A RESEARCH NATURAL AREA PRIMER FOR FOREST PLAN REVISION

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Introduction

The objective of this report is to assist the Southwest Idaho Ecogroup and others in identifying how research natural areas will be treated in the land and resource management plan revision process and how to integrate RNAs into general National Forest management. Specific areas of focus are: (1) the values of RNAs for monitoring, research, and conservation; (2) issues pertinent to RNAs in programatic and site specific planning; (3) how to utilize RNAs at different spatial scales; (4) standards and guidelines for the management and use of RNAs; and (5) the process of selecting new RNAs to fill gaps in the natural area network.

The Value of Research Natural Areas

Since the early 1900s, two objectives have been identified as the primary purpose for developing a comprehensive, representative system of natural areas: (1) "to preserve a representative array of all significant natural ecosystems and their inherent processes as baseline areas," and (2) "to obtain through scientific education and research, information about natural system components, inherent processes, and comparisons with representative manipulated systems" (Federal Committee on Ecological Reserves 1977).

In more recent years numerous authors have described the value and need for research natural areas and other ecological reference areas (Anderson 1975; Buckman and Quintus 1972; Allen 1986; Wellner 1986; Ryan et al. 1994; Andrews 1994; Franklin et al. 1972; Moir 1972; Shanklin 1951). This passage by Anderson (1975) is often cited:

> 1. Because natural biological and physical processes occur unhindered in natural areas, these areas serve as a baseline or standard against which the effects of man's intervention in the natural environment can be studied and evaluated.
>
> 2. Natural areas are the cornerstone of the sciences of resource management. In respect to range science, they provide the basis for (a) defining range sites; (b) determining range condition; and (c) determining the trend of range conditions under grazing and other uses of the resource, all of which are fundamentally the ecological basis for range management.
>
> 3. Natural areas provide representative plant communities or ecosystems which serve as outdoor laboratories where we can increase our knowledge about ecological dynamics, the specific effects of herbivores on the ecosystem, and the impacts of man's ever-increasing manipulations of the landscape....

The Ecological Society of America, the Society of American Foresters, and Society for Range Management were all active in the early history of ecological reference area identification and establishment (Habeck 1981 [as reproduced by Evenden and Kimball 1996] and 1979; McIntosh 1985; Anderson 1975; Shanklin 1951). USDA Forest Service objectives for the establishment of

research natural areas are to a large extent the embodiment of goals identified by these professional organizations (USDA Forest Service Manual [FSM] 4063.02):

1. to preserve a wide spectrum of pristine areas that represent important forest, shrubland, grassland, alpine, aquatic, geological, and similar natural situations that have special or unique characteristics;
2. to preserve and maintain genetic diversity;
3. to protect against serious environmental disruptions;
4. to serve as reference areas for the study of succession;
5. to provide on-site and extension education activities;
6. to serve as baseline areas for measuring long-term ecological changes;
7. to serve as control areas for comparing results from manipulative research; and
8. to monitor effects of resource management techniques and practices.

The identification and establishment of a national network or research natural areas is Congressionally mandated in the National Forest Management Act (NFMA) (36 CFR Sec. 219.25; 36 CFR 251.23). The need for, and value of, research natural areas has a fundamental basis, as well, in NFMA which states that land and resource management plans will include a plan to monitor and evaluate the effects of implementing the management plan (36 CFR Sec. 219.11(d); Burns 1984; Norse et al. 1986; USDA Forest Service 1997a). Natural areas contribute to the land management planning process by providing models of benchmark landscape features and habitat conditions (Ryan et al. 1994; Andrews 1994). At the time NFMA was enacted by Congress (1976) the following statement by the chair, Committee on Natural Areas, Society of American Foresters (Shanklin 1951), had standing (though it was made 25 years earlier), as it still does today:

> Natural areas or segments thereof are laboratory examples of the interrelationships of flora, soil, and water, as found within virgin timber types. How may we measure the changes in plant ecology if we do not have a natural measuring device with which to make the essential comparisons? The natural areas or a sample plot within might well be utilized for such purposes.

