THE ROLE OF RESEARCH NATURAL AREAS IN ECOSYSTEM MANAGEMENT ON NATIONAL FOREST SYSTEM LANDS

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(Note: Although many of the references in this document refer to the early history of ecosystem management in the Forest Service, the document itself is just as germane in 1999 as it was in 1993.)

GOAL: The Rocky Mountain Region and Experiment Station recognize the need to create a comprehensive and representative system of Research Natural Areas (RNAs) which will be useful for research and ecosystem management on National Forest System lands.[40,41,42] This document is intended to help clarify the meaning and utility of the RNA system for the Region and Experiment Station.

RESEARCH NATURAL AREAS: The Forest Service Manual (4063.02) states that one of the objectives of RNAs is to "preserve a wide spectrum of pristine representative areas that typify important forest, shrubland, grassland, alpine, aquatic, geological, and similar natural situations that have special or unique characteristics of scientific interest and importance that, in combination, form a national network of ecological areas for research, education, and maintenance of biological diversity."

ECOSYSTEMS: Because the word "ecosystem" has acquired so many meanings, a working definition will probably be useful. An ecosystem can be defined as all of the biological and physical (including chemical and geological) components within a defined space and the processes which affect these components.[24] Ecosystems are usually studied as flows of energy, material, and species through space and time. Ecosystems include everything from a drop of pond water to the biosphere. Ecosystems are dynamic. They have changing and flexible boundaries depending on the scale of the components and processes under consideration. Clearly, humans are components of ecosystems and their activities affect ecosystem composition, structure, and function.[1,14] Some ecosystems have evolved with human influence for thousands of years.[22] The existence of human civilization and life on Earth are totally dependent upon the functioning of ecosystems.

ECOSYSTEM MANAGEMENT is an evolving approach to resource management within the U.S. Forest Service. One definition of ecosystem management is the management of biological, physical, and human components and processes of ecosystems in ways that maintain sustainable ecological processes, biodiversity, environmental quality, and the production of resource commodities and amenities.[1,9,15,26,28,30,39] Ecosystem management integrates ecosystem components, processes, and resource uses.[26,28,31] Ecosystem and social sustainability are the cornerstones of a holistic approach to ecosystem management.[15,29,34,43]

Biodiversity and biological processes occur at genetic, species, population, community,

ecosystem, landscape, and regional scales[5,23] and need to be managed over a variety of spatial and temporal scales.[12,15] Ecosystem sustainability requires the maintenance of the diversity of plant and animal species and natural processes such as succession, disturbance, and evolution.[39] Combining this requirement with the necessity of producing wood, forage, and recreational opportunities is often a challenge and occasionally a conundrum.[12,29,32]

Some areas of National Forest System lands have departed significantly from their natural condition.[12,21] "Natural" like the word "ecosystem" has many potential meanings. For our purposes natural condition will mean presettlement or our estimate of the condition that an ecosystem would be in if settlement by peoples from Europe, Asia, and Africa had not occurred - ecosystems with relatively intact evolutionary relationships.[14,19] Some lands have been through many timber rotations, or planted with monocultures of genetically similar trees, or grazed by domestic livestock for decades. Some lands have been invaded by non-native weed species, while others are heavily impacted by recreation. Many of these departures from a natural condition occurred on lands before they became a part of the National Forest System. As human demands increase, fewer examples of natural ecosystems remain and some managed lands retreat further from their natural condition.[12,20,21,25]

To reduce the risk associated with our limited knowledge and to insure ecosystem health, diversity, and sustainability, it is prudent to manage some ecosystems within their range of natural variability.[1,2,12,19,26] It would be difficult to determine the range of natural variability without reference to areas such as RNAs that are relatively undisturbed by humans.[19,20,25]

RNAS AS BENCHMARKS: Many management activities on National Forest System lands can be thought of as experiments.[28] The outcome of these experiments in boardfeet, AUMs, or public satisfaction is often calculable. However, many important phenomena, including changes in vegetation, animal populations, soil quantity and quality, plant susceptibility to insect and disease epidemics, and changes in future productivity, are often incompletely understood.[12]

If Forest Service management is an "experiment", then reference points are necessary to evaluate the success of the experiment. This function of being a reference or benchmark is one of the principal values of Research Natural Areas, which are among the least modified sites on Forest Service lands.[8,10,12,18,20,25,37,38] Whether we want to monitor site productivity, soil loss, populations of small mammals, neotropical bird migrants, indicator species, the health of endangered species populations, nutrient cycling, amounts of coarse woody debris, or the impacts of road density on elk populations, reference points are necessary. In Forest Service monitoring, standards to which managed lands can be compared will often be essential.

