# US Forest Service Experimental Forests and Ranges: An Untapped Resource for Social Science

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ABSTRACT

For a century, US Forest Service experimental forests and ranges (EFRs) have been a resource for scientists conducting long-term research relating to forestry and range management. Social science research has been limited, despite the history of occupation and current use of these sites for activities ranging from resource extraction and recreation to public education. This article encourages researchers to take advantage of the rich, though largely untapped, potential EFRs offer for social science by describing their many human dimensions and providing an overview of potential research topics. These topics include human uses, economics, historical studies, population and land-use change, human values, and interdisciplinary social–ecological studies. Lack of awareness among social scientists, limited budgets and networking, and the predominance of biophysical scientists who administer and conduct research at EFRs appear to be inhibiting the development of social science research there. We suggest ways of overcoming these barriers.

**Keywords:** US Forest Service, social science research, experimental forests and ranges, human uses of public lands

For the past century, the US Forest Service has maintained a network of experimental forests and ranges (EFRs) that provide a land base where long-term research, experimental and otherwise, is performed. The network is currently comprised of 81 sites nationwide that range in size from 47 to 22,500 ha (Adams et al. 2008, Wells 2009). EFRs have largely been viewed as places to conduct biophysical research. For example, research at the H.J. Andrews and Wind River Experimental Forests (in Oregon and Washington) has shaped understanding of the structure and function of old-growth forest ecosystems (Wells 2009). Research at Caspar Creek (California) and Fernow (West Virginia) Experimental Forests on the relationship between forests and water has informed the development of watershed management strategies. However, EFRs are also sites where it is possible to perform social science research and, indeed, where social science has a valuable contribution to make, as we show in this article. The advantages to social scientists of working at these sites are many, including the ability to undertake long-term, comparative, and experimental research; the availability of ecological data sets; the presence of a community of researchers with whom to interact and pursue interdisciplinary studies; and built-in research facilities and infrastructure in many places. However, surprisingly, little social science research has been conducted at EFRs to date.

The purpose of this article is to encourage researchers to take advantage of the untapped potential at EFRs for social science and for interdisciplinary research across social and natural science disciplines. We describe the human dimensions of EFRs, summarize the social science research that has been conducted at EFRs to illustrate what is possible, present suggestions for studies desired by EFR site coordinators, and examine barriers to social science research at EFRs and suggest how these barriers might be overcome.

## Methods

In 2009, we collected information from 80 EFRs about human interactions and the social science research that has been conducted at these sites. [1] First, we conducted a review of the published and gray literature resulting from social science research at or associated with EFRs. Second, we contacted EFR coordinators and scientists using e-mail correspondence and telephone interviews to

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**Table 1. Cultural resources at experimental forests and ranges ($n$ = 68).**

| Type of site | No. of EFRs | Percent of EFRs |
|---|---|---|
| Historical sites | 38 | 55.9 |
| Archaeological sites | 20 | 29.4 |
| Cultural heritage sites | 17 | 25.0 |
| Spiritual or sacred sites | 11 | 16.2 |
| Do not know | 14 | 20.6 |

request information about public uses of EFRs, allowable activities, the social science research associated with each site, proposed or possible future studies, and public outreach activities. Typically, a US Forest Service scientist at each research station serves as the Officer in Charge of one or more EFRs. A total of 80 individuals from five research stations representing 58 EFRs provided information during this data gathering phase.

Third, we administered a formal, online survey to US Forest Service personnel affiliated with each site using on online survey tool called Survey Monkey. Its purpose was to systematically verify our findings about human activities, citizen outreach, and social science research at EFRs. We invited key contacts for the 80 EFRs to participate. A total of 68 surveys were completed, representing an 85% response rate. Survey data were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, Washington) and analyzed.

## EFRs: Human Landscapes

EFRs should not be viewed as isolated, empty, untrammeled places. Nor should they be conceptualized as gated or discrete outdoor laboratories accessible only to scientists. Humans have long been a part of these ecosystems and have influenced present conditions there. Lands currently managed as EFRs have strong links to the past and often are sites of historical or cultural significance. They are also places used by neighboring residents and nonlocal visitors for recreation, hunting, fishing, and gathering for subsistence and for connecting to sacred or special places. In addition, EFRs serve as natural outdoor classrooms for students, educators, scholars, and resource professionals. All of these uses suggest fertile ground for social science research.

