CHAPTER 8

Conclusions: Nontimber Forest Products in an Era of Changing Climate

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Nontimber forest species, resources, and products in U.S. forests and rangelands provide a range of ecological, social, cultural, and economic goods and services. This diversity creates challenges and opportunities for management and governance in an era of accelerating climatic variability. Climate variability and change will likely affect forest ecosystems with potentially increasing risks of negative consequences to natural resources and associated social-ecological systems (Ryan and Archer 2008). Drought, insect and disease outbreaks, and fire, as well as extreme events are expected to impact species extent and composition of forests as species respond to climatic variability and change. There is also the potential for loss of species and biological diversity if environmental changes outpace species' ability to adapt. This may in turn adversely affect the potential of NTFPs to provide a buffer for impacted human communities as sources of food, medicine, and other uses. As this report demonstrates, the scientific literature about U.S. nontimber forest products (NTFPs) is considerable. Significant gaps, however, remain in the state of the knowledge about these natural resources and how the social-ecological systems that characterize them may respond to climatic variability.

8.1 Nontimber Forest Product Ecologies and Climatic Variability

Climatic variability is likely to affect the ecological conditions necessary to support nontimber forest species from individual organisms to the landscape level, influencing the presence of wild plants and fungi and their biophysical properties. Because NTFPs are derived from a diverse array of species that span taxonomic and environmental boundaries, understanding the nature and spatial distribution of those effects requires extensive effort (see chapter 3). Effects on NTFP species will vary spatially and temporally. Life history traits may provide insights into likely demographic, evolutionary, and spatial responses to climatic variability for species with shared characteristics. Knowledge about habitat responses also will grow, especially as many NTFPs are understory species that are strongly influenced by the effects of disturbance and management on the forest overstory (see chapter 2). Some predicted long-term climate effects on forest ecologies with implications for NTFPs include altered frequency and intensity of disturbances such as wildfires, storm damage, flooding, invasive species incursions, insect and disease outbreaks and changes in forest productivity.

Projected shifts in forest types for the United States suggest potentially significant changes in forest structure and composition that will affect NTFPs (Melillo et al. 2014, Prasad et al. 2007). Increase in average minimum temperature and changes in precipitation will affect habitats associated with specific NTFPs, with some being more vulnerable to climate change than others (USDA 2015).

Range breadth is frequently used as an indicator of vulnerability to climatic-variability-driven extinction, because a narrow distribution may indicate sensitivity to changing climate as well as habitat specificity (Bellard et al. 2012, Brook and McLachlan 2008, Thomas et al. 2004). At first glance, NTFPs not characterized by a narrow range may appear robust to changing climate. However, specialization to local climate conditions may narrow the thermal niche of a species, thus increasing vulnerability. Relative to trees and weedy species, many NTFP species display limited dispersal distances, which increases the likelihood of local adaptation (Bennington and McGraw 1995, Gregor 1946, McGraw 1985) but also may increase vulnerability (Davis et al. 2005, Etterson 2004). Further, climatic variability may interact with other stressors like harvesting to increase the risk of extirpation or extinction for NTFP populations and species (Brook and McLachlan 2008, Mandle and Ticktin 2012, Souther and McGraw 2014).

Alterations in the phenology of NTFP species are of particular concern for maintenance of their cultural values (see chapter 4) and already are being observed in response to changing climate. Long-term surface data and remote sensing measurements indicate that major events of plant phenology such as leaf-on and leaf-off dates have advanced by 2 to 3 days in spring and delayed by 0.3 to 1.6 days in autumn per decade over the past 30 to 80 years, resulting in a significant extension of the growing season (Badeck et al. 2004, Schwartz et al. 2006). Warmer, shorter winters provide favorable conditions for pest populations as insects and diseases that previously would have been killed by low winter temperatures survive mild winters (Jamieson et al. 2012). In some cases, shorter winters will be characterized by greater fluctuations in temperature, resulting in mortality from extreme cold and/or repeated cycles of freezing and thawing. Earlier spring onset increases frost vulnerability, with consequences for successful fruiting and reproduction of NTFP species. When flowering occurs earlier, blooms are at increased risk of freezing (Inouye 2008, Sherry 2007, Souther and McGraw 2014). Mountain species particularly are experiencing frost damage due to early blooming. Earlier spring dates also may create mismatches, or phenological asynchronies, such as when plants bud earlier and their pollinators have not adapted to this shift in timing. For example, bees may target specific habitats with plant populations they historically pollinate only to find those plants have already bloomed (Fitzpatrick 2010). Such phenological asynchronies adversely impact pollinator and plant alike.