The role of, and need for, ecological reference areas is heightened in recent years with the advent of the ecosystem management paradigm - "management driven by explicit goals...and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function" (Christensen et al. 1996). Implementation of adaptive management strategies is a focal component of ecosystem management. In adaptive management - which involves a repetitive, ordered cycle of planning, implementation, monitoring, and evaluation - the hypothetical, iterative nature of resource management is recognized (Forest Ecosystem Management Assessment Team 1993; Christensen et al. 1996; USDA Forest Service 1997a). A principal tenet of ecosystem management is that biological diversity, productivity, and sustainability may be maintained or enhanced by managing lands within the historic range of variability (Swanson et al. 1994). Research natural areas provide the experimental controls against which ecosystem

management activities may be assessed, the baseline for understanding the range of natural variability, and help establish a basis for defining desired conditions (Ryan et al. 1994; Andrews 1994; Wellner 1986; Franklin et al. 1972; Moir 1972; Moeur 1992).

Issues Pertinent to Research Natural Areas

Issues surrounding the use and establishment of RNAs arise at both the programmatic and site specific planning levels. Historically, a number of factors have made the relationship between programmatic and site specific RNA-related decisions less clear than more conventional resource decision areas: (1) Until May 1994, the Chief of the Forest Service was the deciding officer in the RNA establishment process. Prior to 1994 the Regional Forester was the deciding officer for the Forest Plan Record of Decision, so Forest Plans could only *recommend* RNAs for establishment. The Regional Forester now also has decision-making authority for RNA establishment. (2) The Idaho Natural Areas Coordinating Committee, led by Chuck Wellner, conducted extensive inventories and identified potential RNAs prior to the planning process. Since a large number of high quality potential RNAs were already identified, perhaps the need, for example, for a programmatic decision regarding the process by which RNA needs will be identified and addressed at the site specific planning level, was less apparent.

Programmatic Issues--Principle programmatic RNA issues are related to (1) the recognition and use of RNAs in Forest Plan monitoring; (2) processes for the ongoing identification of gaps in the research natural area network and processes for the selection of research natural areas to fill these gaps; (3) Forest-wide research natural area goals and objectives; (4) Forest-wide research natural area standards and guidelines; (5) withdrawal from mineral entry; and (6) linkage of RNAs to Forest Plan objectives and standards for biological diversity.

The relation or bearing of RNA designation to Congressionally designated areas often appears to be an issue in RNA-related planning activities. This is not, technically, an issue (as it is not something the deciding officer can address through the selection of alternatives) but, rather, an area for clarification. The management plans of Congressionally designated areas have precedence over Forest Plans and are incorporated by reference into the Forest Plan. Congressionally designated area management plans should provide for the recognition and management of research natural areas.

An important function of research natural areas is to provide an ecological baseline reference against which the effects of intensive resource management may be evaluated. The need for Forest Plan monitoring is to assess the effect of implementing the plan. Recognition of the value of RNAs to fill this need should be built into Forest Plan monitoring programs.

The development of a national network of research natural areas is mandated by Congress through NFMA. Traditionally the RNA selection and recommendation process has occurred through the Forest Planning process. Historically, the environmental effects of the establishment of many RNAs in Idaho was sufficiently significant to have required an environmental impact

statement (EIS). The effect here was the withdrawal of lands suitable for timber harvest. In these cases it was convenient to make RNA decisions in the programmatic Forest Plan EIS.

Regardless of the National Environmental Policy Act (NEPA) requirements for RNA establishment (i.e. whether or not the action is a *significant* Federal land management action and triggers an EIS versus an environmental assessment [EA]), the process of RNA site selection and design is fundamentally a site specific planning activity. The Forest Plan programmatic analysis does not allow for sufficient detailed biological analysis to effectively implement RNA selection and design processes. The fact that in the Forest planning process of the 1970s and 1980s, candidate RNAs were identified and presented for inclusion in the Forest Plan programmatic analysis is a great historical legacy but not a legal precedence. To effectively implement the intent of NFMA regarding the development of a network of RNAs, the Forest Plan (at the programmatic level) should provide standards and guidelines for the ongoing identification of gaps in the research natural area network and processes for the selection of research natural areas to fill these gaps. The identification, selection, and design of RNAs, and evaluation of RNA potential, should occur within the context of ecosystem management at the site specific level, on a project-by-project basis.