Many EFRs contain important cultural resources, indicating their rich human history. Our survey of EFR contacts found that historical, archaeological, and cultural heritage sites occur at many EFRs (Table 1). More than one-half (56%) contain historic structures, and many have archaeological, cultural, or sacred sites. Examples include historic structures installed by the Civilian

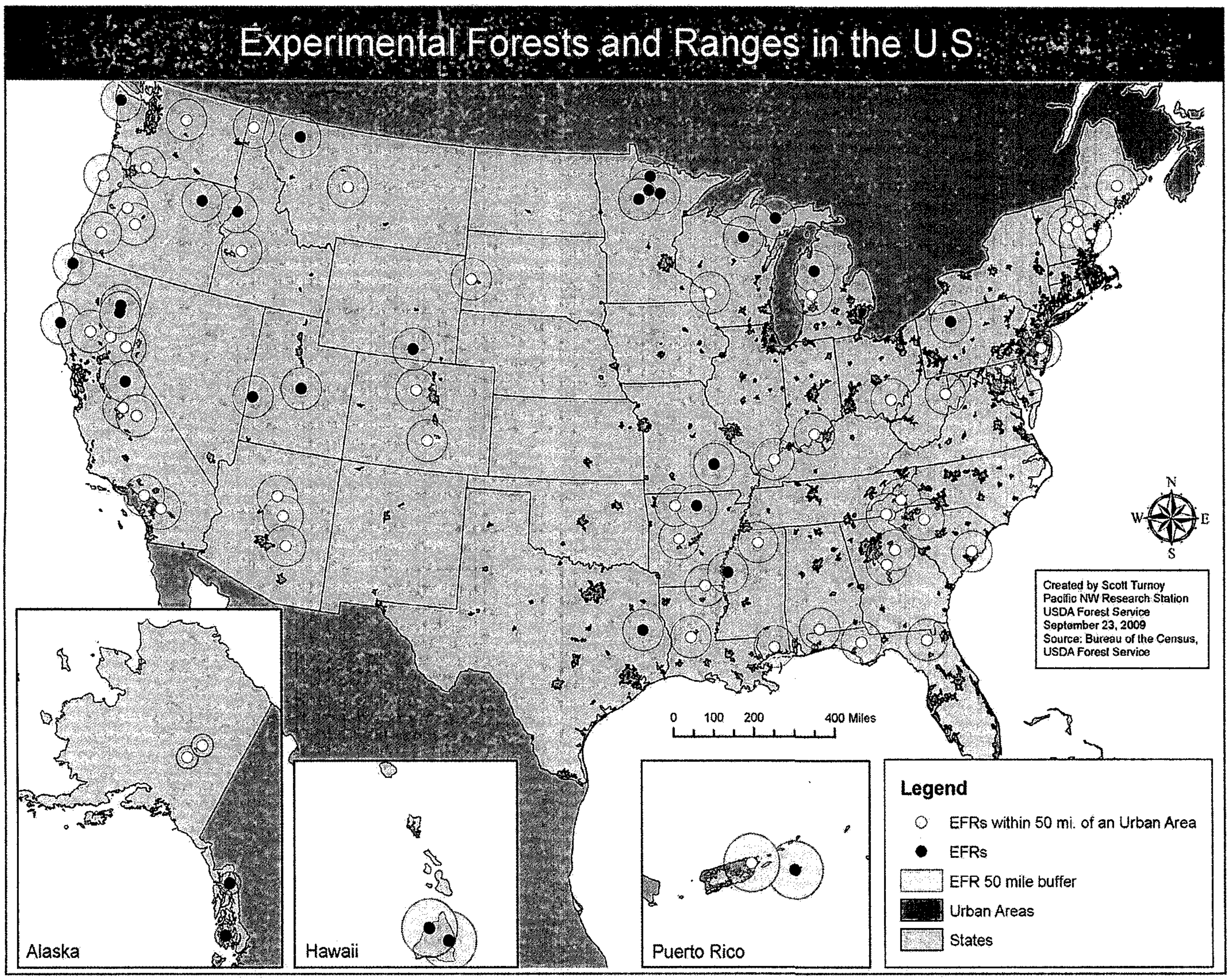


**Figure 1. Experimental forests and ranges in relation to urban areas. (Urban areas are places having 50,000 people or more, as defined by the US Census Bureau).**

Conservation Corps during the 1930s and 1940s; remains from early European settlement such as farming structures, fences, and agricultural tools; archaeological resources such as petroglyphs, tool-making sites, and pre-Columbian dwellings; and cultural heritage sites that are sacred places or sites where important events in human history occurred.

Today, 35.4% of all EFRs in the network lie within 50 mi of an urban area, and just over 15% are located within 25 mi of an urban area, suggesting the potential for urban visitors to use these sites (Figure 1). Another 20.1% of EFRs are fairly remote, located more than 100 mi from an urban area. Human uses of EFRs vary, depending on their unique geographic setting, topographic features, and accessibility. Only two EFRs in the network are completely closed to the public, although one of these is leased by private hunting clubs. Sixteen other EFRs implement special limitations on human use, such as closed areas, restrictions on certain activities, or seasonal closures. Typically, management for human uses is consistent with and determined by the national forest or grassland or other government agency with which it is affiliated.

