**Santa Monica Mountains Ecological Forecasting III**

*Analyzing Recent Wildfire Impacts to Assist the Resource Conservation District of the Santa Monica Mountains in Identifying Tree Species to Replant*

**VPS Title:** Searching for Suitability: Saving the Oak Savanna

**Project Team**

***Project Team:***

Melissa Ferriter (Project Lead)

Laura Jessup

Roger Ly

Joshua Spector

***Advisors & Mentors:***

Natasha Stavros (NASA Jet Propulsion Laboratory, California Institute of Technology)

Latha Baskaran (NASA Jet Propulsion Laboratory, California Institute of Technology)

***Past or Other Contributors:***

Natalie Queally

Kelsey Foster

Emil Chang

Ariana Nickmeyer

Nick Rousseau

**Project Overview**

***Project Synopsis:*** The Santa Monica Mountains make up an ecologically complex region that has been designated as one of the 25 global biodiversity hotspots. In recent years, the native oak and riparian woodlands of the area have experienced extensive dieback due to a combination of prolonged drought, increasing wildfire severity, and invasive species and pests. To equip our project partners with the tools to monitor and preempt these issues, this project identified locations where woodlands will persist under future climate conditions and built upon past work that mapped existing conditions, burn severity, and climate variables.

***Abstract:***

The Woolsey Fire began on November 8, 2018, and lasted for almost two weeks, during which it burned almost 100,000 acres of valuable landscape and habitat, including a vast area of woodland. The persistence of key woodland species provides aesthetic, monetary, and ecological value to the landscape through carbon sequestration, air temperature moderation, and erosion mitigation, among other ecosystem services. This study investigated the impact of the Woolsey Fire on native woodland species distributions and identified areas suitable for restoration within the Santa Monica Mountains National Recreation Area. The team partnered with the Resource Conservation District of the Santa Monica Mountains; National Park Service, Santa Monica Mountains National Recreation Area; California Department of Parks and Recreation, Los Angeles County Division; County of Los Angeles Fire Department, Prevention Services Bureau, Forestry Division; County of Los Angeles Department of Regional Planning; and the University of Montana. The Earth observations used include data from Landsat 8 Operational Land Imager, NASA ER-2 Jet Airborne Visible InfraRed Imaging Spectrometer, Shuttle Radar Topography Mission, and RapidEye. The team produced maps of burn severity from the Woolsey Fire, its impact on plant species distributions, and habitat suitability projections for 2050 and 2099 to assist partners in prioritizing areas for restoration. A plant community classification was successfully created using Multiple Endmember Spectral Mixture Analysis (MESMA). Overall accuracy was assessed at 90.54% by comparing the classification to validation pixels derived from ground truth information provided by our partners.

***Keywords:***

remote sensing, MESMA, fire, climate scenarios, habitat suitability, MaxEnt

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Santa Monica Mountains, CA

***Study Period:*** June 2017 to June 2019, Forecasting to 2099

***Community Concerns:***

* The loss of keystone species, such as oaks (*Quercus* spp.), pose aesthetic, monetary, and ecological threats to the dynamic landscape of the Santa Monica Mountains (SMM).
* Due to their proximity to Los Angeles and the changing climate, SMM plant communities are threatened by habitat loss and fragmentation and increased fire frequency.
* Although the community types in the SMM are adapted to the local fire regime, coastal sage scrub and chaparral are sensitive to frequent fires.
* Approximately 1,000 Native American archaeological sites and large recreation areas are at risk of degradation.

***Project Objectives:***

* Update 2017 maps of burn severity index and tree species distributions
* Generate a map of climate variables, including surface temperature and precipitation, for 2018 using data from NASA Earth Exchange (NEX) Downscaled Climate Projections (NEX-DCP30)
* Create a map of climate variables in 2050 and 2099 based on Representative Concentration Pathways (RCPs) 4.5 and 8.5
* Use maximum entropy (MaxEnt) modeling to determine habitat suitability of woodland species in 2050
* Create a map of predicted woodland planting suitability based on the output from MaxEnt modeling

***Previous Terms:*** 2017 Spring (JPL) – Santa Monica Mountains Climate, 2017 Fall (JPL) – Santa Monica Mountains Ecological Forecasting II

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Resource Conservation District**  **of the Santa Monica Mountains** | Rosi Dagit, Senior Conservation  Biologist | End User | Yes |
| **National Park Service, Santa**  **Monica Mountains National**  **Recreation Area** | Joseph Algiers, Restoration  Ecologist; Marti Witter, Fire Ecologist | End User | No |
| **California Department of Parks**  **and Recreation, Los Angeles**  **Division** | Danielle LeFer, Ecologist | End User | No |
| **County of Los Angeles Fire**  **Department, Prevention** **Services Bureau, Forestry** **Division** | Jay Lopez, Assistant Chief | Collaborator | No |
| **County of Los Angeles**  **Department of Regional**  **Planning** | Joseph Decruyenaere, Senior  Biologist | Collaborator | No |
| **University of Montana, Department of Geography** | Zachary Holden, Ecologist | Collaborator | No |

***Decision-Making Practices & Policies:***

The Resource Conservation District of the Santa Monica Mountains (RCDSMM) has been coordinating with the end users and collaborators on this project to create a Mitigation and Future Forest Priority Map that prioritizes areas of concern and focuses resources on monitoring and restoration. The partners concentrate restoration efforts on replanting trees to replace lost stands and ensure the persistence of mixed-age stands. Pest infestation is also monitored using a citizen science platform that relies on beetle trap data. Currently, partners rely on *in situ* monitoring and written reports from local property owners and arborists to support efforts to restore native species, track pest infestation, and monitor drought and fire impacts.

