferred habitat of critical species, of the species itself, or of a place held deeply by those humans who knew it. With this loss come normal emotional responses, which illuminate our deepest values. These responses may be heightened for those who hold close relationships with the natural world, whether through a profession such as conservation or farming, a practiced tradition such as hunting or birdwatching, or because of a community reliance on the services an ecosystem provides such as subsistence fishing or ranching (Clayton 2018, Jovarauskaite and Böhm 2021, Noy et al. 2022). Many cultures around the world, including Indigenous peoples, equate identity with place, as Cunsolo Willox et al. (2012) describe: "People are not only from a particular place, but they are also of the place; that is, their identities, well-being, livelihoods, histories, and emotional-spiritual connections are emergent from the lands on which they live." Therefore, as a place transforms, so do we.

Language and tools are evolving to capture the complexity of so-called "climate emotions." New terminologies such as *solastalgia* and *noctalgia* take into account the intergenerational time scale of ecological transformations and reflect the emotional longings people feel for a place that no longer exists (Albrecht et al. 2007, Smith et al. 2023). The Climate Mental Health Network developed a tool called the Climate Emotions Wheel based on foundational research by Pihkala (2022). The Wheel demonstrates the wide range of emotions a person may experience when navigating ecological transformations and acknowledges that not all climate emotions are based in anger, sadness, or fear. In fact, our climate emotions can be positively rooted, finding expression as inspiration, empathy, gratitude, and hope.

As you use this Guidebook to navigate the RAD framework, you and your partners may experience various climate emotions that can inform your perceived availability of adaptation options (i.e., whether we can resist, accept, or direct changes), as well as the energy you have available to implement these options. You may need to engage in introspection and find connection through community to hold space for loss and longing while maintaining hope for the future and the shared motivation to find creative adaptation solutions (Fritze et al. 2008, Petrasek MacDonald et al. 2015, Li and Monroe 2019, Godara et al. 2022). Anticipating and acknowledging these normal responses can lead to a more successful implementation of the RAD framework.

Sunset on Tchefuncte River, Louisiana. Photo by Kelly Guilbeau.

Roadmap for the Guidebook: Connecting RAD to Implementation

The RAD framework is the resist, accept, and direct actions. Implementing RAD also requires the capacity to respond to change meaningfully (i.e., RADical thinking, or a cultural shift in thinking). Therefore, RAD implementation requires both the simple framework to categorize actions and an effort to build practices that will allow us to navigate transformation in the places we work.

We hope this Guidebook increases capacity to prepare for change and implement RAD actions. Our audience is people who are on the forefront of implementing adaptation or providing planning or information to help inform adaptation. Together, we are on the cutting edge of RAD implementation to steward ecosystems and biodiversity for future generations.

This Guidebook is not intended to provide stepwise solutions or generic processes because implementing RAD is not a simple, technical problem. It is an adaptive challenge that includes learning about the knowns and unknowns in our environment, engaging multiple perspectives, coping with uncertainty, changing behaviors, challenging beliefs, and identifying tradeoffs among alternatives. Implementing RAD actions will look different in different regions and at different scales because the activities involved for planning and implementing action must be tailored to fit management problems in unique places.

Instead of a single solution or process, we address the range of RAD applications by presenting three conceptual starting points for implementing RAD (Table 1, Figure 4).

> **RAD menus** are developed to understand and communicate the entire universe of actions that could be used in a particular management context.
>
> **RAD portfolios** are used to strategically consider the range of plausible ecological trajectories and how change may unfold both spatially and temporally to identify path dependencies, contingencies, and trigger points at which management actions become necessary. RAD portfolios act as risk-investment strategies that help resource management teams see where and when RAD actions are being applied and track their results.
>
> **RAD decision contexts** embrace the practice of upstream, deliberative engagement intended to bring people together so they can consciously understand and adapt the values, rules, and knowledge bases that bound management.

We do not intend for the subsequent chapters to present a linear process. For example, we discuss the decision context in Chapter 4, after menus (Chapter 2) and portfolios (Chapter 3). This presentation does not imply that the decision context comes last. In fact, one key takeaway from Chapter 4 is that upstream, deliberative engagement can only be successful when it occurs early in the decision-making process (Magness et al. 2022). However, we also recognize that such engagement does not always lead to direct, immediate action. So some teams may be more comfortable participating in the brainstorming process that results in a RAD menu, a tangible product that teams can then share with others. Alternatively, resource managers may have available a suite of knowledge products such as Inventory and Monitoring (I&M) databases or Surface Elevation Trend tables. These products easily lend themselves toward the development of RAD portfolios, which may be the most logical starting

point for them. Chapters 2, 3, and 4 each present a product or practice that supports our ability to use the RAD framework to address climate change meaningfully.

Table 1. The pros and cons of the three starting points for RAD implementation. You can use this table to help identify which approach is most helpful for a given management problem or in a particular context.

Starting Point	**Pros**	**Cons**
RAD Menu	• uses what you already know • can easily be integrated into any process	• misses opportunities for landscape thinking and broader engagement
RAD Portfolio	• creates a framework to organize information and accelerate learning • facilitates strategic decisions • allows uncertainty to be embraced through alternative possible futures • allows the selection of different actions across space and time, which allows bet-hedging	• complex • requires large amounts of information • requires many people
RAD Decision Context	• provides a holistic view of the decision context • builds long-term relationships based on trust • integrates diverse perspectives, which increases the capacity for innovation	• requires a large investment of time and interpersonal skills

Each chapter proceeds through the ***what***, ***why***, and ***how*** to apply each starting point. Each also includes a case study that illustrates the strategy. In the conclusion, we identify next steps, particularly the need to reassess the RAD framework as we implement actions and learn from our successes and our failures.

Tundra swan at Yukon Delta National Wildlife Refuge, Alaska. Photo by Lisa Hupp, USFWS.

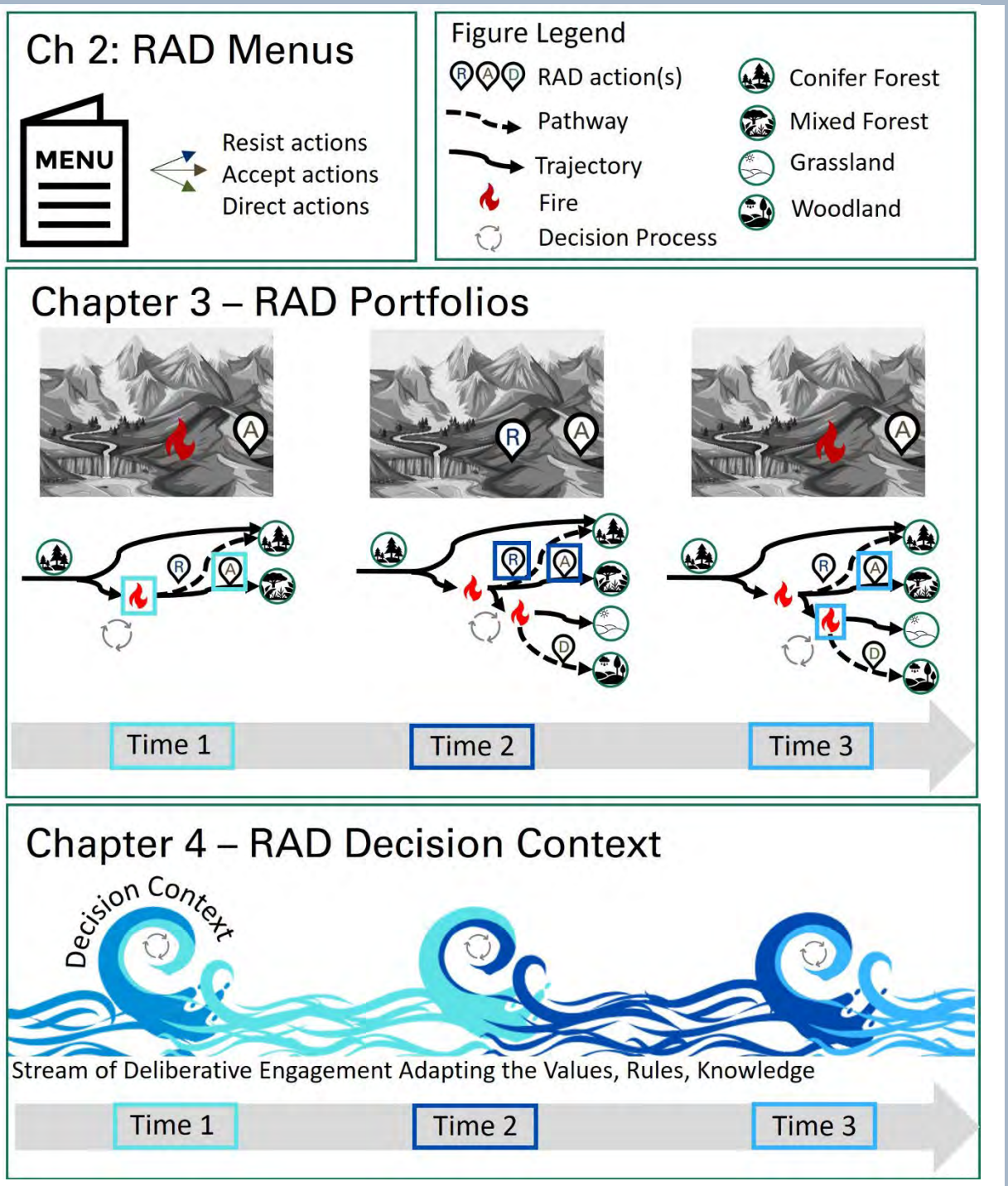


Figure 4. Conceptual map of the RAD implementation chapters in the Guidebook. Resource managers can use RAD menus (Chapter 2) to explore what could be done to resist, accept, and direct ecological transformation. RAD portfolios (Chapter 3) help resource managers apply RAD actions strategically by considering the range of plausible ecological trajectories and planning both spatially and temporally to create pathways toward desirable conditions. The RAD decision context uses upstream, deliberative to adapt the values, rules, and knowledge bases that bound any decision process.

CHAPTER 2. RAD MENUS

Wood bison at the Alaska Wildlife Conservation Center. Photo by Lisa Hupp, USFWS.

Key Messages

- Menus are a starting point for exploring and documenting RAD actions. Menus can be easily developed today even though we will likely not have all the nuances for implementation figured out.
- RAD menus are adaptation menus. Teams simply creatively brainstorm options that can then be explored. RAD menus are the *could dos*, not the *should dos*.
- RAD menus should be extensive. Having more options makes it easier to identify alternatives when a trigger point occurs. The process is intended to be creative and inspirational, so don't be overly concerned about categorizing actions into the RAD framework. However, if you discover a predilection toward one action type, it can be useful to consider other categories intentionally.
- As you brainstorm with your team, consider your various emotional responses to environmental change. Tools are available to help you navigate these responses and think more creatively about change.

RAD Menus

A RAD menu is a type of adaptation menu. Adaptation menus are commonly used to organize and consolidate climate adaptation recommendations into a format that helps managers identify relevant and implementable actions (Handler et al. 2022). RAD menus help us creatively explore and develop options across the spectrum of response possibilities for ecological change and transformation within our unique management context.

Your RAD menu offers choices for adaptation actions. It is up to you to select which actions to take and when. The good news is that the RAD framework does not require a new decision process. You can embed the RAD framework into any decision process, such as, Structured Decision Making, Open Standards for Conservation, or Climate Smart Conservation (see RADical Structured Decision Making box on page 21). We hope you find this message reassuring, as you need not be trained on a new process, nor must you stop using decision methods that work for your team(s).

Developing a RAD Menu

RAD is a facilitation tool that helps us build a comprehensive menu of possible adaptation actions. To begin the brainstorming, your team might respond to the prompt, "What actions could we take to ***resist*** the ecological changes we are seeing?" followed by the same prompt with ***accept*** and ***direct*** as a guide. Creating a RAD menu is inherently iterative. Your menu will grow as you engage new voices, gain updated science and knowledge, and observe changes on the ground.

RAD menus are about what we *could* do, not what we *should* do, so do not filter or critique the feasibility or social acceptance of an action at this stage. Likewise, don't get bogged down by labels. For this strategy, identifying RAD actions is more important than sorting those actions into RAD categories. That being said, we all operate with unconscious biases. For example, you may discover that you or your team holds an inherent preference for resist actions. So as you create your RAD menu, be sure to intentionally identify options for all three strategies: resist, accept, and direct. Use your imagination, creativity, and collective genius to populate your menu. When you develop a more robust menu of alternatives, you can more easily identify viable actions when a trigger point occurs.

Within decision or adaptive management cycles, RAD can be integrated into steps where management options are identified. Refer to your menu as needed and continue to communicate your rationale transparently using the RAD framework as a guide. It may also be helpful to review adaptation menus hosted within The Climate Change Response Framework.

