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BOTANICAL BASELINE MONITORING IN RESEARCH NATURAL AREAS IN OREGON AND WASHINGTON

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ABSTRACT: With human impacts on more and more of the landscape, long-term, high-quality monitoring programs in natural ecosystems are increasingly important. Establishment of botanical monitoring systems in research natural areas in Oregon and Washington is providing baseline data used for (1) testing ecological hypotheses, (2) judging the effects of management activities on similar ecosystems, (3) understanding basic ecosystem processes, and (4) providing data on flora and fauna. Botanical monitoring systems need to be established and carefully referenced, with procedures rigidly defined.

INTRODUCTION

Gene Likens, past president of the Ecological Society of America, stated at the 1983 meeting of the American Institute for the Biological Sciences ". . . .that a major priority for ecology today is to establish long-term studies, including high-quality monitoring programs, in a variety of ecological systems throughout the world. Qualitative and quantitative observations over long periods are vital to formulate meaningful, testable hypotheses in ecology" (emphasis mine). Likens' concept of long-term monitoring studies necessitates research sites that are protected from manipulation where activities such as logging, farming, grazing, and industrial development are not allowed. Federal research natural areas (RNA's) provide these kinds of sites. Representing a wide array of terrestrial and aquatic ecosystems, RNA's are established as permanent study sites to be maintained in their natural condition, with baseline monitoring as a major research focus.

Baseline monitoring on RNA's is not a final objective, but rather a means to an end. Monitoring should provide high-quality data about the ecology of a species, ecology of the community in which it lives, and ecology of the system in which the community exists. Monitoring activities may have a current research objective as well as provide data for future analyses. Ultimately this data will allow the researcher to ask more meaningful questions, to test more viable hypotheses, and to better address the problems of understanding ecosystem processes. This, in turn, will help managers deal with the resource in a way that is more compatible with natural ecological processes.

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The Pacific Northwest (Oregon and Washington) research natural area program has been emphasizing botanical baseline monitoring for a number of years. Permanent sample plots established in 1947 at the Thorton T. Munger RNA in Washington are still being measured. In the last 10 years monitoring has become an increasingly important concept. The purpose of this paper is to discuss botanical monitoring--studies of long-term duration (greater than 5 years)--using examples from RNA's in Oregon and Washington. This includes a fairly broad range of plant-oriented studies--from floral surveys to mortality analyses. Four categories will be discussed: successional plots, floristic surveys, ecological processes, and classification plots.

SUCCESSIONAL PLOTS

Successional plots, in the form of permanent sample plots, are one part of our monitoring program. If monitoring is to be long term, then permanent installations must be established for consistency, statistical validity, and accuracy of data collection. Permanent sample plots may serve many purposes. In the Pacific Northwest RNA program they have been used primarily to look at growth and yield of stands and to monitor mortality. The program uses two major strategies for establishment of permanent sample plots. One type, called reference stands, can be located in selected plant communities, in a particular stage of succession, or in particular type of environment. The other type, circular plots, is used to systematically sample an area.

Reference stands are generally 1 to 2 ha in size. They are surveyed and marked every 50 m around the perimeter and in the center with plastic or aluminum pipe, and every 25 m with either cedar stakes or reinforcing bar (fig. 1). The entire hectare is then divided into a 5 by 5 m grid to facilitate tree tagging and mapping. Within the plot every tree, 5 cm diameter at breast height (d.b.h.) or greater, is tagged, measured for d.b.h., vigor coded, and stem mapped. Generally 20 to 30 trees, representing 20-cm diameter increments, are measured with an optical dendrometer, which provides information on height, volume, and surface area. All standing or down dead wood, greater than 15 cm diameter, is mapped for size and decay class.

