Long-term post-wildfire monitoring of phenology and recovery using a MODIS time series

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ForWarn Satellite-Based Change Recognition and Tracking

http://forwarn.forestthreats.org

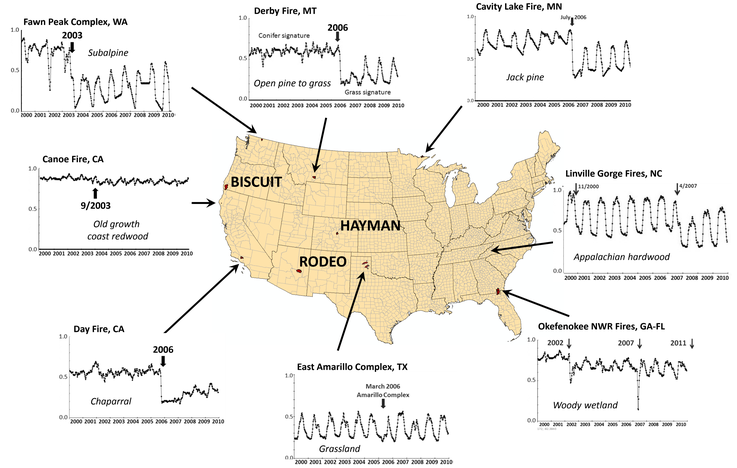
A high severity patch in the 2011 Wallow Fire, AZ. Credit: US Forest Service

THE NEED FOR EFFICIENT LONG-TERM FIRE MONITORING

Transitions from one ecological state to another can be triggered by disturbances such as wildland fire, yet the increase in area burned during the last decade strains our capacity to identify change of greatest concern. Novel successional trajectories may not become apparent until long after the fire occurs. Without an array of *early warning* indicators, it is difficult to know if change observed reflects a fundamental shift in trajectory caused by climate change or invasive species, or if it represents normal post-disturbance successional recovery and ecological resilience.

THE TECHNOLOGY

The US Forest Service-NASA's ***ForWarn*** system provides near real time vegetation monitoring and change detection for the conterminous United States at 232m resolution. The ***ForWarn*** dataset uses daily spectral information collected by MODIS satellite sensors which is then processed to generate a cloud-free 8-day time series of the Normalized Difference Vegetation Index (NDVI) from a 16-day stepped window. MODIS began in 2000. ***ForWarn*** has proved useful for monitoring ephemeral, annual and multi-year impacts to a broad range of vegetation types caused by climate variation and disturbances.



LAND SURFACE PHENOLOGY PROVIDES POWERFUL MONITORING INSIGHTS

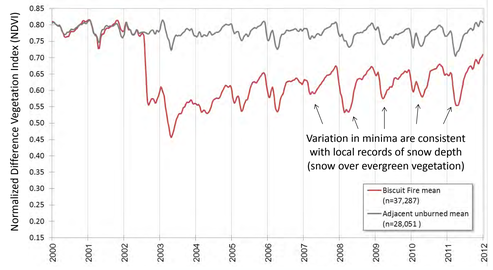
ForWarn's high temporal resolution (8-day) time series provides phenological insights into coarse compositional and structural changes caused by fire and succession. If an evergreen forest increases in grass cover after fire, the phenological profile increases in amplitude and growing season peakedness, while minimum and mean NDVI values decrease. (See examples at left). Aspects of this seasonal dynamic are captured by change in the percentiles of the annual distributions of NDVI values. (See graphs at the bottom of this poster).

LONG-TERM TIME SERIES PROVIDE UNPRECEDENTED PREDICTIVE POWER

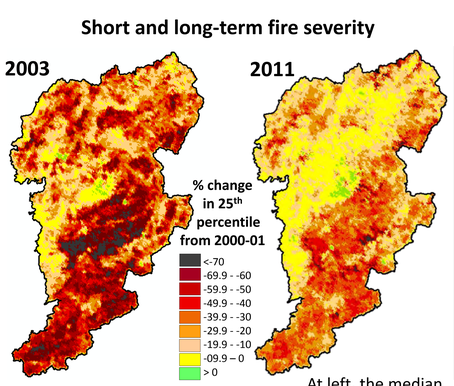
Fire monitoring data helps us document current status and more reliably predict the future. Given the multi-year and multi-seasonal information in ***ForWarn***, coarse scale predictions of successional recovery and potential non-recovery are possible. This early detection can help prioritize areas for field monitoring and management (see green maps below).

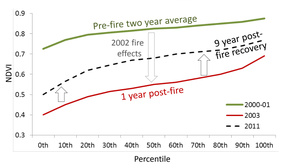
2002 BISCUIT FIRE, Oregon and California

Multiple mid-July lightning strikes ignited the Biscuit Fire that eventually burned nearly 500,000 acres of the Siskiyou and Six Rivers National Forests in coastal Oregon and California. This fire burned through steep terrain and diverse vegetation. After 9 years, it exhibits broad NDVI recovery, including most high severity areas.

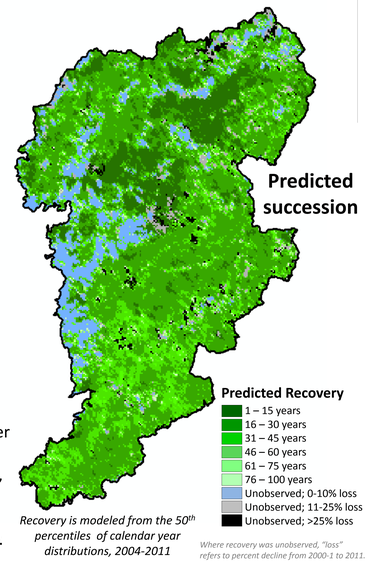


Short and long-term fire severity





At left, the median NDVI is nearly half recovered 9 years after the fire. While rates can decline over time, this provides a strong indication of coarse successional recovery.