RADical Structured Decision Making

Written by Jeremy Conrad

Structured Decision Making (SDM) is a decision analysis framework founded on decision theory and risk analysis. SDM practitioners work through multiple steps to deconstruct problems into their core elements while incorporating value-focused thinking (Runge et al. 2020). SDM is thus unique in its approach to decision analysis as it incorporates and evaluates both objective scientific data and subjective values or policies. The SDM framework necessitates the inclusion of value-based thinking, as all decisions are ultimately a reflection of the decision-makers' values (Runge et al. 2020). As such, identifying the constituent's values early in the decision process helps to identify any potential biases and promotes a transparent and defensible decision analysis.

SDM (Figure 5) consists of five core elements that can be described as the PrOACT cycle (Runge et al. 2013, 2020). The first element in the PrOACT cycle is problem framing (Pr). Problem framing describes the decision context, identifies the problem, establishes both the decision maker and their authorities and limitations, and engages appropriate representatives from groups interested in or impacted by the problem and its potential solutions. The second element in the PrOACT cycle is developing objectives (O). Objectives identify the desired habitat conditions or future outcomes that would result from the decision and are used to measure the effectiveness of actions taken (Lyons et al. 2010). SDM's third element in the PrOACT cycle is developing alternatives (A). Alternative development provides the decision maker a set of actions, which can range from a discrete action to a complex portfolio of actions, that are intended to achieve the objective(s). It is in this alternative development process that the RAD framework can be implemented to assist in developing a RAD menu of alternatives designed to address climate change and ecological transformation. The fourth element of SDM requires evaluating the effectiveness of the proposed RAD alternatives towards achieving the objectives developed in the second phase, known as the consequences-evaluation process. In this process, the decision maker must consider both objective scientific data and the values of the interested parties. The fifth core element of SDM is the robust analysis of tradeoffs among the RAD alternatives. This evaluation assesses the tradeoffs and likelihood of success between the RAD alternatives and identifies the optimum RAD alternative or portfolio of alternatives designed to achieve the desired conditions identified in the objectives. Once the optimum RAD alternatives are identified, the decision maker can implement the action.

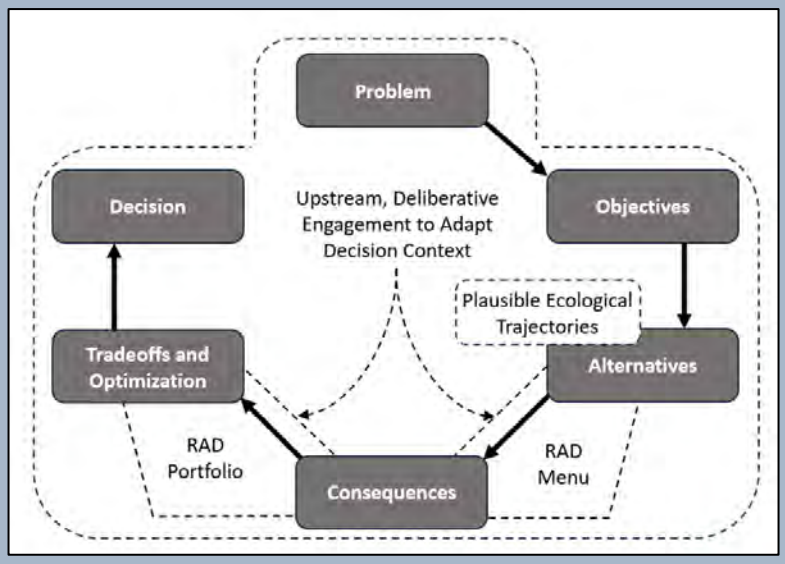


Figure 5. SDM and PrOACT cycle with insertion of RAD Framework components (adapted from Runge et al. 2013).

RAD Menu Thought Exercise

If you are struggling to envision examples of transformation in the ecosystems you manage, consider this case study used at a RAD workshop held at the annual meeting of The Wildlife Society (TWS) on November 9, 2022. The workshop was organized by individuals from TWS Wildlife Habitat Restoration and Conservation Working Group and the Climate Change and Wildlife Working Group. The workshop focused on RAD's application to wildlife habitat conservation and restoration using case studies, one of which was the transformation of the coastal sage scrub plant community in southern California. The California coastal sage scrub plant community provides crucial habitat for the federally threatened California gnatcatcher (*Polioptila californica*, Image 1). The vegetation community is being transformed due to lack of fog and warmer temperatures, resulting in a drier habitat and increased fire frequency. This situation facilitates invasion by a host of nonnative species such as Argentine ants (*Linepithema humile*), which outcompete the native species responsible for dispersing seeds.

Workshop participants brainstormed potential management responses. People worked individually and in groups, capturing as many ideas as they could in a short time. Once they had a list of potential actions, they considered each management response and categorized it by action type: resist, accept, or direct. This list constituted the first draft of a RAD menu.

Workshop members then assessed the menu using the following questions:

- Is one RAD category more represented than the others?
- If so, can we identify options for under-represented categories?
- Are some responses difficult to categorize?
- What (if any) assumptions did we make about desirable outcomes?
- Specifically, do the identified actions skew noticeably toward current or historical conditions?
- What other outcomes can we envision?
- Do these alternative outcomes suggest any actions we can add to our menu?

Image 1. The coastal Californian gnatcatcher. Photo credit: U.S. Fish and Wildlife Service.

At the TWS workshop, participants widely recognized that ecological transformation is accelerating and the need to respond is becoming increasingly urgent. Participants intrinsically understood the RAD trichotomy and easily generated many resist actions, while acknowledging that such actions align with our historical management approaches. Participants were less likely to suggest direct actions. Meanwhile, accept actions emerged only infrequently and were typically associated with feelings of sadness or discomfort.

One common question that emerged was what might happen if we selected incorrectly from our RAD menu. While this question elicited much discussion (and not a little angst), ultimately most participants agreed that we are already getting it wrong, as existing natural resource management approaches are no longer effective for responding to the large-scale transformations occurring in many regions.

San Diego coast, California. Photo by Joanna Gilkeson, USFWS.

Case Study: Devils Hole Pupfish RAD Menu

The Devils Hole pupfish (*Cyprinodon diabolis*) is one of the most endangered fish in the world, with as few as 35 individuals recorded in 2013. These small fish have big personalities, with their name deriving from their playful behavior, specifically, their tendency to frolic about like puppies. The species occurs in the wild only at Devils Hole, an isolated desert spring that consists of a water-filled cavern in southern Nevada (Image 2). The pupfish was one of the first species to receive federal protections under the Endangered Species Preservation Act of 1966 (precursor to the 1973 ESA). While much of the surrounding land now has conservation status, desert springs biota still face various threats. The most serious of these is drought and groundwater pumping, which will likely increase because warmer and drier conditions are projected.

Image 2. The Devils Hole pupfish (*Cyprinodon diabolis*) (right) and its only native habitat in southern Nevada.

To establish a reserve population, the U.S. Fish and Wildlife Service opened the Ash Meadows Desert Fish Conservation Facility in 2013. In addition to serving as a backup population in case of a natural catastrophe, the facility allows scientists to research captive fish in habitat conditions similar to those found at Devils Hole. The findings can inform and support species conservation. However, the facility cost $4.5 million to found and requires a substantial financial investment to run, in addition to the funding needed to maintain the species in the wild at Devils Hole. Captive populations minimize the chance of species extinction, but managers may run out of resources to maintain the population at Devils Hole. Table 2 represents a possible RAD menu for the Devils Hole pupfish. The options listed here are not exhaustive, as actions can vary depending on the RAD team. Remember that these are actions that we *could* do, not necessarily *should* do.

Table 2. RAD Menu for Devil's Hole Pupfish

	ACTION	RESIST	ACCEPT	DIRECT
1	Advocate for reduced groundwater pumping in the Amargosa Valley	X		X
2	Buy existing water rights linked to water loss at Devils Hole	X		
3	Evaluate programs that pay farmers and ranchers to use less water (e.g., System Conservation Pilot Program on the Colorado River)	X		X
4	Increase reproduction and survival rates of pupfish	X	X	X
5	Salvage pupfish from Devils Hole		X	X
6	Redesign infrastructure to protect Devils Hole habitat from anticipated climate impacts	X		
7	Stop investing money to maintain pupfish at Devil's hole		X	X

8	Maintain or mimic natural disturbance regimes (e.g., earthquakes or floods) to learn how to enhance habitat quality	X		X
9	Purchase additional desert spring habitat		X	X
10	Artificially expand Devils Hole habitat	X		X
11	Introduce populations into desert springs with suitable current and future habitat conditions	X		X
12	Provide supplemental food sources or create new food sources for pupfish or both	X	X	X
13	Investigate genetic techniques to enhance adaptive capacity of pupfish	X		X
14	Research effects of potential morphological change from pupfish introduction into different habitats		X	X
15	Use gene-editing techniques (e.g., CRISPR) and genetic material from museum specimens to restore the Devils Hole pupfish genome	X		

Menu options were divided into categories, but some actions may fit into more than one RAD category according to the objective. For example, we might establish three objectives:

1. Maintain the Devils Hole pupfish only in its single, native habitat.
2. Ensure the Devils Hole pupfish remains extant as a species.
3. Facilitate persistence of the Devils Hole pupfish somewhere on the landscape or, if required, in captivity.

The first action on the RAD menu ("Advocate for reduced groundwater pumping in the Amargosa Valley") could be viewed as a resist action under Objective (1), to maintain the species at Devils Hole. Alternatively, the action could be considered a direct action under Objective (3), to facilitate persistence of the pupfish elsewhere. Likewise, the fourth action on the RAD menu ("Increase reproduction and survival rates of pupfish") can be categorized as a resist, accept, or direct action depending on which of the objectives is being addressed. You may have a different interpretation of how to categorize each action and that's OK. The categories are less important than the actions themselves.

As the pupfish conservation community consider objectives, some people may struggle with the idea of letting go of this native population given its unique status, the many efforts that have been made to maintain the population at Devil's Hole, or the large amount of financial resources invested in it. However, this emotional reaction overlooks the crucial scientific information gained by such efforts. Wildlife managers may need to pivot from a species' original recovery objectives, but doing so doesn't devalue lessons learned along the way. Experimentation helps to determine the limits of our capabilities, and science "allows us to bumble along, getting it wrong time after time, and feel perfectly fine as long as we learn something each time" (Schwartz 2008). We can use pilot projects and experiments to gain a broader understanding of our RAD menu possibilities and deploy other actions if a selected action is not working.

Climate change may eventually make it impossible for the species to persist at Devils Hole, leading to the abandonment of resist actions at this location. That would be a dire ecological loss. Nevertheless, if that happens, we can view our collective efforts as helping to inform the options for responding to ecological transformation. Our financial and other resource investments can yield alternatives to facilitate species existence and presence on the landscape even if a native habitat becomes unsuitable.

Steps for Developing RAD Menus

When proactively imagining the myriad of alternative decisions you might make over time, consider the following questions as a guide to your deliberation.

Step 1: Use your upstream, deliberative engagement practices (see Chapter 4) to answer the following questions:

- Which values, rules, and knowledge bases are present on your landscape of influence?
- Who decides when and how to allocate scarce resources?
- What are the current management objectives?
- What alternative objectives are possible?

Step 2: Consider ways you might resist ecological change:

- What are we unwilling to lose? (i.e., what are we committed to maintaining?)
- What are we currently required by law to maintain?
- When are resist actions likely to be feasible and effective?

Step 3: Consider ways you might accept ecological change:

- Where on the landscape does accepting change make the most sense?
- What do these accept alternatives look like over time?
- What are some potential future circumstances under which accept strategies would no longer work?
- What would be the consequences of accepting change across different scenarios?
- Are the predicted changes desirable?
- Do all paths lead to desirable conditions or only some?
- Can the values, rules, and knowledge bases of the current management system accommodate the choice to accept?

Step 4: Consider ways you might direct ecological change:

- At what point in the future would it make sense to use intervention to direct change?
- How do the current values, rules, and knowledge bases create limitations or suggest opportunities to direct change?
- Where could different options be applied on our landscape?
- Will direct options work everywhere? If not, which places are good candidates for direct actions?
- Does directing change lead to chronic intervention? (i.e., can a novel, but resilient future be created?)
- Do we have interventions that are tested and effective for directing change? If not, can we implement pilot projects?

Step 5: Consider your RAD menu as a whole and how it might function as a dynamic RAD portfolio (see Chapter 3):

- What do these strategies look like over time?
- What triggers indicate that it is time to switch strategies?
- What do these strategies look like across your landscape and within your decision context?
- What is missing from your RAD menu? Consider consulting adaptation menus, such as the adaptation menu for terrestrial wildlife management, to look for new or missing ideas.
- If resources were no obstacle, what options would be possible? Alternatively, if no resources were available, what options would be possible?
- For RAD strategies that do not appear to be feasible, can implementation barriers be removed before the strategies are needed?

A flock of bar-tailed godwits flying over the tundra grass at Yukon Delta National Wildlife Refuge, Alaska. Photo by Lisa Hupp, USFWS.

CHAPTER 3. RAD PORTFOLIOS

Black capped vireo at Wichita Mountains National Wildlife Refuge, Oklahoma. Photo by Kenny Seals, USFWS.