As an example, on a Forest Service allotment in the Southwest it was argued that obvious gullying and erosion were more the result of weather and fragile soils than of cattle grazing. A designated natural area with similar fragile soils, climate and vegetation, but no recent livestock grazing, provided a reference, showing that the grazed lands had erosional rates and vegetation loss far outside the range of natural variability (Moir, W. pers.comm.). Livestock grazing regimes

have economic, cultural, and political as well as biological ramifications. Yet, without a firm grasp of ecological reality, which RNAs can often provide, the environmental analysis required by NEPA may rest on a poor foundation, ecosystem sustainability may diminish, and the future needs of society may not be met.

THE RNA SYSTEM: Wilderness, Special Interest Areas, RNAs, and other natural areas can all help provide the references necessary for management and environmental analysis.[10] Among these, the Research Natural Area system is unique because of its goal of providing high quality, relatively pristine, representative examples of the full range of ecosystem types that occur on National Forest System lands. To be useful for management comparison, the RNA system should include good examples of the most productive lands in the National Forest System.[12,20]

Ideally the RNA system should represent a substantial portion of the variability in National Forest ecosystems, including variability in biota, landforms, geology, soils, climate, successional stages, disturbance regimes, and other ecological processes. Since the variation in plant communities often reflects other forms of biotic and abiotic variation,[7,27] plant communities have been chosen initially for defining the RNA system. These communities have been identified at the plant association, plant series, or higher plant community levels by most Regions.[8,16,18] Advances in Forest Service hierarchical ecological maps, Integrated Resource Inventories, and GIS systems[9,26] will help refine the RNA system, measure its representativeness, and make it more valuable as a comparative tool in ecosystem management.

Research Natural Areas need to be large enough to encompass a mosaic of successional stages and disturbance patterns as well as a wide range of biotic and abiotic variability. Large size will help maintain natural processes and viable animal and plant populations and minimize deleterious edge effects. Research in conservation biology has shown that the integrity and value of natural areas increases significantly with size.[3,4,6,21,23,33,35]

RNAS AS RESEARCH SITES: Closely related to the important function of RNAs as reference areas is their availability as sites for scientific research. Ecosystem management implies an understanding of how ecosystems operate.[26,28,31] Unfortunately, our understanding of ecosystems and how humans affect and are affected by ecological processes is fairly rudimentary. RNAs can provide a tool for understanding the functioning of ecosystems in landscapes and the sustainability of both ecosystem processes and community components.

Plant and animal species have evolved adaptations to each other and to their environment which are expressed in complex patterns of succession, predation, herbivory, parasitism, pollination, dispersal, and survival. These biological patterns, in turn, are influenced by patterns of natural disturbance, geomorphic processes, and climate change.[5,12,24] Because species and their complex relationships have evolved and continue to evolve in natural ecosystems, they are best studied in areas which have undergone minimal human disturbance.[2,4,14,19,20,35,38] We also know that some of our "natural" ecosystems have been influenced by thousands of years of human disturbance, such as the burning of grasslands by Native Americans.[14,19] This knowledge will influence our

management of some RNAs and other National Forest System lands.