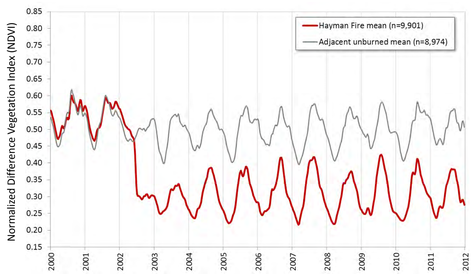


Recovery is modeled from the 50th percentiles of calendar year distributions, 2004-2011

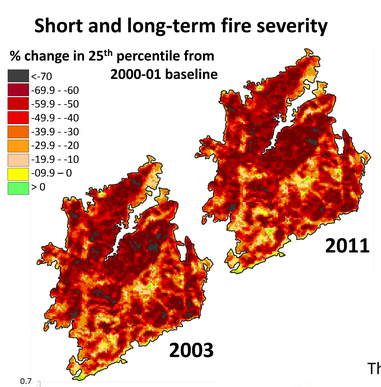
Where recovery was unobserved, "loss" refers to percent decline from 2000-1 to 2011.

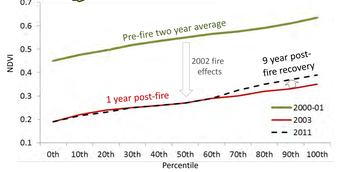
2002 HAYMAN FIRE, Colorado

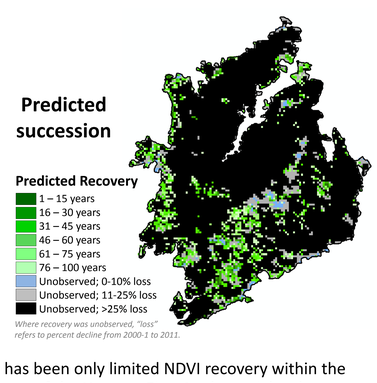
The 138,000 acre Hayman Fire burned for 20 days after a June 8th arson ignition; 60,000 acres burned in a single day with extreme fire behavior that resulted in massive tree mortality. At the time, it was thought that there would be too little seed for recovery. These data are consistently pessimistic. We predict only patchy recovery within the fire perimeter.



Short and long-term fire severity







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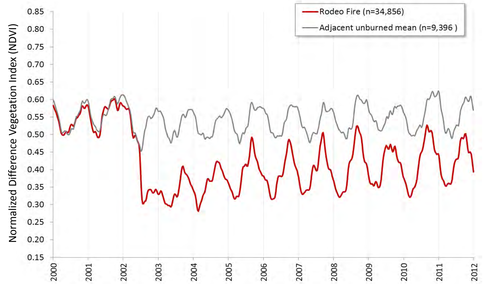
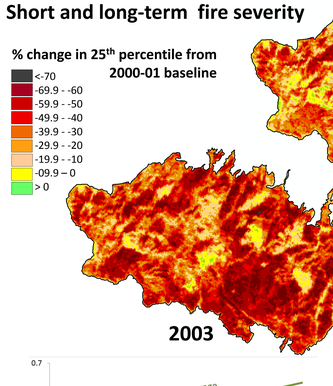
There has been only limited NDVI recovery within the perimeter of the Hayman Fire. At above right, the vast areas lacking any observed recovery are shown in black. At left, the only recovery has been in the higher percentiles of the annual distribution. This suggests that recovery has largely involved deciduous grass or shrubs rather than the evergreen ponderosa pine and Douglas fir that were dominant prior to the burn.

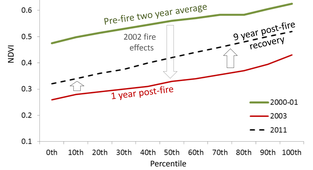
2002 RODEO FIRE, Arizona

The merging Rodeo and Chediski fires of June and July of 2002 were both human caused and they burned over 468,000 acres, mostly on the Apache Indian Reservation and the Apache-Sitgreaves National Forest. Since then, salvage logging and replanting has occurred in portions of the burn and that has likely affected the NDVI recovery in complex ways.

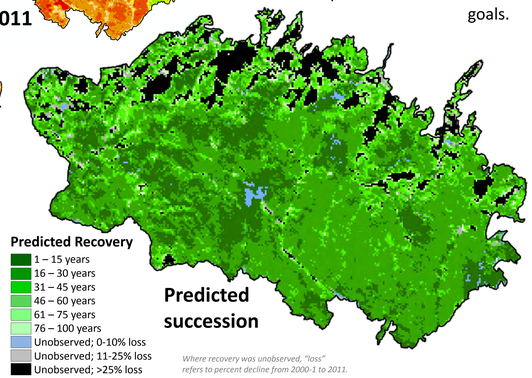


Short and long-term fire severity





NDVI recovery has been strong during the 9 years since the Rodeo Fire with notable exceptions in the northern fringe (below). Within the modest recovery area in green, the species responsible for this increase may include oaks and juniper which may be inconsistent with pine-focused restoration goals.



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