Key Messages

- Divergent futures depend on the unique context and history of our management unit (path dependence) as well as on some element of chance (contingencies). While we do not have total control over the future, we recognize that some future conditions are more desirable than others, and choosing among our available options will require us to engage with tradeoffs. RAD portfolios help us to make informed decisions about where, when, and how to manage resources by thinking about diversity as a risk management strategy.
- We need to act while we develop alternatives for when our management strategies break down. This dual focus approach is the essence of the RAD adaptive management model. Portfolios help us to do so by allowing us to be transparent about our planning process, by giving us time to test new ideas, and by allowing us to monitor our actions so we can switch strategies when needed.
- While we recognize that some challenges are outside our locus of control, we choose to focus our energy where we have influence, following in the steps of leaders such as Aldo Leopold, whose work helped to reshape public policy and opinion regarding wildlife management.
- As we engage in spatial planning, we must balance our understanding of large landscapes and small regions. Regional or landscape information can help us understand the drivers of divergent futures, while ecological units may be better suited for different RAD actions.
- The probability of transformation and the likelihood of different trajectories vary geographically, so different RAD actions are needed for different places. Spatial planning methods, such as landscape conservation design (LCD), can be used to coordinate actions and learn from one another.
- Pathway (temporal) planning is about explicitly defining how RAD actions could change over time. Such planning allows us to understand the costs, benefits, and feasibility of RAD actions and how to create a pathway to desirable future or to avoid an unwanted outcome.

RAD Portfolios

As we now understand, a static management plan is insufficient. We need to act while continuing to develop and test our actions so we are prepared when our management strategies break down. RAD portfolios help us track the progress of the diverse resist, accept, and direct actions that we deploy in different places at any given time. The portfolio approach in conservation draws from financial risk-management. RAD portfolios allow us to see how we can deploy diverse actions to minimize the risk of over-investing in strategies that do not perform, facilitate learning, and provide a structure to track reallocations when we change strategies (Aplet and McKinley 2017). In this chapter, we focus on three concepts that will deepen our ability and preparedness to act locally while thinking strategically:

- **Identifying the range of plausible ecological trajectories** helps us to understand the divergent future conditions that are possible given the inevitability of change. Identifying alternative futures allows us to consider tradeoffs explicitly among a variety of conditions. Trajectories also help us to organize and communicate information about the drivers, conditions, and events that will result in these alternative outcomes.
- **Spatial planning** helps us to understand how the likelihood of alternative trajectories varies across our landscapes. Natural resource managers may not agree upon one "ideal" RAD action, and that's OK. A RAD portfolio acts like a stock portfolio in that it allows team members to choose a mixture of resist, accept, and direct actions that help us mitigate the risk of choosing one, maladaptive approach while learning from the experiences of others.
- **Pathway (temporal) planning** helps us choose when and how to change RAD actions over time. Pathway planning envisions management actions along a range of plausible ecological trajectories. Pathways help RAD teams plan and communicate a sequence of interventions that would be needed to shape an ecological trajectory. Pathway planning considers if and how the RAD actions we take today could constrain our future opportunities to change course, thus allowing us to compare the feasibility of each pathway within a broader future context.

We consider these three planning contexts as we decide where and when to apply actions from our RAD menu, thereby building a diverse RAD adaptation portfolio whose results we continually assess. This portfolio is diversified by the different RAD actions used across our landscape at any given time. We rebalance and reallocate our resources to different RAD actions in response to their effectiveness and to how ecological change unfolds in real time, i.e., how closely our three planning contexts match their unfolding realities.

Storm over Althen Waterfowl Production Area, North Dakota . Photo by Marcie Hebert, USFWS.

The Range of Plausible Ecological Trajectories

We develop ecological trajectories to help us understand and communicate how change could unfold within an ecosystem based on our evolving understanding of climate and other factors; their effects on specific, local ecosystems and their many components as well as their current and historic assemblages; and the socioeconomic factors both driving and resisting change. Ecosystems have no generalizable outcomes because they are complex, path dependent, and contingent systems. This reality means that implementing conservation strategies is challenging, in part because most of the adaptation guidance is too generalized for managers to apply in their own ecosystems (LeDee et al. 2021). To be implementable, RAD actions must be tailored to the unique places and circumstances where they will be used. Considering the range of plausible ecological trajectories allows us to consider tradeoffs and prepare for likely eventualities so we can engage in a range of diverse actions even as we face uncertainty about whether and when divergent outcomes will occur.

Simply understanding how the climate is changing is not enough. Forecasts of climate futures, and the uncertainties among them, have been widely available for over a decade (Tabor and Williams 2010, Lawrence et al. 2021). Knowing that the climate will be warmer, wetter, or drier does not necessarily help us understand how such changes will alter biodiversity and ecosystems within specific landscapes. Ecological trajectories focus on the ecological response to climate change by defining the conditions, event sequences, and tipping points that influence species or ecological outcomes. We can identify the conditions and events that reinforce current or historical community assemblages and ecological conditions as well as those that amplify change and lead to transformation.

Interacting with ecological factors are social and economic drivers (i.e., a socioecological system). All of these factors are important in ecological trajectories because humans and nature are intertwined. For example, new species can rapidly expand and become a key component of a transformed species assemblage when the climate is rapidly changing (Crausbay et al. 2017, Nolan et al. 2018). This change can happen if the new species is better adapted to the emerging conditions than species in the historical assemblage. People then interact with and form connections with these transformed species assemblages, which makes it difficult to distinguish between “natural” and “unnatural” ecosystem states.

We need to identify a range of plausible ecological trajectories so we can consider multiple, divergent outcomes concurrently. When we focus on predicting the one, most-likely trajectory, we limit our strategic problem-solving ability because ecological prediction carries a high degree of inherent uncertainty. Multiple alternative trajectories are possible, and we maximize our likelihood of making successful conservation decisions when we work within the entire range of plausibility. As we explore that range, we consider outcomes that are path dependent and contingent.

- **Path dependence** means that the unique contexts and legacies of an ecosystem, such as dispersal constraints and soil properties, have and will continue to shape future possibilities. Ecosystems vary based on their circumstances as well as the timing and sequence of events occurring in a particular place.
- **Contingencies** are defined as highly influential key events whose timing, location, and likelihood of occurrence are difficult to predict.

For example, the ecological trajectory for the Arctic predicts that the ecosystem will experience an ice-free summer range anywhere from 2030 to 2100 (Kim et al. 2023). Despite such a broad temporal range, we need to prepare now by considering the path dependence of individual ecosystems and the various contingencies so we can identify significant ice-free events and the management responses that could be triggered when they occur. This approach allows us to move forward even when each trajectory entails some degree of uncertainty.

Operating Within our Locus of Control: The Elephant in the Room

Some challenges are outside of our professional control. For example, effectively addressing microplastics pollution or reducing global emissions sufficient to limit global warming to less than 1.5° or 2° Celsius may require structural change to the global economy, widespread social change, or other large-scale policy changes. These forces, though important and influential, are often treated as external drivers for solving natural resource management problems.

Managers focus energy over the spheres where they have influence. For us, interested in navigating transformation and stewarding biodiversity, that means seeking solutions that increase the resilience to these external forces and when change is inevitable, helping to create a future that is desirable (Walker et al. 2002). Regardless of those forces outside of our control, we can choose to be effective by focusing on tractable problems, even when these larger drivers feel like the elephant in the room.

Nevertheless, biodiversity stewards do not have to simply ignore external drivers while working to solve national, regional, or local problems with the levers that they have available. Conservation leaders also have a history of transforming society. For example, Aldo Leopold, in his classic book *Game Management* (Leopold 1933), redefined a classic wildlife problem from a need for sanctuary from overexploitation to a need for wildlife management. After the book's publication, Leopold, Thomas Beck, and J. N. "Ding" Darling were appointed by Theodore Roosevelt to a Presidential Committee on Wildlife Restoration that resulted in the 1934 Duck Stamp Act and the 1937 Pittman–Robertson Act. This legislation shifted public policy and provided meaningful and sustained funding for wildlife management.

We all have a role to play in identifying and drawing attention to big problems. Indeed, we may consider ourselves to have a responsibility to reorient society when our expertise surfaces emerging problems and innovative solutions. For example, the first of three high-level objectives in the U.S. Fish and Wildlife Service's policy manual is "to assist in the development and application of an environmental stewardship ethic for our society, based on ecological principles and scientific knowledge of fish, wildlife, and plants" (022 FW 1 Section 1.5).

Cotton-grass in Alaska. Photo by Lisa Hupp, USFWS.

Plausible Ecological Trajectories: Defining Limits and Divergences

RAD implementation requires that we rigorously consider how future conditions may differ from our experiences. Developing the range of plausible ecological trajectories is one starting point that helps us to develop and share potential outcomes transparently with others who may contribute valuable insights from their unique perspectives and experiences. In doing so, we must distinguish between the known and unknown conditions under which we are making conservation decisions. When we assume current conditions are possible to maintain or that historical conditions are possible to restore, management goals and objectives are easier to communicate because such conditions are based upon empirical evidence. Understanding future possibilities is different. Our mental models of how change will unfold may not be shared by others (Clifford et al. 2022), in part because future conditions can be novel, uncertain, and contested (Magness et al. 2022), resulting in a more complex situation for decision making (Jones et al. 2014). RAD teams can manage these increased degrees of uncertainty and complexity by transparently developing and communicating the range of plausible ecological trajectories. Doing so creates an intentional and shared knowledge base of the different conceptual models that the RAD team and the conservation community are using to envision future possibilities (see Appendix B for steps for developing trajectories).

Developing the range of plausible ecological trajectories is a scenario-planning exercise. Scenario planning is an effective tool for exploring future outcomes when uncertainty is high (Peterson et al. 2003). Natural resource managers been engaged in such exercises for some time, and no new methods or skills are necessary to engage in this particular exercise beyond those you are already using. Scenarios are defined as possible future states representing alternatives that could result under sets of different assumptions; they are not predictions or forecasts (Rowland et al. 2014). Scenario thinking can help us define what is plausible and help us map out the specific trajectories that lead to different outcomes.

Defining the Limits of Plausibility

Plausibility is often visualized as a cone, sometimes called the plausibility cone or the cone of uncertainty. We can imagine this cone like the beam of a flashlight beam cutting through the dark. The beam enlightens a small area so we can navigate through the darkness. Likewise, a plausibility cone identifies a limited set of plausible future conditions that could occur based on the ecosystem's current and historical circumstances as well as future climate and other projections. Plausibility cones can be wide or narrow depending on how much uncertainty exists across the projections and the breadth of the ecosystem's potential climate niche (Figure 6).

A RAD team might encounter an exceptionally narrow plausibility cone. This can happen when the rate and magnitude of climate change is low and refugia conditions are likely. In other cases, uncertainty about the ecological response makes it difficult to envision alternative and desired future outcomes. In such cases, analogs can be useful. For example, we know that climate is a major driver that limits where broad ecological types, called biomes, occur. A RAD team could explore whether approaches such as climate envelope models are available to explore whether its ecosystem's climate is shifting to be more like a climate associated with a different biome. The team can then analyze the

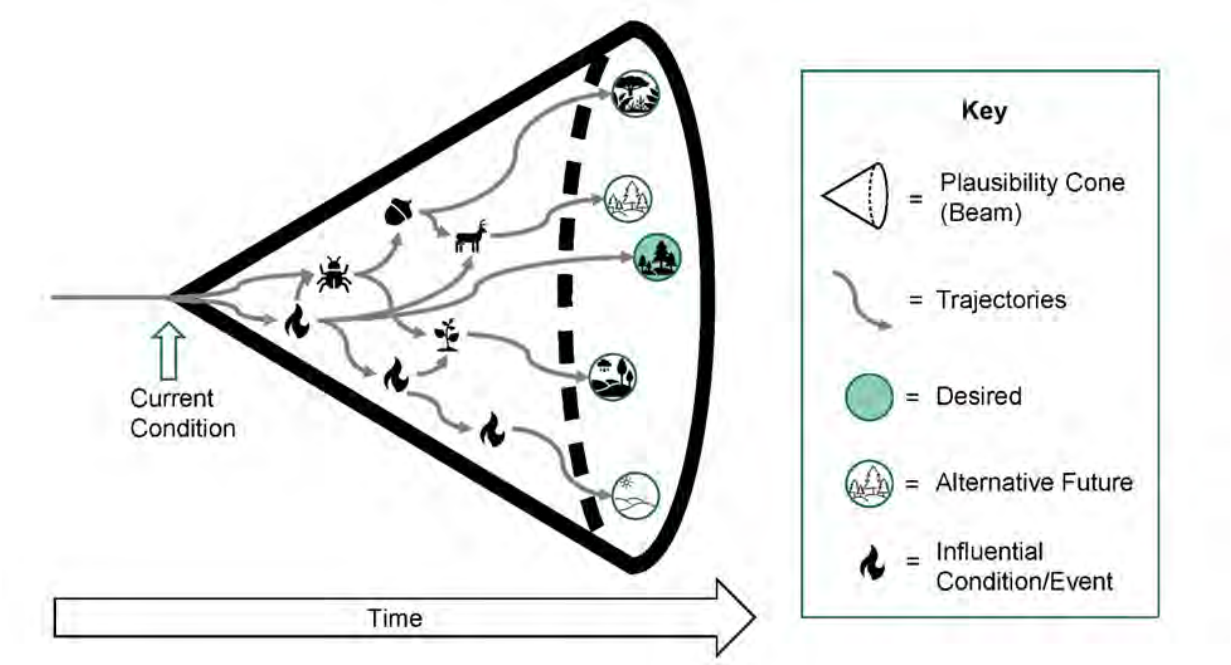


Figure 6. Ecological trajectories may unfold in different ways depending on climate as well as the sequence and timing of random events. Alternative states are thus possible at any point along the trajectory, some of which are more desirable than others. By thinking of plausibility as a beam of light shining upon a cone of future possibilities, RAD teams can consider an ecosystem's current condition along a variety of trajectories. The process can then illuminate alternative futures, helping the RAD team communicate more transparently. Figure adapted from Magness et al. 2022.

existing biome in comparison with the potential emergence of a new, similar biome in its own ecosystem (i.e., an analog) to discover the limits of plausibility.