***Project Benefit to End User:***

The RCDSMM has a long history of leadership in establishing collaborative efforts to address resource management issues on regional and local scales. Developing the proposed end products will provide direction to the partners on four key issues. First, the end products will help them visualize where trees survived both drought and wildfire. Second, the end products will help them prioritize areas of concern to focus scarce resources for monitoring and restoration. Third, the end products will facilitate more targeted education and outreach. Finally, the end products will assist managers in identifying the highest priority areas where forests could persist into the future

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **NASA ER-2 Jet**  **AVIRIS** | Spectral vegetation  indices | Airborne Visible / Infrared Imaging Spectrometer (AVIRIS) data were used to map and detect shrub and woodland vegetation based on the spectral reflectance of each species. The data were also used to investigate changes post-fire. |
| **Landsat 8 OLI** | Burn severity | Landsat 8 Operational Land Imager (OLI) data were used to calculate Relativized Burn Ratio (RBR), which identifies and quantifies burn severity, to understand tree mortality. |
| **SRTM** | Slope, aspect | A digital elevation model created from this dataset was used to assess the role of slope and aspect in vegetation survival. |
| **RapidEye** | Vegetation status | RapidEye data were used to calculate the Normalized Difference Red Edge Index (NDRE) in order to quantify vegetation status and identify surviving vegetation. |

***Ancillary Datasets:***

* Resource Conservation District of the Santa Monica Mountains Oak Study *in situ* data – 41 study plots used for ground truth data for vegetation burn maps
* National Park Service Santa Monica Mountains National Recreation Area Inventory and Monitoring Plots data – Used for accuracy assessment
* NASA Earth Exchange (NEX) Downscaled Climate Projections (NEX-DCP30) – These climate data were used in MaxEnt to generate the Predicted Suitable Woodland Planting Sites Map

***Modeling:***

* Maximum entropy (MaxEnt) (POC: Steven J. Phillips, AT&T Research) – Used to generate a map of predicted suitable woodland planting sites

***Software & Scripting:***

* Esri ArcGIS Pro – Raster manipulation and analysis, image enhancement, and map creation
* QGIS – Raster manipulation
* Harris Corporation ENVI – Analysis of vegetation
* University of California Santa Barbara (UCSB) Viper Tools – Multiple endmember spectral mixture analysis (MESMA)
* R Core Team (2019) R 3.6.1 – NetCDF data manipulation and processing

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Updated 2017 Tree Species and Burn Severity Maps** | NASA ER-2 Jet AVIRIS  Landsat 8 OLI | This product provides partners with an updated 15 m high-resolution map of the tree and vegetation species in the Santa Monica Mountains before the Woolsey Fire event. The overlaid Burn Severity Maps show the remaining distribution patterns of vegetation after the fire and will provide guidance on where restoration and management are needed. | I |
| **2018 Map of Annual Climate Variables** | N/A | This product will be used by partners to identify areas that could support newly planted woodlands in 2050 based on current precipitation and temperature patterns. | I |
| **Existing Conditions Map** | NASA ER-2 Jet AVIRIS  SRTM  RapidEye | The map helps illustrate where oak and riparian woodlands survived both the drought and wildfires. It will be used by partners to prioritize risk areas, examine the rate of mortality and potential causal factors, focus monitoring efforts, and provide guidance on where restoration is possible and management is needed. | N/A |
| **Predicted Suitable**  **Woodlands Planting**  **Sites Map** | NASA ER-2 Jet AVIRIS | End users will integrate this map with their own conceptual framework for future forest retention and restoration that is concurrently under development. | N/A |

**Project Handoff Package**

***Transition Plan:*** The decision support tools and deliverables provided by this study were shared not only with the main project partners but also disseminated to all interested stakeholders within the Santa Monica Mountains. Final data and maps were handed off by email or in person, and team members presented their final presentation to the partners in person during the last week of the term.

***Team POC:*** Melissa Ferriter, ferriter.melissa@gmail.com

***Partner POC:*** Rosi Dagit, rosidagit@gmail.com

***Handoff Package:***

* Updated 2017 Tree Species and Burn Severity Maps
* 2018 Map of Annual Climate Variables
* Existing Conditions Map
* Predicted Suitable Woodlands Planting Sites Map
* Poster
* Presentation
* Project Video
* Technical Paper
* Study Area Shapefiles

**References**

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