The Use of Forest Service Experimental Forests and Ranges for Long-Term Research on Invasive Species

Ralph Holiday Crawford[1] and Gary W. Miller[2]

Abstract

The 81 experimental forests and ranges (EFRs) research sites make the U.S. Department of Agriculture (USDA), Forest Service unique among land management agencies. The EFRs were established for conducting applied research that serves as a basis for managing forests and rangelands. Most EFR research sites have long histories of experimentation and research that provide current and future answers to questions concerning the effects of management activities and how to better achieve management goals. Most EFRs have served as focal points for education and demonstration projects and as venues for the interaction between scientists and land managers and for the training of graduate students in forestry and related sciences. Research on EFRs has and will continue to contribute to a better fundamental understanding of how ecosystems function.

Introduction

Since 1903 the experimental forests and ranges (EFRs) have provided and continue to provide scientific information for managing national forests, rangelands and industrial and private lands (Adams et al. 2004). In accordance with Federal authority 4062.01 of the Forest Service Manual (FSM), section 4000, provisions of the Organic Administration Act of 1897 (16 USC 551), and the Forest and Rangeland Renewable Resources Research Act of 1978 (16 USC 1643), the Secretary of Agriculture has the authority to establish experimental forests and ranges. The major objective is that experimental forests and ranges will be used for conducting applied research that serves as a basis for managing forests and rangelands.

Forest Service Research and Development (R&D) has the primary role of conducting and administering research activities on EFRs. R&D structure includes the Pacific Northwest Research Station, Pacific Southwest Research Station, Rocky Mountain Research Station, Northern Research Station, Southern Research Station, International Institute of Tropical Forestry, and the Forest Products Laboratory. The number of experimental forests and ranges has exceeded 110 since 1903 but, with the processes of establishment and disestablishment, the current number is 81. For example, the Santa Rita Experimental Range was established in 1903 but has since been placed under the ownership of the State of Arizona. Some of the existing and oldest established permanent research sites and EFRs are the Fort Valley Experimental Forest (1908), Priest River Experimental Forest (1911), and the Bent Creek Experimental Forest (1927). The most recently established experimental forests are the Sagehen (2005), the Hawaii Experimental Tropical Forest (2007), and the Heen Latinee (2009). The distribution of EFRs covers vast geographical areas.

Experimental forests and ranges produce unique scientific products. Products have made significant impacts on the science community and have also affected policy at the national level. Table 1 lists a few examples of major scientific accomplishments at select EFRs in which research could focus on terrestrial and aquatic invasive species (plants and animals). EFRs that have long-term research focus on regeneration, harvesting, fire, climate change, and wildlife biology are well positioned for the study of invasion biology and competition between vegetation and other invasive species. Disturbances that contribute to the increase of invasive species on the landscape may be anthropogenic or natural and may interact in an integrated ecological process.

Most EFRs have uniquely valuable long-term studies and monitoring efforts that provide an invaluable record of recovery

[1] National Program Leader for Rangeland Ecology, Forest Service, Research and Development, Washington Office, RPC-4, 1601 N. Kent St., Arlington, VA 22209.
[2] Research Forester, Forest Service, Northern Research Station, Forestry Sciences Laboratory, 180 Canfield St., Morgantown, WV 26505.

Table 1.—*Experimental forests and ranges list of unique scientific products.*

Hubbard Brook Ecosystem Study	Major center for hydrologic research Research accomplishments on forest management Small watershed techniques for studying biogeochemistry First documentation of acid rain in North America Effects of forest-harvesting disturbance on water quality and quantity
Starkey Experimental Forest and Range	Pioneering sites that helped established the discipline of range management Wildlife habitat restoration and invasive vegetation Livestock grazing and wildlife effects on modification of mixed-conifer forests Invasive plants
Luquillo Experimental Forest	Tree species diversity and invasive plants Cross-site comparison of aquatic insect emergence ecosystems Canopy herbivory and soil processes in a temperate and tropical forest Earthworms (invasive species) and soil processes in tropical forest
Bent Creek Experimental Forest	Hardwood improvement cutting Long-term single-tree selection studies Ecological site-classification prediction models Intermediate stand management practices
Bartlett Experimental Forest	Habitat for wildlife Vegetation competition with regeneration methods
Hawaii Experimental Tropical Forest	Exotic grass cycles Nonnative terrestrial and aquatic plants and animals
San Joaquin Experimental Range	Development of sustainable grazing systems in oak woodland savannas Bird populations and diversity in oak woodland savannas
Fraser Experimental Forest	Subalpine forest ecology and hydrology affected by invasive beetles Invasive plants and animals in response to habitat changes

from disturbance and allow unusual events to be placed in the context of larger spatial and temporal patterns. EFRs address questions for forest and rangeland management at the appropriate scales of time and space; they are places to learn the fundamentals of natural ecosystem structure and dynamics. Finally, each EFR provides regional scientific information with well-documented disturbance and response histories, protected under special land use designations that allow manipulative research and protection of control sites (i.e., a secure research platform). There is an EFR in every ecoregion throughout the contiguous United States. The Forest Service has invested tens of millions of dollars into infrastructure, experiments, and long-term data collection and maintenance of EFRs. The activities of these resources are managed and maintained jointly by Forest Service R&D and the National Forest System (NFS). This work has long been recognized as having regional, national, and international importance as a strategy for research and science delivery for the 21st century (Crawford 2006; Miller and Crawford 2006).

