Modified Fire Regime Effects on Plant Functional Groups across the ANF in the Transverse Mountain Range, Southern California

Potential Applications for Early Detection of Ecosystem Tipping Points and Restoration Needs

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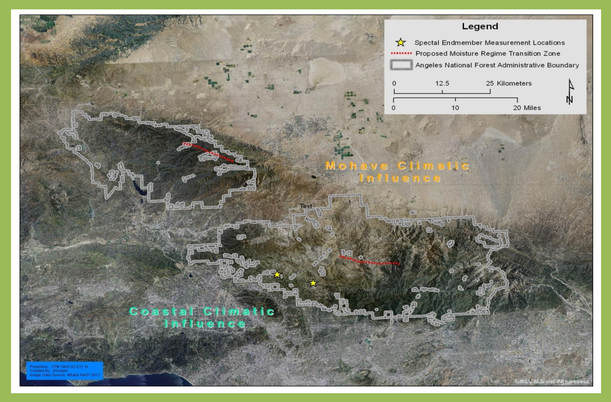
OVERVIEW

One of the primary goals and needs of the forest is to sustain, retain or enhance the native vegetation, the habitat it provides, as well as the ecological and hydrological functioning for natural and human benefits. In order to address the need to retain and enhance vegetation condition and diversity, observation and measurement of the ecosystem response to frequency and severity of disturbances enables clear direction for restoration planning. This study asks how fire residence time and combustion temperatures drive vegetation community plant strategies, and how that indicates the potential for a significant disturbance which may result in an ecosystem which is ecologically and hydrologically imbalanced. We also focus on how to leverage that potential post-disturbance condition for long-term restoration planning and immediate BAER (Burn Area Emergency Rehabilitation) needs.

We propose to leverage Aviris, MASTER, incident progression and IR heat detection as well as a system for measuring and quantifying plant functional response to fires in order to address these questions. Analysis of changes or transitions of vegetation patches through time across the landscape are suspected to provide insight into early detection of events to which we can proactively respond during the immediate BAER treatment period as well as for long-term restoration planning.



QUESTIONS

Early Detection System

Aviris data will enable the classification of plant functional groups with patch configuration and temporal transitions proposed to provide insight into an early detection System for land degradation.

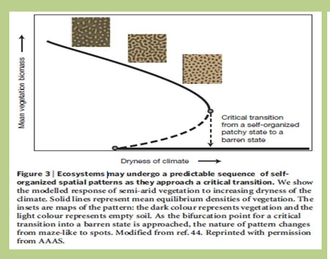
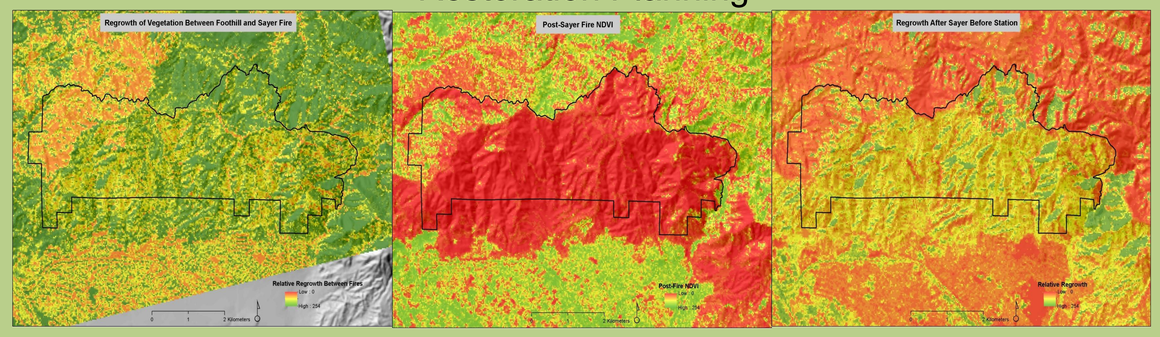


Figure 3 | Ecosystems may undergo a predictable sequence of self-organized spatial patterns as they approach a critical transition. We show the modelled response of semi-arid vegetation to increasing dryness of the climate. Solid lines represent mean equilibrium densities of vegetation. The insets are maps of the pattern: the dark colour represents vegetation and the light colour represents empty soil. As the bifurcation point for a critical transition into a barren state is approached, the nature of pattern changes from maze-like to spots. Modified from ref. 44. Reprinted with permission from AAAS.

Scheffer et al 200 (Left)
Historic Orthorectified Aerial Image (1940) and 2005 DOQQ, 2012 NAIP Imagery Illustrating Cover Reduction in time on ANF.

