Climate Change Effects on Our Nation's Forests

A Science Statement of the National Association of Forest Service Retirees
Approved February 7, 2023

Purpose

To advocate for acknowledging and addressing the accelerating and intensifying effects of changing climatic and disturbance patterns by emphasizing science-based management of our nation's forests and rangelands to protect and conserve their health, resilience to disturbances, and productivity.

Scope

National forests and grasslands, and other publicly and privately owned forests and rangelands are experiencing the effects of changes in climate and disturbance patterns. Benefits from these lands are essential to the health and well-being of communities and economies. To sustain flows of benefits, land managers must respond to an emerging reality where they: (1) have limited control of climate change driving forces; (2) are seeing marked changes on the ground; and (3) face future conditions, though yet unclear, that are likely to change benefits and their flows from these lands. The emerging reality requires land managers to join with community leaders, citizen groups, and other stakeholders to learn and act together in adapting forest and rangeland management to changing conditions and uncertain futures.

Science Context for NAFSR Climate Change Position Statement

The National Association of Forest Service Retirees (NAFSR) supports and promotes science-based management of natural resources on public and private lands. NAFSR believes that changing climatic conditions are already affecting forest and rangeland ecosystems, altering their disturbance patterns, and driving them towards a future whose conditions are uncertain. Adding to the uncertainty are shifting social values, demographics, consumption patterns, and emerging "green" technologies and markets—changes affecting forests and rangelands that are outside the immediate control of resource managers.

NAFSR sees a new reality emerging from the convergence of rapidly changing weather and disturbance patterns and evolving social, economic, ecological, and technological dynamics. Forests and rangelands are increasingly vulnerable to cascading, escalating, changes. Communities and economies already are being affected, and effects—both negative and positive—will increase further in the future.

Setting the Stage for Climate Change Science

The term Anthropocene Epoch is used by geologists, ecologists, anthropologists, and others to describe this current era when human activity exerts a profound global role. The burning of fossil fuels has enabled humans to develop new technologies that interconnect the world into an increasingly complex social-

ecological-technological system where socioeconomic opportunities are linked with global environmental processes, such as climate. Climate changes—altered patterns of temperature, precipitation, and extreme events—are among the effects of human activities. Because climate regulates the function of all ecological systems, changes in climate are one of the ways that human activities are changing the structure and function of plant, animal, and microbial communities, not only in forests but across the entire planet. As ecological communities change, the social, economic, and ecological services they provide that benefit humans also change. Thus, human populations are increasingly confronted with the need to reconsider and adjust—sometimes quite drastically and reactively—their choices, activities, and investments. It is now impractical to manage forests and rangelands in isolation from the dynamics of the social-ecological-technological system. The foundation for creatively balancing these multiple and interacting dimensions is improved scientific understanding of the systems as they change to create innovative adjustments for managing and using natural resources.

Many aspects of local climate are changing with the slow but inevitable shifts in seasonal temperature and precipitation patterns. Depending upon the location, forests and rangelands are experiencing higher summer maximum temperatures, higher minimum winter temperatures, unusually early warming in spring followed by hard freezes, snowpack melting earlier in the year, increased frequency and severity of storms (e.g., thunderstorms, hurricanes), and more intense droughts. All disturbances and changes in local climate affect the species composition, structure, function, health, productivity, and ultimately, the types and amounts benefits provided by forests and rangelands.

Highlighting the Science Issues

Responses of Forests and Rangelands to Climate Change

The composition, growth, and productivity of forests and rangelands are shaped by local soils, topography, climate patterns, and past disturbance regimes. A disturbance regime is the combination and pattern of disturbance events affecting an ecosystem's structure and/or functioning of its processes. Although the types of disturbances in a regime are important, more so is the pattern of disturbances—how many, how often, when they occur, the intensity or severity of the disturbance, and size of area affected.

Disturbance regimes for forests and rangelands include both anthropogenic and natural disturbances. Anthropogenic disturbances are disruptions to the structure or functioning of ecosystems caused or influenced by people's choices or activities. The ecological changes instigated by choices and activities can be both direct and indirect. Choices and activities in or near existing forests or rangelands can induce changes, as can choices and activities distant from or seemingly unrelated to forests and rangelands. Building fire breaks, reducing hazardous fuels, and thinning dense stands to reduce risk of insect outbreaks are examples of anthropogenic disturbances—human activities—aimed at creating positive effects. Clearing forests for a different land use, accidental introduction of nonnative species, and combustion of carbon-based fuels are examples creating potentially negative effects.

