**NASA DEVELOP National Program**

**2020 Summer Project Proposal**

**Colorado – Fort Collins**

**Fisher’s Peak Ecological Forecasting**

*Mapping Vegetation Communities to Inform Conservation Planning of a Future State Park*

**Project Overview**

***Project Synopsis*:** Planning is underway for Colorado’s newest state park at Fisher’s Peak; the park will be the second largest state park in Colorado. A diverse group of collaborators, including Colorado Parks and Wildlife and The Nature Conservancy, are working closely to design the state park to maximize recreation opportunity while also protecting the important conservation values the property holds. The objective of this project is to develop a locally-tailored land cover map of Fisher’s Peak Ranch using partner field data and remote sensing imagery (e.g. Landsat, NAIP, Sentinel, airborne LiDAR, SRTM, GEDI) along with advanced supervised classification algorithms to provide a detailed and reliable product. The team will then use the product to forecast potential development and conservation priority areas. This map can be overlaid with planned recreation to predict which forest communities are being impacted most and to adjust plans to minimize impacts on sensitive vegetation and wildlife.

***Community Concern:*** Fisher’s Peak Ranch is located just outside Trinidad, CO, and Colorado governor Jared Polis has said “this is going to be one of the crown gems of our state parks system - an iconic landmark in Southern Colorado.” This site is expected to provide world-class multiuse recreation, drawing tourists from around the larger region and serving as an economic anchor for the city of Trinidad. Historically, this site has been privately owned with very little anthropogenic disturbance. As such, the property contains extraordinary natural resources that need to be inventoried and assessed in the development of the property for multi-use recreation.

***Source of Project Idea:*** This project idea came from conversations with Chris Pague from The Nature Conservancy regarding the urgency to assess the Fisher’s Peak Ranch ahead of the property transition to a Colorado state park. The timeline of the project and the limited technical expertise with those involved provided an opportunity for a NASA DEVELOP project to address this critical need.

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

***Study Location:*** Fisher’s Peak Ranch, CO (formally Crazy French Ranch and soon to be Fisher’s State Park)

***Study Period:*** January 2019 – May 2020, Forecasting to 2021

***Advisors:*** Dr. Paul Evangelista (Colorado State University), Dr. Catherine Jarnevich (USGS), Tony Vorster (Colorado State University), Nick Young (Colorado State University)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **The Nature Conservancy, Colorado Chapter** | Chris Pague, Senior Ecologist  | End User | Yes |
| **Colorado State Forest Service** | Dr. Amanda Fordham, Science Information Manager | Collaborator | Yes |

***End User Overview***

***End User’s Current Decision-Making Process:***The Nature Conservancy (TNC) is a world-renowned and respected organization whose primary focus is to conserve the lands and waters on which all life depends. This is accomplished in multiple ways including purchasing high conservation-value land and providing conservation easements on other landowner properties. TNC will have direct influence on the plan and ultimate development of Fisher’s Peak Ranch. TNC’s primary objective is to conduct the most comprehensive inventory of the natural resources that exist on the property so that they can be considered in the planning and development of the property. However, they have limited remote sensing capabilities for this project and currently rely on field surveys.

***End User’s Capacity to Use NASA Earth Observations:***

*The Nature Conservancy, Colorado Chapter* – The Nature Conservancy is a global company with wide-ranging expertise, including remote sensing. However, TNC partners engaging in this specific project do not have any remote sensing expertise. The partners are familiar with the general concepts and products of remote sensing, but they do not have the capacity to conduct any technical analysis using remote sensing imagery themselves. This project will enhance their understanding of the range of products that can be used, the characteristics of those products, and some of the methods that can be applied to these data to create decision-making products.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Colorado State Forest Service* – The Colorado State Forest Service will provide forest plot data and expertise of the area.

***Dissemination by Boundary Organizations*:**

*The Nature Conservancy, Colorado Chapter* – The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. To accomplish this, they collaborate on projects with many partners, such as individual stakeholders, governments, and local nonprofits. Many of the projects they support have similar goals to the one proposed here, and the methodologies and results from this project may be shared.

*Colorado State Forest Service* – The Colorado State Forest Service provides technical forestry assistance, wildfire mitigation expertise, outreach, and education. The project proposed here aligns with other projects they conduct throughout Colorado, and the methodologies and results produced throughout the term may be shared with other partnerships or through their outreach and education initiatives.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with partners multiple times throughout the term via teleconference meetings. Email check-ins between meetings will be utilized as questions and updates arise. The DEVELOP Lead/Fellow and Project Lead will be the primary points of contact with the partner organizations.

