

Genetic Diversity and Protection of Alpine Heather Communities in Mount Rainier National Park

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The term biodiversity is frequently used to describe the number of taxa in a specific geographic location, however, it also refers to the genetic diversity of populations within a species. Genetic diversity is a basic component of all other levels of diversity (species, landscape, and process levels). It varies across space and time reflecting each species' life history traits and environmental and evolutionary history. Protection of genetic diversity is necessary for the long-term survival of species and populations because it provides them with the resources to respond to changing environmental conditions, regardless of the cause of that change.

Increased visitation in some parks may result in increased off-trail hiking and camping, potentially causing plant mortality and fragmentation of plant populations. These changes within populations may also decrease genetic diversity of a species, thereby reducing its potential for long-term survival. Resource protection guidelines such as Limits of Acceptable Change (LAC) may be strengthened by utilizing an integrated approach that combines demographic, life history, and genetic diversity characteristics of targeted species. We are currently conducting research on two heather species (*Phyllodoce empetriformes*, *P. glanduliflora*) to determine how genetic diversity data can be utilized to improve resource protection guidelines in Mount Rainier National Park.

Human Use Patterns

Each year almost two million people visit Mount Rainier NP. The most popular destinations are within the subalpine and alpine areas. Approximately 70 percent of all visitors go to at least one subalpine meadow (Paradise), and 98 percent of all cross-country camping (minimum impact camping without developed campsites) occurs within subalpine and alpine areas. This concentrates use on just 35 percent of the park's land mass and on the vegetation least resilient to human use. Overnight use in subalpine and alpine areas has increased by 43 percent since 1984 and is expected to continue to increase as urbanization encroaches on the park.

Resource Protection Guidelines

Mount Rainier NP encompasses 95,389 ha, of which 92 percent is designated Wilderness. Resource protection is addressed through overnight camping limits, LAC standards, and restoration projects. Maximum numbers of parties per night are designated for each crosscountry and alpine zone within the Wilderness. LAC standards for changes

in landscape (vegetation) address the maximum number, size, and density of bareground areas, such as campsites, allowable within one wilderness zone. Restoration projects involve repair or protection of sites where noticeable damage has occurred following human use. Although these projects are usually initiated by development of at least one "severe" human impact (e.g. severe erosion or denudation), they usually address all impacts within an area. In this manner, restoration plans address areas of trampled vegetation and not just bareground sites (destroyed plant communities) addressed by LAC standards.

Mount Rainier's LAC standards currently focus on destroyed plant communities (bareground sites), which is the most severe form of damage from human use. Park staff now are trying to increase the accuracy of monitoring programs by improving methods for monitoring damaged plant populations. One method employs a qualitative assessment of plant health called "condition classes." Visual condition classes are a qualitative assessment of community "health." Condition classes are: 1) little change - no signs of human use; 2) definite change - some evidence of human use, broken or abraded plants, small bare areas, but minimal erosion; 3) severe change - uprooted plants, large denuded areas, severe, local erosion; and 4) habitat destroyed - all plants gone, extensive soil erosion. Recently, a survey documenting "condition classes" of plant cover, was conducted within the Muir Corridor alpine zone (approx. 16.8 ha). Each plant patch was mapped on an aerial photograph and assigned to one of the four visual condition classes. Although the zone meets LAC standards, survey results documented that 47 percent of the area shows definite change, 9 percent has been severely changed, and only 44 percent exhibits little change from human use (see photograph). Over half of the zone (56%) was damaged substantially and we are not certain how these levels of damage affect the potential for long-term survival of plant populations. We are studying the significance of different levels of human-caused damage on these plant communities and developing practical methods to monitor vegetation change.

Management of Genetic Resources

The USDA Forest Service (USFS) and Washington Department of Natural Resources (DNR) have identified conservation of genetic resources as a management objective. Specifically they use the concept of Genetic

Resource Management Units (GRMU) to identify discrete components of genetic diversity within and between species populations. This concept is applied on a limited basis (Riggs, 1990) on some National Forests in California (Millar and Libby, 1991) and on many Washington DNR lands (Wilson, 1990). Each GRMU is composed of a core area and buffer zone. Size and location of GRMUs are based on:

- (1) genetic diversity within a species population,
 - (2) reproductive and other life history traits, and
 - (3) species densities. Conservation plans for individual species include identification of several GRMUs.
- The objective of GRMUs is to:
- (1) conserve genes in an evolutionarily dynamic condition,
 - (2) maintain viable, genetically diverse populations of species, and
 - (3) provide control sites for monitoring (Millar and Libby, 1991).

