Landscape Dynamics

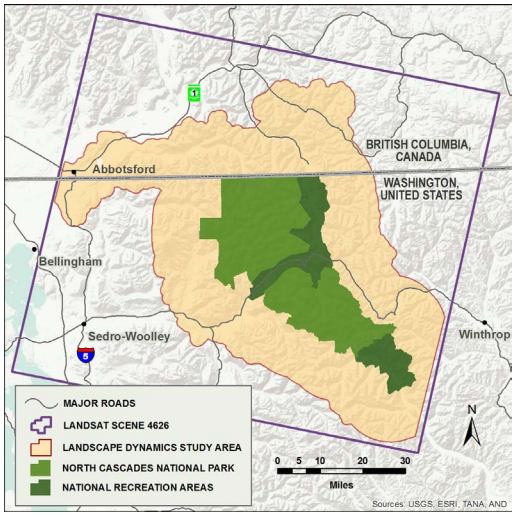
NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

National Park Service
U.S. Department of the Interior

North Coast and Cascades Network
Inventory & Monitoring Program

IMPORTANCE

From year to year, any number of events can alter a landscape in and around the North Cascades National Park Service Complex, including landslides, fires, clearcuts, and human development. These landscape changes occur at a wide variety of scales of time, extent, and magnitude, from a small flood that scours a riparian zone to a large fire that burns thousands of acres. Regardless of size and severity, each event can have lasting effects on the rest of the ecosystem. The North Coast and Cascades Network Landscape Dynamics monitoring detects and maps where these landscape changes occur, how severe they are, and how long they last. One goal of this monitoring program is to document current rates of landscape change, providing a baseline against which human-induced change can be compared in the future.



North Cascades National Park Complex Study Area

Goodell Creek Landslide
December 2003

OBJECTIVE AND METHODS

The landscape dynamics monitoring program uses satellite imagery, Geographic Information Systems (GIS), and statistical analysis to evaluate landscape changes in and around North Cascades National Park Service Complex (NOCA). The program tracks the size, duration, and intensity of each landscape change. The specific objectives are to:

1. Detect and map landscape changes that are larger than 0.8 ha (2 acres) in size and are a result of avalanches, clearing, development, fire, mass movement, progressive defoliation, tree toppling, or riparian flooding. Detection and mapping of changes will occur annually within a 16 km (10 mile) buffer around park boundaries. Reporting will occur at 3 and 10-year intervals.

2. Determine trends in the size, magnitude, location, and spatial distribution of each landscape change category.

Each year, Landsat images covering the extent of NOCA and surrounding areas undergo analysis using a program called Landsat-based Detection of Trends in Disturbance and Recovery (LandTrendr) to detect new areas that have changed compared to the previous year. Each area, or patch, which shows change passes through a size and magnitude filter, resulting in a map that only shows landscape change patches that are larger than 0.8 ha (2 acres) and where at least 10 percent of the vegetation has been removed. Once individual patches are delineated, researchers apply a statistical model to the data to label the patch with a change agent, such as fire, mass movement, clearcut, or riparian flooding. To create the label, the statistical model combines information about the patch's shape, size, and location on the landscape with the information about the event's duration and magnitude from the Landsat images. For example, a square-shaped patch outside the park boundary in which a tall forest canopy has been removed and only bare ground remains is likely a clearcut. A patch with a more irregular shape that is located on a valley wall and shows only partial removal of vegetation and broken tree trunks, might indicate a tree toppling event.

Researchers use the maps of labeled change patches to monitor the constantly changing landscape within and around the North Cascades National Park Service Complex.