Table 2 shows the number of EFRs at which different human uses occur. The most common uses are walking/hiking/running and hunting, which take place at nearly 90% of EFRs. Other common uses occurring at over 75% of EFRs are recreation activities, including wildlife viewing, vehicle driving, and scenic viewing. Timber harvesting occurs at many sites (77.9%), although some of this harvest is conducted as part of the research mission of the site. Less common are motor boating, mining, grazing, commercial recreation, and outdoor events, which take place at fewer than 25% of EFRs. These data suggest that EFRs are currently used by local and nonlocal visitors in a variety of ways. Conversations with EFR contacts revealed that often these visitors are unaware of jurisdictional boundaries and may not know about the research mission of the site. They range from being places where it is simply convenient to walk a dog, to places such as Bent Creek Experimental Forest in North Carolina, which has one of the most premier urban-proximate mountain bike trail networks in the United States. When EFRs are adjacent to national forests with high visitation, or specially designated management areas such as wild and scenic rivers, human activity on the EFR may be affected.

Many EFR scientists and site managers conduct public outreach activities by involving stakeholders, communities, other scientists, students, and citizens in their scientific endeavors (Table 3). Outdoor education programs and field trips are the most frequent ways that EFR scientists connect with the public, with 82.4% of EFRs offering some kind of educational program or experience. It is also common for EFRs to develop and maintain interpretive trails and tours (64.7%). Trails were seen as an effective way to introduce groups to science and to the EFR. Working with partners on stewardship projects and collaborative decisionmaking are other ways that EFRs conduct outreach to citizens and communities. More than one-third (38.2%) of the EFRs in our sample had worked with volunteers and partners in the past on projects ranging from bird counts, bridge construction, and trail maintenance, to environmental restoration. Collaborative decisionmaking is an important part of the operation of some EFRs (30.9%), where respondents felt there was much to gain by establishing collaborative planning processes. Finally, some EFRs (22.1%) reported public involvement in monitoring or data collection. We did not find evidence of technology transfer, participatory monitoring, or other forms of citizen science that involved social science, however.

**Table 2. Human activities at experimental forests and ranges ($n$ = 68).**

| Activity | Occurs on EFR (%) | Occurs frequently (%) | Occurs occasionally (%) | Does not occur (%) | Do not know (%) |
|---|---|---|---|---|---|
| Walking/hiking/running | 89.7 | 54.4 | 35.3 | 8.8 | 1.5 |
| Hunting | 89.6 | 71.6 | 17.9 | 9.0 | 1.5 |
| Wildlife viewing | 88.2 | 47.1 | 41.2 | 7.4 | 4.4 |
| Vehicle driving | 83.6 | 53.7 | 29.9 | 11.9 | 4.5 |
| Timber harvest | 77.9 | 17.6 | 60.3 | 22.1 | 0.0 |
| Scenic viewing/sightseeing | 76.5 | 32.4 | 44.1 | 17.6 | 5.9 |
| Dog walking | 74.6 | 28.4 | 46.3 | 14.9 | 10.4 |
| Mountain biking | 70.6 | 17.6 | 52.9 | 16.2 | 13.2 |
| Picnicking | 70.6 | 19.1 | 51.5 | 19.1 | 10.3 |
| Horseback riding | 61.8 | 23.5 | 38.2 | 27.9 | 10.3 |
| OHV/ATV use | 58.8 | 30.9 | 27.9 | 33.8 | 7.4 |
| Fishing | 55.9 | 32.4 | 23.5 | 39.7 | 4.4 |
| Firewood/Christmas tree cutting | 51.5 | 10.3 | 41.2 | 47.1 | 1.5 |
| Camping | 50.0 | 19.1 | 30.9 | 41.2 | 8.8 |
| Special forest products gathering | 44.8 | 10.4 | 34.3 | 46.3 | 9.0 |
| Target shooting | 44.8 | 13.4 | 31.3 | 47.8 | 7.5 |
| Snow machining | 38.8 | 25.4 | 13.4 | 55.2 | 6.0 |
| Skiing | 37.3 | 13.4 | 23.9 | 58.2 | 4.5 |
| Cultural/spiritual/religious use | 27.3 | 3.0 | 24.2 | 37.9 | 34.8 |
| Geocaching/orienteering | 26.9 | 9.0 | 17.9 | 28.4 | 44.8 |
| Kayaking/canoeing/rafting | 26.5 | 8.8 | 17.6 | 72.1 | 1.5 |
| Organized outdoor events (festivals and races) | 23.5 | 2.9 | 20.6 | 66.2 | 10.3 |
| Commercially guided recreation | 23.5 | 8.8 | 14.7 | 67.6 | 8.8 |
| Grazing | 21.2 | 12.1 | 9.1 | 72.7 | 6.1 |
| Mining | 14.9 | 1.5 | 13.4 | 83.6 | 1.5 |
| Motor boating | 11.8 | 7.4 | 4.4 | 85.3 | 2.9 |

ATV, all-terrain vehicle; OHV, off-highway vehicle.

