Biodiversity, ecosystems and land management in the face of a changing climate

Recommendations for land managers in the San Francisco Bay Area

Land Conservation is more critical than ever to protect biodiversity in the face of climate change. Species need to migrate to track suitable climate and the more habitat that is available, the more likely dispersal will be successful. The landscape has a strong influence on local climatic conditions. Rugged terrain creates variable conditions, including cold air pools in valley bottoms, hot dry south-facing slopes, and moist north-facing slopes. Conserving a range of landscape conditions (e.g. via the Conservation Lands Network) will enhance living systems' resilience in the face of climate change. Cooler, moister locations may serve as "climate refugia" (areas where a species can survive during otherwise unfavorable conditions). Enhanced linkages between protected areas will provide migration pathways. For species of concern (e.g. threatened, rare and California endemics), protecting both current populations and locations where they are likely to live in the future will be critical to long-term survival. Co-benefits of open space protection include greater water supply and water quality, increased carbon sequestration, and higher land values and quality of life for neighboring communities.

Fire: Climate change is expected to increase the frequency and intensity of wildland fire due to more hot, dry weather that in turn increases the flammability of vegetation. If winter rainfall increases, faster plant growth can increase available fuel loads, particularly given current fire suppression practices. Fuel reduction, such as forest thinning or prescribed burns, is an important management tool. Revegetation and succession management following fires provides an opportunity to promote a diversity of species likely to succeed under future climates. It is important to ensure availability of seed stock of climate-adapted species for post-fire treatments, both by protecting native populations and enhancing available nursery stock.

Grazing is an important management tool for grasslands that can promote native vegetation, especially in wetter grasslands, vernal pool systems and serpentine, where competition with non-native grasses and other invasive species is strong. Carefully managed grazing can be a valuable part of a manager's toolbox to enhance water retention and carbon sequestration in grassland soils. Grazing may also be useful to reduce fuel loads and fire risk, suppress woody plant encroachment, and in some cases compensate for the impacts of atmospheric nitrogen deposition. A good source for grazing management is the "Grazing Handbook – A Guide for Resource Managers" by the Sotoyome Resource Conservation District which is available online. Also see Point Blue Conservation Science, Water and Working Lands.

Invasive Species: Non-native, harmful species will continue to pose threats to local ecosystems, especially following disturbances such as wildfires and drought-induced tree deaths. Early detection and control efforts are critical, especially where conditions are projected to improve for invasive species. The California Invasive Plant Council provides an online CalWeedMapper tool with information on climate change and invasive plants.

Restoration in a Changing Climate: Habitat enhancement strategies have traditionally focused on restoring degraded habitats to historical baseline conditions, relying on local seed sources where available. In the face of rapid climate change, this may not be best approach to ensure success under novel conditions. Planting a broader range of genotypes (high genetic variation) within species and perhaps even including non-local species may need to be considered. Climate analogs for a site of interest may be helpful for long-term restoration planning. However, given the uncertainty around future trajectories, planting non-local species based on projected future suitability may be premature. The risks and benefits of using new reference sites and non-local versus local seed are best assessed by the land manager on a case-by-case basis. Some general recommendations include the following.

- Use an experimental approach: test the introduction of new genotypes and species initially in small areas and compare survival rates, pathogen or insect vulnerability, and competitive success across multiple years.
- Be proactive about seed collection and nursery propagation to be prepared for opportunities (e.g., widespread fire) to set systems on climate-adapted trajectories:
    - Collect seed from across climatic conditions within or near your site to capture potential genetic variation along environmental gradients.
    - Collect seed from drier and hotter areas within the distributions of target species, and from other native species adapted to hotter and drier conditions which currently may not be widely used in restoration.

Also see Point Blue Conservation Science, Climate-Smart Restoration.

Monitoring: Biodiversity and environmental monitoring is critical to long-term conservation success. Important targets include foundation species that create and define major habitats, climate change sensitive species that are likely to decline, as well as species projected to persist or positively benefit from climate change. Changes in phenology, recruitment and mortality may provide early indicators of longer-term impacts of climate change. Collaborative monitoring, coordinated at the regional level will enhance the value of monitoring data; in the North Bay, contact Pepperwood Preserve to learn more about ongoing monitoring projects and partners at tbc3@pepperwoodpreserve.org.

Special thanks to TBC3 team members and the Gordon and Betty Moore Foundation.

Pepperwood PRESERVE Berkeley UNIVERSITY OF CALIFORNIA

For more information see www.pepperwoodpreserve.org/tbc3.