Chapter 5.3. Ecosystem Services and Public Land Management

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The concept of ecosystem services connects the activity of environmental and natural resource management to desired outcomes of human economic utility, social well-being, and cultural health. A desire for mutual sustainability between human interests and ecological cycles is inherent in the ecosystem services approach (Patterson 2014). The complex network of interactions between natural processes and human impacts is referred to as a socioecological system.

> **Ecosystem services** refer to the material and nonmaterial benefits derived from natural ecosystem processes, as well as the human regulation and support services required for the production and sustainability of those benefits (Vose et al. 2012).

Social science literature details a mixed history of natural resource economies and their impacts on local communities. Cycles of boom and bust are evident, especially through the industrial resource extraction practices of Old West economies (Frickel and Freudenburg 1996). While service-based sectors rose in the New West, so too did ecological rationales and environmental mandates surrounding the use of natural resources. The *Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range* (hereafter, Sierra Nevada Science Synthesis; Long et al. 2014; see Chapter 1.1, Dumroese, this synthesis, *The Northeastern California Plateaus Bioregion Science Synthesis: Background, Rationale, and Scope*) discusses this social-economic transition as one moving from industrial extraction to amenity value consumption. The changes in land use, economic activity, and social relations that accompany this shift from production to the service sector now require public lands managers to balance a "triple bottom line" of ecological, economic, and social concerns (Winter et al. 2014, p. 497). Negotiating the tensions among these three often divergent perspectives, and doing so with a broad scope and strategic foresight, is at the heart of ecosystem services management in the U.S. Department of Agriculture, Forest Service.

More thoroughly reviewed in the Sierra Nevada Science Synthesis, the concept of ecosystem services has been used in Forest Service management to:

- communicate the value of forests;
- collaborate with stakeholders to define stewardship objectives;
- determine the tradeoffs between diverse goals and stakeholders;
- provide options for forest restoration; and
- support emergent markets for ecosystem services that economically benefit the forest and the community (Patterson 2014).

Although not necessarily step-wise, each type of action informs others: Culture- and value-laden social explorations inform community negotiations, and these negotiated discoveries provide frameworks for building economic mechanisms. Each type of management process is subject to revision and adjustment. The term "ecosystem services" therefore expresses a circulating or iterative approach to human and environmental interdependence in the provision of natural resource benefits.

Forest Service managers were authorized in the 1970s to shift from a relatively narrow, progressive-era commercial imperative of only timber and watershed management, toward sustainable models of land management that also included wildlife, recreation, and grazing. Thus, by the late 1990s the national policy of ecosystem management for sustainability had superseded the previous economic goal of timber industry stability, observable in increased environmental litigation and loss of timber revenue (Nelson 2006). As an alternative to a declining timber industry, the ecosystem management model prioritized environmental protection (Charnley et al. 2018a). These strategies were seen as capable of delivering ecological supports for forests and economic benefits to communities (Moseley and Toth 2004). It is suggested that seeking a viable combination of economic development and ecosystem health may also be able to address inequalities that exist in many rural communities. Rural communities

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paradoxically often depend upon conservation programs and define the feasibility of such ecosystem service initiatives on the local level (Ninan and Inoue 2013; Turner et al. 2003).

General interests of the communities near the Lassen and Modoc National Forests (hereafter the Lassen, the Modoc, or the Lassen-Modoc) regarding ecosystem services are based on economic questions such as:

- What are the economic benefits of biomass, timber harvest, and recreation?
- What are the supply and demand processes for water, timber, range, recreation, and multiple use?

Since the 1990s forest managers have been charged with incorporating the economic benefits of ecosystem services with the realities of demographic trends, toward qualities of social well-being, and with values of cultural knowledge. Ecosystem services thus require a multifaceted approach—one not solely based on economic metrics—because ecosystem service products and processes under public land management in the United States very often do not take place in markets.

Variable and Local: Relevance for the National Forests

In response to observed and expected changes in climate, an "all-lands" approach to socioecological resilience has been called for. This approach surpasses the traditional boundaries between local/regional, rural/urban, and public/private domains. It is advocated because ecosystem services are increasingly vulnerable to biophysical disruptions (e.g., climate and fire) and subject to social responses (e.g., cultural and institutional) that do not abide by those political boundaries (Vose et al. 2012). A recent science synthesis of climate impacts on forest ecosystems (Vose et al. 2012) more thoroughly discusses this in the spheres of rural, urban, and wildland urban interface settings and notes that these impacts pose variable challenges to ecosystem services:

> Future changes in forest ecosystems will occur on both public and private lands and *will challenge our ability to provide ecosystem services desired by society,* especially as human populations continue to grow and demands for ecosystem services increase. *Climate change effects in forests are likely to cause losses of ecosystem services in some areas* (e.g., timber production, water supply, recreational skiing), *but they may improve and expand ecosystem services in others* (e.g., increased growth of high-elevation trees, longer duration of trail access in high-snow regions) (Vose et al. 2012, p. v, emphasis added).

While climate models have become more sophisticated, what is less understood are the capacities of communities to respond to these environmental changes (Rocca et al. 2014). Despite the climate-related pressures on forest ecosystem services, proponents of socioecological resilience also remind us that social choices and actions will shape the provision of scarce or shifting resources (Vose et al. 2012). Thus, managing interdependent, resilient socioecological systems call for collaborative participation in adaptive governance as these systems change. This portion of *Ecosystem Services* is informed by this management philosophy and attempts to respond to the following community-generated question:

- What economic and social benefits of ecosystem services do the Lassen and Modoc provide for local and regional communities?

While scientific peer review literature on ecosystem services directly related to the Lassen-Modoc is limited, a general review of the ecosystem services framework suggests that decisionmakers think about the above question: (1) at relevant scales, which are the local and regional levels defined previously in Chapter 5.2 (Flores and Russell, this synthesis, *Demographic Trends in Northeastern California*); (2) with practical means of institutional implementation, considered here by facilitation between forest management and community engagement, addressed in Chapter 5.4 (Flores and Stone, this synthesis, *Community Engagement in the Decisionmaking Process for Public Land Management in Northeastern California*); and (3) through the alignment of economic and ecological interests, noted in the *Forest Management Practices* subsection of this chapter.