General trends notwithstanding, there is considerable uncertainty in any projection of likely responses to climatic variability by NTFP species. Long-term studies and biotic monitoring projects show that some species have responded to contemporary climatic variability in a manner consistent with expectations (Badeck et al. 2004; Hoffmann and Sgrò 2011; Parmesan 2006; Parmesan et al. 2000, 2013; Parmesan and Yohe 2003; Walther 2010). For instance, many species have shifted distribution northward or upward in elevation and advanced the timing of critical life history events, such as spring emergence in plants or migration in avian species (Badeck et al. 2004; Hoffmann and Sgrò 2011; Parmesan 2006; Parmesan et al. 2000, 2013; Parmesan and Yohe 2003; Pinsky et al. 2013; Walther 2010). However, there have been ecological surprises as well. A significant proportion of species, depending on the datasets analyzed, appear to remain unchanged or respond in a manner opposite to expectations (Tingley et al. 2012, Wolkovich et al. 2012).

8.2 Social, Cultural, and Economic Dimensions of Nontimber Forest Product and Climatic Variability

Shifts in the ecology of NTFPs will condition their availability as social, cultural, and economic resources. Social disruption of climate-induced human displacement, accompanied by economic distress, could also make humans more dependent on NTFPs as sources of food, fuel, and utilitarian materials, as well as social anchors.

As changes associated with altered climate affect landscapes and social systems in which cultural uses of NTFPs occur, they will likely affect cultures throughout the United States and its affiliated territories. Among the contributions to human well-being at risk are the roles of NTFPs in food security (Lynn et al. 2013), health security (Kassam et al. 2010), identity formation, social cohesion, and livelihoods (Cocks and Wiersum 2014, Emery 2002, Lynn et al. 2013, Voggesser et al. 2013). Such alterations could have adverse consequences for diverse communities across rural to urban environments (see chapter 5). Within general parameters, specific effects of climatic variability on NTFP cultural functions will vary by region and cultural group. Each cultural group is vulnerable to the effects of climatic variability depending on their geographic location, species of interest, and capacity to adapt to interacting stressors at multiple scales (Bennett et al. 2014). Such developments may pose new challenges for compliance with laws relevant to cultural values of NTFPs in these regions.

At the same time, culture is dynamic and there are opportunities to mitigate and adapt to climatic variability effects on NTFP cultural values. Indeed, NTFPs frequently provide essential survival resources in times of disruption (e.g., Redzic 2010) and likely will do so during climate-related disturbances. The resilience of cultures and their NTFP-based practices may be a function of the intensity, speed, and duration of events that pose ecological and/or social challenges to them. Indigenous peoples have noted that their cultures are the product of millennia of adaptation to social and ecological change. As a consequence, indigenous peoples may have knowledge and wisdom to offer to adapt to impacts from a changing climate (Voggesser et al. 2013).

NTFPs contribute to microeconomies and macroeconomies, through nonmarket and formal and informal means (see chapter 6). NTFP harvesters and users face many uncertainties in their nonmarket and formal and informal economic activities. Climatic variability adds further risk of (1) changes in biological availability of NTFPs, (2) price pressures for scarce NTFP resources, (3) regulatory barriers in response to reduced production and increased competition, (4) changes in direct and indirect costs of obtaining NTFPs, and (5) disruption of social networks and safety nets due to loss of access to NTFPs. While many social, cultural, and economic consequences of climatic variability effects on NTFPs will unfold over time, others will develop rapidly. Extreme weather events such as hurricanes, tornados, and floods are projected to increase in severity and become more frequent, and produce more acute impacts (short in duration but strong in magnitude) to NTFPs and the people who depend on them. If climatic variability diminishes populations of certain NTFP species, or changes their range, people may lose access to those resources as an economic safety net (see chapter 6).

Risks will be felt more keenly by some individuals than others. Increased food insecurity and decreased nutritional status are likely results for subsistence practitioners and others who rely on wild plants and fungi for significant aspects of their dietary intake. Full-time commercial harvesters also may be hard hit by climatic variability effects on NTFPs, as they tend to rank among the poorest populations in a region (Hembram and Hoover 2008, Schlosser and Blatner 1995). Loss of access to edible plants and mushrooms for personal consumption and/or income from the sale of NTFPs may push more people to rely on assistance programs and make the status of those who already rely on these programs more precarious. Enterprises that rely on wild or forest farmed plants and fungi also may experience differing impacts, with businesses that rely on one or a small number of NTFPs potentially facing greater risks than those whose business is based on a diversity of species and products.

However, climate-related effects on plants and fungi will be complex. Along with potential disruption, NTFP-based opportunities likely will arise. In some cases, disturbance or changing conditions in a location may favor the presence of new NTFP species or increases in the population of previously scarce species. Where this occurs, it could result in increased supplies for subsistence, personal consumption, and sale in value-added or unprocessed forms. Again, adaptive capacity will condition individuals' and communities' abilites to benefit from these new opportunities.