Forest Plan standards and guidelines provide general direction for the management and use of research natural areas. These standards should (at least) comply with FSM policy. Forest Plan standards and guidelines vary in detail and specificity. While some Forest Plans recognize research natural areas as a management allocation (with Forest-wide standards and guidelines) (e.g., USDA Forest Service 1990), others do not (e.g., USDA Forest Service 1988). Forest-wide standards and guidelines may not be sufficiently specific to implement RNA FSM objectives in all situations. The Establishment Record should provide site specific management direction for each established research natural area (Andrews 1993). The question of the standing of an Establishment Record in providing management direction may be academic, until the need for more specific management activities arise; for example, use of prescribed fire to maintain ecosystem processes or the need to restrict recreational use to maintain the representative value of principle RNA biological and physical components. Whether the Establishment Record has standing may actually depend on the NEPA analysis conducted for formal establishment. Numerous examples of Establishment Records that do have standing as site specific management plans are available for RNAs in the Northern and Intermountain Regions of the Forest Service (USDA Forest Service 1996 a and b; 1997b). Clarification of the relationship between the Forest Plan and the Establishment Record could be provided in the Forest Plan.

An important provision of NFMA is for the conservation of biological diversity (36 CFR Sec. 219.26 and Sec. 219.27[g]). The role of RNAs in the conservation of biological diversity is not explicitly stated in the NFMA regulations, though it is implied (36 CFR Sec. 219.25):

> Planning shall make provision for the identification of examples of important forest, shrubland, grassland, alpine, aquatic, and geologic types...

Current Forest Service policy, however, states (FSM 4063.02):

> ...that in combination, form a national network of ecological areas for research, education, and maintenance of biological diversity.

Given the close association between research natural area objectives and their functional role in the conservation of biological diversity, Forest Plan objectives and standards for RNAs and biological diversity should be closely linked and interrelated. For example, the Forest Plans might specifically state how research natural areas (e.g., considering their value in providing high quality reference stand conditions) serve to fulfill Forest Plan objectives for the conservation of biological diversity.

Site Specific Issues--Common site specific issues related to RNAs are (1) the withdrawal of lands from availability for other intensive resource management (commodity) uses (e.g., for livestock grazing or timber harvests) and the relationship of RNA designation to oil and gas leases and mining claims; (2) access to RNAs for recreational use; (3) management of fire disturbance processes; and (4) the appropriateness of proposed areas to meet FSM objectives (e.g., USDA Forest Service 1996 a and b; 1997b).

The Value of Research Natural Areas in Different Spatial Contexts

The question of the value of natural areas, and how they might be used, at varying spatial scales is immense. The question could be addressed from a range of different levels of biological organization, from the perspective of different taxonomic groups, or in seeking to understand any one of the multiplicity of environmental factors or ecological processes that contribute to biological diversity.

Fire disturbance might serve to explore the relationship of RNAs to, and potential use of RNAs at, varying spatial scales. "A fire regime is a generalized description of the role fire plays in an ecosystem" (Agee 1993). This description may be based on recurring patterns in the nature of fire disturbance events. The fire disturbance regime in moderately productive, warm, dry, low elevation forested plant associations is one of relatively frequent, low intensity events. On the typically highly dissected topography, most fire events historically encompassed relatively small areas (Barrett et al. 1997). Forest stands within the *Pseudotsuga menziesii* and *Abies grandis* series on these sites cycle from early mid-seral to late mid-seral successional stages and retain large tree dominated structure for several cycles. These ecological processes may be wholly contained within an RNA that encompasses several first order, or an entire second order, drainage basin. If necessary, prescribed fire ignitions could serve to maintain these processes. On sub-regional and regional geographic scales, similar sites within the network of RNAs should provide replicate examples of the range of natural variability disturbance regime.