Circular plots, 1 000 m^2, differ somewhat from reference stands (fig. 2). They are surveyed in the center and permanently marked both there and on the circumference at the four cardinal points. Four 12.5-m^2 seedling subplots are

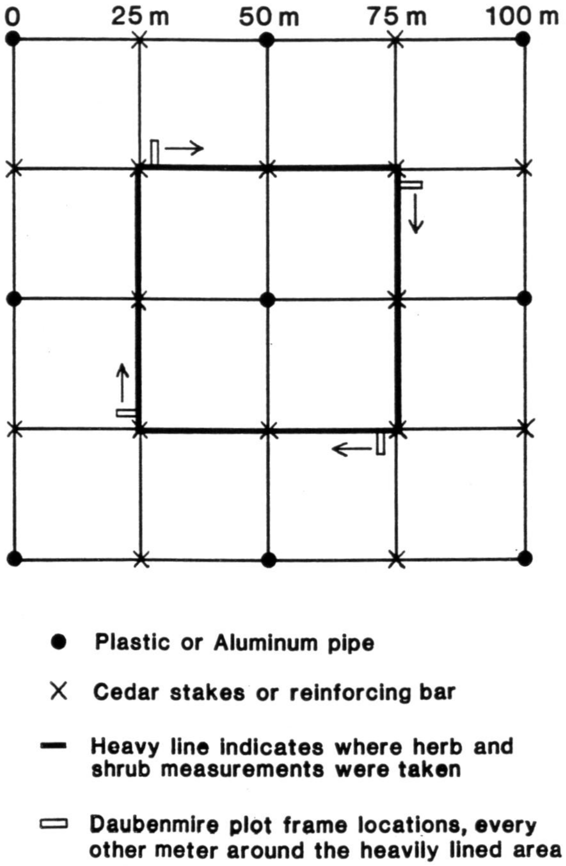

Figure 1.--Reference stand showing permanently marked points and the herb and shrub sampling line.

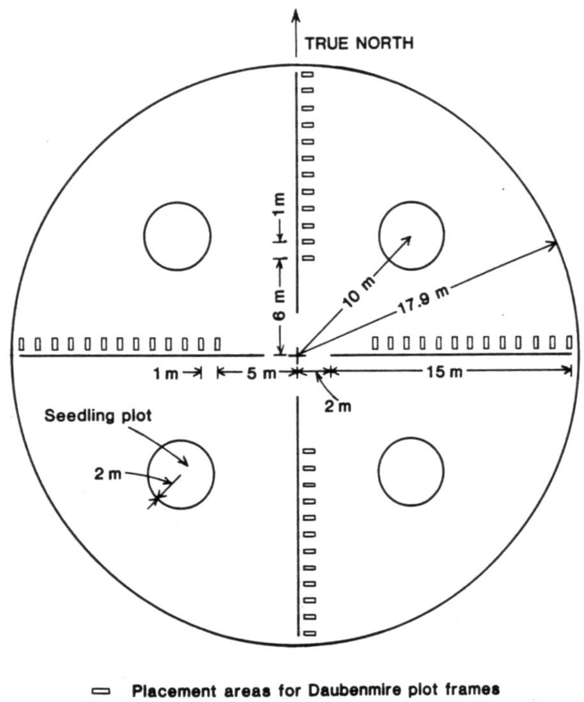

Figure 2.--Circular plot showing center point, seedling plots, and the herb and shrub sampling line.

located 10 m from the plot center. Seedling subplot centers are marked with reinforcing bar. Trees are tagged, measured, and vigor coded. Trees and dead wood are not mapped.

In most cases, herb and shrub vegetation are subsampled in permanent sample plots. The techniques vary. For reference stands a Daubenmire plot frame (20 by 50 cm) is used to measure herb cover. At alternating meters along 200 m of transect (fig. 1) the frame is laid down facing toward the outside of the reference stand. On circular plots the plot frame is laid down at points along four radii emanating from the center in the four cardinal directions (fig. 2). Shrub cover is measured by using the line intercept method along the same transect lines as for the herbs.

Tree mortality checks are made on an annual basis to determine timing and cause of mortality. Every tree in a plot is visited, checked to see if it is dead or alive, and, if dead, measured for d.b.h. and coded for cause of mortality. Tree remeasurements are done approximately every 5 years. Understory vegetation is not ordinarily remeasured unless there is some reason to do so, such as after a wildfire, bug infestation, or mudflow.