Analogs should not be interpreted literally in terms of the species assemblage. Rather, analogs serve as a reference for what is possible under climate conditions that our ecosystem may experience in the future. There has been investment in the development of climate envelope models to understand whether a species or ecosystem could occur in a new place (e.g., Audubon's bird models). Although generalized, this information can encourage creative consideration that shines a light on the range of futures, some very different than current conditions, that may emerge.

Defining Divergent Trajectories

Desirable future alternative states are often not realized because of the limitations imposed by context-dependent legacies (abiotic or biotic), contingent events, and other mechanisms (Magness et al. 2022). As we develop the range of plausible ecological trajectories, we must identify as specifically as possible the key drivers of change for our landscape of interest. Ecological drivers that shape how alternative trajectories could unfold include site conditions, legacies, colonization, mortality levels, and disturbance events.

Socioeconomic drivers include fragmentation, pollutants, changes in the physical locations of communities, demographics, the discovery of extractive minerals, public perceptions of climate change and management decisions, political will, and societal values. As we look for insights into the

conditions and contingencies—such as tipping points, thresholds, or disturbance events—that are influential in our place of interest, we can use mechanistic models, state and transition models, remotely sensed data, social science research, and empirically measured climate change impacts. Our resulting mechanistic understanding allows us to map the trajectories, including potential places where trajectories may intersect or diverge and lead to convergent or divergent future conditions (Figure 6). As we identify alternative ecological trajectories and their divergent future states, we become able to evaluate tradeoffs among these outcomes.

Tips for Identifying Alternative Trajectories

- Use analogs to imagine futures that are different from historical or current conditions.
- Consider the small-scale changes across your ecoregion as potential future harbingers.
- Use various approaches such as matching known spatial patterns to detect real signals.
- Use divergent signals (i.e., model flipping) to gain insight into the conditions and events that lead to alternative futures. This information can help you identify the monitoring points that reveal system movements.
- Update trajectories often by integrating new information from sources such as iterative learning and fast prototyping.
- Rely on the collective genius, as different people will have different knowledge bases, experiences, and insights.

Mushrooms on Kodiak Island, Alaska. Photo by Erin Strand, USFWS.

Spatial Planning

RAD teams can minimize risks by considering actions at the landscape scale. Choosing different RAD strategies in different places allows us to apply actions where they will be most effective, for example at the leading vs. the trailing edge of a species range shift. Using different actions and strategies in different places will allow us to learn from one another, test approaches, and minimize the risk of overinvestment in any one strategy given the uncertainty inherent in management decisions.

RAD portfolios can encompass multiple preferences and variable conditions across space. This degree of spatial flexibility is useful because the probability of transformation and the likelihood of different trajectories vary spatially across regions and landscapes. Thus, different places require different RAD strategies. Spatial planning within a RAD portfolio provides a unified approach to tracking and coordinating all our conservation initiatives across our landscape.

RAD portfolios offer a diverse set of strategies, and diversity in RAD choices across a landscape can be a strength. A diversified RAD portfolio is a risk-management strategy because it spreads the risk and allows us to reallocate resources based on performance (Aplet and McKinley 2017). Intervention actions (i.e., resist and direct) are clearly associated with ecological risks and uncertainties, but nonintervention actions (i.e., accept) can also have serious consequences, such as ecosystems lacking sufficient populations, genetic diversity loss, invasive biota in novel assemblages, mass extinction, and future opportunity loss. In other words, the choice of any RAD portfolio option involves inherent tradeoffs.

RAD strategies are crafted and chosen based on the unique history, culture, and community interests in a particular landscape or for a particular species. Different spaces across a landscape entail different rates and magnitudes of climate change exposure, species assemblages, population demographics, human use, and legal options that inform RAD choices (Foden et al. 2019). RAD implementation requires local commitment and action. RAD actions are implemented within local management units and are influenced by agency missions, policies, and priorities as well as by staff dynamics, worldviews, and norms. The bottom line is that we don’t have to make the same RAD choices everywhere.

At the same time, climate change and the resulting species range shifts unfold at continental scales. In some cases, diversity in RAD approaches can dilute conservation goals. When necessary, RAD teams can define landscape-scale desired conditions and goals, which can then serve as the foundation upon which to make local RAD decisions. For example, one barrier to action that managers have identified is the concern about investing in a strategy that will be swamped by regional change (Clifford et al. 2020). Portfolios, in conjunction with spatial planning, help alleviate this concern while elucidating the special role of each land unit within the larger landscape, ecoregion, or continent (Magness et al. 2022). RAD portfolios can organize actions so that we can strategically assess the sum of all local RAD choices. This calculation then allows us to assess whether these local choices are contributing to our regional and national conservation outcomes that fulfill our mission and mandates.

Tips for Developing a RAD Spatial Plan

- Build your social network for upstream deliberative engagement based on spatial patterns of plausible ecological trajectories. For example, if a species is forecast to decline locally, find where emerging conditions may be favorable and start engaging with managers and communities situated in the potential future range.
- Share failures and success. Piloting a RAD strategy that fails is as important as piloting a strategy that meets your objectives.
- View different RAD choices within the landscape as opportunities.
- Invest in regional spatial products, such as remotely sensed habitat quality or vegetation mapping, and socioeconomic demographic tools. Even though these products might not be perfect, they can provide regional context for changes.
- Invest in surveillance monitoring, such as the grid-based design of the USDA Forest Inventory and Assessment (FIA). Surveillance monitoring can identify surprising change that more targeted monitoring can miss.
- Find or create collaborative spaces where regional portfolios can be strategically assessed by interested and impacted parties.

A dunlin sits on driftwood at the Yukon Delta National Wildlife Refuge. Photo by Mark Lindberg, USFWS.

Developing and Using a RAD Spatial Plan

The first step in strategically developing a RAD spatial portfolio is to gather the spatial knowledge available for a landscape (see Appendix C for advice about working at multiple scales). Tools—such as GIS, remote sensing, and machine learning—allow us to visualize, communicate, and conceptualize spatial variation across entire regions. We can scan for signals of change across larger areas, such as an ecoregion, to learn from early signals happening initially at smaller scales. We can also discover drivers and early indicators of change by creating knowledge bases actively and transparently about the range of plausible ecological trajectories. Such information about spatial variability can help RAD teams design robust monitoring programs, model the factors that accelerate drivers of change, and deploy pilots of RAD actions where they have the highest probability of success.

RAD spatial planning is a form of landscape conservation design (LCD). LCD acts as both a process and a convening space for resource managers and communities to develop and implement RAD portfolios. The RAD approach helps to make the LCD process dynamic, and the partnerships around LCD processes are ideal venues for housing and coordinating RAD portfolios. In fact, without LCD processes and other types of collaborative landscape initiatives, it's hard to imagine how portfolios could function beyond the boundaries of a single management jurisdiction.

RAD portfolios can be set up to serve a variety of purposes. They can be used internally to organize efforts within a conservation network. For example, a portfolio could be used to strategically coordinate and diversify choices across management units in the National Wildlife Refuge System, which is legislatively mandated to function as a continental-scale conservation network (Magness et al. 2011). Portfolios can also be multijurisdictional, in which case they can be designed across conservation units managed by different agencies that will respond differently but with purpose based on their unique missions and mandates. Engagement across these entities can ensure decisions consider the landscape holistically. Finally, portfolios can be applied within a single conservation unit when we want to recognize and compare goals across the spectrum of RAD actions to learn which to favor based on performance (Magness and Morton 2017).

Pathway (Temporal) Planning

Pathway (temporal) planning prepares us for the ways we will need to change RAD actions over time. RAD teams can develop sequences of actions that could be implemented progressively depending on how change unfolds in real time (Werners et al. 2021). Pathway planning is a way to identify actions and sequences of actions to achieve desired outcomes, even if we don't know exactly what will happen, where and when. We can use pathways to communicate strategies and understand the costs and benefits of different approaches. Doing so can help identify management triggers for moving among the specific RAD menu actions that align best with the management purpose (Figure 7). This type of planning helps us to consider tradeoffs in investments to prioritize which approaches need to be piloted and how much effort will be needed to achieve desired conditions at scale. Together, these actions form a RAD portfolio that is managed through time even under conditions of uncertainty, as such planning reveals the mechanisms we have to monitor how the trajectory is unfolding. Pathways connect signals from our real-time tracking tools to RAD actions based on factors such as whether change is localized or regionally synchronized.

In the context of developing a RAD portfolio, pathway planning offers three benefits. *(1) It allows managers to remain in a state of readiness, capable of acting during windows of opportunity or when the RAD strategies we have implemented become unproductive.* Pathway planning allows us to consider when and how we might use options from our RAD menu across the range of plausible ecological trajectories that we have identified (Magness et al. 2022). This strategy increases our capacity to be proactive and to develop implementable RAD options even as uncertainty remains about which trajectory we are on (Prober et al. 2017). Pathways can be used to chart smaller, incremental actions and to plan for using intervention to transform the ecosystem actively. Pathway planning increases our ability to recognize when to act, identify when to switch RAD strategies, and prepare us for action so that windows of opportunity are not missed. For example, we can continue to resist in some areas but will need to switch to either accept or direct once current conditions can no longer be maintained.

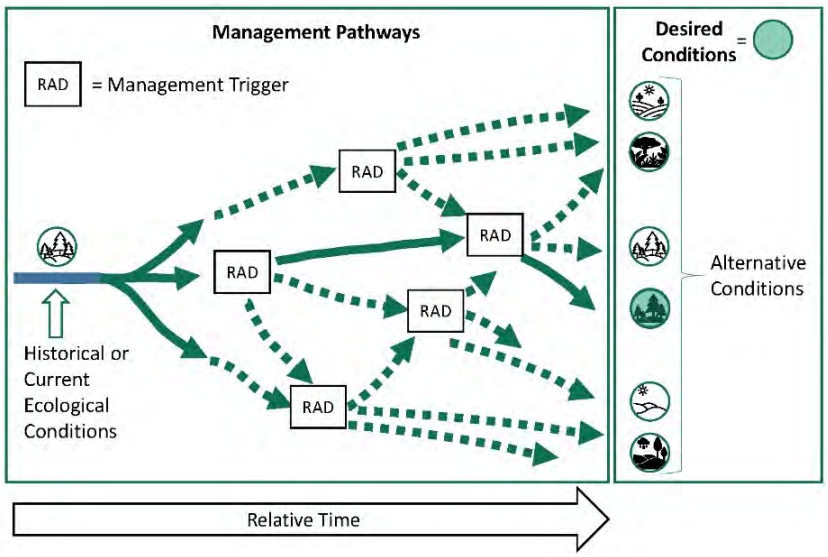


Figure 7. We can identify management triggers as key moments when management intervention can or should influence the trajectory, forming a pathway to a desirable or acceptable future condition. Pathway planning helps us consider tradeoffs among RAD pathways and how a choice or action today may create or limit future options. Figure adapted from Magness et al. 2022.

(2) Pathway planning identifies the various potential tradeoffs of engaging in a strategy today vs. tomorrow by exploring the ways the strategies can play out over time. Investing in a management action today can reduce opportunities to invest in other strategies in the future. Pathway planning is used to explore how the actions we take today constrain our future choices and opportunities. Working through alternative pathways comprehensively and inclusively allows us to consider tradeoffs among pathways in line with our contexts, objectives, and value systems. Pathways are used to achieve desirable, or at least acceptable, conditions and to avoid unwanted outcomes. Without such planning, we risk getting stuck in a maladaptive strategy. Pathway planning helps us to think more critically about short-term decisions within the context of long-term change and the need for sequential actions (Prober et al. 2018).

(3) Pathway planning creates transparency in our planning process and allows us to communicate alternatives. Pathway planning creates a venue for transparent deliberation about alternatives and their implementation feasibility. The process encourages us to address social, political, technical, and other barriers and opportunities for shaping the future long before an action must be taken. This process can help to reduce resistance and can contribute to buy-in when the decision-making moment arrives.

