Natural Resource Management; Reframing Strategies for Climate Change

February 13, 2008
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Issues

Many current natural-resource management strategies and practices are based implicitly or explicitly on assumptions of a stable environmental background over time. That is, even where successional or disturbance dynamics and spatial heterogeneity are acknowledged (e.g., managing for a "range of natural variation"), the assumption is that the backdrop is unchanging. Incorporating the implications of climate change, either natural variability or human-driven, forces a rethinking of basic management frameworks and methods. In managing for climate change, the point is not just to "think outside the box, but to recognize that the box itself has moved" (Seastedt et al. 2008), Further it is to recognize that the box will continue to move in bursts and fits, reversals, and even with some periods of relatively little change. It is to recognize that, useful as predictive models are, they cannot accurately forecast complex ecosystem responses at a scale of relevance to managers. Uncertainty yet certain change becomes a robust context in which managers must act. This leads to the question in many managers' minds, "OK, we get that climate is changing. Now, what do we do about it?"

Likely Changes

The panoply of physical, biological and social changes that is ensuing as a result of rapidly changing climates affects nearly every aspect of resource management. For example, with warming temperatures, declining montane snowpacks, and earlier stream runoffs, fundamental watershed management decisions are affected that rely on such factors as: river water temperature, streamflow levels, water quality, water seasonality; riparian habitat composition and quality; hillslope erosion and sediment delivery; structure, function, and composition of upland vegetation at genetic, species, and association levels; habitat quality and durability for wildlife; population stability of threatened, endangered, and sensitive species; relationships of invasive species; insect and disease relations; fuel quality and densities; fire regimes, timing, severity, and recovery; atmospheric quality; recreation opportunities and carrying capacities.

Environmental changes that unfold as a result of changes in climate will differ in different parts of the country, will affect ecosystems complexly, and thus management implications will vary widely. There will be no single overarching change or set of changes and likewise no one-size-fits-all management adjustment.

Options for Management

Key overarching concepts include:

• *Embrace and work with change*.
• *Accept uncertainty as a premise for decision-making.*
• *Recognize that some existing management paradigms have limited value*.
• *Manage for desired future processes and ecosystem services rather than desired future conditions*.

Overall Strategy: *Adopt a Toolbox Approach*

No single solution and no individual management approach will be appropriate to all or even most situations. Now and later, tools should be mixed and combined to best match the particular management context under consideration.

Contents of the ToolBox: *Adaptation, Mitigation and the "5-R Strategies"*

Adaptation and Mitigation. At the highest level in the toolbox are two broad climate-change strategies: *adaptation and mitigation* (IPCC 2007a). Adaptation implies all those approaches taken to adjust, prepare, and accommodate new conditions that are created by changing climates. For natural-resource managers, adaptation strategies include those actions taken to assist natural resources in accommodating the changes and new conditions imposed by climate. Mitigation strategies include those actions taken to reduce and reverse the human influence on the climate system, primarily through reduction of greenhouse gas emissions and feedbacks.

Adaptation and mitigation strategies are best considered joint paths – these primary tools optimally are combined and integrated. Approaches to adaptation and mitigation will often be complementary. However, conflicts are likely to arise. Thus, evaluating pros and cons of short- and long-term choices becomes extremely important.

Five broad sub-strategies within the adaptation-mitigation toolbox are listed below. They are summarized in order from most conservative to most pro-active.

*Adaptation Strategies: 1. Increase **Resistance** to Change.* Defending high-value resources against change is an appropriate and defensible, if short-term, approach for resource managers under certain circumstances. High-risk, high-value, and/or extremely urgent situations, such as critically vulnerable endangered species, extreme fire-risk situations, or volatile invasive species epidemics, are most appropriate subjects for resistance management. In such cases, using great force to armor resource against change may be the best option. This action may be extremely expensive, take much time, resource, and staff effort, and be possible only for the short term. Resisting change may often be risky; in many situations conditions will eventually become so different that a resource threshold passes and resistance becomes futile. Then, an undesired consequence can be that the system ratchets forward catastrophically. Thus, choosing to resist change might be considered a "paddling upstream" option.