The fire disturbance regime in cool, moist subalpine forested plant associations (by comparison) is one of relatively infrequent, high intensity events. On these high elevation broad valley and mountain slope topographies, fire events occur over large areas. Forest stands within the *Abies lasiocarpa* series on these sites cycle from early- to mid-seral stages and typically only achieve a

pole or medium tree dominated structure. These ecological processes encompass areas on a spatial scale of one to three orders of magnitude larger than most RNAs. Prescribed fire ignitions would likely not serve to maintain these processes. On large geographic scales similar sites within the network of RNAs should encompass the range of natural variablility resulting from the disturbance regime, but with little replication of any one stage of development.

Standards and Guidelines for the Management and Use of Research Natural Areas

Management concerns for research natural areas parallel the issues described above. In this section standards and guidelines for the management and use of proposed and established research natural areas are discussed. Standards and guidelines for the selection of research natural areas is discussed in the following section. Forest Service policy regarding the management and use of RNAs is found in FSM 4063.3. Policy for the management and use of RNAs must support the objectives of establishing the area. To work effectively, the Establishment Record must state these objectives and identify the values for which the area was established. The principle guiding management standard is provided by FSM 4063.3(1):

> Protect research natural areas against activities that directly or indirectly modify ecological processes. The prime consideration in managing research natural areas is maintenance of unmodified conditions and natural processes.

Commodity Resource Use--Timber harvesting and wood gathering are not permitted in RNAs. Tree cutting of any kind is usually considered inappropriate. In some extreme cases (e.g., in activities needed to manage live fuels in the restoration of fire disturbance processes, or in the reduction of hazards along State and Federal highways), it may be necessary to fell trees. In all cases felled trees should remain on the site. Timber harvest activities adjacent to RNAs should be planned to protect the integrity of the natural area (Pacific Northwest Interagency Natural Area Committee [PNWINAC] 1990).

Large-hooved, congregating ungulates have little natural role in the ecology of the indigenous vegetation of the Intermountain region. Domestic livestock grazing is not needed in this region to emulate ecological processes or effects produced by native grazing animals (PNWINAC 1990). If research natural areas are to effectively serve as baseline reference areas to evaluate the effects of livestock grazing, than livestock grazing must not occur. The standard must be that no livestock grazing will occur, lest what is the ecological baseline reference for determining the "level of acceptable casual or incidental livestock use that can be tolerated" (FSM 4063.3[3])?

Extractive Resource Use--Mineral extraction and some mineral exploration activities irreversibly impact RNA values. While the restoration of mining impacted areas is desirable, restoration of natural conditions to the extent that would be consistent with RNA objectives is likely not achievable. The Mining Law of 1872 provides authority for mining activities to override other uses on public lands. Research natural areas should be withdrawn from mineral exploration and entry. Section 204 of the Federal Land Policy and Management Act of 1976 provides for the

withdrawal of areas from mineral entry.

Scientific, Educational, and Recreational Use--Scientific use of research natural areas is encouraged. To assure appropriate, non-destructive use, researchers should submit a proposal outlining study plans to the appropriate RNA coordinator. Research findings are to be summarized and reported to the Forest Service. Physical information regarding the site, or information on the occurrence of species and plant associations should be forwarded to Idaho Conservation Data Center (ID CDC). As the Natural Heritage Program for the state, ID CDC maintains information concerning the biological and physical components of conservation sites, including National Forest System RNAs.

FSM policy is to allow only upper class and graduate level educational use of RNAs (FSM 4063.33). Exceptions may be made for limited use by other educational groups. Well defined guidelines for educational use by all groups should be in place. Educational use of RNAs should be closely monitored.