Human activities have been "bending the curve" of ecological system dynamics for millennia. Vital to their welfare, humans hunted and fished, learned to use fire to their advantage, foraged for medicinal plants and foodstuffs, and gradually developed methods to grow important food groups. As humans settled in larger groups, and traveled to settle new lands, the effects of human activities on forest and rangeland ecosystems began to grow substantially. Within the Anthropocene Epoch, the scale of effects and influence from human activities has become profound and pervasive regionally and continentally.

Natural disturbances, such as lightning-ignited wildfires, insect and disease outbreaks, and hurricanes were significant components of historical disturbance regimes. They still create major effects today. But new and different from historical regimes are the added effects of climate changes. For example, the 2022

aerial survey of Pacific Northwest forests conducted by the USDA Forest Service found true fir trees were dying on 1.23 million acres in Oregon and Washington—the largest die-off ever recorded. Record-breaking heat during the summer of 2021, significant drought in 2022, and outbreaks of insects and fungal diseases are thought responsible.

Today, the emerging disturbance regimes of forests and rangelands include both natural and anthropogenic disturbances and the interactions and synergies among them. Changing climates are a leading influence driving changes in disturbance regimes. Interactions are growing among the types and patterns of disturbances, expanding and intensifying their cumulative effects on forests and rangelands.

Resilience is the capacity of an ecosystem to absorb the effects of stresses and disturbances while maintaining its fundamental structure, processes, and function. Today, forest and rangeland ecosystems are increasingly exposed to two interacting challenges. First, their local climates and disturbance regimes are changing because of human choices and activities. Second, their capacity to respond to the new, changing disturbance regimes is also affected by the changing climate. Because of climate changes, the frequency, intensity, and area of influence of some disturbances now reach levels that can significantly alter the usual successional pathways and the fate of forests and rangelands—both in the near term and into the future. Such disturbances are termed extreme events. Extreme events demand attention because they can result in major ecological changes—in species composition, structure, processes, function, health (vigor), productivity, and flows of benefits. Sometimes, extreme events cause the previous forest to cease to exist or be transformed into a novel type of forest, one without historical precedent resulting from human influence. Such forests may function sustainably with resiliency to human-caused disturbances and may include nonnative species. Recent extreme events, like unprecedented droughts, floods, and wildfires, are fueling national discussions about how to respond to these events. The Fourth National Climate Assessment, Chapter 8, and NASA's National Integrated Drought System describe recent effects on forests from the confluence of droughts**,** and wildfires.

Challenges to Forest and Rangeland Management

Today, anthropogenic and natural disturbances frequently are becoming more tightly coupled into new disturbance regimes that are increasing the complexity of risks and uncertainties faced by forest and rangeland managers. Managers may have little experience with these new risks and uncertainties and sometimes little control. ***There is uncertainty about the direction that forest succession will follow under the influence of the combined effects of anthropogenic and natural disturbances.*** There are two confounding sources of uncertainty. One is the climate itself, which changes continuously in unprecedented and difficult-to-predict directions. The other source of uncertainty—also challenging to predict—is changes in the social-ecological-technological system, driven in part by changing human aspirations, choices, and investments. Adding to the uncertainty is the fact that the direction of environmental change caused by novel disturbance regimes differs in different parts of the country.

Forests and rangelands respond to disturbances and changing environmental conditions by altering their structure, species composition, and productivity. In response to climate change, forests will acclimatize and adapt through mechanisms of succession (in the short-term) and evolution (in the long-term). Novelty in forest and rangeland structure and species composition is the result of their response and adaptation to environmental changes. ***However, it is difficult to predict the outcomes of forest and rangeland succession and evolution because disturbances and climate change have set in motion all organisms and their environments, causing unprecedented mixing of species in both spatial and temporal scales and changing the speed of ecological processes.*** Natural processes, if left alone, will over time generate landscapes with novel combinations of ecological systems, including forests, shrublands, and grasslands that are different from what is present today. These future ecological systems will not be stable if conditions continue changing. For specific time periods, they may be resilient and functional, but at

different rates than those of today. They will deliver different levels and kinds of ecological benefits than today's ecological systems while continuing to change and perhaps reorganizing into new systems.