Why are local-level scales of collaboration emphasized? One reason is the quality of measurement. Although large-scale economic valuations of forest ecosystem services reveal net benefits of ecosystem conservation, in general, economic analyses of ecosystem services are still developing and often found lacking (Kenter et al. 2015; Ninan and Inoue 2013). This is an indication of the relatively early stage of these economic models and of the complexity involved in quantifying variable, interdependent, and often intangible ecological system benefits. Furthermore, the constraints of ecosystem services valuation are not simply informational: Attempts to determine monetary value may potentially reveal that our current political systems and economic markets are, in many ways, incompatible with the ecological health and social well-being communities may desire. Patterson (2014) reminds us that market-based tools are not entirely adequate, because "the vast majority of ecosystem services are not and will never be marketable" (p. 555).

A second reason is that local scale also prioritizes community capacity and trust. A primary socioeconomic challenge for ecosystem services managers is to mediate the distinctions between market values and social values in an innovative manner with stakeholders. As Winter et al. (2014) encourage, "Decisionmakers who have a thorough knowledge of local social and economic conditions will also be better positioned to make decisions that draw on the existing capacity in a community, and help build local capacities that need to be developed by directing resources accordingly" (p. 615). Or, as Turner and Daily (2008) caution:

> Stakeholder perceptions, property rights and institutional arrangements are thus important components of any scheme to capture benefits on a practical and lasting basis. Failure to recognize and accommodate these components invites a lack of trust, accountability and legitimacy (p. 28).

The Sierra Nevada Science Synthesis notes that the shift in the scale and quality of approach requires a corresponding shift in evaluation criteria: There is a move away from fixed quantitative targets when studying landscape-level implications. Instead, resilience-based approaches typically favor plans "to reduce vulnerability and strengthen capacity to respond and adapt," that is, to flex with change over time, across geographic areas, and with the involvement of local community members (Long et al. 2014, p. 94).

A recent study of forest adaptation frameworks notes that some conceptions of governance over climate adaptation (and therefore how public forest ecosystem services are supported by the Forest Service) are misleading. Uniform or automatic Federal and State policies—which have been historically prominent in the forestry sector—may offer guidance and administration. Yet related to the above comments about flexibility, local politics, local resources, and community-level capacity are the drivers when community choice and commitment are vital to adaptation plans (Wellstead et al. 2014). The public meeting and comment process has shaped this science synthesis and is intended to frame the land management plans for the Lassen and the Modoc.

Social Benefits of Ecosystem Services

Forest ecosystem services that provide physical sustenance by serving as catchments for drinking water, filters for air quality, timber for fuel and wood products, and so on will be discussed later regarding economic benefits and regarding community engagement. Here, we discuss the social relevance of forest ecosystem services, directed to the questions:

- What social benefits of ecosystem services do forests provide for local and regional communities?
- What are the different social and nonmarket cultural values that local residents, visitors, and different user groups attach to forest land?

Relationships and Realities: Social Values Inform Human Well-Being

Shared social values inform relations between the Forest Service and local communities, and values also grow out of the decision processes they make together for human well-being in the socioecological system. The public hearings among Lassen-Modoc stakeholders illustrate the "deliberation through the public sphere, public debate, and consultation [which some argue] are needed to articulate shared and social values" (Kenter et al. 2015, p. 91).

> **Social:** Interpersonal relationships and activities on small scales between individuals as well as networks on larger group, organizational, community, or society levels.

Decision making in natural resource conservation is shaped by social values. Individuals have (1) underlying value orientations that shape their *perceptions* of the world, including how they understand the natural environment, usually in human-centered or eco-centered ways. People also have (2) values that they assign to the *things* within their perceived worlds, including ecosystem service benefits, which may be valuable in themselves, for use, or for nonuse. Social values are emotionally, historically, culturally, and politically driven. And while they are influenced by the scientific, rational, or economic concerns about an ecosystem, social values may be distinct from those realms (Ives and Kendal 2014).

> **Social values:** Commonly held principles of meaning or importance that exist beyond a singular person, i.e., through a deeper cultural tradition, within particular social context, and on a scale beyond individual values.

Accordingly, the social sciences often study the subjective, qualitative aspects of underlying and assigned values and investigate the value relationships that connect particular people with certain places. Theory suggests that certain social values influence a person's or a society's disposition toward particular attitudes and behaviors—about wildlife, land use, clearfell timber harvesting, etc. Generally, stronger use-values are associated with accepting higher or more intense timber production, while stronger ecological and cultural values are associated with adopting the nonmarket functions of forests (Ives and Kendal 2014).

> **Social benefits:** The enhancements of human relationships and choices to improve human life or well being with interpersonal, material, or health outcomes.

Mentioned casually above, the term *well-being* is often used in social scientific literature to express these human social benefits, but well-being is also referenced by the terms "welfare" or "quality of life" (Balmford and Bond 2005; Bieling et al. 2014; Charnley et al. 2018a; Gasparatos et al. 2011; Krekel et al. 2016). Social benefits are the intangibles, or externalities, for which conventional economic measures can only provide a proxy (Bawa 2017, p. 2). Some of the social benefits of engaging in forest ecosystem services include: a sense of present and future security of one's community and place, through balancing production and conservation; strengthened social relationships and personal identities, through negotiating the management of ecosystem services; and the social agility that comes through practicing collaboration and adaptation over time.

Coupling and Change: Values Connect Ecosystem Services With Social Benefits

Social values are associated variably with different forest ecosystems services. Before considering the variety of potential *Economic Benefits of Ecosystem Services* in the next subsection, we return to the above idea that social values influence a person's or a group's disposition toward certain attitudes and behaviors—and *choices*—regarding their community's forest ecosystem service interests. Presented below are examples of how social values are attached to land conservation and ownership, alternative fuel, fire management, and recreation to produce social benefits.

Research about ecological values are relevant to understanding values of the Lassen-Modoc communities, including consistent findings that:

(i) values change over time,

(ii) values differ between groups of people,

(iii) multiple values can be assigned to the same places,

(iv) multiple pathways exist between values, attitudes, and behaviors towards ecosystems, and

(v) values influence people's judgment of management decisions (Ives and Kendal 2014, p. 70).

For example, land is increasingly valued for the preservation of local open spaces, as opposed to cultivation, production, or restoration. "The personal values many people may associate with local open space lands," whether for recreation, aesthetic, or environmental characteristics, arise in the immediate contexts of where community members live and work, that is, "in people's daily lives" (quoting Kline 2006, p. 646; with sentiment by Bawa 2017). Yet degraded spaces are becoming more prevalent, and the availability of intact landscapes is decreasing. This tension between increasing social value for open space and declining ecosystem health is expected to accelerate the social values that demand conservation (Hjerpe et al. 2015).