Any form of recreational use that interferes or threatens the objectives of a research natural area may be prohibited. Impacts of recreational use may be difficult to document. When the impacts become apparent, use patterns are established and difficult to change. Protection of research natural areas should be promoted through minimum impact and stewardship land ethics (PNWINAC 1990).

Camping, firewood gathering, and campfires are prohibited in most RNAs. Hiking should occur only on existing trails. The maintenance of existing trails should be kept to the minimum necessary to prevent soil erosion, for safety, and to protect RNA values. Motorized and mountain bike off-trail use is prohibited. Motorized trail use is usually prohibited. Mountain bike trail use should be prohibited, especially when use contributes to increased soil erosion. Most RNAs are closed entirely to recreational stock use. Recreational stock use may be permitted on trails which pass through an RNA. Overnight use and grazing of recreational stock is usually prohibited in RNAs.

Roads, Trails, and Facilities--RNAs may incorporate old road and trail treads. New construction of roads, trails, or fences is not permitted in research natural areas unless they contribute to the objectives or protection of the area. New trails and roads will usually not be needed to meet RNA objectives. New fencing, however, may be needed to protect research natural areas from livestock or excessive public use. The establishment of new utility rights-of-way should be prohibited within RNAs.

Construction of buildings is not permitted in RNAs. Temporary structures, such as gauging stations and instrument shelters, may be constructed following the policy guidelines of FSM 4063.31.

Vegetation Management--The guiding principle for vegetation management within RNAs is stated as follows (FSM 4063.34):

> Use only tried and reliable vegetation management techniques and then apply them only where the vegetative type would be lost without management. The criterion here is that management practices must provide a closer approximation of the naturally occurring vegetation and the natural processes governing the vegetation than would be possible without management.

In the Northwest, the primary need for vegetation management is to maintain or restore fire disturbance processes. Due to changes in fire disturbance regimes resulting from decades of wildfire suppression, management constraints for surrounding lands, and concerns for the biological values of RNAs, it is not possible to allow uncontrolled fire disturbance. Rather, prescribed fire (including planned and wild ignitions) will "provide a closer approximation of the...natural processes governing the vegetation than would be possible without management" (FSM 4063.34). Since prescribed fire may not always meet the FSM "tried and reliable" criterion, prescribed fire should be applied through an adaptive management strategy involving the following (ordered) activities: inventory, plan and implement, and monitor and evaluate.

PNWINAC (1990) recommend the completion of three levels of planning for prescribed fire activities in natural areas: individual prescribed burn, site fire management, and fire management program planning. Plans for management activities within RNAs are approved by the Station Director with concurrence of the Forest Supervisor and District Ranger. The prescribed burn plan should provide the objectives of prescribed fire use, proposed fire prescriptions, operation precautions, and criteria for evaluation of the attainment of prescribed fire objectives. The site plan should identify burn units, establish a schedule, and provide the rationale for the frequency and timing of prescribed burns. The program plan might summarize the site plans for all RNAs on a particular Forest and identify equipment, training, and staffing needs.

Natural Area Protection--Management direction for research natural areas must provide for protection of the area from fire, insect, disease, and animal activity (FSM 4063.32 and 4063.3[8] and [9]). Wildfires that threaten research natural areas should be extinguished as quickly as possible using methods that cause the least disturbance to the natural area. The use of heavy equipment in suppression efforts should be prohibited. Mineral soil fire lines (hand dug) should be avoided, when possible, in research natural areas. Fire suppression through the use of chemical fire retardants is discouraged. Fire management plans may be developed to specifically direct the use of prescribed fire in natural areas (as described above). In the absence of an approved plan, wildfire is actively suppressed.

No actions are taken within RNAs to control insects, disease, native plants, or animals unless the Station Director and Regional Forester decide that proposed activities are needed to protect features of the research natural area or adjacent areas. When these activities are approved they are to be as specific as possible against the intended organism and result in minimum impacts to other ecological components within the natural area.