**Table 3. Outreach activities taking place at experimental forests and ranges ($n$ = 68).**

| Activity | Total no. | Percent |
|---|---|---|
| Outdoor education/field trips | 56 | 82.4 |
| Technology transfer to local stakeholders | 46 | 67.6 |
| Interpretative trails/tours | 44 | 64.7 |
| Outreach to local communities | 32 | 47.1 |
| Work with volunteers and partners for forest stewardship | 26 | 38.2 |
| Collaborative planning and decision making | 21 | 30.9 |
| Citizens involved in monitoring/data collection | 15 | 22.1 |
| Other | 5 | 7.4 |

## Social Science Research at EFRs

Although EFRs have largely been viewed as natural laboratories for conducting ecological research relating to forest and rangeland ecosystems, more social science research has occurred in association with these sites than is evident at first glance, and

**Box 1. The impact of recreation on elk and mule deer, Starkey Experimental Forest and Range, OR.**

At the Starkey Experimental Forest and Range in Oregon, a 25,000-ac ungulate-proof enclosure was constructed in 1987 that makes it possible to study interactions between humans and ungulates using controlled research experiments. Scientists have been doing just this since 1991. A 10-year experimental study of the effects of hunting pressure on elk and mule deer found that elk respond to hunting pressure by fleeing disturbance, and that hunter density and traffic counts were positively correlated with elk velocity. Hunting poses significant energetic costs to elk. In contrast, deer responded to hunting pressure by hiding, which entails much lower energy costs. Habitat use by both species did not shift, but daily patterns of use were disrupted. Archery hunts affected animal movements for longer periods during a day than rifle hunts. Another study at Starkey evaluated the impacts of off-road recreation—including all-terrain vehicle (ATV) use, horseback riding, mountain biking, and hiking—on elk and mule deer using controlled experimental treatments. Scientists found that off-road recreation activities have a substantial effect on elk behavior, causing their movement rates and flight responses to become highly elevated. ATV use and mountain biking provoked the greatest travel response. ATVs caused elk to decrease their feeding time, and mountain biking and hiking caused them to be restless. However, mule deer exhibited little response to off-road recreation activities. The results of these studies can inform hunting regulations and management guidelines for off-road recreation in national forests throughout the west where recreation, elk, and mule deer co-occur. (Based on Johnson et al. 2004, Wisdom et al. 2004.)

several studies are currently ongoing or proposed. In some cases, social science research has been one component of a larger study focusing on biophysical research questions. In other cases, social science research has been conducted on the national forest or rangeland, or in the larger region, where the EFR occurs and has included it, but has not exclusively focused on it. We group the social science research that has occurred at or in association with EFRs into six topic areas: human uses; economics; studies of the past; human dynamics at the wildland–urban interface; human values relating to forests, rangelands, and their management; and interdisciplinary social–ecological research.

## Human Uses

People use EFRs in numerous ways that potentially influence ecosystem processes and functions. Understanding the nature of these human uses, their ecological effects, and how to manage them has emerged as one area of research at EFRs. One reason the EFR network was originally established was to study the effects of grazing and silvicultural practices on forest and rangeland ecosystems and to use this understanding to inform management (Shapiro 2008). For example, research on grazing, rangeland ecology, and management have been ongoing for nearly 100 years at the Great Basin Experimental Range (Utah) and Fort Valley Experimental Forest (Arizona; Adams et al. 2008, Pearson et al. 2008). Similarly, the Bent Creek Experimental Forest (North Carolina) and the Crossett Experimental Forest (Arkansas) are sites where nearly 100 years of silvicultural research has provided a foundation of knowledge for forest management (Adams et al. 2008).

Recreation research began at EFRs in the 1950s with an experimental study at the San Joaquin Experimental Range (California) that tested a permit registration card developed for regulating the number and timing of sport hunters (Philpott et al. 1958). EFRs have since served as sites for experimental research relating to recreation and its impacts, as well as sites where ongoing recreation activities have been studied. For example, an experimental study at Hubbard Brook (New Hampshire) assessed the effects of hiking and associated trampling on ground flora along trails (Kuss and Hall 1991). In at least five EFRs, there is ongoing or proposed research on how recreation uses affect wildlife and forest and range conditions. At four additional sites, scientists expressed a desire for future research on hunting and off-highway vehicle use because of concerns about the effects of these activities on natural resources and on study plots. One example of this type of study is highlighted in Box 1. Administrators and scientists contacted for this study expressed particular interest in future research to help them learn more about EFR visitors and the experiences and activities they seek.