This applies also to forestlands, where values have changed over time to valuing timber production and *material* services less and valuing ecological, spiritual, aesthetic, cultural, and recreational *experiences* more (Barrio and Loureiro 2010; Bieling et al. 2014; Ives and Kendal 2014). These occur in both personal and community realms. In California, some forest residents have expressed personal "wildlife values" of the surrounding forests, with statements about the biological diversity of a "beautiful valley … full of grizzly bear and moose and wolves and the few remaining caribou" (Bixler 2014, p. 164). Forest residents also describe community values of working together for wildlife conservation (Bixler 2014). Others have expressed community values surrounding land "preservation" and "protecting the environment," and scenic values of "[living] near natural beauty" (Ferranto et al. 2011, p. 191). But they have also expressed land conservation as a personal value, specifically for the benefit of their posterity or for individual financial benefit, including the provision of conservation trusts or easements.

The trend in some areas of California has been toward lifestyle values centered on amenity and investment (Ferranto et al. 2011). This value shift has occurred with a parallel shift in forest land ownership, wherein private land has shifted as relatively fewer ranchers and farmers divest large parcels of land into drastically smaller parcels of land to relatively more landowners. With these changes in land ownership come "changes in social values and demographic characteristics" tied to the land (Ferranto et al. 2011, p. 184). For example, "new landowners often have less experience with vegetation management than traditional foresters and ranchers, and a greater focus on recreational and residential qualities" (Ferranto et al. 2012, p. 132).

Another coupling of social values with ecosystem services is the development of bioenergy. In forest communities like the Lassen-Modoc, bioenergy projects for rural development and well-being are linked to social values about the role and funding for local education systems to teach applicable skills for bioenergy production. Such projects are also related to values about equity and justice, which shape whether subsidizing opportunities for smallholders is appropriate and illuminate whether bioenergy production places disproportionate stress on women or other subpopulations. Values regarding efficiency determine if local-scale benefits of bioenergy development outweigh land uses like food production or potential health effects. Finally, differing values about investment in the public good are connected to questions about how private leases for bioenergy development on federally managed land are balanced by democratic processes and industry regulation (Gaspartos et al. 2011).

It is important to note shifts in values vary between and within communities. We would expect groups within the Lassen-Modoc to hold different social values that create both overlapping and contradictory interests in their local forest ecosystem services. The ecosystems that provide benefits to human society are changing rapidly and potentially in a restrictive direction. Therefore, we may expect the social values connected to ecosystem services to be impacted in similar ways—swiftly, variably, perhaps with great difficulty, but not necessarily negatively. These impacts to values may catalyze people to engage in social action about their environments in new ways, toward what the community determines is for their own well-being, if not also for the good of their forest ecology (Balmford and Bond 2005; Goldman 2010).

An example of social values changing toward creative solutions is the shift during the past 2 decades from valuing fire suppression less to valuing fire management more. Moritz and colleagues (2014) call this "learning to coexist with wildfire," (p. 58) a phrase that recognizes the coupling of natural and human systems. Such awareness has developed in rural forest communities like those of the Lassen-Modoc area more rapidly than in the wildland urban interface. If we extrapolate from Kline (2006), this may be because rural members living and working closer to their ecosystem in their everyday lives, having a more attuned awareness of their environment compared to their exurban neighbors. Materially and ecologically, prescribed fire has been shown to reduce the financial cost of suppression and to improve forest health in the Western United States. But in terms of social benefits, managed fire contributes to well-being by reducing risk to the lives of firefighters and by increasing evacuation success of residents (Moritz et al. 2014). Public health and safety are also affected by wildfire intensification and degraded air quality. Reducing the intensity of wildland fire through management also would allay smoke-related effects such as respiratory and pulmonary disease, compromised visibility, and increased risks on roadways and in air traffic (Stavros et al. 2014).

Eco-tourism and recreation represent social value/ecosystem service combinations with more mixed outcomes for local communities (fig. 5.3.1). Nature-based tourism has been a growth industry with associated economic benefits (Balmford and Bond 2005). It has also been shown, however, to "detrimentally [affect] the social and cultural fabric of local communities," especially when it is a consumer activity where not only cultural

Figure 5.3.1—Eco-tourism and nature-based recreation can have positive economic and social effects such as generating tourism revenue for local communities and creating greater awareness, understanding, and support for environmental conservation. Nonetheless, eco-tourism can also have negative effects such as producing single-industry economies and changing the social and cultural identity of local communities (photo by Dawn M. Davis, used with permission).

practices become marketable commodities, but where people of the community also become products (Stem et al. 2003, p. 388). If economic benefits are distributed unevenly, the social networks of communities and families become vulnerable to fracture. Commodification may also dramatically shift traditional values about natural environments, especially among tribal cultures or in isolated communities. Outdoor recreation, however, is largely defined by user-group aesthetic or athletic preferences and tends toward social engagement that is more experiential than consumptive. Recreation is directly related to a general sense of well-being and improved health and illustrates how "forestlands could also act as a common ground among neighboring communities that helps to strengthen societal bonds" (Bawa 2017, p. 1). Hunt and colleagues note that these value distinctions between tourism operators and independent recreationists create the potential for conflict (Hunt et al. 2009).

Finally, social well-being is also expressed in the successes or sufferings that are deeply intertwined with our economic livelihood. Employment opportunities provided in the ecosystem services sector have social value and use-value, and "both contribute to welfare and utility" (Hjerpe et al. 2015, p. 47). The next section more directly discusses economic benefits of ecosystem services that are of interest to the Lassen-Modoc.

Economic Benefits of Ecosystem Services

The previous section gave examples of how ecosystem services are connected with social benefits through social values and lifestyles, but it cannot ignore the economic and commodity values that are basic to the realities of human livelihood. Economic benefits are particularly important to the communities around the Lassen and the Modoc, which are situated in counties recognized as having high economic distress and as having endured concentrated declines in forest products employment (Winter et al. 2014). Lassen and Modoc Counties were classified in 2015 as nonrecreation dependent, nonmanufacturing dependent, nonretirement destination, low-employment, nonmetropolitan counties (Charnley et al. 2018b). Thus, determining if and how these forest communities align their economic necessities with their social and ecological interests will crucially shape their ecosystem services opportunities and land management plans (Turner and Daily 2008).

This section considers the following question in terms of opportunities in forest products, forest services, and forest-derived energy markets:

- What economic benefits of ecosystem services do forests provide for local and regional communities?