8.3 Nontimber Forest Product Policy, Management, and Climatic Variability

Regulations and policies that address access, management, extraction, trade, and conservation of nontimber forest products exist at multiple governmental levels in the United States (George et al. 1998, McLain and Jones 2002; see chapter 7 for detailed descriptions). At the Federal level, the Endangered Species Act (ESA 1973), the Lacey Act (1900), and the National Environmental Policy Act (NEPA 1969) have particular relevance. Among Federal agencies with jurisdiction over public lands where NTFPs are harvested are the Forest Service, Department of Defense, and three Department of the Interior agencies: Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service. In addition to the ESA, Lacey Act, and NEPA, each of these Federal agencies operates under a suite of further laws and regulations that apply to NTFPs. Legal canons applying to Native peoples' access to NTFPs include, but are not confined to, the Federal Indian Trust Responsibility, the Alaska National Interest Lands Conservation Act, and the Hawai'i State constitution. Further laws and regulations are in force at State and local levels.

Maintaining natural diversity through silvicultural practices and other management strategies may be key to mitigating the impact of climate change on NTFPs. High species diversity increases ecological resiliency (Tilman and Downing 1996) and may contribute to functional redundancy (Peterson et al. 1998), protecting ecosystem functions in the face of climate-induced disturbance and change. Conversely, intensive management for one or a few high valued NTFPs may decrease diversity, decreasing resiliency and placing forests and NTFP species in them at greater risk (see chapter 2).

Managed relocation, or assisted migration, may be a viable option for adapting to climate change and its impacts on NTFP-based social, cultural, and economic values. Efforts are underway to see if assisted migration can help tree species that are imperiled by the anticipated impacts of increased drought and higher temperatures on their limited native distributions (McLachlan et al. 2007, Williams and Dumroese 2013). Further, knowledge development may help address challenges with assisted migration of important genetic diversity within the native plant communities by finding seed sources with strong resilience to drought (Vose et al. 2012, p. 287).

Assisted migration may be a promising mitigation approach, but particular consideration must be afforded to potential negative impacts, such as gene-pool degradation, competition with existing native plants, and changes in ecosystem dynamics. The effectiveness of widespread assisted migration is not yet known (Williams and Dumroese 2013), and some have expressed concerns about the risk of introducing invasive species (Mueller and Hellman 2008). The fitness of species that are adapted to other sites may be negatively impacted when associations with key environmental factors are changed. Additionally, the introduction of nonlocal genotypes may cause outbreeding depression or a decline in fitness of subsequent generations due to infiltration of maladapted genotypes (Frankham 1995, Kramer and Havens 2009, Pertoldi et al. 2007). Nevertheless, gene flow from populations adapted to warmer climates may provide genetic variation and traits necessary to adapt to novel climatic conditions (Hampe and Petit 2005).

8.4 Gaps in the State of the Knowledge

There are inherent challenges to managing for NTFPs in a time of changing climate. Forest cover change, invasive species, and increased frequency and severity of extreme weather events all contribute to an environment of intensifying uncertainty. Most forest management is based on historical conditions. Today, we cannot be sure the past is an analog to future forest conditions.

Knowledge is essential to informed planning for and response to the effects of climatic variability on NTFPs. Unfortunately, there are significant gaps in the state-of-the-knowledge about all aspects of NTFP social-ecological systems. The knowledge needed to fill these gaps includes:

- Basic ecology of NTFP species particularly those with high social, cultural, and economic value.
- More detailed information on the abundance and distribution of major NTFPs and impacts of harvesting trends, disturbance, and land-use change.
- Social and ecological dynamics of NTFP management and use.
- Traditional and local ecological knowledge and practices related to NTFPs.
- Forest silviculture and management and harvest practices for NTFP species that addresses responses to climate-induced phenomena.
- Implications for food and health security.
- Climate modeling, projections, and risk-analysis at finer scales for entity-level decisionmaking and reporting on NTFPs.

8.5 Conclusions

Nontimber forest products have supported the peoples and cultures of the United States and its affiliated territories since before the founding of the Nation. Wild and forest farmed plants and fungi continue to sustain humans through personal consumption. They are sources of income for people who have limited options for other earnings and help to smooth chronic and occasional disruptions in household economies. NTFPs supply businesses from cottage industries to multinational corporations.

The plants and fungi from which NTFPs are derived number in the hundreds (appendix 4). Their responses to climate variability and change are proving to be diverse (see chapter 3). As ecological processes proceed, they will have social, cultural, and economic consequences. In some cases, the results may be favorable. It seems likely that in many more cases, short-term to mid-term results will be negative with potentially serious consequences.

Knowledge on the range of NTFP policy and management challenges posed by climatic variability is incomplete. This report identifies many potential outcomes and synthesizes the state of information on the social-ecological systems of wild plants and fungi used for food, medicine, and other purposes. Nevertheless, critical knowledge gaps remain. While there is yet much to learn, traditional, local, and scientific knowledge provide current bases for planning adaption and mitigation of the adverse impacts of climatic variability on NTFPs and the people who depend on them.

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