Interestingly, much of the research on human uses at EFRs has been conducted by natural scientists rather than social scientists because the main object of study has been the environmental effects of human activities rather than the people engaged in these activities. Humans are typically treated as a disturbance factor. This is particularly true for studies using experimental designs. Future interdisciplinary research on human uses that includes social scientists could be undertaken to gain insight into the motivations and behaviors of forest and range users.

## Economics

Economics research at EFRs dates back to the 1930s and represents the longest-standing area of social science research conducted at EFRs. From the 1930s to the 1950s, economics research took place at the Desert Experimental Range (Utah) to evaluate the economic impacts of alternate grazing strategies (e.g., Hutchings 1946). Studies to assess the economics of different silvicultural treatments in the context of forest management for timber production have also occurred for decades, having been performed on at least eight EFRs nationwide (Adams et al. 2008). More recent economic studies at EFRs have focused on recreation. For example, current studies at Bent Creek Experimental Forest (North Carolina) are investigating the economic impacts of recreation activities on the local economy and the broader economic value of recreation there (Payne 2009). EFR scientists and administrators identified ecosystem services as a desirable area for future economics research.

Rarely has comparative social science research of any kind been conducted across multiple EFRs. One exception is a study of forest-economy relations at six long-term ecological research sites (LTERs), four of which are EFRs.[2] This study is highlighted in Box 2.

## Studying the Past

A third area of social science research consists of studies of historic and prehistoric uses of areas now being managed as EFRs and how these activities have shaped ecosystems there. The earliest historical study comes from the Bent Creek Experimental Forest (North Carolina) and contains a detailed reconstruction of the land use history of individual ownership tracts that now make up the forest (Nesbitt 1941). Several

**Box 2. Forest ecosystem-economy relations, Bonanza Creek, AK; H.J. Andrews, OR; Coweeta, NC; Hubbard Brook, NH.**

Comparative research across six LTERs, four of which are experimental forests, was undertaken to develop a framework for assessing the multiple relationships between forest ecosystems and regional economies and to improve understanding of the variables that influence these relationships. At three EFRs, timber harvesting was the most economically important forest management activity. Although demand for timber was increasing, jobs and income associated with converting a unit of forest resources to timber products were either stagnant, and likely to decline (Coweeta, Hubbard Brook), or were decreasing (H.J. Andrews). At all sites, researchers found that allocating forest resources to intensive timber production in the future would likely generate fewer jobs and lower incomes than in the past. Furthermore, at all sites, competing demands for forest resources—such as other commercial uses and intrinsic forest values such as biodiversity and other ecosystem services—are likely to increase relative to timber industry demands in the future. Thus, communities that continue to depend on the timber industry are predicted to stagnate or contract economically. The framework for evaluating forest ecosystem–economy relations developed at these case study sites can be applied elsewhere to help managers evaluate the economic impacts of forest management decisions. (Based on Courant et al. 1997.)

studies that examine how historic settlement patterns and land-use activities have shaped present forest conditions at experimental forests have been conducted since the 1990s (e.g., Gragson and Bolstad 2006). One study looked at how past forest management practices on an EFR shaped the social and economic history of the surrounding region (Darling and Bragg 2008). Other studies simply document the history of individual EFRs and the research endeavors that have occurred there (e.g., Douglass and Hoover 1988).

The only archaeological study we are aware of comes from the San Joaquin Experimental Range (California; Beck 1995). Between 1978 and 1995, students in the Anthropology Department at Fresno City College conducted surveys of cultural resources from the Indian and early ranching and mining periods. The students learned archaeological survey methods, and the Range gained valuable information about its cultural resources. This information included an inventory and description of the sites and their archaeological, ethnographic, and historic backgrounds and maps of their geographic locations.

Another research area looks at how indigenous peoples used and managed natural resources on and around EFRs in the past. One area of inquiry concerns Indian burning practices and the use of fire for forest management in historic and prehistoric times (e.g., Natcher et al. 2007). Box 3 highlights a study of past natural resource use practices by American Indians at Cascade Head Experimental Forest in coastal Oregon.