We have added to limited research on the economic benefits of ecosystem services on the Lassen-Modoc with more general benefits forests provide for local and regional communities. As mentioned in the beginning of this chapter and more thoroughly reviewed in the Sierra Nevada Science Synthesis (see Chapter 9.4 in Long et al. 2014), ecosystem services emerged in the 1990s as the multiple-use management paradigm that replaced a one-dimensional timber industry in the Northwest. Ecosystem services as a business sector contributes to economic benefits in a number of ways, including jobs in postdisturbance restoration, recreation, tourism, and infrastructural services; as well as in grazing, biomass removal, nontimber forest products (NTFPs), and, of course, continued timber production (see Chapter 9.5 in Long et al. 2014).

Residents of forested regions often take pride in the surrounding landscape and demonstrate pride through personal and collective action, including economic innovation based on their forest resources. "The rules and norms that these communities formed for their forests tend to correspond to their interest in and knowledge about the products they use" (Poteete and Welch 2004, p. 309). For example, collaborative forest landscape restoration is one project the Lassen has participated in and has knowledge about (Winter et al. 2014). Now, however, the Lassen-Modoc community has expressed interest in moving beyond restoration projects and wishes to examine the possibilities for diversifying their market opportunities in forest products, forest services, and forest energy.

Forest Products: Timber and Nontimber Forest Products

The forest products industry in California is predominantly concentrated in the Northern Sierra Nevada region, including Lassen, Modoc, Plumas, and Sierra Counties. A variety of factors such as changes in regulation, policy, economics, timber supply, wildland fire, and technology have significantly decreased forest industry production. The decrease in timber production has sparked increases in transportation costs, fuel use, and carbon emissions related to timber harvesting; and parallels decreases in the price of timber and local employment (Morgan et al. 2004).

Distinct from the more heavily forested areas of coastal Northern California, the Modoc Plateau in the northeastern-most ecoregion of the State is approximately 50 to 60 percent forest area, primarily of juniper softwoods (see Chapter 2.1, Moser, this synthesis, *Understanding and Managing the Dry Conifer Forests of Northeastern California*). It contains the comparatively lower carbon densities that characterize adjacent areas of Nevada to the east and the Great Basin as a whole, as opposed to other ecoregions of Northern California (Hicke et al. 2007). Drought is becoming the hallmark of climatic temperature rise in the Southwest United States and will lead to a greater likelihood of compromised forest productivity, increased tree mortality, reduced biodiversity, and the resulting capacity for more intense, larger-extent fires (Rocca et al. 2014; Vose et al. 2012; Wellstead et al. 2014). The Lassen-Modoc area is expected to experience this warming, drying scenario (Vose et al. 2012). Timber markets and property values may be affected negatively in private-ownership economies. These private economic losses are expected to have parallel declines in public goods such as aesthetic values, water quality, and recreational space in the national forests (Hicke et al. 2007; Vose et al. 2012).

A review of literature by Pramova and colleagues (2012) suggests ways forests can support adaptation to changing ecosystem conditions. First is the obvious provision of goods to local communities, with timber and nontimber forest products that add security to domestic food consumption and diversity to commercial sales (fig. 5.3.2). Second, by contributing to soil improvement and windbreaks, trees help regulate or stabilize the microclimates of agricultural fields for better production. Third, forested watersheds regulate water and protect soils. Each of these contributes to a combined ecological and economic longevity.

Significant changes have taken place for the type, quantity, and availability of Federal timber sale opportunities. In the 1990s, the Forest Service shifted to an "ecosystem management" and wildfire risk reduction paradigm. Harvest of larger, older trees declined, and new policies and programs such as the Northwest Forest Plan emphasized science-based management to restore ecosystems and protect biodiversity (Spies and Duncan 2009). In addition, with growing concerns about wildfire, several policies including the National Fire Plan and Healthy Forests Restoration Act followed in the early 2000s to remove hazardous fuels and restore forest health to reduce wildfire risk (Steelman and Burke 2007). These earlier shifts have led to an array of challenges and realities for forest-based businesses throughout the United States that are adjacent to national forests, which vary across different forest regions (Davis et al. 2018). Accompanying these shifts are impacts to forest-based businesses adjacent to public lands. In a study of timber-purchasing businesses active in six Forest Service regions where ecosystem restoration and wildfire risk reduction policies have prevailed, Davis et al. (2018) found that most businesses purchase small-diameter timber (8 inches diameter breast height or less) and had sought business assistance, most commonly from accountants and lending institutions. Secondly, those with the greatest dependence on Federal timber—76 percent or more of their supply from Federal sources—were less likely to have sought assistance of any kind. Thus, they suggest that more attention is needed to the timing, quantity, and types of supply that Federal lands offer and how this affects business success, particularly to understand how design of timber sales, service contracts, and stewardship contracts and sales may better serve businesses and allow them to produce community economic outcomes (Davis et al. 2018).

For example, one such study by Daniels et al. (2018) conducted an economic analysis of two contracts on the

Figure 5.3.2—Forest management can provide local communities with timber products that add economic diversity to rural communities. However, increased drought and wildfire, as well as shifts in the timber market industry create significant challenges to the potential economic benefits of timber production (photo by Ken Sandusky, Forest Service).

Mount Hood National Forest in Western Oregon. The study examines economic contributions from stewardship contracts and how they compare against county revenue-sharing systems such as Secure Rural Schools funding. The findings from this case study show that: (1) commercial thinning, service work, and retained receipts projects all contributed to local economic activity; (2) expenditures accounted for $4 million in output and generated 36 jobs; and (3) benefits were distributed across a wider variety of economic sectors than timber harvesting alone. Therefore, county-level expenditures on commercial thinning, service work, and retained receipts projects greatly exceeded what could be expected from payments to counties' revenue sharing (Daniels et al. 2018).

Timber resources in Lassen and Modoc Counties previously have been evaluated across all ownerships, together with Shasta, Siskiyou, and Trinity Counties as the North Interior Resource Area of California (Waddell and Bassett 1997). The Lassen-Modoc community has requested assessment of local timber production at a level of detail beyond the peer-reviewed literature, previously synthesized by Long et al. (2014). With access to primary data sources particular to their bioregion, the local national forests are better suited to determine the current capacity and future forecasts of the economic benefits delivered by industrial forest products in the Lassen-Modoc.