European settlement of large portions of the North American continent has resulted in the

introduction of a great number of plant and animal species. These species detract from natural area values by changing reference stand composition and altering ecological processes. Establishment of exotic species should be prevented in natural areas whenever possible. This is an important reason for restricting the use of and access to research natural areas. Humans and domestic livestock are important vectors for the spread of exotic plant species. If exotic plant and animal species become established, they should be eliminated from research natural areas as quickly as possible.

Standards and Guidelines for the Selection of Research Natural Areas

The selection and establishment of research natural areas occur through the continuing land and resource management planning process and associated environmental analyses (FSM 4063.03). Evenden and Kimball (1996) provide a flow chart of a model pathway for the selection and establishment of research natural areas (note, however, that it is not necessary for a proposed RNA to be identified during the forest planning process [FSM 4063.3]).

The principle policy guideline for the selection of research natural areas is provided by FSM 4063.1 and 4063.2. Research natural areas are to be located at sites where conflicting uses are minimal. There should be no evidence of human disturbances. However, when undisturbed conditions are no longer available, proposed areas may be identified that represent the best possible conditions. To maintain the interrelationships between terrestrial and aquatic systems, RNAs should encompass entire drainage basins. Drainage basins are also easily delineated, usually encompass representative environmental gradients, and provide valuable baseline areas for research and monitoring. Research natural areas must be large enough to provide unmodified conditions within the interior. The standard minimum size of an RNA is 300 acres, though the identification of larger areas is often necessary and usually well supported.

Identification of Need--The regional research natural area committee is responsible for determination of RNA needs. In the Pacific Northwest, recognition of research natural area needs has historically occurred through cooperation of the Forest Service, academia, and Natural Heritage Programs (Greene et al. 1985; Washington Natural Heritage Program 1995; Oregon Natural Heritage Advisory Council 1998; Dyrness et al. 1975; Wellner and Johnson 1974). In Idaho Wellner and Johnson (1974) and Wellner and Tisdale (1985) provide early assessments of research natural area needs. I have updated this information with prioritized lists of natural area needs (Rust 1997). Numerous important forest, shrubland, and grassland plant associations are inadequately represented within the natural area network on National Forest System lands in Idaho.

Selection Criteria--Andrews (1993) uses Natural Heritage Program protocols to elaborate on FSM policy guidelines for the selection of RNAs. He identifies four principle criteria for site evaluation: quality, condition, viability, and defensibility. Quality pertains to how well a site represents the targeted plant association, or ecological component. A high quality, representative site will encompass large portions of the natural range of variablility of specific

plant associations or a set of associations. Several RNAs may be needed within the natural area network to provide representation of the entire range of the natural variability. A high quality, representative site is large enough to encompass principle ecological processes that contribute the composition, structure, and function of the targeted ecological component.

Condition pertains to the extent of site degradation from natural conditions. The objective is to locate areas that provide a good baseline reference of natural conditions and are free of evidence of human-caused disturbances (e.g., the introduction of exotic species; the presence of roads and trails; evidence of past logging, grazing, or recreational use; the effects of fire suppression). As stated above, however, in particular ecosystems it may no longer be possible to identify sites that are completely free of human-caused disturbance. In these cases the site in the best possible condition may be identified for consideration as an RNA.

Viability pertains to the likelihood that high quality, representative stands in excellent condition will be maintained, in the case of research natural areas, in perpetuity. The viability of a site is influenced by its landscape context - predominant surrounding landuses, the degree of connectivity to, or isolation from, other sites in a natural condition, and the functioning of ecological processes on the surrounding landscape. Some examples are: An old growth forest stand that is isolated within an area of predominantly early seral stands dominated by sapling- and pole-sized trees is more susceptible to blow down than an old growth stand located within a matrix of forest dominated by medium- and large-sized trees. A late-seral stand of *Artemisia tridentata wyomingensis* located in a landscape predominately converted to exotic annual grassland is less viable than a late-seral stand of *Artemisia tridentata wyomingensis* located in a landscape dominated by *Artemisia tridentata wyomingensis* stands in good condition.