## Human Dynamics at the Wildland–Urban Interface

A fourth area of inquiry looks at the effects of nearby development and changing demographic patterns on EFRs and the broader landscapes of which they are a part. Population growth and associated development have occurred around many national forests and rangelands, driven by an influx of urban residents, retirees, second-home owners, and telecommuters who wish to live closer to natural areas. On average, population density within 50 mi of an EFR was higher in 2000 (110 persons/mi$^2$) than the US average (78 persons/mi$^2$); and population growth within 50 mi of the five EFRs that saw the most growth ranged from 43.8 to 67.8% between 1990 and 2000 (Arthaud n.d.). Although few studies have been conducted around EFRs specifically that focus on human dynamics at the wildland–urban interface, two have been proposed, both in the southern United States. People interviewed for this study expressed a high level of interest in better understanding the implications of population and land-use change around EFRs. Some scientists worried that the arrival of new residents could threaten the research mission of EFRs.

## Human Values

Studies of peoples' values and beliefs relating to forests, rangelands, and their management were initiated in association with EFRs in the 1970s and 1980s. These early studies involved showing photographs to

**Box 3. Resource use by indigenous peoples, Cascade Head Experimental Forest, OR.**

A study from Cascade Head Experimental Forest reconstructs the use of plant and animal resources by a subgroup of the Tillamook tribe called the Salmon River people, who occupied the area historically. Drawing on anthropological records from the early 1900s, archaeological data, and secondary sources, Zobel developed a list of species he believed to have been used by the tribe. He then checked this list against scientific data about the presence and distribution of plants and animals in the Cascade Head area. The long history of research at Cascade Head Experimental Forest and the neighboring Cascade Head Scenic Research Area produced detailed ecological data about the region that made it possible to cross-reference sources. Zobel concluded that at least 68 plant species and 56 animal species from Cascade Head had been used by the Salmon River peoples, and documented at least 308 different uses of these species. Such information provides insight into how indigenous peoples who occupied EFRs lived in the past, and how these ecosystems have changed since European settlement. (Based on Zobel 2002.)

people living in the surrounding area to examine aesthetic preferences regarding alternative silvicultural treatments (e.g., Benson and Ullrich 1981). Scientists were apparently motivated by public concern over the visual impacts of clearcutting, a harvest method that was used in experimental treatments at these forests. The goal of federal forest management shifted from sustained-yield timber production to ecosystem management in the 1990s. Human values research shifted accordingly, focusing on treatments associated with the goals of ecosystem management and peoples' scenic preferences. Study findings provided information about the social acceptability of different harvest practices, an important consideration in determining which practices to implement. The research highlighted in Box 4 is one example of this kind of project. Another kind of human values study that has been performed at EFRs solicits input from members of the public on specific management issues, such as forest road clo-

**Box 4. Social acceptability of ecosystem management, H.J. Andrews Experimental Forest, OR.**

Are forest management practices such as timber harvesting and prescribed burning that try to mimic past natural disturbance regimes socially acceptable? H.J. Andrews has been a partner in a study designed to develop and evaluate disturbance-based management systems. Thus, residents of the watershed that contains the H.J. Andrews Experimental Forest and residents living in nearby cities were surveyed to find out their knowledge about and perceptions of disturbance-based management and their level of support for it. The survey found that over one-half of the respondents supported disturbance-based management, although about one-quarter did not fully understand it. Concerns revolved around timber harvesting and associated road building. Favorable past interactions between citizens and US Forest Service employees was the variable most highly correlated with the tendency to support it. The research findings will help managers communicate with and engage the public in developing ecosystem management strategies and overcome barriers to implementing disturbance-based management regimes. (Based on Shindler and Mallon 2006.)

sures or restoration activities. The findings can be used for planning and management.

Several of the EFR scientists and administrators mentioned research on human values as being particularly desirable. They expressed interest in continued research on attitudes toward silvicultural treatments. More broadly, the EFR network provides a unique opportunity to bring people on site and gather information about their perceptions of forest treatments, as well as postfire conditions, road characteristics, wildlife distribution, recreation density, and other features. EFRs could also be used to learn more about how people and children connect with the natural world by exposing them to different kinds of forests and natural places.

### Interdisciplinary Social–Ecological Research

Finally, a number of integrated social and ecological studies have occurred or are underway, especially at EFRs that are LTERs. Six EFRs participate in the LTER network: Baltimore (Maryland), Bonanza Creek (Alaska), Hubbard Brook (New Hampshire), H.J. Andrews (Oregon), Coweeta (North Carolina), and Luquillo (Puerto Rico). The best examples of interdisciplinary social–ecological studies come from these sites.