*Adaptation Strategies: 2. Promote **Resilience** to Change*. Promoting resilience is the most commonly discussed adaptation strategy (Dale et al. 2001, Spittlehouse and Stewart 2003). When a species, habitat, watershed or other natural resource returns to its former condition or function after disturbance, it is said to have resiled. In that climate change brings new types and

intensities of extreme events, management actions to promote resilience are those that improve the capacity to return to desired prior conditions after climate-induced disturbance. A widely held but mostly untested assumption is that "healthy" species, forests, ecosystems are more resilient to change. Thus, preventative treatments aimed at increasing health, are prescribed. As in resistance options, strategies to promote resilience are likely only successful in the relatively short-term, in that eventually changed climates will force new environmental conditions such that ecological re-setting rather than resilience will be "healthiest" path toward adaptation.

Adaptation Strategies: 3. Enable Ecosystems and Resources to ***Respond*** *to Change.* Responding to and managing change is the most proactive approach described here. This strategy assumes that a decision-maker acknowledges the inevitability of change and adopts the humility that we have limited capacity to understand what change will happen at the scales needed by managers. Many types of actions can assist species, ecosystems, or resources to move to new and adapted conditions and processes. Some choices are highly deterministic – that is, acting as if we can predict what changes will occur. Others are based on uncertainty about direction of change. The following are examples of strategic approaches:

- *Assist species and resources to follow changing environments*.
- *Anticipate and plan for associated risks.*
- *Experiment creatively and learn from experiments*.
- *Use redundancy*.
- *Relax genetic-management guidelines*
- *Experiment with refugia.*
- *Increase diversity*
- *Promote connected landscapes*

Adaptation Strategies: 4. ***Realign*** *Conditions to Current and Future Dynamics.* For systems that have been pushed (manipulated, disturbed) far out of range of natural variability, actions that promote alignment with current conditions and processes may be the best approaches for restoration rather than returning to historic conditions. Using historic range of variability and returning habitats to pre-settlement or pre-disturbance conditions, which are widely used models for ecosystem restoration, will often be inappropriate because so much change has occurred since pre-disturbance times. In western North America, for instance, pre-settlement period is the mid-1800s, which coincides with the coldest part of the Little Ice Age. Clearly these are inappropriate conditions to use as a target for the 21st century environments. Re-aligning or tuning to current and anticipated environments and processes is more likely to be successful.

Mitigation Strategies: 5. ***Reduce*** *Greenhouse Gases and* ***Reduce*** *Non-Renewable Energy Use.* The forestry sector has an enormous opportunity to reduce human influences on the climate system. Reducing greenhouse gases can be achieved through management actions designed so that sequestration is enhanced, carbon stored in natural resources is retained longer, emissions are lowered and non-fossil fuel alternative energy favored. By contrast, poor management, lack of management, or inadequate capacity to manage can inadvertently accelerate negative effects, for instance through increase of large, catastrophic forest fires.

Setting Priorities

More than ever, demands will exceed capacity and conflicts among choices will have higher stakes. Evaluation of options and setting priorities will be increasingly important. At an overall level, decision-makers have three options for engaging climate-management, each defensible under different scenarios. They can do nothing (no advance planning), react after disturbance or extreme events (when trajectories are often adaptively reset under natural conditions) or act proactively in advance (Joyce et al. in press). Several approaches to priority setting have been discussed in the context of climate change. These include tiered approaches such as no-regrets, low regrets, win-win (Willows and Connell 2003), and employing low- to high-technology approaches judiciously (Ralph 2007). Formal triage approaches, developed and used widely in military and emergency medicine, can be successfully adopted in resource situations whenever time is short and capacity to meet urgent demands inadequate. Systematically evaluating vulnerabilities provides an essential first step in all approaches (IPCC 2007b).

Recommended Reading

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