Possible Paths Forward for Natural Resource Managers and Stakeholders

The Infrastructure Investments and Jobs Act (Pub. Law 117-58) and related bills that better fund public agencies' science and natural resources management programs provide critical support for expanding climate-smart management of natural resources. Society also faces more crucial tests. One is keeping forest land in forest cover rather than being converted to other uses. Another is promoting afforestation or reconversion to forest of lands recently in other uses, such as cropland abandoned due to changed markets or a changed climate—forest restoration on a very large scale. The third is supporting forest management activities aimed at safeguarding the health of forest ecosystems and communities, even when risks and uncertainties exist. Climate-smart management can succeed in reducing the vulnerability of forests only if there is broad and deep public support for the surge needed in research and on-the-ground forest management, monitoring, and analyses that climate-smart management requires.

The Conundrum That Must Be Faced

Forest and rangeland management faces a conundrum. It can either preserve a "natural" condition (meaning current historic states of forests and rangelands) or preserve natural processes (meaning forest and rangeland responses to the local climate and disturbances). For example, this conundrum manifests itself in some environmental laws and regulations that call for protecting and promoting reestablishment of historical conditions (e.g., the Endangered Species Act of 1973 (P.L. 93-205, as amended)). ESA focuses on protecting populations of vulnerable species at specific locations for the foreseeable future by sustaining habitat conditions critical to their survival. Sustaining past habitat conditions, or even present ones, may be difficult in specific areas over the long term, given recent trends in climate changes and other disturbance effects.

Altering, perhaps even counteracting, the natural processes set in motion by climate change and novel disturbance regimes to accomplish various social goals will involve high costs and widespread intensive management activities without the assurance that desired goals will be attained. However, if the natural responses of forests and rangelands to anthropogenic effects are compatible with, and incorporated into, management interventions, the climate change adaptation costs might be within reach. Addressing this conundrum requires resource managers and stakeholders to learn to recognize which responses of forests and rangelands are compatible with management and societal objectives (including existing laws and regulations) and which are not. Further, management and societal objectives themselves will need to become more compatible with sustainable forest and rangeland management in a warmer climate (perhaps by revising existing laws and regulations). Here again, humans will need to find additional ways of "bending the curve" of social-ecological-technological system dynamics to help forests and rangelands, and more broadly the entire social-ecological-technological system, adapt to climate changes.

Resource managers and stakeholders need fresh insights and understanding about when and how to intervene and when not to intervene with a natural process following extreme events. Approaches can be adjusted with information about new forest and rangeland compositions and the altered processes being experienced by forests and rangelands. Although management instinct may be to control or minimize new species and compositions, there may be value in recognizing possible futures and adaptations where system transformations occur faster than can be responded to by managers. Expectations, goals, and views of available services may need to change as systems shift and policies and management actions focus on reducing risks amid the uncertainties inherent in human and technological choices. In doing so, it will be important to avoid policy and/or management solutions that protect human values from lower energy high frequency events but increase vulnerability to less frequent yet more catastrophic events.

Redefining Conservation of Forests and Rangelands

Conservation of forests and rangelands under the conditions of the Anthropocene Epoch requires a redefinition of the responsibilities of natural resource managers and stakeholders, one that addresses the important evolving role of forests and rangelands in supporting human activity and life quality during times of cascading, escalating changes in climate and the social-ecological-technological system. Forest managers need to think and act with broader goals in mind, interpreting "sustainability" in terms of the entire system rather than just the ecosystems affected.

Conservation expectations for both public and private lands will change. Carbon sequestration will be included in the management goals and objectives for forests and rangelands. Also included will be scenic beauty, nature protection, watershed and water quality protection, wildlife and fish abundance, outdoor recreation opportunities, production and use of wood and paper products, and energy production from the sun, wind, and wood. Conservation will be broadened to include many social and technological choices and investments whose effects—positive or negative—spill over onto forests and rangelands. All aspects of forestry activity will need to change—fish and wildlife management, sustaining biological diversity, providing outdoor recreation options and opportunities, restoration of riparian areas, and above all, water management. Water management will be affected, even where annual precipitation quantities do not change significantly, as seasonal timing and intensity of rainfall events and stream flows will affect municipal water supplies, irrigation, and recreation as well as aquatic habitat. Conservation will include all these aspects because they all have large influence on socioeconomic conditions.