The Research Natural Area system is intended to include the full array of terrestrial and aquatic ecosystems for the scientific research necessary to ecosystem management.[37,38] RNAs provide an opportunity for studying the same ecological process over a range of ecosystem types. Baseline data and long-term ecological research on RNAs will provide an important body of information for land and water management.[4] These data and research from RNAs will be useful for cumulative effects analysis on similar managed ecosystems and for investigating the impacts of global climate change.[12] RNAs are great natural libraries, "unconditional gifts of potential knowledge for the future."[19]

Scientific information from RNAs can change our basic understanding of ecological processes and offer important guidance for ecosystem management. As an example, old-growth forests have been previously characterized as decadent stands with little productivity. Permanent plots dating from the 1930s on an RNA in the Pacific Northwest have documented that some old-growth forests have much higher levels of productivity than previously thought possible (Greene, S. pers.comm.). In the increasingly complicated times ahead, scientific research on minimally disturbed ecosystems will be essential to the task of successfully managing National Forest System lands.

RNAS AS SITES FOR BIODIVERSITY PROTECTION: The protection of biodiversity is an important goal of ecosystem management.[9,26,28,30] RNAs and other protected natural areas harbor only a small portion of the total biodiversity on National Forest System lands.[12] Nevertheless, a system of RNAs, composed of the best remaining examples of most ecosystem types, is a significant contribution to biodiversity protection in its own right.[20,36] Because we know so little about the diversity of non-vascular plants, soil micro-flora and fauna, terrestrial and aquatic invertebrates, and many other elements of biodiversity (as well as the complex relationships and processes which connect them), the RNA system helps provide a safety net, a form of insurance against the loss of species and biotic communities. This is a coarse filter approach to protecting biodiversity.[36]

Additionally, many RNAs offer protection for populations of Threatened, Endangered, and Sensitive species and for rare and sensitive plant communities and animal habitats (the fine filter approach).[40,41] In California alone, over 132 rare plant species are found on Forest Service RNAs.[16] RNAs can provide benchmarks for evaluating the success of biodiversity protection on National Forest System lands and help meet some of the legal obligations for protection and monitoring required by NFMA, NEPA, and the Endangered Species Act.[26]

Research Natural Areas are embedded in a matrix of lands with many different management prescriptions. Within the larger managed landscape, some RNAs may function as core areas for the maintenance of genetic diversity and sensitive species, or, in a few circumstances, an individual RNA might serve as a corridor for dispersal and migration of some plant and animal species.[10,11,21,22,33] RNAs are not isolated units; they are integral parts of a landscape mosaic

which needs to be managed as a whole.[4,10,11] The surrounding landscape will occasionally need to be managed to insure the integrity of RNAs. Coordination and cooperation across ownership boundaries may be desirable to help insure this integrity. RNAs are generally a direct benefit to biodiversity at most of the spatial and temporal scales implicit in ecosystem management.

RNAS IN FOREST PLANNING: RNAs can contribute to the land and resource management planning process by providing models for some of the landscape features the Forest Service would like to extend, restore, and plan for. Information provided by RNAs can help achieve desired future conditions that balance "goals for the land with goals for the people."[39] By identifying sites which fill gaps in the RNA system and by developing management plans for RNAs, National Forests and Grasslands can make valuable contributions to ecosystem management. RNAs will also provide useful tools for helping to insure that Forest Service management activities meet the environmental requirements of the law. Ecological research, of the kind performed on RNAs, needs greater recognition for its importance to society and as one of the significant multiple-uses of public lands.

RNAS IN CONSERVATION PARTNERSHIPS: Developing constructive partnerships is a tenet of ecosystem management.[9,26,28,30] Many individuals and organizations have a great interest in Research Natural Area programs, including state Natural Heritage and Natural Areas programs, The Nature Conservancy, Native Plant Societies, many academic institutions, and the scientific community at large. Conservation partnerships with these diverse parties have been of mutual benefit to both the public and the Forest Service.[26,42] Statewide conservation planning, in which Forest Service RNA programs play a key role, can forge effective working partnerships between government agencies, private organizations, and the scientific community.[8,18] RNAs can be effectively used as interpretive and educational tools to demonstrate the scientific basis for land management and to increase dialogue with the public. Within the Forest Service, Research Natural Areas provide an important bridge between the concerns of Research and National Forest Systems.

CONCLUSION: In the future, Research Natural Areas will be one of the more useful tools available to the Forest Service for improving and evaluating the success of ecosystem management. Because of the multiple purposes they serve and the important biodiversity and ecosystem processes they harbor, RNAs have high value for present and future generations.

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