Developing and Using a Pathway Plan

As we develop pathway plans, we must remember to develop multiple pathways to account for differences among divergent trajectories. The range of plausible ecological trajectories helps us identify contingencies that can serve as management triggers for RAD actions. Management triggers signify decision points when intervention can be highly influential. For example, fires are disturbance events that create windows of opportunity for, among other things, seeding new species assemblages. Management triggers can also identify tipping points that signify it is time to switch RAD actions. For instance, the second

thousand-year flood event in a decade could be the contingency event that triggers the decision to change from a resist action to an accept or a direct one.

As part of our planning strategy, remember that we need to pilot RAD actions to ensure they are effective and feasible before we implement them at larger scales. Our pathway plan should include a roadmap for not only the management triggers and our responses but also the monitoring, experimentation, and pilot programs that will prepare us to act most effectively. We also need to assess our monitoring programs to ensure we have the data and processes in place to know when the triggers occur. Finally, we can use our RAD menu to identify the options that would be most beneficial for responding to the given trigger.

Pathway planning encourages longer term and more comprehensive examinations of uncertain and divergent alternative trajectories. However, it is not possible to map out every option perfectly and with complete understanding. We should expect surprises and maintain the nimbleness to respond. RAD adaptive management includes both a real-time assessment of how current conditions are changing along our chosen pathway and the tools to understand the other available pathways (Lynch et al. 2022).

Tips for Using Pathway Planning to Decide When to Reallocate Strategies

- Plan for divergent outcomes that could occur across the range of plausible ecological trajectories by thinking in if–then terms about actions that could shape the trajectory.
- Identify tipping points for the resilience of the current system.
- Identify opportunities for positive future states and not simply risks or barriers.
- Clearly identify and communicate influential decision points that serve as triggers for interventions or indicators that it is time to shift RAD strategies.
- Identify which future outcomes need chronic, recurring intervention and which catalyze a self-sustaining new state. Communicate these findings in terms of the timing and sequence required for interventions to shape a trajectory.
- Use pilot projects to test the effectiveness of interventions. Share failures as much as successes.
- Identify short-term actions that would limit long-term opportunities to switch strategies. Assess current actions based on how they constrain future opportunity.
- If some options on the RAD menu are not feasible, identify whether barriers to action can be removed. Are there barriers that we should be proactive about removing or opportunities that we could be proactive about creating?
- Avoid getting stuck on any one pathway. Work to build opportunities for desirable conditions across divergent futures.
- Expand and improve alternative pathways iteratively. Update pathways with new information about the trajectories that align with emerging conditions. Engage with inventory and monitoring programs to develop and implement metrics that improve this understanding.

Blooming ball cactus at Big Stone National Wildlife Refuge, Minnesota. Photo by Mike Budd, USFWS.

Case Study: Using Dynamic Landscape Conservation Design to Inform RAD Portfolios

Landscape Conservation Design (LCD) Context

The Southeast Conservation Adaptation Strategy (SECAS) is a partnership that brings together public and private organizations managing the lands and waters of the Southeast and the Caribbean to support healthy ecosystems, thriving fish and wildlife populations, and vibrant communities in a bold vision for the region's future. With a data-driven LCD, called the Southeast Conservation Blueprint, and an ambitious regional goal, SECAS helps accelerate conservation action in the places where it will have the biggest impact. The SECAS LCD sets both long- and short-term goals for the health, function, and connectivity of Southeastern ecosystems using the Blueprint, which functions like a RAD portfolio.

The Blueprint is a living, spatial plan intended to help resource managers achieve the SECAS vision of a connected network of lands and waters across the Southeast and Caribbean. It is regularly updated to incorporate new data, partner input, and information about on-the-ground conditions. The Blueprint identifies priority areas based on a suite of natural and cultural resource indicators representing terrestrial, freshwater, and marine ecosystems. In total, Blueprint priorities and priority connections cover roughly 50% of the Southeastern Association for Fish and Wildlife Agencies geography. A connectivity analysis identifies corridors that link coastal and inland areas and that span climate gradients. The Blueprint priorities for this case study are shown in Appendix D, Figure D1 (for more information, visit https://secassoutheast.org/blueprint).

Using the Blueprint

In the following, we develop a hypothetical case study to show how RAD planners could use the Blueprint to develop a RAD portfolio through space and time. The discussion below ***is hypothetical and not reflective of decisions made affecting the Southeast and the Caribbean*.** Additionally, the analysis presented here ***only for the instructional purposes*** of demonstrating how to think about plausible ecological trajectories and engage in spatial and pathway (temporal) planning.

The case study includes five National Wildlife Refuges and one National Forest in coastal North Carolina. Each management unit has a unique geography and landscape composition of wetland habitat types, vulnerability to sea level rise, resilience, and connectivity to adjacent lands that can inform RAD portfolios at the regional scale and within the management unit. Our hypothetical case study is intended to provide an example of how we might increase the capacity of each federal land unit to see itself within a RAD portfolio. Doing so provides information to help individual managers allocate their management choices for their land and problem solve with other interested parties within the multijurisdictional landscape.

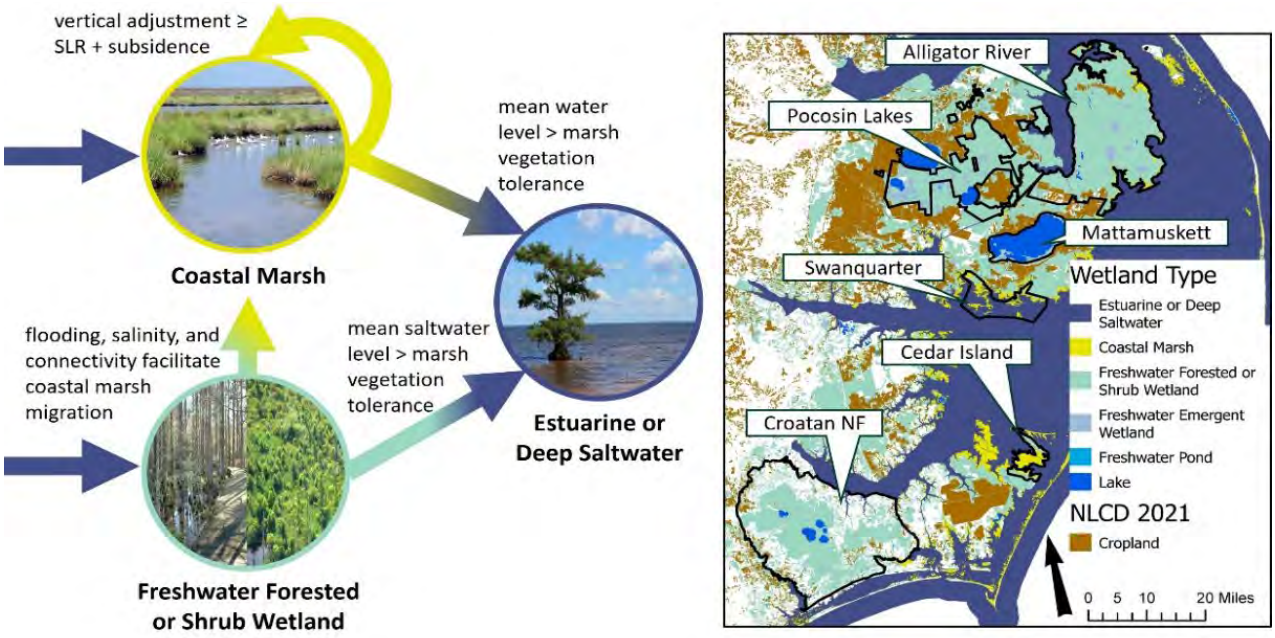


Figure 8. Simplified ecological trajectories for coastal marsh transformation. SLR interacts with vertical adjustment rates and geomorphology to transform the ecology. Coastal marsh habitats (yellow) can transform to estuarine and deep saltwater habitats (dark blue) if flooding events create conditions that exceed the coastal marsh vegetation tolerances. Coastal marshes can migrate to adjacent uplands and freshwater wetlands, such as freshwater forested and shrub habitats (mint green), given water levels, salinity, and sufficient connectivity (Osland et al. 2022). NF = National Forest; NLCD = National Land Cover Dataset

Range of Plausible Ecological Trajectories

The case study involves a region with large areas of low-elevation, freshwater forested or shrub wetlands (Figure 8) that are affected by sea level rise (SLR) in various ways. Coastal marshes can be resilient to moderate SLR when vertical adjustment (via plant growth and sedimentation) keeps pace with SLR and marsh subsidence (Morris et al. 2002, Saintilan et al. 2023). Higher exposure to SLR can transform coastal marshes to estuarine or deep saltwater regions. SLR can also transform inland freshwater wetlands to coastal marshes. Both salinity and inundation drive changes to these diverse and valuable freshwater wetlands (Anderson et al. 2022). Salinity thresholds for freshwater wetlands can be exceeded through saltwater intrusion or other episodic events like hurricanes or drought. For this case study, we consider simplified ecological trajectories for this coastal marsh (Figure 8).

A scenario approach is useful because the multiple sources of uncertainty make it difficult to predict exactly when and how each place will be affected. The main sources of uncertainty are about the amount of SLR that will cause transformation and the details regarding future SLR rates and timing (Figure 9). Coastal marshes as well as freshwater forested and shrub wetlands can have highly variable rates of change in surface elevations, accretions, and net vertical elevations (Moorman et al. 2023). NOAA has low mapping confidence for the lowland refuges in this region at 1–3 ft SLR. The geomorphology of the Outer Bank barrier islands creates complex interactions that influence SLR rates in the back-barrier sounds and estuaries (Mallinson et al. 2018). Despite these uncertainties, we can develop a range of plausible ecological futures that allows us to be prepared to act when

monitoring efforts signal the time has come. Refuges are monitoring surface elevation tables (Moorman et al. 2023). These data, when linked with remote-sensing approaches, allow for yearly monitoring of coastal marsh health that can alert managers when areas begin to exhibit transformational signals (Ganju et al. 2023).

Spatial Planning

Because SECAS has nurtured and developed partnerships and collaborations throughout the region, it offers an ideal venue for resource managers to develop a RAD portfolio to facilitate a regional, coordinated response that accelerates learning by sharing the experimentation and piloting of RAD actions. Such spatial planning can inform and coordinate national-, regional-, and refuge-scale efforts to protect and support healthy coastal marsh and freshwater wetlands for future generations. Within the larger Atlantic coastline, this region is at risk of catastrophic landscape-scale loss for both coastal marsh and freshwater wetland habitats (Osland et al. 2022). Moreover, nearly a quarter of the public lands in this case study fall into the Blueprint's highest priority category (Appendix D, Figure D1), underscoring the conservation importance of these public lands. These conservation areas are important both for conserving biodiversity now and for planning before an emergency arises.

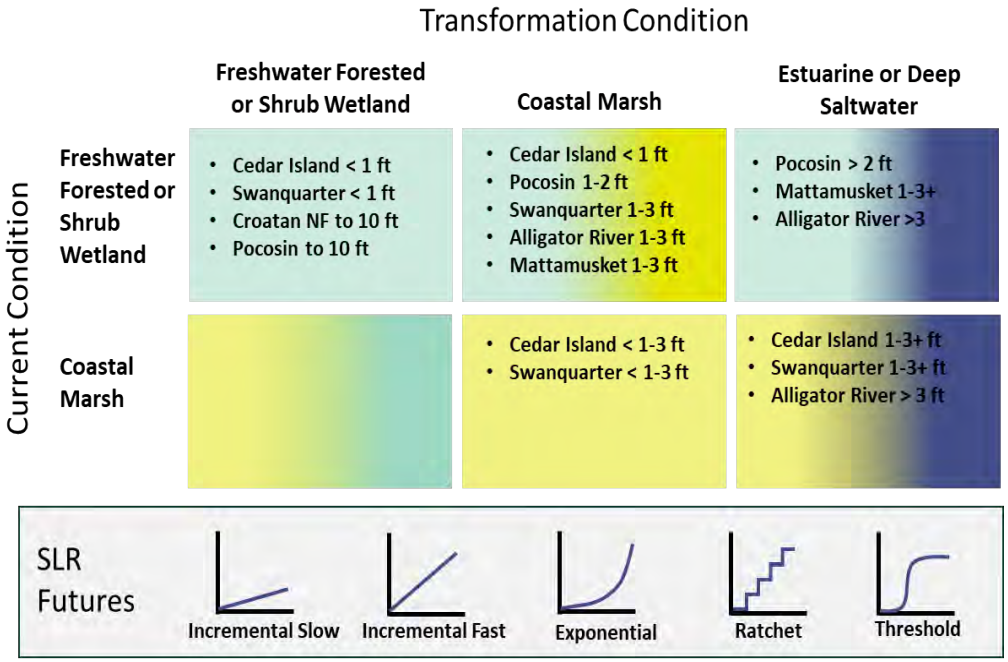


Figure 9. Range of plausible ecological trajectories, depicted as scenarios. The SLR for each Refuge and Croatan National Forest at which transformation could occur depicted as a matrix from initial habitat types (rows) to post-transformation habitat types (columns). Colors indicate freshwater forested and shrub habitats (mint green), costal marsh (yellow) and estuarine and deep saltwater habitats (dark blue). Management units vary in their degree of vulnerability to transformation, so there is uncertainty about the exact amount of SLR that will cause transformation. Therefore, these numbers should be used as a relativity comparison to contextualize the areas that may be more likely to transform early. The SLR futures panel communicates the uncertainty regarding the rate of SLR and how it will map across the lowlands. Please note that the Futures panel is separate from the Transformation and Current Conditions panels. As such, the SLR Futures are not intended to align with the columns. A scenario approach offers us some concrete information even in the face of uncertainty, so we can prepare even though we cannot perfectly predict how change will unfold.

