Climate Change and Your National Forest

Forestlands across the world are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes are negative, natural resource management can help mitigate these impacts. Management strategies informed by the best current science enable natural resource professionals within the Forest Service to better protect the land and resources and conserve the region's forestlands into the future.

Assessing the potential effects of climate change on El Yunque National Forest

Climate Trends – Average temperatures in El Yunque have increased over the past 30 years, and scientists predict warming will continue at an accelerated pace, however, climate models vary in the degree of warming. Projected decreases in precipitation in the Caribbean suggest drier wet seasons, and even drier dry seasons. Increasing sea surface temperatures may lift the base altitude of cloud formation and alter atmospheric circulation patterns. Any change in the cloud base height will further decrease precipitation in El Yunque.[1-5]

Extreme Weather – In the Caribbean, the occurrence of very warm days and nights is accelerating, while very cool days and nights are becoming less common, increasing the likelihood of extreme heat waves. The frequency of extreme precipitation events is expected to increase, leading to potential increases in inland flooding and landslides. Hurricane events are likely to become less frequent but more severe, with increased wind speeds, rainfall intensity, and storm surge height. As annual rainfall decreases over time in the Caribbean region, longer periods of drought are expected in the future. In Puerto Rico, where nearly all wildfires are associated with human activity, the interactions between climate warming and drying and increased human development have the potential to increase the effects of fire.[6-14]

Biological Diversity – Plants and animals at risk will respond to environmental changes by adapting, moving, or declining. Species with high genetic variation will be better able to survive in new conditions. Higher temperatures will cause many species to shift ranges up in elevation. However, in some cases, the rate of warming combined with land use changes will restrict the ability of plants and animals to move into suitable habitat. Highland species with restricted habitats and are more likely to be negatively impacted by climate change than are lower elevation species. In montane cloud forests in El Yunque, narrow thermal ranges may pressure these high elevation species beyond their upper elevational limits.[15-21]

Aquatic Ecosystems – Shifts in rainfall patterns due to climate change will lead to periods of flooding and drought that can significantly impact aquatic ecosystems and water resources. Increases in heavy downpours and more intense hurricanes in the wet season can lead to greater erosion and sedimentation in waterways. Riparian areas will see changes in structure and composition due to altered temperature, precipitation and run-off regimes as well as changes in the distribution of plant and animal species. Extended droughts in the dry season may significantly affect water resources by decreasing dissolved oxygen content. Freshwater aquatic communities during drought will experience crowding of species, leading to habitat squeezes and a decrease in reproductive output.[22-28]

Cloud forest species may be particularly vulnerable to future changes

Terrestrial Ecosystems – Higher temperatures, changes in precipitation patterns, and any alteration in cloud cover will affect plant communities and ecosystem processes. Increasing night-time temperatures may affect tropical tree growth and induce tree mortality. Both intensified extreme weather events and progressively drier summer months in the Caribbean are expected to alter the distribution of tropical forest life-zones, potentially allowing low-elevation Tabonuco forest species to colonize areas currently occupied by Colorado forest. El Yunque's tropical montane cloud forests are among the world's most sensitive ecosystems to climate change. Cloud forest epiphytes may experience moisture stress due to higher temperatures and less cloud cover with a rising cloud base, affecting epiphyte growth and flowering. Plant communities on isolated mountain peaks will be most vulnerable, as they will not be able to adapt to the shifting-cloud base by moving to higher elevations.[29-36]

Wildlife – Wildlife species will be affected in different ways, depending on their needs. Climatic warming may push the narrow thermal tolerances of many species in tropical environments above their upper limits, prompting population losses and habitat changes that will affect animal communities. Because of their cool-adapted, range-restricted nature, high elevation amphibians, including Puerto Rican Coquí frogs, are especially vulnerable to future changes. More frequent drought conditions may increase the vulnerability of both reptiles and amphibians to water loss, disease, and parasites. Reduced rainfall may lead to decreased habitat quality for neotropical bird migrants wintering in El Yunque, while cavity-nesting birds, including the Puerto Rican Parrot, could see an increase in habitat competition and nesting predation with an increase in major hurricane disturbances.[37-50]

Recreation – The Caribbean region, where year-round warm weather is the principle tourism resource, may see increasing competition from other regions as warm seasons expand globally. Sea level rise will affect coastal resorts, which may affect tourist and recreationist preferences throughout Puerto Rico. Climate change may affect recreation in El Yunque through changes to local ecosystems and resources that impact scenic values, as well as changes to weather patterns that may disrupt recreational activities and lead to changes in visitor use. Visitors to El Yunque may see impacts to the local plant and animal communities that make the forest unique. An increase in extreme weather events may increase damage to facilities and structures, reduce tourist access in some areas, and increase the need for road repairs.[51-56]

MANAGEMENT IMPLICATIONS

Management activities provide national forests with an opportunity to reduce the susceptibility of their resources to multiple threats, including drought, invasive species, disease, and wildfire. Adaptation to climate change as a management goal may provide multiple benefits. By using sound natural resource management practices that keep predicted future conditions in mind, the Forest Service can promote the immediate and long-term health of its forests. Specific approaches vary with site and species of concern, but examples of adaptive strategies include:

- Anticipate changes in visitor behavior and proactively plan to mitigate any seasonal increases in use.[57]
- Enhance landscape connectivity by maintaining natural migration corridors between lowland and upland forests to allow species to move up-slope into cooler environments as climate warms.[58]
- Maintain piles of natural woody debris and promote wetlands and ponds in areas of high amphibian diversity to supplement habitats that retain cool, moist conditions.[59]
- Monitor for new invasive species moving into areas where they were traditionally not found, especially following hurricane events in high-elevation communities.[60]
- Mitigate future negative effects on sensitive species following intense hurricane events by promoting the establishment of more disturbance-resistant species, such as palms.[61]

Adaptation to climate change as a management goal may provide multiple benefits

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Climate Change and Your National Forest: Citations

Information in this factsheet is summarized from 60 peer-reviewed science papers found in the USDA Forest Service's TACCIMO tool. TACCIMO (the Template for Assessing Climate Change Impacts and Management Options) is a web-based application integrating climate change science with management and planning options through search and reporting tools that connect land managers with peer-reviewed information they can trust. For more information and the latest science about managing healthy forests for the future visit the TACCIMO tool online: **www.forestthreats.org/taccimotool**

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