New satellite-based methods to document landscape-scale changes in western national parks

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INTRODUCTION

As human management and climate change exert increasing pressure in and around national parks, changes are likely to occur in disturbance regime, community composition, habitat suitability, and land cover type. Cumulative changes in vegetation and land cover can influence wildlife, biogeochemical cycles, hydrology, and the overall visitor experience in national parks. Managing for these changes requires long-term, landscape-wide monitoring. However, direct field-based observation is difficult in many large national parks in the western U.S. because parks are large, ecologically diverse, and often include sparse trail or road access.

Satellite imagery from the Landsat sensors provides one means of observing some types of landscape change consistently and efficiently over large areas. For this reason, many networks in the National Park Service's Inventory and Monitoring Program are developing protocols to utilize Landsat imagery in support of landscape dynamics monitoring.

Here, we describe how a new approach being applied to a wide range of parks across the west that takes full advantage of the recently-free Landsat imagery archive, allowing capture of a wide range of disturbance and recovery processes in vegetation.

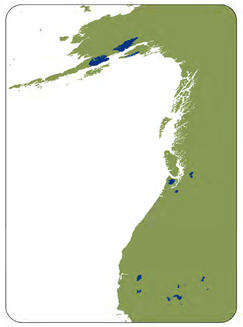


Figure 1. Parks (in blue) where our Landsat-based approaches to landscape monitoring are being planned or implemented.

METHODS

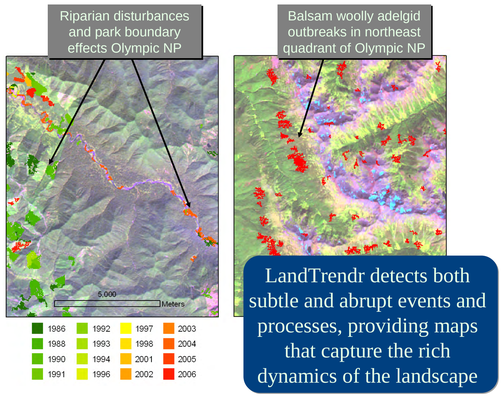
There are three phases to our process, with overviews below:

LandTrendr: Identify change in terms of disturbance and recovery metrics

Temporal smoothing + POM: Apply land cover labels from the parks to describe changes identified by LandTrendr

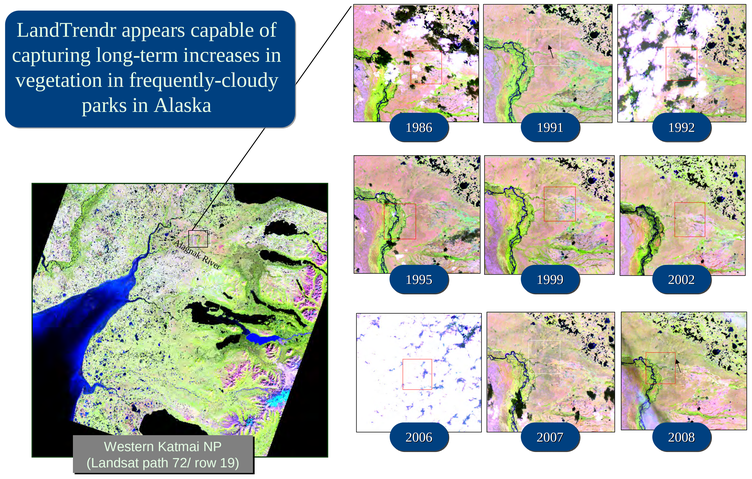
TimeSync: Use human interpretation to corroborate automated LandTrendr and POM algorithms

LANDTRENDR

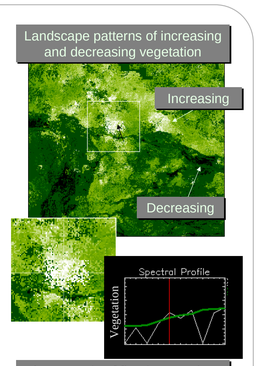


LandTrendr detects both subtle and abrupt events and processes, providing maps that capture the rich dynamics of the landscape

LandTrendr appears capable of capturing long-term increases in vegetation in frequently-cloudy parks in Alaska