Restoration Planning



The above figures illustrates the response of vegetation after repeated fires within a short time interval derived from Landsat data, facing the coastal side of the ANF in the Transverse Ranges. Prior to the Sayer Fire in 2007 was the Foothill fire in 2004 (Fire Scar Far Left of Far Left image). The Far Left Image illustrates the vegetation which has grown back before the Sayer Fire occurred and after the Foothill fire. The center image illustrates the amount of photosynthetically-active vegetation remaining immediately after the Sayer Fire. In 2009 was the Station Fire , which effected a few of the watersheds of the eastern portion of the Sayer Fire area. Although the Station Fire only consumed vegetation in the far eastern portion of the watersheds, the far right image illustrates the relative regrowth of vegetation between 2007 and 2009. Deriving the areas of highest post-fire productivity and the associated plant strategies is proposed to provide insight into restoration methodologies which sustain these shrub-dominated systems.

An improvement in estimating growth and response of vegetation a by plant functional strategy group is expected when combined with the Aviris Data through time. Historic acquisitions and testing of the Aviris instrument especially in areas of repeated measurement are proposed to provide a portion of this information. Organization of Plant Functional groups based on plant strategies (Schmidtlein et al 2012, Lavorel et al 1997) is proposed to strengthen our understanding of what physiological plant traits are most desirable for restoring areas which are likely to be subjected to repeated fires and altered climate regimes in the future. The development of a crosswalk between plant strategy communities and eVeg (USFS standard vegetation mapping system) may enable the historical analysis of vegetation dynamics for southern California shrublands.

METHODS

*Field Veg Data Collection (Began 2012)

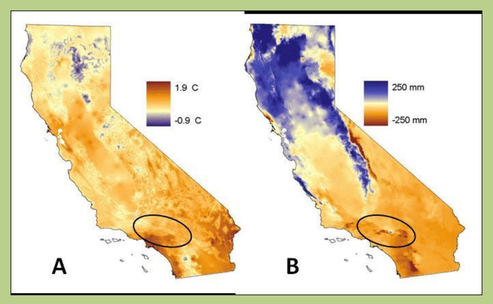
*Test difference in data collection production rate with inverse or Site Sampling Location Approach

*Determine Residence time and Combustion Temps from Master data and Ancillary Datasets.

*Determine Most Appropriate Plant Functional Group Organization for Response to Disturbance and Insight into Restoration Needs and Ecological and Hydrological Functioning.

*Compare Current and Historic Plant Functional Groups through Historic Aerial Classification

Restoration Planning for Changing Climate



Spatial representations of differences in mean annual temperature (A), and mean annual precipitation (B) between the 1930's and 2000's, as derived by the PRISM climate model. The Angeles and San Bernardino National Forests area is found within the circle. According to PRISM, temperatures have risen and precipitation decreased across most of the area. Graphic courtesy of S.Dobrowski, Univ. of Montana.

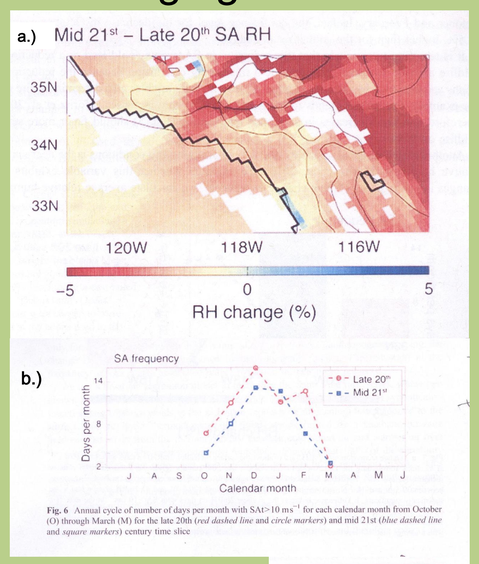
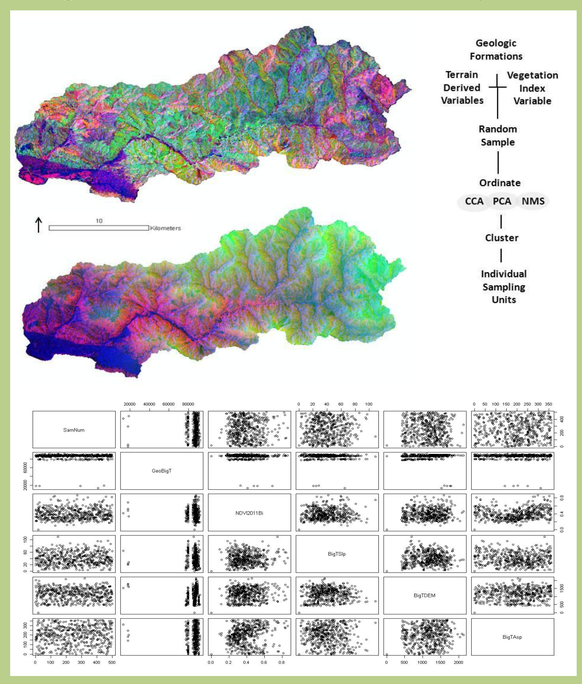