Going forward, conservation success will depend on continuing, but creating even broader, collaborative, more adaptive relationship between society and natural resource managers to redefine and agree on conservation goals for forests and rangelands and practical paths forward that sustain benefits from forests and rangelands. If that broader, collaborative, more adaptive societal relationship cannot be attained, then waves of undesirable system responses become more probable. Already, futurists are talking about surges of human migration (both continentally and intercontinentally), global human health emergencies, and economic dislocations—all driven by deterioration in forest, rangeland, and agricultural ecosystems in heavily affected areas.

Science Can Help Illuminate Management Options and Accelerate Learning

NAFSR supports and promotes science-based management of natural resources. The science available for climate-smart planning and management has grown since 2000 and sufficient knowledge exists to implement climate-smart management. Yet because conditions are dynamic, site-specific, and changes are accelerating, more science is needed.

Addressing the complexity of the social-ecological-technological environment of forests and rangelands in the context of growing uncertainties and risks requires a new level of understanding that no individual discipline or knowledge sector can provide. Instead, a transdisciplinary approach is needed that includes all accumulated knowledge, including knowledge and wisdom outside of traditional scientific fields such as from indigenous peoples and nations, who also have capacity and objectives to bring to the table. Understanding within this broader community is sufficient to move forward on the issues described previously in this statement.

A new approach to management interventions in forest and rangeland landscapes would be helpful. Forest and rangeland managers, whether public agency employees or private landowners, need to plan field management activities with the future climate change reality in mind. Active management prescriptions can be formulated as hypotheses to be tested scientifically for their effectiveness. For national forest lands, this approach requires management interventions to be jointly developed between field managers and scientists and closely coordinated with stakeholders so that all parties learn together from the outcomes of various interventions. Proper design and monitoring of interventions results in knowledge

that can be used to improve the next round of interventions, creating a greater opportunity to attain forest resilience. Responding to these opportunities requires a significant surge in workforce capacity for both research and field management, expanded use of innovative approaches proven successful in some areas, and stronger public support for these increases.

The scientific foundation for climate-smart management needs to be reinforced with the following:

- ***Long-term projections*** of climate changes, the effects of no management response, and outcomes from implementing individual and combinations of climate-smart management practices; all at finer spatial scales, tailored to specific forest types, stand compositions, and site conditions, and for plausible alternative futures.
- ***Finer-scale analyses*** of recent landscape-scale trends and projections of plausible alternative futures across larger landscapes, including across jurisdictional and ecological boundaries.
- ***Scenario-based planning*** capability and capacity; the preferred approach when dealing with unclear futures.
- ***Better working knowledge of social-ecological-technological systems***, what is new and changing, especially the effects of evolving preferences, choices, activities, and investments on forests and rangelands.
- ***Stronger inventory, monitoring, and assessment programs*** that track, analyze, and report on changing climatic patterns and disturbance effects on forest conditions.

This expanded, deeper, and more diverse portfolio of science is the critical foundation for climate-smart forest and rangelands management planning and decision-making. Resources Planning Act (RPA) Assessments have pioneered research in several of these areas. The RPA team can lead expanded research in the five areas, blending the talents of agency and university researchers through cooperative ventures.

Accommodating changes of such breadth and magnitude requires a more integrated and holistic way of engaging the full spectrum of agency capabilities; already being done in some places but needed everywhere. The six adaptation actions outlined in the USDA Forest Service's Climate Adaptation Plan (July 2022) are a good start and deserve widespread support by the public and elected officials. A broader focus encompassing effects of social-ecological-technological systems, in broader landscapes, and over longer time horizons is warranted.

The U.S.'s population today is 334 million people. The Census Bureau projects 530 million in 2080. The forests restored and made more resilient by climate-smart management actions over the next decade will, 50 years from now, serve the needs of a much larger, more diverse citizenry. Although the climate, society, and technology will all be different in 2080 with effects on forests and rangelands yet unclear, uncertainties must not paralyze taking actions today. The outcomes of redefining conservation goals, of continuing and expanding the recent hard work to develop broader and better collaborative relationships among stakeholders and resource managers, and of learning together from climate-smart plans, decisions, and resource management activities implemented in the next few years—these outcomes will be our legacy bequeathed to future generations. We owe them our best efforts.