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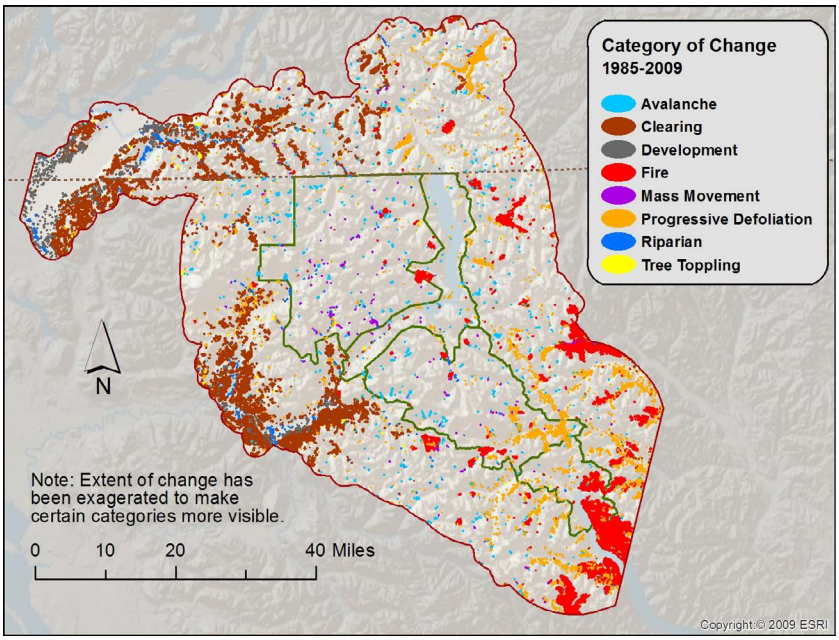
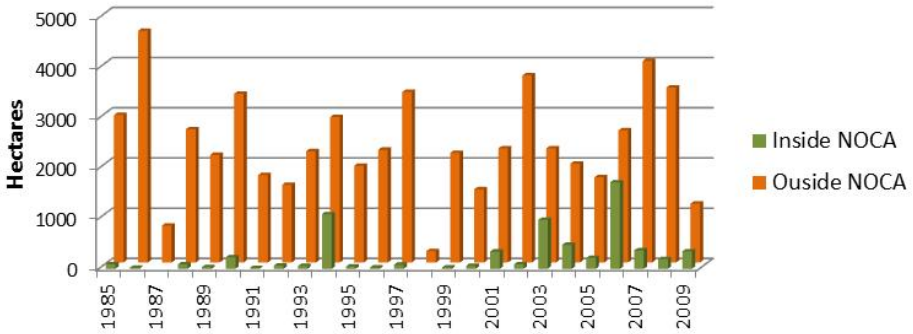
STATUS

Approximately 60,000 ha (5.65%) of the study area underwent detectable change between 1985 and 2009, affecting about 2% of NOCA and about 7% of the areas outside the park boundary. For a given year, the annual average area impacted by landscape change within the study area was just over 2,000 ha. Within the park boundary, the annual average area undergoing change was about 250 ha. Clearing was the major change type within the study area over the last 25 years, followed by Fire. Clearing occurred predominately outside the park boundary. Inside the park, Fire was the most significant agent of landscape change, followed by Progressive Defoliation and Avalanches.
The inter-annual variability in the total area experiencing landscape change was considerable. The greatest amount of change outside the park boundary was documented in 1986, with 2006 and 2007 being also significant. Within the NOCA boundary, 2006 was the year with the greatest change detected followed by 1994 and 2003. An analysis of the size of change patches showed that, on average, Avalanches, Mass Movements and Riparian changes are smaller but more numerous, whereas Fires tend to be larger but fewer. Progressive Defoliation events tend to affect large areas of the park and are represented by numerous small events.

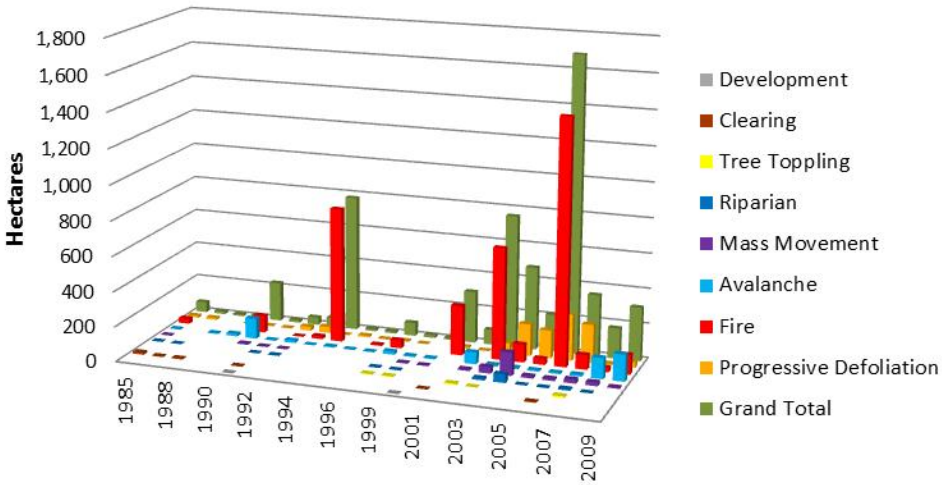


Map of North Cascades National Park Service Complex study area showing landscape changes from 1985 to 2009 by change type.



Total area disturbed within the North Cascades National Park Service Complex study area by year, separated by inside and outside the park boundary.

2003 Stehikin River Road riparian damage



Time series of area disturbed within the North Cascades National Park Service Complex boundary by change category.

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