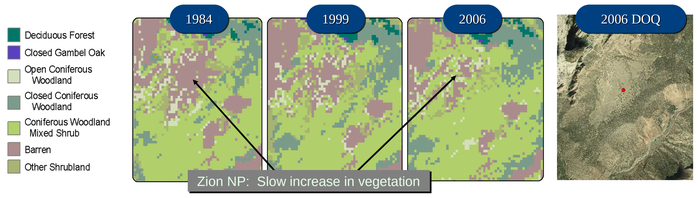


Landscape patterns of increasing and decreasing vegetation

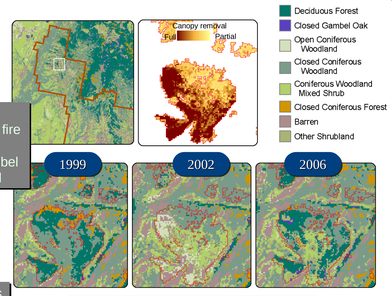


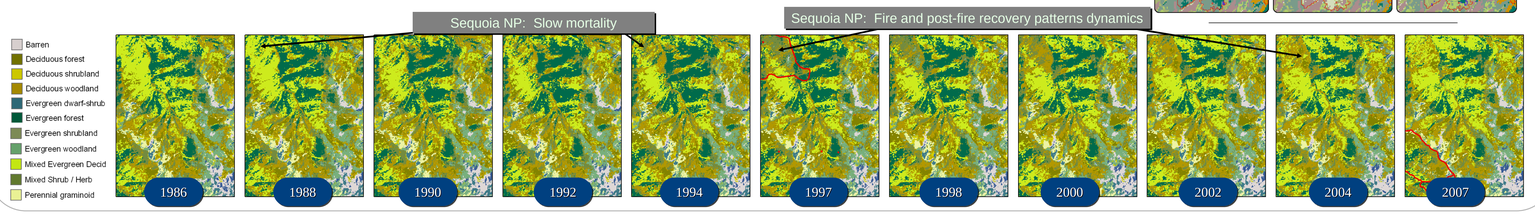
An example of fitted vegetation indices. White line shows original values, green line the fitted value Clouds are shown as inverted spikes, and are ignored during fitting. Overall increases in vegetation are captured here despite occasional cloudy years.

LANDTRENDR + POM



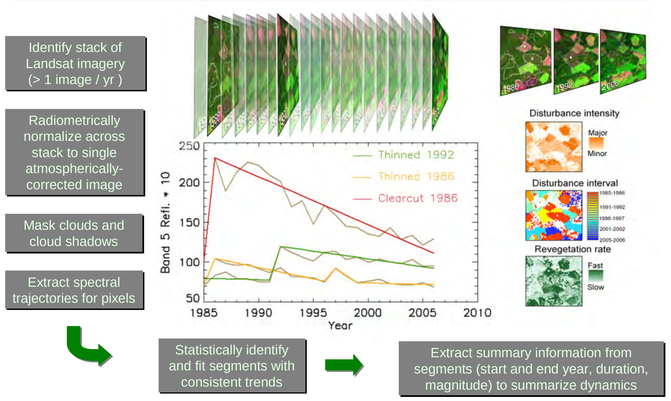
Combining LandTrendr change detection with POM labeling better maintains unchanging portions of landscape while capturing and describing areas of subtle or long-term change.





LANDTRENDR (Landsat Detection of Trends in Disturbance and Recovery)

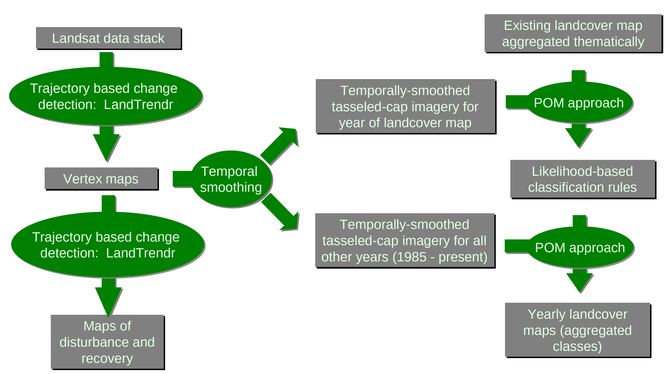
Key characteristics: Uses full temporal trajectories to capture both events *and* trends; Allows better separation of change from no-change; Robust to clouds and gaps (e.g. Landsat 7)



Steps in the LandTrendr change detection process.

Temporal Smoothing + POM (Probability of membership classification)

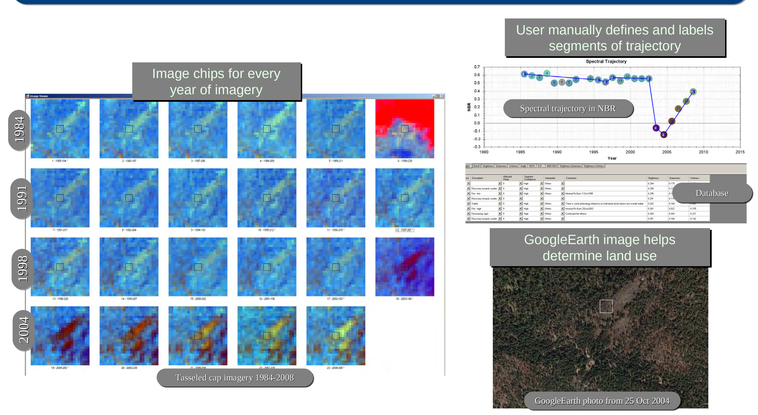
Key characteristics: Uses LandTrendr segments to produce temporally-smoothed spectral space on which to apply maximum-likelihood-type classifications; Utilizes park-specific maps as base to characterize dynamics using familiar class labels



Steps in the LandTrendr + POM approach.

TIMESYNC

Key characteristics: Provides user-friendly interface and database to allow quick and consistent interpretation of change through entire image stack; Allows linkage with GoogleEarth and other high-resolution databases.



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