Climate-Smart Restoration Principles

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1. Show your work

Deciding how to restore places in a way that prepares them for the consequences of climate change is relatively new endeavor for conservationists. The task is made challenging by the high level of uncertainty about how climate will change and how society will respond. In some cases, the information we use to guide action today, may be very different from the information we use to guide action in the future (e.g., Jim Hansen's predictions of sea-level rise). By showing our work, we help future generations understand if they need to take new action as new information becomes available. Showing your work aids in arriving at the best possible actions, as you asked and answer key questions about the project.

2. Look forward but don't ignore the past

Climate-smart restoration needs to set forward-looking goals, use available science on climate change predictions, and learn from historic conditions and events.

Using the best available climate models, at the scale appropriate, aids project design and likely increases the probability of long-term success. Practitioners can use climate projections when planning restorations, for example, by increasing the proportion of plant species that will be favored under expected future conditions and reducing the proportion with low tolerance to expected future conditions.

Because climate change will create conditions that are different from past and current ones, setting forward-looking goals will be essential.

It is important to recognize that there remains much to be learned from the past that can help in designing projects to succeed in the future. Information on a species' or ecosystem's response to historic climatic extremes can serve as a useful analog to how they might fare under a future with more frequent droughts. Additionally, it is likely that historical ecosystems were more resilient than current ones (e.g., less fragmented) and hence can serve as models for future conditions.

3. Consider the broader context

Climate-smart restoration needs to be concerned with climate change impacts beyond the scale of individual projects, prioritize what and where to do restoration, and must be considered within the context of threats beyond those posed solely by climate change.

Success of individual projects is influenced by the surrounding landscape (e.g., adjacent land use), ecological setting (e.g., hydrology), and future conditions (e.g., sea-level rise). Hence, considering the landscape can be used to prioritize projects as well as to plan for specific actions.

A landscape scale perspective also reinforces the need to keep connectivity as a key characteristic of restoration to improve the potential for species to move in response to climate change and for preserving the ecological processes for evolutionary adaptations to climate change.

Climate change does not act alone in stressing ecosystems and considering it in isolation for restoration is likely to put the success of a project as risk. It is essential to consider and plan for the full range of threats in the system, such as loss of habitat. As an increasing number of climate change vulnerability assessments become available for ecosystem services and individual species, they will serve as an important tool for quantifying the impacts of climate change in the context of other ecological stressors.

4. Build in ecological insurance

Restoration approaches that incorporate redundancies and are robust to a range of future scenarios may act to provide ecological insurance against uncertain future conditions.

Redundancy is an approach used by engineers and designers of complex systems where duplication of important components or functions increases the reliability of the system. Increasing redundancy in restoration means adding additional and/or more abundant components (e.g., fire adapted species in places where fire is likely to increase) and functions (e.g., engineered placement of large woody debris capable of withstanding greater stream flows while maintaining fish refugia). In cases where the available science is highly uncertain or divergent, restoration should be designed to succeed in multiple scenarios.

Increasing or maintaining ecological diversity may contribute to ecosystem function and resilience and hence may be a form of ecological insurance. High ecological diversity could reduce the probability of ecosystem collapse if it buffers change in functional composition of the community, and there is relatively little risk in increasing it in restoration projects.

5. Build evolutionary resilience

It is increasingly recognized that microevolutionary change can occur at the relatively short timescales relevant to natural resource management decisions, and may therefore be a critical pathway by which species escape extinction under climate change. Consequently, restoration actions that build evolutionary resilience by managing microevolution are climate-smart.

Evolutionary resilience can be accomplished by restoration projects that increase the size and connectedness of populations to allow for the maintenance of genetic variation and ongoing evolution in order to keep pace with climate change and may increase the probability that an ecosystem can recover after climatic extremes.

6. Include the human community

The long-term success and growth of climate-smart ecological restoration projects will be facilitated by a community of advocates with an understanding of the what, why, and how to prepare systems for climate change. Additionally, project sustainability will be increased when people who understand and care about it can monitor and maintain it. Hence, projects where students, teachers, and the general public are involved will be better supported and their influence increased.

7. Monitor and Experiment

Given the great uncertainties around how climate change will impact ecosystems and how society will respond, it is important to conduct ecological monitoring to manage adaptively.

Restoration experiments can help provide answer to key uncertainties, provide tools to access key information, and help evaluate effectiveness.