

Conceptual Management Approaches to Climate Change Adaptation

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“Organizations increasingly face adaptive challenges requiring them to abandon the familiar and routine. Instead, they need to develop the capacity to harness knowledge and creativity to fashion unique responses, stimulate organizational learning and sometimes embrace transformational change.”¹

--Carl Sussman (Management and Community Development Consultant)

Definitions of Key Terms

From Brian Hurd. 2007. Challenges of Adapting to Climate Change, in prep.

- **Vulnerability** identifies and indicates how susceptible a system is to climate changes. It is integrative of the other terms and measures the overall extent to which a particular human or natural system is exposed to the climate, the degree of its sensitivity to changes, and the level of its capacity to respond to adverse changes with the least disruption to essential functioning – otherwise termed as its adaptive capacity.
 - **Exposure** is a critical element of vulnerability, and is one that is often influenced by institutions and policies.
- **Sensitivity** describes how climate changes can affect a system and its function (distinct from any adaptations).
- **Adaptation** is a deliberate change system design, function, or behavior either in response to (**reactive or autonomous adaptation**), or anticipation of (**proactive or anticipatory adaptation**) changing conditions and/or external events. For example, a sustained precipitation increase across a grassland ecosystem could stimulate the growth of shrubs and trees and the adaptive transformation of the grassland into a chaparral or woodland ecosystem.
- **Adaptive capacity** is the ability of systems, organizations, and individuals to 1) adjust to actual or potential adverse changes and events, 2) take advantage of existing and emerging opportunities, and/or 3) cope with adverse consequences, mitigate damages, and recover from system failures. It is an indicator of how well a system could or would adjust to external changes.
- **Adaptation success** is said to follow a change or disturbance, if the level of system services and functionality is approximately maintained or restored.

Table 1. Examples of climate change-related effects on key ecosystem attributes upon which management goals depend for major resource management systems. Adapted from Kareiva, P., C. Enquist, A. Johnson, S. Julius, J. Lawler, B. Petersen, L. Pitelka, R. Shaw, J. West, *Synthesis & Conclusions* in U.S. Climate Change Science Program Synthesis and Assessment Product on Adaptation Options for Climate-Sensitive Ecosystems and Resources (SAP 4.4), *in review*.

Resource management system	Ecosystem attributes critical to management goals	Potential climate-related changes that could influence management goals
National Forests	<ul style="list-style-type: none"> • Fire tolerance • Insect tolerance • Tolerance to invasives 	<ul style="list-style-type: none"> • Altered fire regimes • Vegetation changes • Changes in species dominance
National Wildlife Refuges	<ul style="list-style-type: none"> • Persistence of threatened and endangered species • Wetland water replenishment 	<ul style="list-style-type: none"> • Threatened and endangered species decline or loss • Altered hydrology
Wild and Scenic Rivers	<ul style="list-style-type: none"> • Fish habitat (e.g. cold water) • Water quality • “Natural” flow 	<ul style="list-style-type: none"> • Increased water temperatures • Changes in runoff • Altered stream flow
National Parks	<ul style="list-style-type: none"> • Fire tolerance • Snow pack • Community composition 	<ul style="list-style-type: none"> • Vegetation shifts • Changes in snow pack amount • Temperature-related species shifts
State Game & Fish Departments	<ul style="list-style-type: none"> • Persistence of key game species & other species of conservation need 	<ul style="list-style-type: none"> • Declines of common species • Increased competition from exotics • Increased water temperatures

Table 2. Top five of over 400 climate change adaptation strategies summarized in a meta-analysis of over 200 published studies during the past two decades (adapted from Zavaleta & Heller 2007, *in press*).

Adaptation Recommendation	Example
1. Increase connectivity to accommodate need for movement & migration	Design corridors, remove dispersal barriers, reforestation, etc.
2. Integrate climate change into planning process and incentive programs	Reserve or protected area design includes gradients & replication; residential or commercial backyard habitat programs provide guidance and awards to citizens
3. Study species responses to climate	Demographics, behavior, physiology
4. Translocation of species	"Assisted migration" newer term being employed in context of climate change, but currently not a lot of guidance for implementing
5. Manage intensely to secure populations	Do whatever possible to ensure the survival of species of concern

Table 3. The “5-R +1” conceptual adaptation framework proposed for the National Forest System (adapted from L. Joyce, C. Millar, USFS May 2007 presentation and Millar et al., *Ecological Applications*, *in press*). Overarching tenets: (1) accept uncertainty yet be certain there will be change and (2) manage for desired future processes.