All data from permanent sample plots are entered into a micro-computer and stored in the Forest Science Department Data Bank, Oregon State University, Corvallis. Permanent ink maps of the stands have been drawn by hand in the past. Recently a micro-computer program was written that will produce a stem map. A program is currently being developed to map dead wood.

Location of reference stands is a subjective process. Generally an attempt is made to locate the permanent sample plot in a representative stand of a particular forest type or successional stage. Location of circular plots is usually more systematic with plots laid out at regular intervals along transect lines. In some cases a series of transect lines may create a systematic grid of plots. Transect lines may also be oriented to sample across environmental gradients and ecotones.

Because both kinds of plots are permanently marked in the field and are well documented, many other kinds of long-term studies can capitalize on their presence. Mammal population dynamics, insect collections, litter decomposition, biomass sampling, growth and yield of forest stands, nutrient cycling, forest meteorology, accumulation of heavy metals, and disturbance patterns are some examples of studies that have been done on these plots. The existence of these permanent sample plots also makes data collection by other researchers more cost effective.

As of March 1984 there were 33 ha of reference stands and 250 circular plots, representing 14 different forest types on 15 out of 96 established RNA's in Oregon and Washington.

FLORAL SURVEYS

A floral survey is one of the most basic kinds of botanical monitoring. It can be used both to determine the presence of rare, threatened or endangered species and to get a thorough inventory of plant species, their habitat, and abundance. Until this is done, it is nearly impossible to determine whether changes in individual plant populations or floral compositions are taking place.

Floral surveys can be very time consuming and can differ widely in their usefulness. Fourteen floral surveys have been conducted on RNA's in the Pacific Northwest. Six of these surveys have been published by the Pacific Northwest Forest and Range Experiment Station[1/] (Mitchell 1979, Schuller 1981).

For these six surveys each area was visited 7-10 times, depending on size and accessibility, during the growing season. On the first visit a walk through the area was done to determine the range of habitats. The RNA was then stratified and described in units that would be recognizable in the future. The number of units depended on the size of the RNA and habitat heterogeneity. On successive visits all habitats within the various units were surveyed on at least one occasion. Special attention was paid to small-scale, unmappable anomalies, such as rock outcrops, seeps, and small ponds, as these areas tend to harbor a large variety of species.

When reliable identification of species could not be made in the field, unknown taxa were collected, taken to the lab, keyed, compared with voucher specimens, and identified. Most specimens collected in the field were deposited in an herbarium. Location and habitat descriptions were included. Herbaria especially welcome specimens from RNA's because RNA's serve as permanent reference areas.

The survey publications include information on the environment and habitat or community types of the RNA surveyed. The checklist in each one includes family, genus, and species, as well as the habitats where the plants were found.

Floral surveys are often somewhat subjective. Those doing such surveys should be familiar with the flora of the region and have a feel for habitat variation, especially if the approach to sampling is nonquantitative.

ECOLOGICAL PROCESSES

Most ecological processes exhibit a lot of yearly variability (Likens 1983). Long-term records are needed to clearly understand these processes. Numerous examples exist where extrapolation drawn from two to three years of data have led to the wrong conclusions. RNA's in Oregon and Washington have provided opportunities for monitoring some ecological processes with the use of permanent sample plots, cone plots, and seed and litterfall traps.

Five RNA's have a continuous record of cone crops for periods ranging from 5 to 17 years. These plots were established where 15 to 20 tree tops could be easily detected from a trail or road. Trees were numbered with tree paint and mapped from the road or trail using a compass. Cone counts on all trees are made each year from the same spot and direction, with the help of a spotting scope. Continuous records such as these are useful in predicting cone crop periodicity and understanding the dynamics of one part of the stand regeneration process.

Tree seed has been collected for 20 years from two RNA's, one in Oregon and one in Washington, to extend our understanding of regeneration. The traps are 20 by 50 cm wooden frames with wire bottoms. Nylon mesh liners are placed on top to intercept the seed. Six to 8 traps are spaced at 10 m intervals on the forest floor.

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[1]Cornelius, Lynn C. Checklist of the vascular plants of Sister Rocks Research Natural Area. Adm. Rept. PNW-2. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experimental Station; 1982. 8 p.