RAD portfolios help us decide upon a suite of actions in which to engage, recognizing that any action, including the decision to take no action, involves tradeoffs. The Blueprint contains more than 60 prioritized indicators (displayed in Appendix D as a subset). The indicators are linked to spatial data to help us think strategically about how different places locally can serve different roles both locally and at larger landscape levels. The unique geography of each place will inform the roles each land unit can best serve in the larger portfolio. For example, Swanquarter has coastal marsh habitat that is vulnerable to transform to open water habitat when SLR exceeds 3 feet (Figure 9). The potential for coastal marsh migration is low for Swanquarter because although it is connected to Mattamuskett, Mattamuskett doesn't have large areas of freshwater habitats available to transform and receive displaced coastal marsh species (Figure 8). This geography will constrain the feasibility of RAD actions to direct marsh migration out of Swanquarter refuge.

Pathway (Temporal) Planning

In this case study, coastal marsh, freshwater wetland, and estuarine habitats are culturally important and each provides different ecosystem services, so managing them requires value tradeoffs. Blueprint indicators help us to explore tradeoffs among management priorities such as maintaining biodiversity; allocating space for carbon storage; and preserving ecosystems factors including seagrass, island habitat, stable coastal marsh, and South Atlantic maritime forest. Pathway planning identifies and prepares for the actions and sequences of actions we can use to achieve desired outcomes, even though we cannot predict exactly what will happen, where and when. Pathways can be visualized and communicated in a variety of ways (Haasnoot et al. 2024). Here, we use a simplified decision tree to illustrate pathways when coastal marsh habitat is prioritized. (Figure 10). The starting point for our example is regular monitoring. Action is triggered when a coastal marsh deterioration signal is detected.

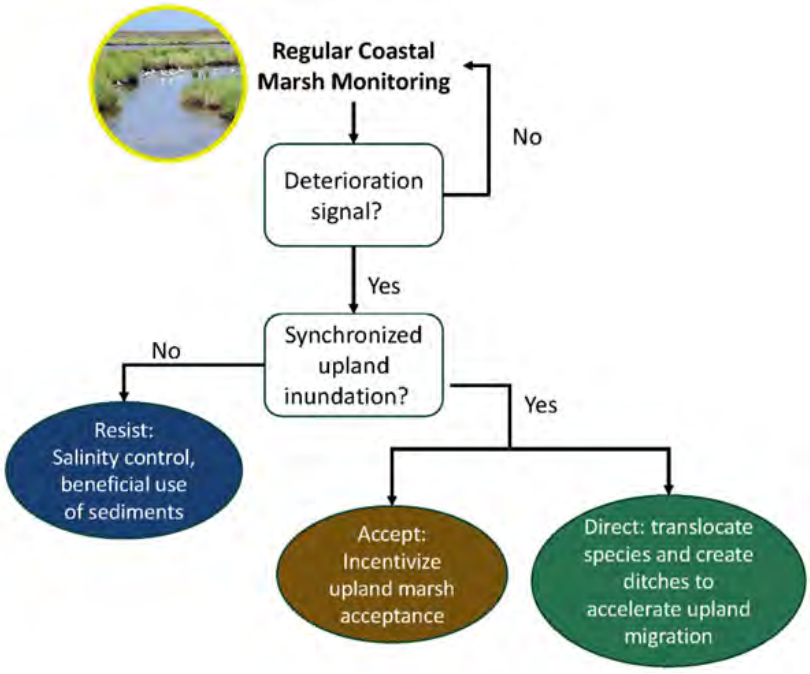


Figure 10. Pathway decision tree representing alternative pathways that managers could take. The management trigger for action is based on the monitoring of unvegetated to vegetated ratios, which can act as a signal of costal wetland deterioration. At any given time, different management units can be acting at different places within the pathway map. In this example, coastal marsh that is highly connected to upland habitats are distinguished from disconnected areas. Disclaimer: the pathway map was generated hypothetically for this case study and should not be interpreted as an actual RAD portfolio for Refuges. As we gain more real-life examples, this case study can be replaced with real data.

Conclusion

The foregoing is a hypothetical case study based on an ongoing initiative in the Southeastern Atlantic. We used existing data to demonstrate how a RAD portfolio might emerge in a specific context. The values, rules, and knowledge within this decision context (see next chapter) will undoubtably enrich and shape how a RAD portfolio would be developed and applied in the real world. This case study simply illustrates concepts that we hope could help further local implementation of adaptation actions linked to broader scale conservation networks like the SECAS Blueprint.

Black Skimmers in North Carolina. Photo by Eve Turek, USFWS.

CHAPTER 4. ADAPTING THE RAD DECISION CONTEXT

Monarch butterflies at Chautauqua National Wildlife Refuge, Illinois. Photo by Mike Budd, USFWS.

Key Messages

- We do not make management decisions in a vacuum, but within a context that includes an ecosystem or landscape and the people who inhabit or interact with it. Upstream, deliberative engagement is a practice that creates the relationships and understanding that allow us to create RAD menus, develop RAD portfolios, and implement RAD actions.
- Engagement is about more than communicating decisions. It is about sharing perspectives that inform and collaboratively adapt the values, rules, and knowledges that bound our decision-making processes. Doing so informs our conservation approach, reveals new understanding and strategies, and builds trust.
- Effective engagement involves dedicating time, considering interested parties' availability, communicating clearly, creating safe spaces for diverse perspectives, and maintaining transparency. Key to deliberative engagement is understanding which parties to include, the historical and cultural context, and our own degree of emotional intelligence. Internal engagement within an institution is also important because we may not all be on the same page about ecological transformation.
- The RAD host entity plays a pivotal role in identifying relevant interested parties for engagement. Specialized knowledge holders and those most impacted should be considered. Trusting the collective wisdom and outcomes of the process is essential, even when the results are uncertain.
- The process is iterative and is not necessarily tied to a decision. Instead, the practice of upstream, deliberative engagement creates the information, understandings, and relationships that will allow us to meaningfully respond when ecological transformation occurs.

RAD Decision Context

Every effort to implement RAD is constrained by the decision context, defined as an interconnected social system of values, rules, and knowledge bases (Gorddard et al. 2016). The decision context bounds the choices available to us as we create and navigate decision-making processes. Choices depend on many factors, for example, who has the formal authority to decide, our collective understanding of social desirability and feasibility, people's individual and communal comfort levels with proceeding amid uncertainty, and the technical capacities brought to the decision-making table.

Values are the ethical principles that guide how people choose actions and evaluate events. Values are relatively stable and slow to change; however, people weigh tradeoffs among competing values, resulting in a wide variety of attitudes and beliefs that are more fluid over time than the values themselves (Schwartz 2012). Given these differences, people may have different interpretations for how we should consider tradeoffs among RAD actions (Magness et al. 2022). Value adaptation takes time, even generations, but it is possible given adequate humility, intentionality, and determination.

Rules are interwoven formally and informally throughout RAD implementation. Formal rules can take the shape of regulations, legislation, treaties, or ordinances. Informal rules, which can be harder to name but just as influential, include social norms, practices, taboos, habits, or heuristics. All of these rules can bound, restrict, or limit alternatives, so it is important to consider whether achieving desirable RAD alternatives first requires a shift in formal or informal rules (Gorddard et al. 2016, Clifford et al. 2022).

Knowledge bases can take many forms throughout a decision-making process (Gorddard et al. 2016). Evidentiary knowledge bases, such as modeling and empirical studies, play a large role for scientifically focused resource managers. Other knowledge bases, such as traditional ecological knowledge alongside mythology and folklore, provide complementary perspectives and information. Because the RAD framework is multiscalar, it is important to understand the myriad of ways-of-knowing found across a landscape (Ward et al. 2023).

To date, most adaptation actions have been incremental and have focused on business-as-usual solutions (Berrang-Ford et al. 2021, LeDee et al. 2021). Expanding the possible range of adaptation options will require recognizing and adapting the decision contexts in which we operate through frequent communication and collaboration, both internally and externally. Our current values, rules, and knowledge bases could act as barriers to creating adaptation approaches that meet the realities of species on the move and transforming ecosystems (Colloff et al. 2017). Implementing RAD—and climate adaptation more broadly—requires a cultural shift in which our perception of environmental change evolves to see not only threats but opportunities as well. In the face of uncertainty, we need to work together with our partners and communities to innovate and adopt new practices that are future oriented, proactive, and action based (Stein et al. 2024). Upstream, deliberative engagement is a practice that creates the relationships and understanding necessary to do this.

Upstream, Deliberative Engagement

When we participate in upstream, deliberative engagement, we adapt the RAD decision context by putting people at the center of decision making through informed discussions involving diverse perspectives (Magness et al. 2022). In the RAD context, these people are connected to specific places, species, or ecosystems that are undergoing rapid change. Such people may include representatives from government agencies and institutions, Tribal Nations and Indigenous communities, non-governmental organizations, academia, and affected community members, particularly those who may be disproportionately impacted by decisions. Upstream, deliberative engagement involves dedicating the time necessary for these parties to learn about an issue, hear each other's perspectives, and discuss possible ways forward before drawing informed conclusions. When the challenge being deliberated is highly controversial, and mistrust exists among the partners, this process can be more challenging. For these reasons, key to the success of implementing the RAD framework is engaging interested parties as early in the process as possible through the extension of a genuine invitation to participate in the planning and to influence an outcome. We define the process components as follows:

- **Upstream:** Alerting interested parties of an issue as early as possible, involving them as soon as is feasible, and continuing to involve them throughout the process.
- **Deliberative:** Dedicating the needed time and resources for people to think carefully through a situation, discuss it, and form possible responses.
- **Engaged:** Involving interested parties in a process that is transparent, with the shared goal of learning from each other and expanding the circle of who informs and makes decisions.

This form of engagement provides a setting where people can engage authentically so we can learn from multiple perspectives to develop a robust set of strategies that meaningfully addresses transformation. In situations where deliberative engagement has not been done and relationships are being forged for the first time, the RAD planning process acts as the upstream initiative for future relationships and partnerships to develop. In other cases, such as the SECAS Blueprint described in Chapter 3, upstream partnerships are already in place. Regardless, a key part of upstream, deliberative engagement is the building and strengthening of partnerships, which is its own goal, and which complements the RAD framework's other goals without acting in subordination to them.

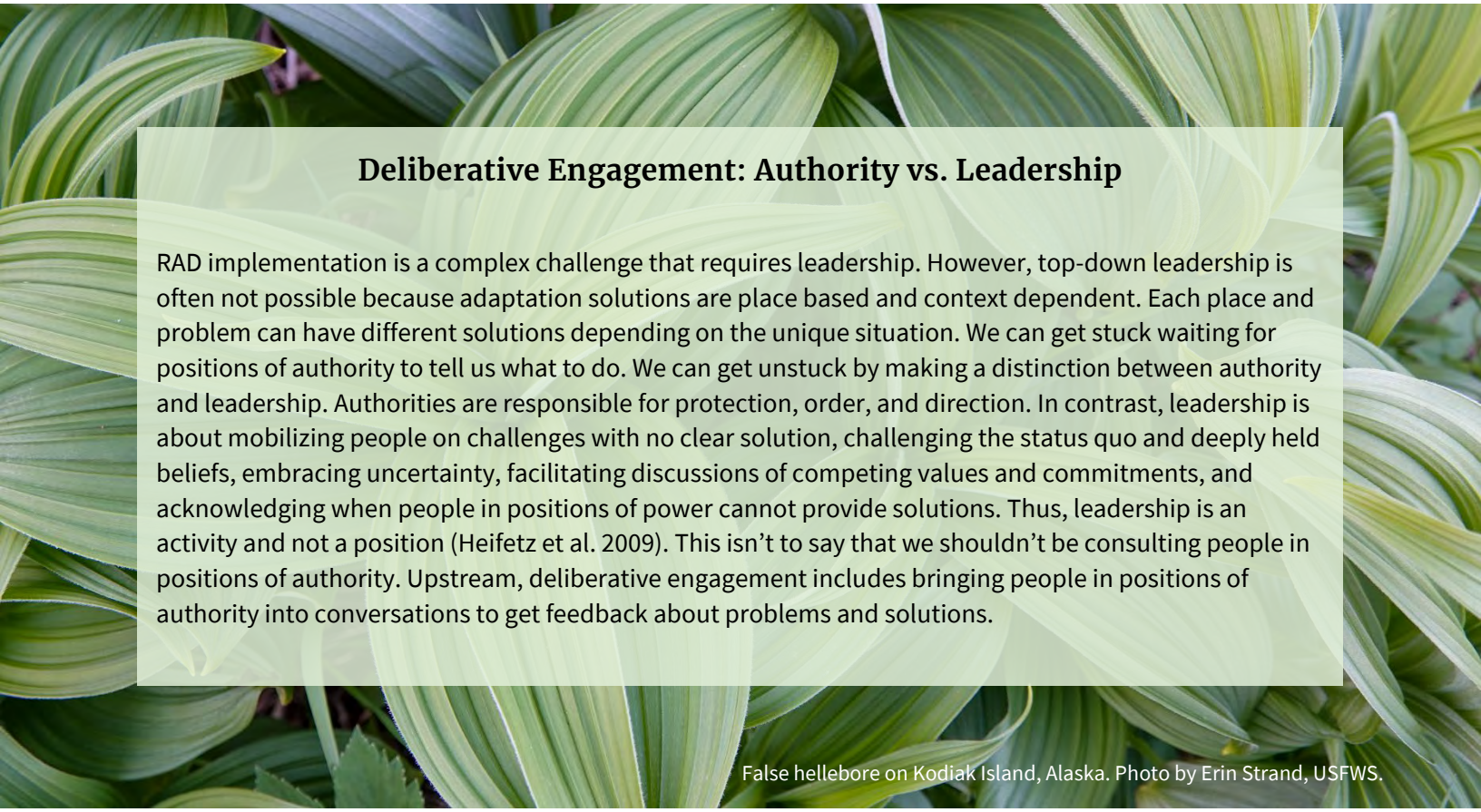
In this era of change, navigating transformation and stewarding biodiversity for the continuing benefit of present and future generations is a collective effort. RAD menus require creativity, and RAD actions require implementable solutions. We can implement solutions more effectively if we engage with people and allow new opportunities to emerge. These relationships, built on trust and shared values, are integral to solving problems. Human ingenuity is a resource, spread across our diverse communities. When we tap into this wellspring, creative and effective solutions can emerge.