The most prolific site in terms of interdisciplinary research has been the Baltimore Ecosystem Study, where numerous studies that measure interactions between the social, physical, and ecological components of the urban ecosystem have been published over the past 10 years (e.g., Pickett et al. 2008). Around Bonanza Creek the emphasis has been on studying adaptation and resilience in arctic socioecological systems in response to global social and environmental change (e.g., Chapin et al. 2006). New research being proposed will focus on "moose-human systems," investigating place-based feedbacks between ecological disturbance–moose interactions, human uses of moose, and human responses to change.

Since the mid-1990s, interdisciplinary research at Coweeta has included studies of the social, economic, and environmental factors driving land cover change in the southern Appalachians region and the consequences of these changes for water quality and quantity, terrestrial and aquatic biodiversity, and regional carbon cycles (Swank et al. 2001). Box 5 describes integrated research at Luquillo that focuses on interactions between human and natural disturbances and how they affect forest characteristics. Interdisciplinary social–ecological research still has to materialize in a substantive way at Hubbard Brook and H.J. Andrews, although social science has been conducted at both locations.

## Overcoming Barriers to Social Science Research at EFRs

The extent of human uses of EFRs documented here, together with the range of social science research topics that can be addressed, suggests that these sites hold enormous potential for contributing to our understanding of human–natural resource interactions—past, present, and future. Despite these potential contributions, the volume of social science research conducted at EFRs, to date, is quite small compared with that of biophysical research. One recent overview of 79 EFRs lists for each site the reasons they were established, the key research topics pursued, major research accomplishments, and the long-term databases they maintain (Adams et al. 2008).

**Box 5. The effects of interacting natural and human disturbances on forests, Luquillo Experimental Forest, Puerto Rico.**

At the Luquillo Experimental Forest, scientists are studying how natural and anthropogenic disturbances interact to influence forest characteristics. Economic globalization caused a shift from agriculture to manufacturing in Puerto Rico beginning in the late 1940s. This shift caused people to abandon their farmlands and migrate to urban centers. Farm abandonment, in turn, led to forest recovery in places where agriculture had been marginal. Scientists have reconstructed the land-use histories of different forested areas and found that processes of forest recovery varied, depending on the land-use legacy of a particular area. For example, forests that reestablish on land used for pasture versus coffee plantations have different compositions and structures, which are different from those of primary forests that lack a history of anthropogenic disturbance. Moreover, the effects of anthropogenic disturbance last a long time.

These forests are also subject to natural disturbances. Hurricanes are the leading natural disturbance agent in Puerto Rico. Researchers investigated how hurricanes interact with human disturbance to influence forest characteristics. They found that human land-use legacies had a greater influence on forest characteristics than hurricanes, although this influence diminished over time once human disturbance ceased. Forests with a history of human land use were predicted to change to resemble forests lacking a history of anthropogenic disturbance over a 200-year period, regardless of hurricane regime. The research findings indicate that forest dynamics can not be understood without considering how both natural and anthropogenic forces influence ecological processes. (Based on Garcia-Montiel and Scatena 1994, Thompson et al. 2002, Grau et al. 2003, Uriarte et al. 2009.)

Economics research was mentioned as having been conducted at 8 of the 79 sites. No other EFRs mention social science research at their sites, with the exception of the Baltimore Ecosystem Study. Another recent US Forest Service publication highlighting "100 Years of Research Success Stories" at EFRs (Wells 2009) makes no mention of social science research. The majority of social science studies that have been undertaken have been discrete, terminal studies as opposed to long-term research trajectories. In addition, rarely has comparative work been undertaken between sites. Why have social scientists not taken advantage of the unique opportunities to conduct research at EFRs?

Part of the explanation may lie in the history of social science research relating to public lands in the United States. Social scientists concerned with forestry and grazing on public lands have typically focused on communities (place based, occupational, or interest based) or individuals (e.g., forest workers and their families and family ranches) as the unit of analysis. Doing so may explain why they have overlooked EFRs as places to conduct research. EFRs that are remote, closed to the public, or receive little use may have no pressing social science research questions to address. Furthermore, studies of the socioeconomic impacts of forest and range management—another area of social science research relating to public lands—typically look at the management of national forests and grasslands at a broad scale.

When we asked EFR scientists and administrators why more social science had not occurred, they offered several explanations. A widely shared view pertained to limitations on budgets and staffing. US Forest Service Research and Development (R&D) has always been dominated by biophysical scientists. Many research laboratories lack social scientists on site. With few social scientists on staff and limited research budgets, biophysical research projects have taken precedence. Biophysical scientists, who have dominated both the research and the administrative aspects of these sites, may also be unaware of what social science has to offer and therefore have not made an effort to encourage social science research at EFRs, although many with whom we spoke were open to working with social scientists.