This paper discusses the role of EFRs in future R&D efforts for invasive species research. The continued cutting-edge research activities and products from EFRs are the result of extremely strong partnerships between universities, other Federal agencies, tribal governments, State governmental agencies, private industry, and private landowners.

Critical Natural Resource Science Issues

The existing network of EFRs has a rich legacy of generating important research products and currently houses invaluable data sets that may be useful in addressing compelling natural resource science issues of interest to society. These issues generally involve considerable temporal or geographical scales that require pooling appropriate EFR data sets and integrating them with other national ecological networks to analyze regional or national problems. Examples of research problems that can be addressed by forming EFR networks include the following:

- The effect of global change on biodiversity, water yield, carbon sequestration, and ecosystem productivity.

- The causes and consequences of landscape changes such as fragmentation, urbanization, hydrologic alterations, and changing biotic patterns.
- The response of forest and rangeland ecosystems to disturbance, both natural and anthropogenic, to allow balanced resource utilization, habitat conservation, site restoration, and management of invasive species.

An important advantage of network-based research is that it enables the agency to address a common set of invasive species issues across different ecoregions. It facilitates measuring and interpreting results in a large-scale setting, thus giving resource managers research products of wider applicability on the landscape. For example, networking of research sites would shed light on the effects on both terrestrial and aquatic invasive species in ecosystems across regions, as opposed to an individual ecosystem.

It is important to develop the potential value of an EFR network while recognizing the continuing value of individual EFRs to address unique local resource issues. Defining large-scale science questions that require EFR partnerships may first be conceptualized according to strategic program areas (Fire, Resource Management and Use, Inventory Monitoring and Analysis, Invasive Species, Recreation, Water and Air, and Wildlife and Fish), thus allowing research priorities to be addressed from a national perspective across research work unit, programs, and station boundaries. In addition, individual EFRs have a tremendous potential to produce research products (data, information, knowledge, tools, and technologies) that are uniquely applicable to the ecosystem type in which they are located. Individual EFRs can continue to support sustainable land management within the local ecosystem types they represent, as well as collaborate with EFRs in other ecosystem types to produce research products that are applicable to much larger regional and national issues for invasive species.

Formation of High-Priority EFR Networks

Lugo et al. (2006) referred to the existing collection of EFRs as a network of permanent research sites, although it is understood that individual EFRs have unique attributes and data resources that may or may not be useful in studying certain research problems. In practice, data from subsets of EFR sites with the appropriate attributes can be integrated to address specific science questions at larger geographic scales. Similarly, subsets of EFRs may also be used to complement external networks (National Ecological Observatory Network, Long Term Ecological Research Network (LTER), Consortium of Universities for the Advancement of Hydrologic Science, Research Natural Area, Forest Inventory and Analysis, National Atmospheric Deposition Program, etc.) to further address large-scale invasive species science questions.

Emphasizing a network-based strategy can facilitate the integration of available knowledge, data sets, and technology to address regional and national environmental issues. Individual EFRs can continue to provide vital scientific discoveries applicable to local ecosystem conditions and land management challenges on public and private land. An integrated EFR network, however, also has the potential to yield vital scientific discoveries at much larger scales. For example, the LTER program supported by National Science Foundation is essentially a network of Forest Service experimental watersheds. A network of EFRs will allow for integration across broad temporal and geographical environmental gradients, thus generating new information in the expansive ecological space where complex invasive species management problems are emerging (Bailey 1991; Kneipp 2005; Lugo et al. 2006; Miller and Crawford 2006).

Summary

As we move forward in the 21st century, the experimental forests and ranges still possess a unique capability for answering large-scale invasive species questions of great societal benefit if they are integrated as a network of science assets. An integrated network of EFRs will enable resource managers and policymakers to address emerging local, national, and global natural resource issues pertinent to society.

A comprehensive strategy is proposed for updating the support, protection, management, and use of EFRs in the 21st century (Miller and Crawford 2006). The strategy will increase the agility of the EFRs and enhance their ability to respond to contemporary and emerging invasive species science issues. The prioritization of the initiatives is difficult, but the strategy is designed to be responsive to changing complex ecological and economic factors.

- Define the critical natural resource science issues on invasive species of interest to land managers and society that EFRs can address at regional and national scales.
- Support the formation of high-priority EFR networks and partnerships with land managers and other ecological networks to address critical invasive species science issues.
- Increase visibility of and support for EFR sites, infrastructure, and research programs by illustrating their value, relevance, and unique ability to address current and emerging invasive species issues of importance to the public, the agency, and the world science community.
- Enhance internal and external communication among Forest Service land managers and Research and Development scientists, as well as cooperators and customers associated with EFRs, so they can nurture relationships and cooperate in the research and science delivery process for invasive species.
- Develop flexible data networking tools and policies that integrate scientific information on flora, fauna, water, air, and soils, thus allowing EFRs to form effective internal and external networks across broad temporal and spatial scales.

When emerging research priorities are such that existing EFRs are not capable of providing appropriate scientific information, the Forest Service Chief has the authority under 7 Code of Federal Regulations (CFR) 2.60(a) and 36 CFR 251.23 to establish new EFRs as recommended by the station director with concurrence of the regional forester under FSM 4062.04. Additional EFRs may be needed to study 21st-century issues, such as invasive species associated with the urban-forest environments. If the EFRs are not integrated, the loss is essentially a costly, missed opportunity to conduct new science on immensely important research problems. Such a missed opportunity will delay our ability to build on 100 years of science on EFRs and reach the cutting edge of large-scale research efforts at a time when this type of effort is critically needed.

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