Nontimber Forest Products (NTFPs)

NTFPs such as "foods, medicinal plants and fungi, floral greens and horticultural stocks, fiber and dye plants, lichens, and oils, resins, and other chemical extracts from plants, lichens, and fungi…[as well as] poles, posts, Christmas trees, and firewood" (Winter et al. 2014, pp. 649–650) are collected and used for "energy sources, food items, medicinal products, materials for household equipment, construction materials, as well as equipment and materials for agricultural activities" (Illukpitiya and Yanagida 2010, p. 1952). They are relatively more abundant in the Sierra Nevada and Modoc Plateau compared to drier regions but less abundant compared to wetter regions of California. Most NTFPs in Northern California are harvested for personal or subsistence use, with some sold commercially or for supplementary domestic income.

As mentioned in Chapter 5.2 (Flores and Russell, this synthesis, *Demographic Trends in Northeastern*

California), forest communities may anticipate land use/land cover shifts between agriculture and forestlands and between developed and undeveloped areas. NTFP harvesters in rural areas may experience this agriculture/forest trade-off as restricted access to forest products and depletion from over-harvest as population density increases. The literature indicates, however, that where communities are actively involved in management decisions, forests and forest products are well-conserved (Illukpitiya and Yanagida 2010). Watson (2017) importantly suggests that in a post-timber production market, public forests offer an arena in which forest managers and forest resource users may cooperate in new ways. Harvesters may contribute to the sustainable management of NTFPs on national forest lands by sharing their ecological knowledge and management practices and by participating in NTFP research efforts (Long et al. 2014).

Communities have also been able to reap from the forests economic benefits that exist outside of formal markets. Sharing and reciprocal exchange often characterizes subsistence communities that use wild forest resources. This alternative or informal economic distribution system has been shown to reinforce the social benefits of familial, friendship, clan, and tribal relationships that create community identity (Dick 1996). Other nonmaterial motivations—"maintaining cultural practices, sharing knowledge, building community, engaging in spiritual practices, connecting with nature, supporting stewardship, having fun and recreating, and developing alternative food and health systems"—in turn illustrate social positions from which gatherers advocate for economic rights to wild, sustainable products (Poe et al. 2013, p. 416). Wilsey and Nelson (2008) capture the notion that economic activity is essentially cultural, or "embedded in and guided by underlying social institutions," (p. 815) and reinforce the idea that NTFP harvesting is an example not only of economic livelihood, but of a socio-cultural lifestyle for forest communities.

Forest Services: Recreation, Wildlife and Wild Horse Viewing, Carbon Storage, and Energy

Recreation

The economic value of recreational activities such as hiking, camping, and biking in the national forests has been estimated through a willingness-to-pay, travel cost approach to be $90 per person per trip for site access (Binder et al. 2017)[2]. After experiencing declines in timber production and having explored forest restoration services, forest communities are poised to pursue or maintain the economic benefits of outdoor recreation and eco-tourism. Winter et al. (2014) remind us that the economic benefits in this sector vary a great deal, adding some jobs that pay well but many other jobs that are less-beneficial low-wage jobs and/or restricted to seasonal opportunities.

Often recreation-related management decisions can account for attributes preferred by recreationists and the quality of those attributes, including: topography, ecosystem type, and state of fire recovery; size, age, and species of trees; clearings and wildlife viewing areas (fig. 5.3.3) "Altering attributes of the forest site, either directly or indirectly, can influence the attractiveness and value of a site for recreation" (Binder et al. 2017, p. 19). Management has tradeoffs, however: "[W]hat may be an ecosystem service at one level of provision may be a disservice at a different level" (p. 21). Or, one recreationist's trail is another recreationist's trial.

While many intense, landscape-damaging wildfire scenarios negatively impact user value, the number of recreation visits surges in some postfire sites. This is due to initial booms in wildflower cover and wildlife range, and generally to the thinning of the woods that occurs with lower-intensity fires, which leave larger trees intact (Bawa 2017). Therefore, related to the next section on fire management, a "reduction of hazardous fuels and forest restoration activities are thus likely to be viewed by recreational users as increasing quality at a given site" (Bawa 2017 p. 10).

Wildlife and Wild Horse Viewing

The Wild Free-Roaming Horses and Burros Act of 1971 charged the U.S. Department of the Interior, Bureau of Land Management (BLM) and the Forest Service with protecting and managing wild horses (*Equus caballus*) and burros (*E. asinus*) on public lands. As of March 1, 2016, more than 67,000 wild horses and burros are roaming Western public rangelands, which is currently above the appropriate management level of 26,715 set by the BLM. While herds consistently double in size every 4 years, coupled with the dramatic decrease in adoptions, the current program is becoming increasingly challenging

[2] For a discussion of the annual economic benefits to the State of California from outdoor recreation on federally managed lands in the Sierra Nevada region, see Chapter 9.1 (Winter et al. 2014, pp. 513–527) in Sierra Nevada Science Synthesis (Long et al. 2014).

Figure 5.3.3—While recreational activities on national forests such as snowmobiling, hang gliding, and fishing can add economic value to surrounding communities, management decisions have tradeoffs, sometimes favoring one aspect of recreation while having negative consequences for another type of recreation, or type of land use (photos by Modoc Outdoor Recreation and Tourism, used with permission).

to maintain—both ecologically and socially. Therefore, updating current management practices is complex, and requires agreement from multiple stakeholders on the ecological, social, and economic costs (White 2016). Consequently, stakeholders are increasingly polarized about how wild horses and burros are or should be managed. While the ecological and animal health and welfare implications of unmanaged wild horse and burro populations are somewhat understood, publicly acceptable strategies to maintain healthy populations, healthy and functioning rangelands, and multiple uses that sustain wildlife and local communities remain unresolved (Scasta et al. 2018).

Wildlife viewing, including wild horses, is a way to observe the wildness, power, resilience, and freedom in the American West. Landscape-scale and experimental investigations have shown that free-roaming horses and burros induce numerous alterations to native-ecosystem components and processes through influences on soil, water, plants, and other aspects of biodiversity. The management of free-roaming horses has been complicated by "socio-ecological mismatches" (Beever et al. 2019). Such mismatches arise from an inability to reconcile conflicting processes and functions in a social-ecological system. These conflicts often reflect differences in the spatio-temporal scales at which diverse components operate. Introduced species, or in the case of wild horses, reintroduction after 10 to 15 millennia, can have important effects on the component species and processes of native ecosystems. Effective management of such species can be complicated by technical and social challenges (Beever et al. 2018). Beever et al. (2019) identify three socioecological mismatches of wild horse and burro management for both ecological and social sustainability: (1) social systems and cultures may adapt to a new species' arrival at a different rate than ecosystems; (2) ecological impacts can arise at one spatial scale while social impacts occur at another; and (3) the effects of introduced species can spread widely, whereas management actions are constrained by organizational and/or political boundaries.