Even at sites where there is a strong interest in incorporating social science, natural scientists sometimes do not know who to engage because of a lack of people having social science expertise nearby or lack of awareness of existing social science networks. Social scientists may also be unaware that EFRs exist and of the research opportunities they present. An inquiry we conducted of US Forest Service R&D social scientists and economists (there are roughly 50) found that only one of those currently on staff had conducted research at an EFR. Finally, biophysical and social scientists alike may be unclear on how to link their work in interdisciplinary research projects. Although there has been emphasis recently on integrated research about coupled human–ecological systems, the practice of working across scientific disciplines can pose challenges. It is not always evident how to integrate social science with the biophysical studies that take place at EFRs.

How to overcome these barriers? We believe that highlighting the broad range of human activities and social science research topics associated with EFRs is an important first step to making social and natural scientists alike aware of the untapped potential these sites offer for social science and interdisciplinary research. It is also important to make scientists and site administrators aware of the potential contributions social science research can make to the body of knowledge produced at EFRs, so that they will support and allocate funding for it. These contributions are many.

EFRs are places where natural scientists test and experiment with alternative forest and range management techniques related to fuels reduction, timber harvesting, grazing, watershed restoration, and carbon sequestration, to name a few. However, natural resource management goals are socially defined; and implementing effective management approaches to achieving these goals will depend on whether they are economically feasible and socially acceptable (Shindler et al. 2002). Integrating social and economic components into these kinds of studies can help managers understand what values people want public lands to be managed for, and help research results be successfully applied.

EFRs are also places where people currently engage in a variety of human uses, and where people have lived and used natural resources in the past. Forest and range ecosystems have been shaped by their human histories, and they continue to be shaped by people today. EFRs are places where the ongoing dynamics between social and natural processes can be studied to better understand how they interact to influence forest and rangeland conditions, and socioeconomic conditions.

Natural scientists may be concerned about the ecological effects of human uses at EFRs and the impacts of these uses on scientific research there. Social science can help document the nature, extent, and motivations behind different forest and range uses and their importance to people. This information can be used to develop solutions to management issues and to promote sustainable human uses of EFRs. It can also generate information on how the public views and values the science mission of EFRs to ensure the relevance of the research conducted there.

Social science research can also improve understanding of the changing social environment surrounding EFRs, and the implications of this change for EFRs. This knowledge can help EFRs develop effective education and outreach programs, establish positive collaborative relationships with local communities, engage citizens in their science, address management issues, and garner support for the science mission at their sites.

Regarding science integration and working across disciplines, much can be learned from scientists involved in the LTER network. These scientists have discussed how to promote interdisciplinary social–ecological research and how to enhance social science research at LTERs (see Redman et al. 2004). Suggestions include collaboratively building a conceptual framework for integrated research, focusing research on the interactions between the social and ecological components of ecosystems, developing a multiscale approach to research questions, and identifying tools and models that both natural and social scientists can use. Inviting social scientists to participate in all-scientist meetings at EFRs (local to national), as occurs at meetings of LTER scientists, is one way to promote communication, networking, and relationship building that could result in future studies. Social scientists could also be involved in the strategic planning process associated with EFRs in which future science questions are developed. One excellent example, again from the LTER network, is the Maps and Locals project. This comparative research project is being developed across several LTER sites to study patterns of landscape change over time, the anthropogenic versus nonanthropogenic drivers of ecosystem change, and the implications of this change for human livelihoods.

## Conclusions

We encourage social and natural scientists alike to use their knowledge of the social science research opportunities at EFRs described here to reach out to one another and promote more social science research at

EFRs. We are optimistic that the next 100 years at EFRs will include a substantial social science research component. Several signs point in this direction. The need and desire for social science research at EFRs is recognized by scientists and administrators associated with these sites. Some funding organizations that support EFR research, including the US Forest Service and the National Science Foundation, are increasingly calling for interdisciplinary research that addresses both the biophysical and the human dimensions of forest and rangeland ecosystems and their management. One of the newest EFRs in the network—Heen Latinee, or "River Watcher" in Tlingit (Alaska)—was created in part because it is accessible to Juneau where there is an opportunity for US Forest Service social and natural scientists to work together to develop integrated studies and to involve the community in outreach and education. Social science will thus be incorporated at the outset, providing a model for future EFR sites. One hundred years of research at EFRs has yielded valuable insights about the workings of forest and rangeland ecosystems. We hope that the next 100 years will do the same, with a greater contribution from the social sciences.

## Endnotes

[1] The total number of EFRs changed during the course of this study. It began at 79, but then two new EFRs were added to the network and one was removed.

[2] LTERs are places where scientists conduct research on ecological processes at broad spatial scales and over long time periods. The network, established in 1980 by the National Science Foundation, has 26 sites representing a wide range of ecosystem types, environmental conditions, and human characteristics (US Long Term Ecological Research Network 2011).

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