They provide a tool for evaluating resource damage and developing LAC standards in Wilderness. Impacts from human use, air pollution, or other environmental stresses can be measured more effectively with GRMUs, because change can be detected more easily than at the population level in species or more complex levels of organization in ecosystems. In addition, they can be used to predict relative endangerment of species. Application of the GRMU concept is a recent development in biological conservation, and has been used as a management tool for only a few years.

Research Objectives

We are evaluating the concept of GRMUs as a management tool for protecting biological resources in Mount Rainier NP and its surrounding ecosystem, with an emphasis on genetic diversity of species populations (Rochefort and Peterson, 1991). This work is supported by funding from the Natural Resource Preservation Program. The research objectives for our study are:

- (1) determine the genetic diversity of selected plant species in the subalpine/alpine zone of Mount Rainier NP,
- (2) describe potential GRMUs for populations of these species, and

(3) develop resource management guidelines for application, management, and monitoring of GRMUs.

We are using a population genetics approach to address how the impacts of stress from urbanization and associated resource use can be identified in park ecosystems. We are specifically studying how these impacts affect the biological diversity of plant populations and how NPS resource managers can protect this diversity.

Research Methods

Our project utilizes basic genetic and ecological information in a framework that is directly applicable to resource management. Once data are collected and analyzed, management applications will be developed with a team of NPS and USFS resource managers and scientists. Our first step was to determine the geographic distribution and condition of two heather species: *Phyllodoce glanduliflora* and *P. empetrifoliosa* populations. Heather communities are of particular concern due to their sensitivity to trampling, slow recovery rates, and length of time for community development. Specific heather communities within Mount Rainier NP have existed for as long as 10,000 years, although establishment of new meadows with continuous cover requires at least 200 years (Edwards, 1980). Populations were mapped on topographic maps and entered into the park GIS. Each population we monitor will be evaluated with regard to the severity of human impact using the park's visual condition class rating.

Currently we are working on the second step of our research-- surveying genetic and morphologic diversity of a subsample of populations of each species. Sample sites will be distributed at four general locations

(north, south, east, and west sides of the mountain). At each of the four sites, paired populations will be sampled at the high and low elevation range of each species. At each population, 20-30 individuals will be sampled for genetic analysis and surveyed for several morphologic characteristics (needle color, angle, and size). Additional sample sites will be established within damaged populations in order to compare undamaged and damaged sites.

The third step will be to analyze genetic and morphologic variation with special emphasis on trends within and among populations and along geographic and elevation ranges. Genetic diversity will be determined using allozyme analysis (Allard, 1970; Asins and Carbonell, 1987). Allozymes are alternative forms of enzymes present as genetic traits on chromosomes, and provide standard yardsticks for making comparisons among populations and taxa. The greater the number of allozymes (that is, heterozygosity), the greater the genetic diversity of the organism. We also will determine if there are correlations between genetic diversity and morphologic and reproductive characteristics (Loveless and Hamrick, 1984).

Our final step will be to develop guidelines for the application of data on genetic diversity, demography, and life history to improve resource protection policies. Specifically, the GRMU concept will integrate NPS policies with scientific data as a means of protecting biological diversity within Wilderness.

Summary

NPS Service Management Policies direct us to protect biodiversity and state that we "... will strive to protect the full range of genetic types (genotypes) native to plant and

animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity." (chapter 4:10). Policies also direct us to minimize our interference with gene pools during revegetation projects (chapter 4:9); however, there is little guidance available for resource personnel on how to apply this principle in the field.

Our study uses two high elevation heather species in Mount Rainier NP as a test case for how genetic diversity data can be integrated in the development of resource protection guidelines. This project will determine if quantifying genetic variation can provide additional protection to plant species beyond that contained in current regulations.

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Heather community in Mount Rainier NP. This community is estimated to be 10,000 years old and been severely changed (condition class 3) by human use.