Approach	Definition	Example(s)	Caveat
Resistance (Reactive adaptation)	Defend high-value resources against change	“Homeland Security Approach”; intensive management of endangered species	Paddling up-stream? May only be short-term solution
Resilience (Facilitative adaptation)	Improve capacity of resource/natural system to return to [prior conditions] after disturbance	Reduce stress on system; prescribed fires, etc.	May be only short-term; system may increasingly contain novel elements if begins transition to a new state; mostly “no-regrets”
Response (Proactive adaptation)	Assist resource to follow changing climates	Assisted migration; “off-site” plantations; plan for extremes; use redundancy; bet-hedge; connectivity	Risky if future climate predictions are highly uncertain
Realign	Used in lieu of restoration; facilitate the establishment of conditions outside Natural Range of Variation (NRV)	Re-think restoration principles	Difficult to determine what these conditions are or should be
Reduce (Green house gas (GHG) mitigation)	Use management options that sequester carbon and limit GHG emissions	Reduce deforestation; reduce catastrophic wildfire; reduce employee reliance on fossil fuels	Science still limited in carbon accounting; benefits reached in long run; may require well-coordinated policy at the national level
Triage	As in medical emergencies, prioritize situations according to urgency and magnitude of need		No action may be taken as an option because a situation may be “untreatable” even if urgent.

Table 4. Conceptual approaches to adaptation and examples that support ecological resilience across major resource management systems; confidence levels (determined by expert opinion) in parentheses. Adapted from Kareiva, P., C. Enquist, A. Johnson, S. Julius, J. Lawler, B. Petersen, L. Pitelka, R. Shaw, J. West, *Synthesis & Conclusions* in U.S. Climate Change Science Program Synthesis and Assessment Product on Adaptation Options for Climate-Sensitive Ecosystems and Resources (SAP 4.4), *in review*.

Approach	National Forests	National Parks	National Wildlife Refuges*	Wild & Scenic Rivers
Protection of Key Ecosystem Features	Conduct thinning & fuels abatement treatments to reduce crown fire potential & risk of insect epidemics (<i>Medium</i>)	Prevent establishment of invasive exotic species that threaten native species or current ecosystem function (<i>Medium</i>)	Improve the matrix surrounding refuge/reserve by partnering with adjacent owners to improve/build new habitats (<i>High</i>)	Manage dam flow releases upstream to save flora & fauna downstream in drier reaches (<i>High</i>)
Reduction of Anthropogenic Stress	Attempt to balance need for recreational opportunities & access with ecological sensitivity (<i>High</i>)	Move or remove human infrastructure to minimize ecological effects of sudden changes (<i>High</i>)	Minimize human water withdrawals to restore hydrologic regimes (<i>Very high</i>)	Claim or purchase more water rights; consider moving access points (<i>High</i>)
Representation	Hedge against change by modifying genetic diversity guidelines to increase the range of species, favor genotypes known for broad tolerance ranges (<i>High</i>)	Allow establishment of species that may be locally non-native but maintain native diversity in overall region (<i>High</i>)	Strategically expand unit boundaries to increase ecological, genetic, geographical, behavioral & morphological variation in species (<i>Very high</i>)	Increase physical habitat heterogeneity in channels to benefit aquatic fauna (<i>Low</i>)
Replication	Spread risks by increasing ecosystem redundancy & buffers in natural environments & plantations (<i>High</i>)	See previous (<i>N/A</i>)	See previous (<i>Very high</i>)	See previous (<i>Low</i>)
Restoration	Have immediate plans to encourage return of desired species to site post-disturbance (<i>Medium</i>)	Restore ecosystems with vegetation that is no longer present locally, but is native to overall region (<i>Medium</i>)	See previous (<i>Medium</i>)	Stabilize eroding banks, repair in-stream habitat, or promote fish passages (<i>Medium</i>)
Refugia	Identify areas “buffered” against climate change & use as sites for new plantations or long-term conservation (<i>High</i>)	Create refugia for valued aquatic species at risk to the effects of early snowmelt on stream flow (<i>NA</i>)	Reforest riparian boundaries with native species to create shaded thermal refugia for species in streams (<i>Low</i>)	See previous (<i>Medium</i>)
Relocation	See following (<i>Low</i>)	Assist in species migrations & transplants (<i>Medium</i>)	Facilitate long-distance transport of threatened endemic species (<i>Low</i>)	Move isolated populations that become stranded when water levels drop (<i>Very Low</i>)

*Analogous to The Nature Conservancy & NMGFD reserve systems.

Table 5. Barriers and opportunities to successful implementation of climate change adaptation strategies. Adapted from Kareiva, P., C. Enquist, A. Johnson, S. Julius, J. Lawler, B. Petersen, L. Pitelka, R. Shaw, J. West, *Synthesis & Conclusions* in U.S. Climate Change Science Program Synthesis and Assessment Product on Adaptation Options for Climate-Sensitive Ecosystems and Resources (SAP 4.4), *in review*.