Conservation success in the 21st century depends on collaborations among those that care for and depend on a landscape. The work of doing so requires time and intensive learning, and it will extend beyond project cycles. In reality, trusted collaborations are built upon many years, decades, and centuries of relationships between people and place. Each of us must ask what we can do to strengthen the health of our relationships with each other and with nature during our tenure as

conservation practitioners. The concept of upstream, deliberative engagement helps to demystify this work and provides practical guidance on ways to make progress.

RAD promotes the active involvement of partners and the public in deliberations, especially those who are most likely to be impacted by RAD decisions (Carr et al. 2014). Done well, upstream, deliberative engagement actively works not to repeat historical processes of marginalization in environmental decision making. It can also lead to more creative, informed, and community-supported conservation actions. Engagement creates a strong social network. Investing in our social networks enhances our ability to learn from the diversity of experiences and perspectives. Tapping into this collective genius increases our effectiveness and reduces the likelihood of being trapped in maladaptive strategies (Hill et al. 2014).

As we work to understand the abilities, motivations, and limitations of those sharing in and affected by our decision-making spaces, we must be transparent about our own. Genuine engagement requires that our own organizations and institutions clearly and transparently communicate who we are, what we care about, the issues we are working on, our expertise (including its limitations), and the solutions we prefer and believe we can implement. Without this self-awareness, we risk additional uncertainty, confusion among ourselves and others, or conflicting messages that impede progress toward shared goals.



Deliberative Engagement: Authority vs. Leadership

RAD implementation is a complex challenge that requires leadership. However, top-down leadership is often not possible because adaptation solutions are place based and context dependent. Each place and problem can have different solutions depending on the unique situation. We can get stuck waiting for positions of authority to tell us what to do. We can get unstuck by making a distinction between authority and leadership. Authorities are responsible for protection, order, and direction. In contrast, leadership is about mobilizing people on challenges with no clear solution, challenging the status quo and deeply held beliefs, embracing uncertainty, facilitating discussions of competing values and commitments, and acknowledging when people in positions of power cannot provide solutions. Thus, leadership is an activity and not a position (Heifetz et al. 2009). This isn't to say that we shouldn't be consulting people in positions of authority. Upstream, deliberative engagement includes bringing people in positions of authority into conversations to get feedback about problems and solutions.

False hellebore on Kodiak Island, Alaska. Photo by Erin Strand, USFWS.

Practicing Upstream, Deliberative Engagement

RAD decisions are ultimately value-based decisions; that is, the alternatives discussed during upstream, deliberative engagement will be grounded in the value systems of the parties involved—including ecological values. With any value-based decision, it is important to start with a shared understanding of the motivations influencing the need for the decision in the first place. Creating the time, space, and resources to explore this topic with interested parties far ahead of the decision-making moment provides a "map" that can help identify both shared values and the junctures that will inevitably arise. When disagreements about how to move forward happen, a group can revisit this map of shared understanding to refocus on desired directions and reground themselves in shared values.

Deliberative engagement also includes internal discussions within our home organization or institution. We cannot assume that everyone agrees about the possible ecological changes or what they mean in the context of our mission and mandates. These internal interactions help us understand our individual and institutional blinders, thereby increasing our ability to be transparent with others and our capacity to avoid maladaptive approaches.

Upstream, deliberative engagement is iterative. Each decision cycle offers an opportunity for upstream engagement that will affect the next decision cycle. Each engagement is a building block that can establish trust and deepen collaborations; in fact, not every engagement needs to be directly tied to a decision. In reality, a shift in values, rules, or knowledge bases—all of which are part of the decision context—may be needed before a decision can be made. If so, engagement may look like facilitating discussions around these cultural shifts as opposed to the making of any official decision. The active preparation of the decision context and pathway planning to identify windows of opportunity to effectively navigate change are as important as the decision point or process.

The RAD host has a critical role in creating the conditions for a meaningful experience for everyone contributing to the process. Typically, the host(s) will initiate a conversation with the interested parties for a RAD decision process. Identifying the right representatives of interested parties is foundational to subsequent discussions and actions; it also requires insider knowledge from partner groups and communities. Therefore, the RAD host should carefully consider which parties to include and then consult with their respective leadership to learn about the most appropriate representatives for the RAD process. When assessing whom to engage, the RAD host should also consider the "specialized knowledge holders" of this landscape (i.e., people with specialized knowledge on ecological interactions or people–place connections). These people will be best able to speak to the potential impacts of the ecological changes occurring in this geography.

Your aim is to engage the larger community long before you ever start to identify RAD adaptation actions. This is the upstream part—like a stream flowing toward a big decision, you need to start much farther upstream than the decision itself. Many times, we have seen ecosystem transitions after a major disturbance, such as a catastrophic hurricane or a major wildfire (Walker and Salt 2012). The moment of the disturbance is too late to identify interested parties, bring them into conversation, identify shared goals and values, and make necessary decisions together. The time to start those conversations is now, hopefully well ahead of the next disturbance event. Then, when a disturbance does occur, we can either implement or shift our adaptation plan accordingly (Lynch et al. 2022).

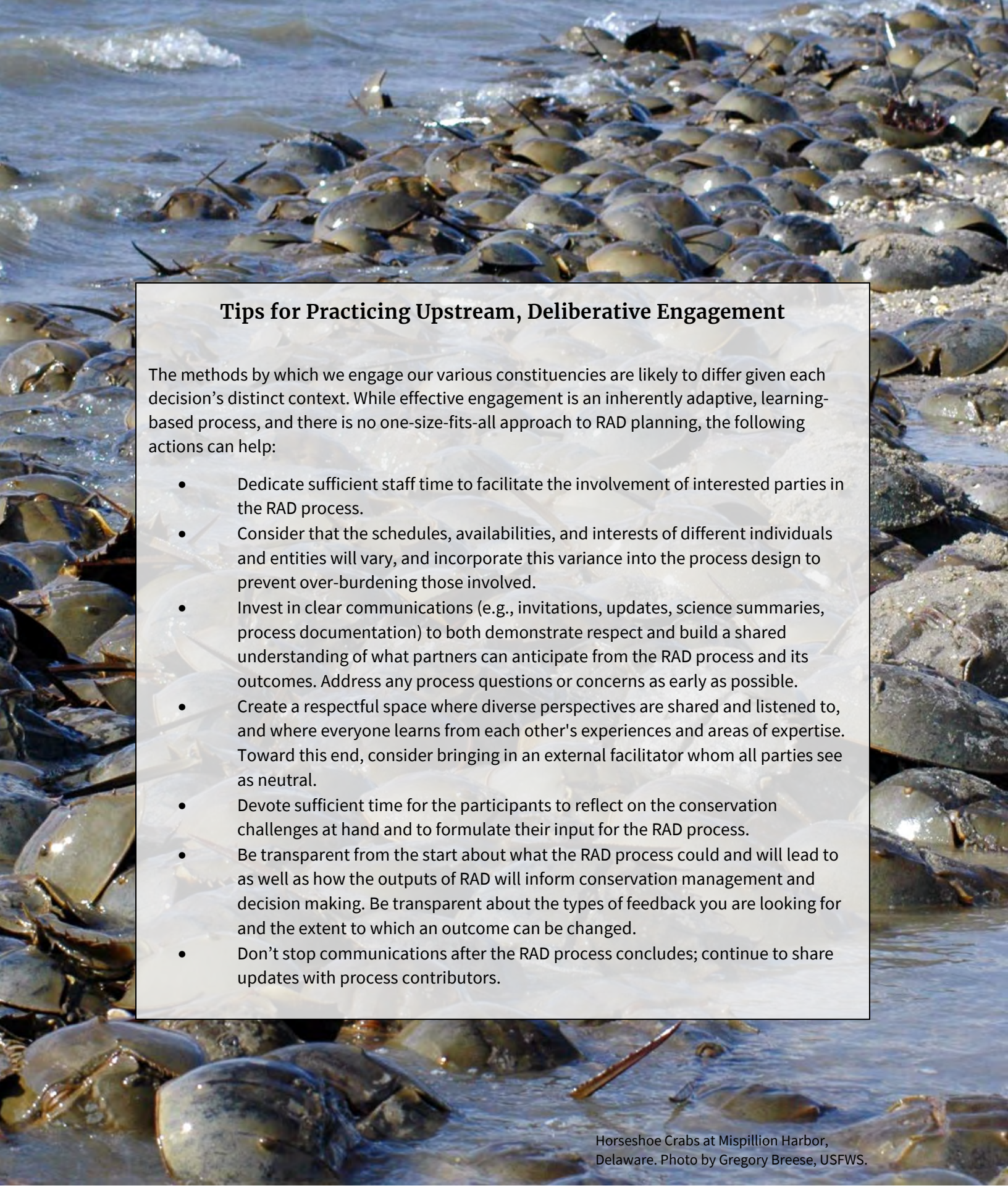
Effective engagement is inherently an adaptive, learning-based process that does not require perfection. Each RAD process requires a certain level of tailoring so it fits the given circumstance, landscape, and local community's needs. Similarly, we need to do our homework regarding historical relationships (especially those that have been strained or broken). We can begin by developing cultural responsiveness, emotional intelligence, and an ability to navigate difficult conversations and negotiate optimal decisions.

Depending on the decision context, our organization or institution may be constrained in how much decision-making authority can be shared with partners and the public. For example, the regulatory roles of a federal agency may demand they act in certain circumstances, existing legal processes may require a federal entity to coordinate with state and territorial agencies and Tribal governments to make decisions, or a sudden decrease in funding might make an agreed-upon decision no longer viable. In situations such as these, we (and our partners) can be limited in our ability to cede authority to others at the decision-making table.

In these circumstances, we must be transparent about how decisions are made. The tenets of upstream, deliberative engagement often still hold true: alert interested parties as soon as possible, engage them in a way that enables them to provide informed feedback, commit to considering that feedback seriously, and follow up to inform them of the outcomes and how they were reached. Engaging in this way through time and over multiple projects helps the decision context to evolve—in this case, through improved trust among partners, especially the government and the communities it represents—making future collaborations easier and more likely to succeed.

Not knowing the outcomes of a process during facilitations can be scary. Remember to hold space for the normal emotional responses that may surface during these deliberative conversations. But remember as well that a critical element of meaningful engagement is to trust others and the wisdom of the collective. We can achieve greater outcomes working together than we can by working separately.

Columbia Torrent Salamander, endemic to southwestern Washington and northwestern Oregon. Photo by Chris Cousins, USFWS.