***Transition Plan*:**  At the end of the term, the team will host a virtual seminar to disseminate project results to the partners. A handoff package will be sent to the end users via email following the seminar. As part of the handoff package, the end user will receive a vegetation community map and predictions of the impacts of planned state park development on vegetation. There is no software release required for this project.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Spectral vegetation indices, tasseled capped indices, bands | Landsat 8 will be used to distinguish different vegetation communities in Fisher’s Peak Ranch. |
| **Sentinel-2 MSI** | Spectral vegetation indices, tasseled capped indices, bands | Sentinel-2 will be used to distinguish different vegetation communicates in Fisher’s Peak Ranch and will be compared to Landsat 8. |
| **ISS GEDI** | Canopy height and profile metrics | GEDI will be used to distinguish different vegetation communities in Fisher’s Peak Ranch. |
| **SRTM** | Elevation, topographic position index, slope, aspect | SRTM will be used to derive topographic indices to help distinguish vegetation communities. |

***Ancillary Datasets:***

* The Nature Conservancy, rapid natural resource inventory dataset – This dataset will be used to validate the vegetation community map.
* Colorado State Forest Service, forest prism plots – These plots will be used for training and validating models.
* National Agriculture Imagery Program (NAIP), High resolution imagery – NAIP will be used to evaluate the vegetation communities and potentially derive training data for the supervised classification.
* Colorado State Forest Service Aerial Lidar – This dataset will be used to help distinguish vegetation communities via canopy height.

***Modeling:***

* Random Forests (POC: Nicholas Young, Natural Resource Ecology Laboratory – This algorithm will be used to run a classification model of the vegetation communities of Fisher’s Peak Ranch and evaluate future impacts on sensitive vegetation.
* Boosted Regression Tree (BRT) (POC: Nicholas Young, Natural Resource Ecology Laboratory) – This modeling technique will be used to run a classification model of the vegetation communities of Fisher’s Peak Ranch.

***Software & Scripting:***

* R Statistical Software – This software will be used to organize and filter data and run Random Forest classification and Boosted Regression Trees modeling.
* Google Earth Engine – This platform will be used to view, filter, derive and export Landsat 8 OLI, Sentinel-2 MSI, SRTM, and NAIP imagery.
* ESRI ArcGIS – This software will be used to visualize model results and create map products

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Vegetation Community Map** | This product will provide a spatial inventory of the vegetation communities that exist on Fisher’s Peak Ranch. This map can be overlaid with planned recreation to predict which forest communities are being impacted most and to adjust plans to minimize impacts on sensitive vegetation and wildlife. | Landsat 8 OLI, Sentinel-2 MSI, and GEDI imagery will be used with topographic and structural information from SRTM, lidar, and ocular sampling of NAIP images. A random forest model will be used to distinguish and map different vegetation communities.  | N/A |
| **Forecast of Impacts of Planned State Park Development for Vegetation** | These predictions will help in the planning and development of Fisher’s Peak Ranch, supporting a quantitative and informed prioritization of potential planned development scenarios. | Vegetation community maps generated from spectral indices and Lidar will be used to identify future scenarios of recreation management and evaluate their potential impact. | N/A |

***End User Benefit*:** Our end-products will allow our partners to make informed planning decisions as they transition Fisher’s Peak Ranch into a new state park. A reliable map of the vegetation communities on the property, not currently available, will provide a critical baseline to support planning, management and long-term monitoring of this unique area.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Summer 2020

***Related DEVELOP Work:***

2019 Fall (CO) – Medicine Bow Disasters: Utilizing Remote Sensing to Evaluate Herbicide Treatment Efficacy on Invasive Cheatgrass in Medicine Bow National Forest, Wyoming

2017 Spring (GSFC) – New York Ecological Forecasting: Utilizing NASA Earth Observations to Map Eastern Hemlock for Hemlock Woolly Adelgid Management in Adirondack Park and Tug Hill

**References:**

Bente Eegholm, Shane Wake, Zachary Denny, Pete Dogoda, Demetrios Poulios, Barry Coyle, Pete Mulé, John Hagopian, Patrick Thompson, Luis Ramos-Izquierdo, Bryan Blair. (30 August 2019) "Global Ecosystem Dynamics Investigation (GEDI) instrument alignment and test," Proc. SPIE 11103, *Optical Modeling and System Alignment*, 1110308; doi: 10.1117/12.2532471