# Informing Coastal Restoration Planning Decisions in a Changing Climate


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## ABSTRACT


### Climate change presents new challenges and opportunities for the protection and restoration of coastal ecosystems worldwide

Accelerated rates of sea level rise, increases in air and water temperatures, changes in precipitation patterns, and increased frequency and severity of extreme weather events are some of the anticipated effects on coastal systems. The complexity, variability, dynamism, and diversity in the effects of climate change creates tremendous uncertainty for coastal ecosystem restoration planning. The range of social responses and adaptations to a changing climate is extensive and complex.

Principles to support restoration planning in the face of these challenges include futuristic thinking, building resilience, use of relevant and contemporary rationales, adaptive management, and a focus on opportunities. To apply these principles, I present a four-step framework as a decision support tool for restoration planning and implementation. Integrating climate change effects into restoration begins with a spatially explicit assessment of vulnerabilities and opportunities across a coastal landscape. Identifying the distribution of constraints and opportunities resulting from climate change (e.g., social, economic, ecological, hydrological, geomorphological) enables decision makers to prioritize areas for restoration. Information regarding the vulnerability and adaptive capacity of social-ecological systems can be used to inform restoration strategies. The principles and the decision framework suggest that achieving desirable coastal restoration outcomes will require integrative and adaptive approaches to planning and implementation that can account for complex connections between humans and nature under conditions of persistent uncertainty.


## PROBLEM ADDRESSED

### Coastal ecosystems are valuable landscapes

They support tremendous biological production, recreational opportunities, aesthetic beauty, and are important portals for economic activities.

### They are intensively occupied

One-fifth of the world's population lives in coastal zones.

### Biophysical processes maintain coastal ecosystems

These processes have been altered, disrupted, and degraded by human activities.

### Small- and large-scale restoration efforts are becoming more common

Restoration includes both physical activities (e.g., removing barriers to tidal flow, removing coastal erosion structures, etc.) and protection activities (e.g., property acquisition, setbacks, easements, etc.).

### The consequences of increased levels of atmospheric carbon dioxide are still emerging

Climate change predictions point to some general trends, including: accelerated rates of sea level rise; increases in mean air and water temperatures; changes in precipitation patterns; increased frequency and severity of extreme weather events; and increased acidity of sea water.

### Predicted Climate Change Effects on Coastal Ecosystems

**Increased**

- Storm-related flooding events
- Storm-related coastal erosion
- Landslides
- Mass-wasting events
- Maximum saltwater intrusion
- Acidification of seawater (decreased pH)

**Altered**

- River and stream flow patterns
- Nutrient loading patterns
- Sediment accumulation patterns
- Estuarine circulation patterns
- Coastal upwelling events
- Fish and wildlife movement and migration patterns

### Research Questions

Q1: What new opportunities and challenges does climate change present to the planning of coastal ecosystem restoration?

Q2: How do restoration planners and practitioners optimize their ability to understand the type and range of vulnerabilities and opportunities that climate change presents?

## PRINCIPLES

### Principles for planning ecological restoration in the face of climate change are emerging

As a result of a meta-analysis of the conservation biology, landscape ecology, restoration ecology and climate change adaptation literature, I offer the following subset of principles relevant to the planning of coastal restoration and protection actions. These principles should be considered in addition to sound strategies described in the large and growing literature of restoration ecology (e.g., Hobbs & Norton 1996; Perrow & Davy 2002; Clewell & Aronson 2007).

- The Future is Now
- Emphasize and Broaden Resilient Approaches
- Contemporary Restoration Rationales Win
- Minimize Uncertainty Using Available Tools
- Search For and Seize Opportunities

## DECISION FRAMEWORK

### A framework developed as a decision support tool for restoration planners and practitioners

The following four-step framework was developed as a decision support tool for restoration practitioners seeking to integrate climate change considerations into planning for large-scale recovery of degraded coastal ecosystems. The goal is to expand current restoration approaches to include a framework for examining vulnerabilities and opportunities for restoration as a result of climate change.

**STEP 1. Define Restoration Planning Area and Timescale**

- Geographical Planning Area
- Planning Horizon

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**STEP 2. Assess Landscape for Vulnerability and Adaptation Potential**

**Biogeophysical Processes and Effects**

- Exposure
- Sensitivity
- Adaptive Capacity

**Social Context and Adaptation Potential**

- Exposure
- Sensitivity
- Adaptive Capacity

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**STEP 3. Inform Restoration Goals and Strategies**

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**STEP 4. Incorporate Climate Change Monitoring into Adaptive Management**

## SOCIAL CONTEXT

### Climate change illustrates the coupled nature of social and ecological systems perhaps better than any other environmental issue

In a social-ecological system (SES), humans depend on resources and services provided by ecosystems, and ecosystem dynamics are influenced by human activities (Berkes et al. 2003). Climate change not only directly links human activities to the future of ecological systems, but also conjures images of human adaptation to coastal change at heretofore-unprecedented scales. From a SES perspective, restoration practitioners can better understand and appeal to the social motivations for restoration (Clewell & Aronson 2006).

Approaching restoration and ecosystem management from an SES perspective can also:

- Increase the transparency of the complex connections among science, human values, and policy choices that dictate the pattern and intensity of coastal restoration;
- Allow the analysis of ecosystem change to consider and anticipate implications for human well-being, both positive and negative; and
- Account more explicitly for social elements such as property use and rights, wealth and infrastructure, and cultural ties to the land during decision-making about how best to invest public funds (Chapin et al. 2009).

## SUMMARY

To be robust in an accelerated, changing climate, large-scale, strategic restoration in coastal ecosystems around the globe will need to account for both ecosystem science and the human dimensions of climate change. Keys to effective protection and restoration of coastal ecosystems include a social-ecological system perspective, resilience thinking, and an understanding of climate-induced vulnerabilities and opportunities across the landscape. Climate change may redefine our view of coastal ecosystem protection, management, and restoration. Restoration of tidal wetlands has the potential to mitigate greenhouse gas emissions, and the impetus for coastal restoration as a climate change adaptation tool is growing. For example, managers in the Florida Everglades are restoring tidal marshes to build resilience against sea level rise and the associated increase of saltwater intrusion into freshwater aquifers. Opportunities to reduce climate change threats and take advantage of climate-induced biophysical and social changes through restoration should be incorporated into coastal zone management and sustainable ecosystem management programs today.


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References

Berkes, F., J. Colding, and C. Folke. 2003. Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, New York.

Clewell, A. F., and J. Aronson 2006. Motivations for the Restoration of Ecosystems. Conservation Biology 20:420–428.

Clewell, A. F., J. Aronson, and Society for Ecological Restoration International (SERI). 2007. Ecological restoration: principles, values, and structure of an emerging profession. Island Press, Washington, D.C.

Chapin, F. S., G. P. Kofinas, and C. Folke. 2009. Principles of ecosystem stewardship resilience-based natural resource management in a changing world. Springer, New York, NY.

Hobbs, R. J., and D. A. Norton. 1996. Towards a conceptual framework for restoration ecology. Restoration Ecology 4:93-110.
Perrow, M. R., and A. J. Davy. 2002. Handbook of ecological restoration. Cambridge University Press, Cambridge, UK; New York.


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