Cornelius, Lynn C.; Schuller, S. Reid. Checklist of the vascular plants of Cedar Flats Research Natural Area. Adm. Rept. PNW-5. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 14 p.

Kemp, Lois; Schuller, S. Reid. Checklist of the vascular plants of Thorton T. Munger Research Natural Area. Adm. Rept. PNW-4. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 16 p.

Schuller, S. Reid; Cornelius, Lynn C. Checklist of the vascular plants of Goat Marsh Research Natural Area. Adm. Rept. PNW-3. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 18 p.

The liners are collected during midsummer and after spring snowmelt. The seed is sorted according to species and is counted and tested for viability.

A litterfall study of anthropogenic substances has been under way by Batelle Northwest Laboratories for nearly 7 years on four RNA's in the Pacific Northwest. Monthly samples of litter are collected from permanent collection buckets installed at each site. The litter is analyzed for nutrient content to determine the amount and kinds of airborne pollutants being intercepted by tree canopies.

A study that uses litterfall to index primary productivity on an annual basis is taking place at Wildcat Mountain RNA in Oregon. For 7 years litter has been collected from six 1 m^2 traps systematically located in the forest stand. The samples continue to be collected, and are first sorted according to twig, leaf, bark and branch, then oven dried, weighed, and archived.

VEGETATION CLASSIFICATION PLOTS

It is the responsibility of the area ecology program in Oregon and Washington to provide the National Forests with a plant community classification and predictions of site productivity. Included are the establishment of permanent photo points and sample plots that can be revisited at regular intervals. Because much of the forest is slated for future harvest cutting of some type, RNA's are among the few areas where permanent sample plots and photo points can be protected. At least 20 RNA's have been used by the area ecologists for the establishment of 30 permanent plots in 24 forest types.

Plots are established within specific habitat types. They are marked permanently in the field, on air photos, and on topographic maps. Measurements of site productivity, of wildlife use, and of basal area by species are taken. Soil descriptions and a stand density index are also included. Permanent photo points are established, and all information is entered in the Forest Service Total Resource Inventory System.

These plots provide practical information for use by the Forest Service. They also yield much data that can be used by the research and academic communities.

PROBLEMS

Establishing and monitoring permanent sample plots is only the beginning. The field work is often the fun part, but if it is not followed up by careful referencing, data organization, and some financial support the process can easily become stymied. As in any research study, objectives must be clearly defined before the study begins. One must know what and why one is measuring and monitoring. Each plot location must be well marked in the field and documented in some kind of report in the office. Procedures for data collection must be rigidly and clearly defined, so someone 40 to 50 years from now can know exactly what, how, and where things have been done. The large volume of data generated must be carefully organized. Continuous records must be maintained, updated, entered into the computer, verified, and analyzed. The data need frequent analysis in order to detect inconsistencies, omissions, and problems.

Botanical baseline monitoring takes time, money, and people. Convincing managers, directors, rangers, supervisors, and program coordinators that this kind of work is worthwhile can itself be a large task. One of the best ways is to make sure that the benefits of monitoring programs are known to the scientific community and to managers. Nothing is more convincing than actual use of such programs and the data they provide.

In the Pacific Northwest scientists have just begun to gather baseline data on RNA's. Ninety-five percent of the monitoring programs are west of the Cascade Range, and 99 percent of these are in forested stands. Botanical baseline monitoring programs are also needed for thousands of acres of shrub-steppe, desert, and other nonforest vegetation in RNA's.

CONCLUSIONS

Baseline data collection is often viewed as merely descriptive or as number gathering with no purpose in mind. Presently the huge natural landscape of the west is being altered by a resource management that tends to significantly change the natural world. As this is happening it becomes more and more important to know what is being lost, and to understand the patterns and processes of a rapidly diminishing natural landscape. In the face of these changes, baseline monitoring becomes all the more important.

Well-documented baseline monitoring should be a long-term goal. We need to have well organized and related sets of data that identify ecosystem components and how they function. This is especially true for ecosystems that have not yet been altered by management activities. This is not to say that short-term projects are not important; rather, such projects should be interactive with a long-term goal--understanding and documenting the baseline.

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