Tips for Practicing Upstream, Deliberative Engagement

The methods by which we engage our various constituencies are likely to differ given each decision's distinct context. While effective engagement is an inherently adaptive, learning-based process, and there is no one-size-fits-all approach to RAD planning, the following actions can help:

- Dedicate sufficient staff time to facilitate the involvement of interested parties in the RAD process.
- Consider that the schedules, availabilities, and interests of different individuals and entities will vary, and incorporate this variance into the process design to prevent over-burdening those involved.
- Invest in clear communications (e.g., invitations, updates, science summaries, process documentation) to both demonstrate respect and build a shared understanding of what partners can anticipate from the RAD process and its outcomes. Address any process questions or concerns as early as possible.
- Create a respectful space where diverse perspectives are shared and listened to, and where everyone learns from each other's experiences and areas of expertise. Toward this end, consider bringing in an external facilitator whom all parties see as neutral.
- Devote sufficient time for the participants to reflect on the conservation challenges at hand and to formulate their input for the RAD process.
- Be transparent from the start about what the RAD process could and will lead to as well as how the outputs of RAD will inform conservation management and decision making. Be transparent about the types of feedback you are looking for and the extent to which an outcome can be changed.
- Don't stop communications after the RAD process concludes; continue to share updates with process contributors.

Horseshoe Crabs at Mispillion Harbor, Delaware. Photo by Gregory Breese, USFWS.

Case Study: Hawaiian Forest Bird Conservation

Written by Jeff Burgett

A recent experience in Hawai‘i illustrates the importance of upstream, deliberative engagement in developing both durable conservation decisions and supportive cultural understanding. Four species of birds endemic to the forest in Hawaii—the ‘akeke‘e, ‘akikiki, ‘ākohekohe, and kiwikiu—are in imminent danger of extinction due to mosquito-borne disease exacerbated by climate change. In 2021, conservation agencies were developing a Biological Assessment based on conventional Western science and management experience with these species. Concern emerged among State and Federal decision makers that Native Hawaiian cultural views had not been considered in the development of management options, which included relocating the species off their home island. Time was short for management decisions to be made and funding to be secured. An interagency hui (group) of representatives from the Fish and Wildlife Service, National Park Service, and the Office of Native Hawaiian Relations convened to complement the Biological Assessment with a Biocultural Assessment. The goal of the Biocultural Assessment was to integrate Native Hawaiian Indigenous knowledge and cultural perspectives into the decision-making process to understand the broader context of the landscape and the implications of the management options.

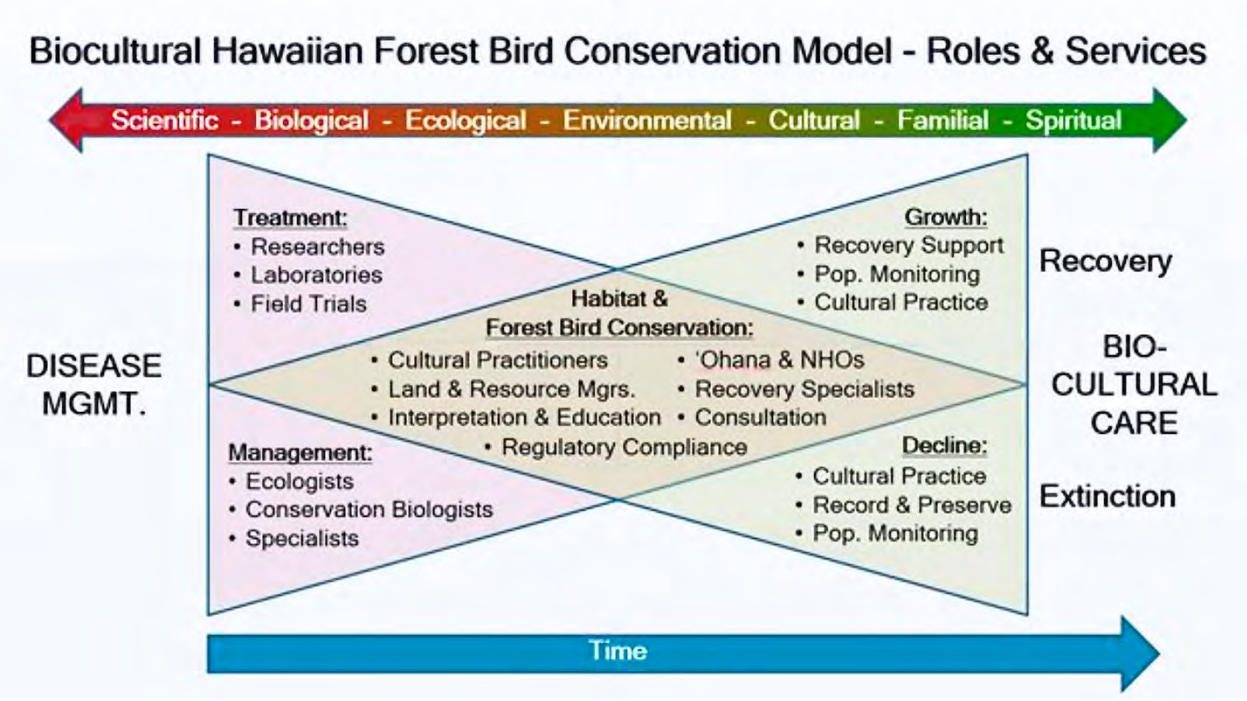


Figure 11. Biocultural care model to guide actions taken. Figure from Paxton et al. 2022. NHO = Native Hawaiian Organizations.

The hui invited a select group of Native Hawaiian subject matter experts and cultural practitioners to share their experiences, viewpoints, and knowledge bases (Paxton et al. 2022). While their input was not comprehensive, it resulted in a Biocultural Assessment that successfully articulated important Hawaiian viewpoints and shed light on the options under consideration (Figure 11). The process revealed several issues key to successful engagement in the context of species at high extinction risk and with limited options. It also showed the shortcomings of not beginning deliberative engagement early ("upstream") enough, with community representatives becoming aware of proposed management options relatively late in the process. From this experience, we highlight a few of the lessons learned:

- **Early engagement**: Respectful engagement cannot be perceived of as an afterthought. It requires adequate preparatory time to prevent the perception that unequal weight is being given to agency perspectives over community concerns, that management options are foregone conclusions, or that engagement is merely one more box to check in the regulatory process.
- **Ongoing relationships**: Establishing and maintaining relationships with the community should be an agency priority. The hui members had preexisting relationships with experts and cultural practitioners, and these relationships became critical in selecting an advisory group and completing the Biocultural Assessment within a tight timeframe. However, the problems caused by a lack of upstream engagement led to the risk of the agencies overexploiting these personal relationships. Specifically, hui members incurred reputational risk by requesting participation in a rushed effort with an uncertain outcome.
- **Cultural competence**: The Hawaiian relationship to the natural world is fundamentally different from the European one. Therefore, culturally competent, respectful, and transparent engagement early on is paramount. We must be respectful and recognize the importance of knowledge holders, practitioners, Traditional or Indigenous Knowledge systems, and their relevance. We can do so by creating a respectful space for early and timely conversations to occur.
- **Cultural context**: Native Hawaiians are tied to forest birds, their habitat, and the broader island environment through the Kumulipo (cosmological and genealogical creation chant). Thus, the four Hawaiian forest birds are 'ohana (family), and Native Hawaiians have kuleana (rights and responsibilities) regarding care and stewardship of the birds.

An important metaphor that emerged from this effort was the familial role in human palliative care. The hui developed a biocultural care model that could serve as a guide for appropriate, coequal stewardship for Hawaiian species risking extinction and undergoing aggressive management (Paxton et al. 2022). This model serves as a useful example for how other indigenous experiences can be integrated into our decision-making efforts.

Rose Atoll coral in American Samoa. Photo credit USFWS.

CHAPTER 5. WHERE DO WE GO FROM HERE?

Great Dismal Swamp National Wildlife Refuge in Virginia and North Carolina Photo by R. Winn, USFWS.

Key Messages

- We have an important role in creating a positive future for future generations.
- This Guidebook is intended to support our value of innovation. The information in the Guidebook will be reassessed in 5 years based on our successes, failures, and other learning that can only come from doing. We invite you to help.

Inspiring Change Navigators

The field of conservation has a history of adapting to address urgent and novel challenges as they emerge. Today, the unprecedented threat of climate change requires us again to rise to the challenge as species distributions shift, novel species assemblages develop, and ecological transformation accelerates. In the 20th century, conservation managers relied on historical conditions to guide our management actions. In the 21st century, the rapid pace of change demands that we enter a new era of conservation.

This new era of conservation needs "change navigators." We can better serve communities by engaging with them to navigate the continually changing ecological baseline. In this effort, we need to be clear eyed, acknowledging that we cannot continue making the same decisions in the same ways we have in the past. We are experiencing a paradigm shift that calls for a refined 21st-century approach to conservation. This paradigm shift is twofold: We can no longer rely on historical or current conditions for management baselines, and we cannot separate humans and nature.

When historical and current conditions cannot be maintained, we must identify the values, rules, and knowledge bases that allow us to meet our mission effectively within this constantly changing reality. Ecosystems and community assemblages have always been in flux, but we have managed them as if they were stable. Much of our existing decision context assumes that we can return to the past (e.g., using the historical condition as a baseline, implementing our current laws and policies, or being reluctant to take risks). We must find ways to shift our management of biodiversity, biocultural resources, ecosystems, and species targets toward futures that are different than the past.

This paradigm shift also highlights how humans are intertwined with nature in linked socioecological systems. Conservation actions can strengthen both ecological health and human well-being, defined as thriving human communities that have dignity and the autonomy to choose their future. We have a responsibility to future generations that will inherit a world shaped by the decisions we make today. Our management of public lands must engage surrounding communities consistently and authentically, and this effort includes listening to many voices that have previously not been heard. As we do so, we become better equipped to identify and incorporate a holistic set of values into our decision-making processes. Approaching our work in this way provides greater certainty that our decisions are representative, equitable, and strategic regardless of future conditions. Over time, consistently approaching collaboration in this way builds mutual respect and trust among people, which increases our ability to navigate transformation and steward biodiversity. Moreover, it brings us closer to others working collaboratively across disciplines and sectors at the local, national, and global scales to achieve optimal health for people, animals, and our environment.

Adaptive leadership delineates conservation issues into two categories: technical problems and adaptive challenges. Technical problems require skills, standard operating procedures, tools, direction from authority, etc. They constitute the daily work of conservation, and we are well trained to address them, so we feel confident and certain in doing so. However, we increasingly face situations in which conservation practitioners disagree about the solutions and sometimes even the definition of the problem. In these situations, our routine business practices become inadequate, which results in feelings of uncertainty. These adaptive challenges require all involved to be curious,

to explore values, to be open to compromise, and to embrace experimentation. Unless all parties involved adapt, we will see only limited progress on our toughest conservation challenges.

Next Steps

Stewarding fish, wildlife, plants, and their habitats through this era of ecological transformation is no small or easy task. While we have many tools and strategies, we need to supplement them with the ideas outlined in this Guidebook to truly become "change navigators." Implementing climate change adaptation strategically and across the RAD spectrum is not a passing fad. In fact, the field of biodiversity conservation has a history of addressing emerging problems while working across multiple scales, from the continental to the local. Implementing RAD will require us to tap into the collective genius within our institutions and across the communities we serve. No single person or team knows enough to understand the important work being done in every program or across every conservation landscape. This Guidebook is just a beginning.

We intend to continue to learn from and build connections to the work that we all do. We are seeking case studies to adapt the content of this Guidebook and to build knowledge bases through real-world examples. In other words, we need each of you. This Guidebook is intended to support our value of innovation. Our plan is to reassess the Guidebook in 5 years based on our successes, failures, and other learning experiences that can only come from doing. The multiscale and complex nature of the problem does not facilitate a one-size-fits-all or top-down approach. Instead, we need adaptive and technical leadership at all levels, which requires listening to each other and creatively addressing our needs locally while coordinating conservation at regional, national, and global scales.

Northern Harrier at Montezuma National Wildlife Refuge, New York. Photo by Doug Racine, USFWS.

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GLOSSARY

Adaptation A human or ecological response intended to moderate harm or take advantage of opportunities that occur as climate change unfolds.

Contingencies Key events that are highly influential but difficult to predict.

Decision context The interconnected social system of values, rules, and knowledge bases that bounds the problems and solutions that can be considered in decision-making processes (Gorddard et al. 2016).

Directional change Also known as nonstationarity, directional change is a continual trend or step change in ecosystem drivers that push the system outside the bounds of natural variability (Milly et al. 2008, Schuurman et al. 2022). Climate change is an example of directional change.

Ecological transformation The emergence of a persistence ecological system, often after disturbance, that is dramatically different from the prior ecosystem in terms of structure, function, or species composition or some combination thereof. Ecological transformation primarily results from climate change but also occurs due to other factors including invasive species, disease, pollution, and changes in land use (Lynch et al. 2021).

Landscape Conservation Design (LCD) "LCD is a partner-driven approach to achieve a sustainable, resilient landscape that meets the ecological and social needs of current and future generations" (Recommended Practices for Landscape Conservation Design).

Path dependence An ecosystem's unique context and legacies, such as dispersal constraints and soil properties in terms of how they have and will continue to shape future possibilities.

Portfolio A risk-management approach, similar to a financial portfolio, for conservation and management that is used to maximize conservation benefit and learning. RAD strategies are diversified and performance is monitored to facilitate the reallocation of strategies when needed (Aplet and McKinley 2017).

Eastern Gray Treefrog at Horicon National Wildlife Refuge, Wisconsin. Photo by Rachel Samerdyke, USFWS.

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