Defensibility refers to the capability to protect a site from exogenous degrading factors (including unauthorized human use and biological and physical factors such as invasion by exotic species or the drift of chemical pollutants). Large size and the use of easily defined RNA boundaries help build defensibility. As with the viability of a site, defensibility is influenced by landscape context. When ever possible, RNAs should be located away from existing conflicting uses. It is important to recognize, however, that this may not always be possible. Some ecological components will inherently be engaged with conflicting uses. Research natural areas should not be promoted for unauthorized uses. For example, the defensibility of RNAs is reduced through their inclusion as destinations in popular recreation guides.

Literature Cited

Agee, J. K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington.

Allen, B. H. 1986. Remember rangeland reference areas? Rangelands 8(4): 180-182.

Anderson, E. W. 1975. Why preserve natural areas? In: Laycock, W. A. 1975. Rangeland reference areas. Range Science Series No. 3. Society for Range Management, Denver. 66 pp.

Andrews, T. 1993. Research Natural Area Guide for the Rocky Mountain Region, USDA Forest Service. Unpublished report. USDA Forest Service, Rocky Mountain Research Station and Rocky Mountain Region, Fort Collins. 37 pp.

Andrews, T. 1994. Research natural areas in ecosystem management and research. Unpublished report. USDA Forest Service, Washington Office, Forest Management Research and Land Management Planning. 9 pp.

Barrett, S. W., S. R. Arno, and J. P. Menakis. 1997. Fire episodes in the Inland Northwest (1540 - 1940) based on fire history data. USDA Forest Service, Intermountain Research Station General Technical Report, INT-GTR-370. 17 pp.

Buckman, R. E. and R. L. Quintus. 1972. Natural Areas of the Society of American Foresters. Society of American Foresters, Washington.

Burns, R. M. 1984. Importance of baseline information to the research natural area program. In: Johnson, J. L., J. F. Franklin, and R. G. Krebill, coordinators. Research Natural Areas: Baseline Monitoring and Management. Proceedings of a Symposium in Missoula, MT, March 21, 1984. USDA Forest Service General Technical Report INT-173. 84 pp.

Christensen, N. J., et al. 1996. The report of the ecological society of America committee on the scientific basis for ecosystem management. Ecological Applications 6(3): 665-691.

Dyrness, C. T., J. F. Franklin, C. Maser, S. A. Cook, J. D. Hall, and G. Faxon. 1975. Research Natural Area needs in the Pacific Northwest. USDA Forest Service General Technical Report PNW-38. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 231 pp.

Evenden, A. G. and S. F. Kimball. 1996. Natural Areas Source Book. Unpublished report. USDA Forest Service, Northern Region and Intermountain Research Station, Natural Areas Program, Missoula.

Federal Committee on Ecological Reserves. 1977. A directory of Research Natural Areas on federal lands of the United States of America. USDA Forest Service, Washington D.C. 280 pp.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economical, and social assessment. Joint publication of the USDA Forest Service, USDC National Oceanic and Atmospheric Administration, USDC National Marine Fisheries Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, USDI National Park Service, and US Environmental Protection Agency, Washington D.C.

Franklin, J. F., R. E. Jenkins, and R. M. Romancier. 1972. Research natural areas: contributions to environmental quality programs. Journal of Environmental Quality 1(2): 133 - 139.

Greene, A. A., R. E. Frenkel, and C. A. Wellner. 1985. Pacific northwest natural area program: a successful partnership. Natural Areas Journal 5(4): 14 - 23.

Habeck, J. 1979. Slow progress: a report on research natural areas. Western Wildlands, Spring. 4 pp.

McIntosh, R. P. 1985. The background of ecology, concept and theory. Cambridge University Press, Cambridge.

Moeur, M. 1992. Baseline demographics of late successional western hemlock/western redcedar stands in northern Idaho Research Natural Areas. USDA Forest Service Research Paper INT-456. Intermountain Research Station, Ogden, UT. 16 pp.