The way that the current wild horse and burro program is being managed is considered ecologically and financially unsustainable (Danvir 2018; GAO 2008; Garrott 2018). How the BLM and the Forest Service manage wild horses and burros if often being challenged through litigation and public pressure and ultimately Congress may have to supply a decision on sustainable social-ecological management in the best interest of the American public and natural resources (Hendrickson 2018). Options that can contribute to achieving the intent of the Wild Free-Roaming Horses and Burros Act of 1971 are: (1) maintain the status quo; (2) gather and place excess horses and burros in holding facilities for the remainder of their lives; (3) increase adoptions; (4) increase fertility control; (5) remove livestock from wild horse management areas; and (6) fully implement the Wild Free Roaming Horses and Burro Act (Hendrickson 2018). Use of each tool in the BLM and Forest Service toolbox has pros and cons, and while scholars recommend the full implementation of the Wild Free Roaming Horses and Burro Act, it is currently up to each unique management area on which option or options to choose (Hendrickson 2018).

Carbon Storage

Global initiatives for forest carbon sequestration incentivize forest conservation and guide land use, and in so doing, create a market for forest carbon (Mahanty et al. 2012). Participation in carbon sequestration projects requires community knowledge around contributions by public and private property owners, and negotiations regarding the distribution of potential benefits. The 2012 science synthesis on climate change more thoroughly reviews issues surrounding carbon storage (see Chapter 4 in Vose et al. 2012). Nelson and Matzek (2016) are mindful about the tradeoffs of cap-and-trade mechanisms like the regional California Air Resources Board program:

> While it is widely recognized that these mechanisms will impact carbon and energy markets in the U.S., these programs also have the potential to impact land use patterns, rural livelihoods, wildlife habitat, and ecosystem service provision across the country (Nelson and Matzek 2016, p. 2).

The rate of carbon sequestration in the United States increased by one-third from the 1990s to 2000s, due to increased forest area and restoration efforts (Powers et al. 2013). The Western United States is expected, however, to experience disturbances of warming climate such as lower forest productivity, increased fire, and beetle kill—a combination of changes that unfortunately reduces carbon storage in forest ecosystems and is generally seen as "jeopardizing the current U.S. forest sink" (Vose et al. 2012, p. 45). Faced with complex decisions between competing carbon strategies, forest managers may have to negotiate between sequestration by afforestation, by managing decomposition, or by fuels and fire reduction, as appropriate to their ecosystems (Powers et al. 2013). In the Lassen-Modoc area, carbon density has been classified largely as soil organic carbon, as opposed to live forest biomass or dead wood and forest-floor carbon (Oswalt et al. 2014). Relatedly, a study of sequestration strategies in postfire Plumas and Lassen Counties suggests that in fire-prone ecosystems, "the green canopy forest and no salvage logging treatments store the most carbon 10 years after a wildfire" (Powers et al. 2013, p. 276). Further, Powers and colleagues advise ecosystem services managers who combine carbon storage and fire hazard reduction to "maximize carbon storage and carbon sequestration rates in large-diameter live trees and other recalcitrant pools, including soils and dead trees, if possible" and to "minimize carbon storage in saplings, understory, and surface fuels" (p. 276).

Other issues of land use and local capital influence potential carbon markets. Relevant to the Lassen-Modoc is a finding by a recent economic model of the carbon market in the Central Valley of California, namely, that carbon farming has performed poorly against some agricultural commodities. In the case of orchard agriculture, for example, the price of "a carbon offset would have to increase nearly a hundredfold to make reforestation compete economically" (Nelson and Matzek 2016, p. 1). A study of California's Improved Forest Management projects showed that making carbon offsets viable required a level of cost and complexity, capital, knowledge, and technology that excluded marginal landowners. Carbon sequestration projects, therefore, may possibly involve more heavily State-managed initiatives, as opposed to balanced collaboration with small community landowners (Kelly and Schmitz 2016).

Energy

We have noted that economic benefits of forest ecosystem services exist on a spectrum between large-scale timber harvesting and domestic nontimber forest product, and between the negotiated goals of fire management and carbon stocking. Forest-dependent communities are being encouraged to respond to ecosystem service opportunities conditioned by climate change policy. "Under the 2011 California Renewable Energy Resources Act (SB X 1-2), electrical utilities are required to obtain 33 percent of the electricity they sell to retail customers in California from renewable sources by 2020" (Winter et al. 2014, p. 645). This section considers issues of bioenergy, solar and wind, and geothermal energy that may be informative for Lassen-Modoc stakeholders.

Bioenergy Fuel. Forest residues differ from timber in that it is the "trees and woody plants—including limbs, tops, needles, leaves, and other woody parts—that grow in forests, woodlands, or rangelands" (Charnley and Long 2014, p. 641). The removal of forest residues in forested land can also reduce wildfire hazards and associated costs of fire disturbance (fig. 5.3.4). The cost of removal and transport of forest residues to facilities can be significant, if not prohibitive.

In areas where cultivating hardwoods to sequester carbon is less viable, developing bioenergy from other forest and wood waste is an alternative (Becker et al. 2009). The margin for growth is large because forest residues, as a renewable source capable of providing a consistent baseload of power, contribute only about 2 percent of California's electricity (Winter et al. 2014, p. 645). As of the publication of the Sierra Nevada Science Synthesis in 2014, California had more biomass power plants than any other State, and the plants existed in various states of operability, generating various types of fuel and/or energy. At the time, Lassen County featured one idled facility, and Modoc County had no biomass power plants.

The development of forest residue production in these counties was constrained in several ways. First, the supply of material was limited ecologically by the prominence of shrub cover over forest cover in many areas. Aboveground live forest residues are dramatically less prevalent in the Lassen and the Modoc, relative to adjacent areas of the Sierra Nevada and Coastal California (Vose et al. 2012). Second, a market disadvantage was already in place, with the preexistence of active plants in the region, concentrated near Redding. Finally, other economic issues related to "lack of industry infrastructure, harvest and transport costs … and market trends" were noted (Winter et al. 2014, pp. 642–643). (See also Charnley and Long 2014.)

