

Protocol Development Summary

Protocol: Forest Vegetation Monitoring [short name: Forest]

Parks Where Protocol will be Implemented: LEWI, MORA, NOCA, OLYM, and SAJH

Justification/Issues being addressed:

Late-successional, coniferous forest is critical for ecosystem function (such as carbon sequestration) and biological conservation in the Pacific Northwest. Such forests are well-represented in the North Coast and Cascades Network (NCCN). We expect that climate change and air pollution are the greatest threats to national parks in the Pacific Northwest. Tree recruitment, growth, and mortality are sensitive indicators of ecological change which can only be documented and understood through detailed, long-term observations. Increases in tree mortality have recently been reported for western North America (van Mantgem et al. 2009), demonstrating the utility of long-term forest monitoring. Structure and composition of forest vegetation ranked 15 overall in the NCCN.

Specific Monitoring Objectives to be Addressed by the Protocol:

We will monitor the following parameters:

Structure and Composition

- Trees – We will monitor dimensions, canopy cover, indicators of health, and indicators of wildlife habitat by species to detect changes in the structural framework of forests upon which the other inhabitants depend. Wildlife habitat indicators will link this protocol with wildlife monitoring protocols.
- Snags – We will monitor changes in density and size as indicators of forest structure and carbon cycling.

Processes

- Tree recruitment – We will monitor saplings to track changes in establishment success and species composition as indicators of changing forest structure.
- Tree growth – We will monitor growth of tagged trees as an indicator of changing conditions for forests.
- Tree mortality – We will monitor numbers of deaths annually by species to detect changes in rate and cause (if possible) as indicators of changing forest structure and composition.

Environment (some of these are static and only need to be measured once)

- Landscape position of plot including slope, aspect, terrain position
- Soil properties (descriptive attributes such as texture and soil series)
- Physical characteristics (e.g., gap formation, water distribution on plot)

Basic Approach:

As of 2008, we have established 35, 1-hectare plots at Mount Rainier, North Cascades, and Olympic, at elevations from sea-level to 1800 m. Plots established to date include at least 21 tree species, with about 6000 live trees. We intend to establish additional plots at San Juan Island, Lewis & Clark, and North Cascades. The specific forest types we have chosen capture the extremes and the middle of the environmental gradient for forests in the network. Sitka spruce forests from 0-300 m elevation at Olympic and Lewis & Clark comprise the warm and wet end

of the gradient. These forests are important winter feeding grounds for Roosevelt Elk. The cold and dry end of the gradient consists of subalpine fir forests between 1500-1800 m elevation at North Cascades and Mount Rainier. The middle of the gradient is represented by western hemlock with a salal and/or Oregon grape understory, between 600-900 m elevation, measured at Mount Rainier, North Cascades, and Olympic. These forest types are common throughout the region; our monitoring results will provide benchmark information for managed forests. Target vegetation communities for San Juan Island have not yet been identified.

We will assess tree mortality annually, and record tree recruitment and growth every five years. We will report trends in tree mortality every year, starting in the fourth year. We will report trends in tree recruitment and growth after 15 years. We will also report on trends in stem densities and tree basal area after 10 years.

Principal Investigators and NPS Lead:

The protocol was developed by USGS-FRESC in collaboration with NPS. Principal investigators Andrea Woodward (USGS) and Steve Acker (NPS). NPS Lead: Steve Acker at OLYM, 360-565-3073.

Development Schedule, Budget, and Expected Interim Products:

The original version of the protocol was submitted to the USGS peer review process in 2007, completed peer review in 2008, and was expected to be published in early 2009. We made changes to the protocol after the USGS version was submitted for peer review in response to direction from the NCCN Board of Directors to limit costs. We restricted the focus of the protocol to tree demography and canopy structure and species composition. We dropped measurement of understory vascular and non-vascular plants, tree seedlings, large woody debris and litter, and herbivory. We reduced the number of plots and altered the schedule of measurements as a consequence of this change in emphasis, resulting in six plots for each combination of park and elevation stratum instead of 18 plots as in the USGS version of the protocol. We increased the area within each plot for subsampling of small trees and saplings. A statistical analysis completed in 2008 confirmed that the new approach will yield adequate power to detect changes in tree mortality similar to those that have recently been published for forests in the Sierra Nevada (van Mantgem and Stephenson 2007). The protocol was revised to reflect these changes and was submitted for NPS administrative review in early 2009. The NPS administrative review team will consider whether or not a new peer review is needed.

Annual costs of fieldwork will be reduced by performing only mortality checks for four out of five years. We will perform fieldwork with three crews of two, one GS-7 and one GS-5, stationed at Mount Rainier, North Cascades, and Olympic. In years of mortality checks we anticipate five pay periods for the field crews; in years with tree measurements we anticipate eight pay periods. We estimate costs for fieldwork (i.e., seasonal employees, travel, vehicles, supplies) of \$56,057 for years of mortality checks and \$89,991 for years of tree measurements. We estimate that other costs (i.e., time of the Project Lead, Park Plant Ecologists, Data Manager, and GIS specialist) will be constant, so that the total estimated cost is \$127,865 for mortality check years and \$161,799 for tree measurement years.

References:

Van Mantgem, P. J., and N. L. Stephenson. 2007. Apparent climatically induced increase of tree mortality rates in a temperate forest. *Ecology Letters* **10**:909-916.

Van Mantgem, P.J., N. L. Stephenson, J. C. Byrne, L. D. Daniels, J. F. Franklin, P. Z. Fulé, M. E. Harmon, A. J. Larson, J. M. Smith, A. H. Taylor, and T. T. Veblen. 2009. Widespread increase of tree mortality rates in the western United States. *Science* **323**:521-524.