Moir, W. H. 1972. Natural areas. Science 177: 396 - 400.

Norse, E. A., K. L. Rosenbaum, D. S. Wilcove, B. A. Wilcox, W. H. Romme, D. W. Johnston, and M. L. Stout. 1986. Conserving Biological Diversity in our National Forests. Prepared by the Ecological Society of America for The Wilderness Society. 116 pp.

Oregon Natural Heritage Advisory Council. 1998. Oregon Natural Heritage Plan. Natural Heritage Advisory Council, State Land Board, Salem.

Pacific Northwest Interagency Natural Areas Committee. 1990. A Guide for Developing Natural Area Management and Monitoring Plans. Unpublished report. USDA Forest Service Pacific Northwest Forest and Range Experimental Station; The Nature Conservancy, Oregon Natural Heritage Program; and Washington State Department of Natural Resources, Washington Natural Heritage Program. 52 pp.

Rust, S. K. 1997. Representativeness assessment of research natural areas on National Forest System lands in Idaho. Unpublished report prepared for USDA Forest Service Northern Region, Intermountain Region and Intermountain Research Station. Conservation Data Center, Idaho Department of Fish and Game, Boise. 67 pp.

Ryan, M. G., L. A. Joyce, T. Andrews, and K. Jones. 1994. Research natural areas in Colorado,

Nebraska, North Dakota, South Dakota, and parts of Wyoming. USDA Forest Service General Technical Report RM-251. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 57 pp.

Shanklin, J. F. 1951. Scientific use of natural areas. Journal of Forestry 49(11): 793 - 794.

Swanson, F. J., J. A. Jones, D. O. Wallin, and J. H. Cissel. 1994. Natural variability--implications for ecosystem management. In: Jensen, M. E., and P. S. Bourgeron, technical editors. 1994. Volume II: Ecosystem management: principles and applications. USDA Forest Service General Technical Report PNW-GTR-318. Pacific Northwest Research Station, Portland, OR. 376 pp.

USDA, Forest Service. 1988. Land and Resource Management Plan, Payette National Forest. Payette National Forest, Intermountain Region. McCall.

USDA, Forest Service. 1990. Land and Resource Management Plan for the Boise National Forest. Boise, ID: Intermountain Region, Boise National Forest.

USDA Forest Service. 1996a. Environmental Assessment, Designation of Research Natural Areas on Idaho National Forests. Environmental Assessment and Project File. Volumes 1 - 3. Intermountain Region, Ogden.

USDA Forest Service. 1996b. Environmental Assessment for the Designation of Ten Research Natural Areas and a Botanical Special Interest Area. Northern Region, Missoula. 23 pp, plus appendices.

USDA Forest Service. 1997a. Southwest Idaho Ecogroup Forest Plan Revision, Preliminary Analysis of the Management Situation, Summary. Boise, Payette, and Sawtooth National Forests, Boise.

USDA Forest Service. 1997b. Environmental Assessment for the Designation of Research Natural Areas and Botanical Special Interest Areas. Northern Region, Missoula. 13 pp, plus appendices.

Washington Natural Heritage Program. 1995. State of Washington Natural Heritage Plan, 1991/1993 update. Washington State Department of Natural Resources, Olympia.

Wellner, C. A. 1986. Why natural areas? In: Loop, D. J. and J. R. Bird, eds. 1986. Montana Natural Areas, Conference Proceedings, October 14 - 16, 1986, Billings, Montana. The Nature Conservancy, Helena.

Wellner, C. A., and F. D. Johnson, editors. 1974. Research Natural Area needs in Idaho: a first estimate. Report of the Natural Areas Workshop; 1974 April 24-25; Boise, ID. Moscow, ID: College of Forestry, Wildlife and Range Sciences. 179 p.

Wellner, C. A., and E. W. Tisdale. 1985. Coverage of natural diversity in northern, central, and southern Idaho within established and proposed Research Natural Areas and equivalents. Unpublished report. Idaho Natural Areas Coordinating Committee.