The prevailing market trend regarding renewables was that wind and solar were the sources of electricity favored by "the largest electrical utilities in California" (Winter et al. 2014, p. 645). Research is needed to assess whether the September 2012 passage of California's Senate Bill 1122 was successful in removing some market barriers and stimulating the State's bioenergy markets through small, networked biomass projects. More than urbanization and

Figure 5.3.4—Converting noncommercial forest residue into products with economic value would further support traditional harvesting of trees for forest products, as well as bolster efforts to thin younger, overstocked stands to reduce fire risk and intensity (photo by Ken Sandusky, Forest Service).

population growth, policies that govern the direction of the bioenergy sector may ultimately be more impactful for rural land use decisions:

> Stronger shifts in comparative returns to forestry and agriculture would probably result from policy changes, especially those designed to encourage bioenergy production. The degree to which a bioenergy sector favors agricultural feedstocks, such as corn, or cellulosic feedstocks from forests will determine the comparative position of forest and crop returns to land use, and therefore land use allocations. The allocation among feedstock sources depends on energy policies at both federal and state levels, which could differentially affect rural land uses (Vose et al. 2012, p. 106).

Solar and Wind Energy

The 1992 Land and Resource Management Plan for the Lassen indicated that the forest had medium suitability for solar energy, but expanding solar use was cost prohibitive at the time. Similarly, while several exposed ridge areas of the Lassen were classified as providing excellent wind resources usable for wind energy, development faced prohibitive costs of access, infrastructure, and electrical transmission (USDA Forest Service 1992). At that time (1992), demand for solar or wind energy was not significant.

Geothermal Energy

The County of Modoc website indicated that Modoc County has great geothermal potential "right under [its] feet" (Moeller 2017). Modoc County has 119 authorized geothermal energy zones on public land managed by the BLM (Thermal Zones Modoc 2016). Additionally, Surprise Valley in Modoc County is identified as a key geothermal resource site in California (Geothermal Energy Association 2016). Similarly, Lassen County has 32 authorized geothermal energy zones on BLM-managed public land (Thermal Zones Lassen 2016).

According to the Geothermal Technologies Office 2016 Annual Report (2017), which is a product of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, geothermal energy can provide several social and economic benefits. For example, geothermal energy "supplies clean, renewable power around the clock, emits little or no greenhouse gases, and takes a very small environmental footprint to develop" (p. 3). Additionally, the development of "available geothermal can create temporary and permanent jobs and revenue streams in California" (Geothermal Technologies Office 2017, p. 2). Furthermore, the high temperatures produced by geothermal energy may dissolve "rare-earth minerals and other high-value, critical or strategic materials" into "fluids associated with geothermal energy extraction" (p. 11). Subsequently, these materials, which include rare minerals and lithium, are crucial to the production and use of "many clean energy technologies, including solar panels, wind turbines, electric vehicles, and energy-efficient lighting" (p. 11). For additional benefits of geothermal energy, specific to California, see Geothermal Energy Association's (2016) presentation on "Geothermal energy potential: State of California."

While the benefits from geothermal energy are significant, its production can be "challenging and costly, with resource confirmation relying on the drilling of multimillion-dollar wells with varying success rates" (Phillips et al. 2013, p. 1). Therefore, for Lassen and Modoc Counties to pursue the social and economic benefits provided by geothermal energy, forest managers can develop an "understanding of temperature, permeability, and fluid signatures that indicate geothermal favorability" (Phillips et al. 2013, p. 1). Furthermore, research to enhance innovative exploration technologies can continue to be conducted to improve the identification and development of geothermal systems. See Phillips et al. (2013) for more information.

Forest Management Practices

This section focuses on general forest management guidelines and some examples from California forest communities in order to respond to the question:

- How can *forest management* practices improve decisionmaking processes for ecosystem service benefits?

As noted previously in this section, "place matters, the planning or decisionmaking process matters, and original, specific, and local solutions may be best" (Vose et al. 2012, p. 196) because social values (described above) play a critical role in why communities derive meaning from their local ecosystem services and how members invest in them. Assessing social values prepares forest managers and publics to communicate their way through potential conflicts and congruencies, and to participate in democratic, multifaceted decision making. Methods of assessing community values and attitudes include surveys and opinion polls, and more interpretive practices such as public-participation GIS mapping, workshops, focus groups, storytelling, interviews, nature journaling, and a number of psychometric measures of well-being (Bieling et al. 2014; Ives and Kendal 2014; Kenter et al. 2015).

Economic Valuations

A recent review of literature (Binder et al. 2017) indicates that the economic valuation of forest ecosystem services is under-utilized in forest management. The review focuses on nonurban forests, ecological production functions, and economic benefits functions; but does not include social, cultural, or spiritual ecosystem services that we have already identified as "difficult to quantify and whose value is often thought to be antithetical to consideration in monetary terms" (p. 1). In short, the community's social preferences and economic values are either translated into practical negotiations of time and monetary investments or they are measured by observed behaviors.

> Economic valuation of an ecosystem's goods and services represents an attempt to estimate changes in people's economic well-being—as measured by their own preferences—due to incremental (marginal) changes in the ecosystem's components. When ecosystem goods are traded in markets (e.g., timber), the market price (e.g., U.S. dollars/cubic meter) is a measure of the benefit people get from a unit of the good. Since most ecosystem services are not traded in markets, and therefore do not have observable prices, economists estimate the value of changes in ecosystem services by leveraging the information conveyed by individuals' observable decisions (Binder et al. 2017, p. 3).

While economic valuation methods do have limitations, they are able to provide stakeholders with information to make management decisions. Binder et al. (2017) summarize guidance for economic valuation assessments in Forest Service decisions with four suggestions that may shape the forest management plan, and note that this guidance could be tailored to the needs of the specific forest and its community. These involve cataloging assets, projecting possible change, communicating these valuations with stakeholders, and monitoring performance, described below.

How could the Forest Service proceed given the current state of the literature on the assessment and economic valuation of ecosystem services?

1. Estimate the economic benefits of a given forest and associated management policy, using available methods for services related to timber, carbon, water, amenities, recreation, and wildlife. This practice is important to identifying and describing the range of benefits provided by the forest. It also provides a baseline for evaluating changes in management.
2. Estimate the change in economic benefits associated with a change in management, regulations, or incentives, or a natural disturbance. This practice is important to evaluating and prioritizing different policies, evaluating potential tradeoffs in management decisions, and assessing the damages caused by natural disturbances.
3. Enhance communication with stakeholders about the economic benefits and costs of potential changes in forest management. This practice is important because communities' preferences for different ecosystem services may be affected by estimates of economic performance.
4. Monitor the performance of agency programs. This practice is important to tracking whether the actual economic benefits and costs of agency programs are consistent with projections.