POLICIES AND PROCEDURES	
Barrier	Opportunity
Legislation and agency policies may be highly static, inhibit dynamic planning, impede flexible adaptive responses and force a fine-filter approach to management.	Re-evaluate capabilities of, or authorities under, existing legislation to determine how climate change can be addressed within the legislative boundaries. <i>Example:</i> Use state wildlife action plans to manage lands adjacent to national wildlife refuges to enable climate-induced species emigration.
Seasonal management activities may be affected by changes in timing and duration of seasons	Review timing of management activities and take advantage of seasonal changes that provide more opportunities to implement beneficial adaptation actions. <i>Example:</i> Take advantage of shorter winter seasons (longer prescribed fire season) to do fuel treatments on more national forest acres
Agency policies do not recognize climatic change as a significant problem or stressor.	Take advantage of flexibility in the planning guidelines and processes to develop management actions that address climate change impacts. <i>Example:</i> Where guidelines are flexible for meeting strategic planning goals (<i>e.g.</i> , maintain biodiversity), re-prioritize management actions to address effect of climate change on achievement of goals
HUMAN AND FINANCIAL CAPITAL	
Barrier	Opportunity
Lack of incentive to take risks, develop creative projects; reward system focuses on achieving narrowly prescribed targets; funds allocated to achieve targets encourage routine, easily accomplished activities.	Shift from a culture of punishing failure to one that values creative thinking and supports incremental learning and gradual achievement of management goals. <i>Example:</i> NPS “Safe to Fail” policy/program
Little to no climate expertise within many management units at the regional and local level; disconnect between science and management that impedes access to information	Use newly created positions or staff openings as opportunities to add climate change expertise; train resource managers and other personnel in climate change science <i>Example:</i> Use incremental changes in staff to “reinvent and redefine” organizations’ institutional ability to better respond to climate change impacts
National and regional budget policies/processes constrain the potential for altering or supplementing current management practices to enable adaptation to climate change; general decline in staff resources and capacity	Look for creative ways to augment the workforce and stretch budgets to institute adaptation practices (<i>e.g.</i> , individuals or parties with mutual interests in learning about or addressing climate change that may be engaged at no additional cost). <i>Example:</i> Identify organizations or private citizens that benefit from adaptation actions to share implementation costs in order to avoid more costly impacts/damages.
INSTITUTIONAL COORDINATION & COLLABORATION	
Barrier	Opportunity
Political boundaries do not necessarily align with ecological processes; some resources cross boundaries; checkerboard ownership pattern of public and private lands at odds with landscape-scale management	Identify management authorities/agencies with similar goals and adjacent lands; share information and create coalitions and partnerships that extend beyond political boundaries to coordinate management; acquire property for system expansion. <i>Example:</i> Coordinate habitat and thermal needs for fish species with entities that control the timing and amount of up-stream water releases

INFORMATION AND TOOLS	
Barrier	Opportunity
Often no inventory or baseline information on condition exists, and nothing is in place to detect climate change impacts.	Identify existing monitoring programs for management; develop a suite of climate change indicators and incorporate them into existing programs. <i>Example:</i> Use monitoring programs such as the NPS Inventory and Monitoring Program, the Watershed Condition Assessment (WCA), and the Vital Signs monitoring programs to monitor for climate change impacts and effectiveness of adaptation options
Historic conditions may no longer sufficiently inform future planning (e.g., “100-year” flood events may occur more often and dams need to be constructed accordingly)	Evaluate policies that use historic conditions and determine how to better reflect accurate baselines in the face of climate change; modify design assumptions to account for changing climate conditions. <i>Example:</i> Change emphasis from maintenance of “minimum flows” to the more sophisticated and scientifically based “natural flow paradigm”
Lack of decision support tools and models, uncertainty in climate change science, and critical gaps in scientific information that limits assessment of risks and efficacy and sustainability of actions.	Identify and use all available tools/mechanisms currently in place to deal with existing problems to apply to climate-change related impacts. <i>Example:</i> Use early detection/rapid response approaches (such as that used to manage invasive species) to respond quickly to the impacts of extreme events (e.g., disturbances, floods, windstorms)
Occurrence of extreme climate events outside historical experience.	Use disturbed landscapes as templates for “management experiments” that provide data to improve adaptive management of natural resources. <i>Example:</i> After fire, reforest with genotypes of species that are better adjusted to the new or unfolding regional climate with nursery stock tolerant to low soil moisture and high temperature, or with a variety of genotypes in the nursery stock
Stakeholders/public may have insufficient information to properly evaluate adaptation actions, and thus may oppose/prevent implementation of adaptive projects (e.g., such as those that have ground-disturbing elements like salvaging harvests after disturbance and using herbicides before revegetating). Appeals and litigation from external publics often results in the default of no action	Inform public and promote consensus-building on tough decisions; invite input from a broad range of sources to generate buy-in across stakeholder interests. <i>Example:</i> Conduct public outreach activities with information on climate impacts and adaptation options—including demonstration projects with concrete results—through workshops, scoping meetings, face-to-face dialog, and informal disposition processes to raise public awareness and buy in for specific management actions

¹C. SUSSMAN, . BUILDING ADAPTIVE CAPACITY: THE QUEST FOR IMPROVED ORGANIZATIONAL PERFORMANCE 1-20. (Sussman Associates 2004)