Fig. 6 Annual cycle of number of days per month with SAt>10 ms^{-1} for each calendar month from October (O) through March (M) for the late 20th (*red dashed line* and *circle markers*) and mid 21st (*blue dashed line* and *square markers*) century time slice

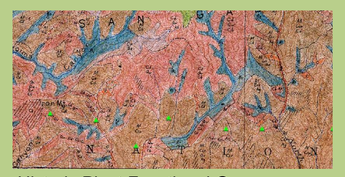
Spatial and Graphical Depiction of Santa Ana-associated RH% between 20th and 21st century indicates (a), changes in Santa Ana-associated RH and b.)Frequency and Timing across the year and (c) differences in temperature between the 20th and 21st century for Desert and Ocean lower atmosphere (Hughes et al 2011). This fine-scale weather data which integrates the effect of the unique topography are proposed to aid in the clarification fire effects due to fire residence time, wildland fire combustion temperatures, and how the frequency of wind-driven versus fuel/topography driven events effect vegetation plant strategy response. Graphics scanned directly from Hughes et al 2011.

Vegetation Response Post-Fire Analysis

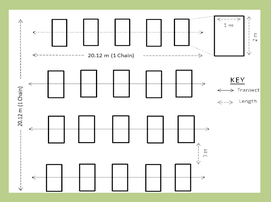


Post-Station Fire NDVI and terrain variables were evaluated to understand the association of vegetation recovery rates and terrain-related variables. This preliminary analysis suggest aspect is the primary driver for vegetation recovery across the front country of the ANF in the Transverse Ranges. Areas of the side of the ANF influenced by desert climate conditions are expected to be have similar results but have yet to be tested.

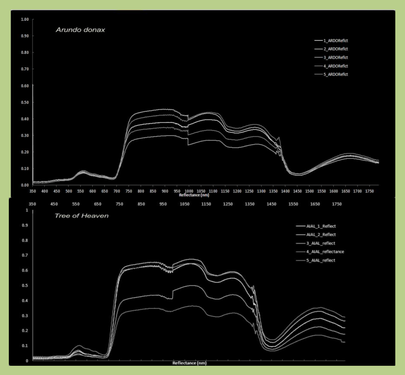
Quantifying Veg Change and Interaction for Restoration Planning



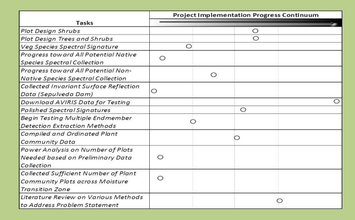
Historic Plant Functional Groups are Identified with an AerialPhoto/Wieslander VTM Map Fusion Approach (Wieslander VTM).



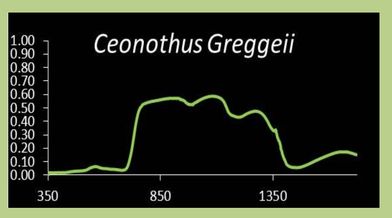
Vegetation Percent Cover
Is measured within each modified Daubenmire (1968) Quadrat Across the 20 m Representing Aviris Pixel.



Spectral Reflectance of Native and Non-Native Species have been collected to identify representative signatures at the species level. These species will be organized based on plant functional group strategy. Temporal analysis of plant functional strategy groups derived from Aviris data will enable the delineation of near-past changes, while historic aerials and Wieslander VTM maps provide long-term details in changes.



Current Project Accomplishments and Needs



Spectral Reflectance of native species and their extent/presence can enable interplant competition with natives and non-native invasive species.

REFERENCES:

Schmidtlein, S., Feilhauer, H., Bruelheide, H. 2012. Mapping Plant Strategy Types with Remote Sensing. Journal of Vegetation Science 23: 395-405.
D. Daubenmire (1959). A canopy-coverage method of vegetation analysis. Northwest Science 33:43-64.
Hughes, M., Hall, A., and Jinwon Kim (2011). Human-induced changes in wind, temperature and relative humidity during Santa Ana Events. Climate Change; S119-132.
Lavorel, S., McIntyre.S., Landsberg. J., and Forbes T.D.A. 1997. Plant functional classifications:from general groups to specific groups based on response to disturbance. Tree vol 12; 12.
Scheffer, M., Bascompte, J., Brock, W.A., Brovkin, V., Carpenter, S.R., Dakos, V., Held, H., van Nes, E.H., Rietkerk, M., and Sugihara, G. 2009. Early-warning signals for critical transitions. Nature; Vol 461.
Schmidtlein, S., Feilhauer, H., Bruelheide, H. 2012. Mapping Plant Strategy Types with Remote Sensing. Journal of Vegetation Science 23: 395-405.
Wieslander VTM Maps; Images from the Wieslander Vegetation Type Mapping Collection are courtesy of the Marian Koshland Bioscience and Natural Resources Lirbary, University of California, Berkeley. www.lib.berkley.edu/BIOS/vtm.