(Adapted from Binder et al. 2017)

Vose et al. (2012) describe the socioeconomic vulnerability assessment (SEVA) process. SEVAs first require a review of Census Bureau data and other secondary resources relevant to the local area. SEVAs then could:

> (1) "briefly discuss the social history of the forest and its human geography, including both communities of place and communities of interest,
>
> (2) link current and expected biophysical changes to community-relevant outcomes,
>
> (3) determine stakeholders' perceptions of values at risk (e.g., resources, livelihoods, cultures or places threatened by climate change), and
>
> (4) prioritize threats to vulnerable communities and identify those that the landowner or land manager, singly or with their partners, can best address." (p. 117).

Like other assessment approaches, the SEVA is considered an iterative, monitored, and flexible process subject to revision and adaptation in collaborative forest management.

Fire Management

Changes in the climate regimes are affecting the ecological health and economic costs of forest ecosystem services throughout the United States differentially by region. Increased seasonal temperatures and higher drought indices are projected for the Pacific Southwest Region generally and California specifically, including impacts upon the Lassen and Modoc reviewed elsewhere in this science synthesis. Current and anticipated increases in wildland fire frequency, intensity, and impacts on forest systems are expected to have complex effects on carbon sequestration, vegetation extent, biodiversity, and other ecosystem services. Prescribed and natural fire management, fuel treatments, and forest restoration have been shown to be effective management tools for containing or reducing wildland fire, especially at the local scale; and their use has been encouraged for the health of the ecosystem (Hurteau et al. 2014; Rocca et al. 2014; Vose et al. 2012).

In addition to its ecosystem benefits, a more robust fire management program may also provide economic benefits. Opportunities for more regularized, less seasonally driven employment for the community-based forest and fire labor force could support the local economy more reliably. Employment through fire management and fire hazard reduction represents a reversal of the fire suppression practices that were intended to create jobs in the 1930s. The National Fire Plan in 2000 discusses fire management for the dual tasks of "reducing fire hazard on public lands and providing economic benefit to rural communities and workers" (Moseley and Toth 2004, p. 702). An early evaluation in the Northwest Region found that the National Fire Plan created economic benefits for some rural communities, but not necessarily for the more isolated rural communities, which the Lassen-Modoc area may resemble. Through the local benefit criterion, the National Fire Plan granted more contracts to firms located closer to national forests. Finally, the plan also delivered more contracts to historically underutilized businesses, which in the Northwest as in the Lassen-Modoc are characterized by poor rural counties and tribal lands. Minority-owned 8(a) businesses, typically located in urban areas and not proximate to national forests in the Pacific Northwest, received comparatively fewer contracts (Moseley and Toth 2004).

Fire management, especially in the form of wildland fire use, also "provides economic benefits in terms of avoidance of costs—for environmental damage remediation, fuel treatment projects, comparatively more expensive suppression tactics" (Dale 2006, p. 279). Fire management also adds savings in terms of material security to private homeowners and safer evacuation passage for forest residents (Moritz et al. 2014). Additionally, long-underestimated health effects of wildfire exposure have been re-assessed as monetized damage (Richardson et al. 2012). Doing so enables communities to consider smoke-related health impacts and defensive health strategies as economic costs that could otherwise be mitigated with increased fire management and fire reduction. Estimated spending for fuels management per Forest Service region are by far the highest in the Pacific Southwest Region (see table 3 in Lee et al. 2015, p. 265).

Models of Ecosystem Services Management in California

The Inyo National Forest in Eastern California contains dry forest ecosystems similar to some areas of the Lassen-Modoc bioregion. One outcome of science-management collaboration was the Climate Project Screening Tool, the purpose of which is to assess whether climate change would affect natural resources and therefore impact current-year management of ecosystem services (Vose et al. 2012). Another science-management collaboration tool is the Strategic Framework for Science in Support of Management that was produced for the Southern Sierra Nevada, CA. It addresses parallel concerns of the Lassen-Modoc, including wildland fire and potential wildland urban interface encroachment.

Public and private stakeholders in the Mokelumne River Basin, known as a water source for the San Francisco Bay area and for its whitewater rafting and kayaking, gathered in 2012 to make an economic case to broker increased fuel treatment in the basin (Elliot et al. 2016; also see Buckley et al. 2014). As previously discussed, economic values are difficult to assign to resources such as wildlife, recreation, and cultural sites. While these were left out of the analysis, the avoided costs of sediment erosion were included in a number of fire and hydrology risk-assessment models (Elliot et al. 2016). The resulting analysis estimated that "the economic benefits of the fuels treatments were 2 to 3 times more than the costs of treatments" (p. 884) and helped land and water managers, including the Forest Service and BLM, plan fuel treatment strategies with stakeholders to protect water utility and other infrastructure resources. This recent fuel treatments project illustrates the mutual benefits of collaborative management:

> Offsite stakeholders are not commonly engaged in forest management planning processes. This methodology helped to bring together watershed managers and water users who had not realized they too were stakeholders in forest fuel management (Elliot et al. 2016, p. 885).

This chapter reviews some supply-side issues of forest management in which "the formal methods of professional economic analysis reflect a vision of comprehensive administrative rationality" and in which public land managers "operate in a world of large uncertainties with respect to scientific facts, future social and economic trends, likely political pressures, and many other factors" (Nelson 2006, p. 550). In addition, the concept of ecosystem services as a socioecological paradigm that attempts to balance these factors was introduced. The management of ecosystem services is a negotiation of meaningful social values and practical economic interests among culturally rooted forest stakeholders in a changing world. In times of increased climate disruption and hazard events, the measure of successful forest ecosystem services management is marked by "efforts that benefit and promote goals of ecosystem sustainability," and as has been repeated, is shaped by local contours. Successful implementation occurs

> When projects are developed and deployed for specific places with concrete treatments and prescriptions, explicit objectives, and for definitive time periods. Successful implementation also implies that monitoring and adaptive management schedules are integrated in out-year efforts, and are secured with funds and capacity needed for completion (Vose et al. 2012, p. 125).

Because economic use-values do not necessarily coincide with social well-being, Chapter 5.4 (Flores and Stone, this synthesis, *Community Engagement in the Decisionmaking Process for Public Land Management in Northeastern California*) addresses how local community members advocate for their demand-side concerns, and how forest managers negotiate competing demands with educational and outreach practices.

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