**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Colorado – Fort Collins**

**Utah & Colorado Water Resources**

*Design a Landsat-based Modeling User Interface to Assess Changing Hydrology, Sediment Features, and Riparian Vegetation to Support NPS Management Strategies for Rivers within National Parks*

**Project Overview**

***Project Synopsis*:** This project will use Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-2 MSI, and the Shuttle Radar Topography Mission (SRTM) to provide partners at the National Park Service (NPS) with maps of hydrology, sediment features, and riparian vegetation, through an interactive Google Earth Engine user interface tool. This tool will allow hydrologists and land managers in the NPS to more effectively map and monitor changing in fluvial geomorphology. Providing this interactive tool will allow the NPS to more effectively manage the Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*Gila elegans*), which are endangered fish species in the Upper Colorado River Endangered Fish Recovery Program.

***Community Concern:*** The Upper Colorado River Endangered Fish Recovery Program was established in 1988 to facilitate the recovery of four of endangered fish species. This program is a unique partnership of local, state, and federal agencies, water and power interests, as well as environmental groups working to recover endangered species in accordance with federal and state laws. This program, in which the NPS is a partner, focuses on nonnative fish management, habitat restoration, and instream flow identification and protection as a means to monitor and facilitate the recovery of these endangered species. Currently, the Recovery Program does not effectively monitor the effects of flows designed to benefit endangered fish and their habitats on the in-channel riparian or sediment features. NPS monitors changes in riparian vegetation at specific sites within NPS managed lands, but the methodology used is time-consuming, expensive, and does not effectively utilize NASA Earth observations for a broader reach-wide evaluation.

***Source of Project Idea:*** NPS Fishery Biologist Melissa Trammell was introduced to the NASA DEVELOP Program through another colleague, NPS ecologist David Thoma, who had worked with the DEVELOP program in the past. Recognizing that the geospatial capacity necessary to efficiently complete a portion of one of her current NPS projects was not currently available, Melissa Trammell approached the DEVELOP program to learn more about the application of NASA Earth observations and to discuss project feasibility.

***National Application Area Addressed:*** Water Resources

***Study Location:*** UT & CO

***Study Period:*** 1984 - 2017

***Advisors:*** Dr. Paul Evangelista (Natural Resource Ecology Laboratory), Nicholas Young (Natural Resource Ecology Laboratory), Tony Vorster (Natural Resource Ecology Laboratory), and Brian Woodward (Natural Resource Ecology Laboratory)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service, Water Resources Division** | Melissa Trammell, Fisheries Biologist  Mark Wondzell, Hydrologist | End User | No |
| **National Park Service, Inventory & Monitoring Division, Northern Colorado Plateau Network** | Dusty Perkins, Program Manager | End User | No |
| **Upper Colorado River Basin Endangered Fish Recovery Program** | Don Anderson, Instream Flow Coordinator | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:*** The Upper Colorado River Endangered Fish Recovery Program partners develop and revise controlled flow releases from dams designed to benefit endangered fish and their habitats. However, data on the effects of said flows on fish habitats has been limited. To effectively manage the focal endangered fish species and the habitats that sustain them, up-to-date monitoring of channel forms, sediment features, and riparian vegetation is necessary. Knowledge of the sediment and riparian vegetation conditions associated with dam releases downstream of Flaming Gorge Dam and within the National Park Service (Dinosaur National Monument and Canyonlands National Park) will provide the NPS and Recovery Program managers, ecologists, fish biologists, and geomorphologists with crucial insights to be used to monitor changes of these features in the short- and long-term. This will allow informed decisions on current and future proposed changes to the flow recommendations.

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

*National Park Service, Water Resources Division –* This division of the National Park Service works to conserve, protect and restore water resources in America's national parks. The WRD is tasked with providing guidance, assistance, and technical expertise towards aquatic ecosystem stewardship within national parks, so that current and future generations can experience healthy aquatic ecosystems. Our specific point of contact does not have experience using NASA Earth observations in their research. This project will build capacity for both our specific point of contact as well as the NPS organization as a whole by showcasing the use and application of NASA Earth observations across disciplines.

*National Park Service, Inventory & Monitoring Division, Northern Colorado Plateau Network* – The Inventory & Monitoring division works with more than 280 parks grouped into 32 distinct networks. This division strives to inventory the natural resources under National Park Service stewardship to determine their nature and status. The goal of this division is to monitor park ecosystems to increase collaboration among parks, information sharing, and economies of scale in natural resource inventory and monitoring. Our specific point of contact with I&M has limited experience using NASA Earth observations in their research.

*Upper Colorado River Basin Endangered Fish Recovery Program -* The Recovery Program is a partnership of various agencies, water and power interests, and environmental groups working to recover endangered fish in the Upper Colorado River Basin. The program works to restore and manage stream flows and habitat, boosting populations of endangered fish. The goal of recovery is to achieve natural, self-sustaining populations of the endangered fish so they no longer require protection under the federal Endangered Species Act. Our specific point of contact with the Recovery Program has limited experience using NASA Earth observations in their research.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with partners at NPS and the Recovery Program on a biweekly basis. Since the partners are based in the Intermountain Region, both in-person and telecommunication conference meetings will be scheduled. The Center Lead and Project Lead will be the primary points of contact with both partner organizations.

***Transition Plan*:** At the end of the term, the team will host a seminar to disseminate project results and hand off decision support tools. A short training workshop on the use of the data and tutorial will follow the seminar.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m2) resolution needed for mapping hydrology regimes and spectral indices of riparian vegetation. |
| **Landsat 7 ETM+** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m2) resolution needed for mapping hydrology regimes and spectral indices of riparian vegetation. Landsat 7 imagery will be used as an ancillary dataset to Landsat 5 when cloud free imagery is not available. |
| **Landsat 8 OLI** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m2) resolution needed for mapping hydrology regimes and spectral indices of riparian vegetation. |
| **Sentinel-2 MSI** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal and spatial (10, 20, and 60 m2) resolution needed for mapping hydrology regimes and spectral indices of riparian vegetation. |
| **SRTM** | Elevation, slope, aspect, and compound topographic index | This dataset will be used to derive topographic indices to be used as predictors that could represent important characteristics of hydrologic networks. |

***Ancillary Datasets:***

North American Land Data Assimilation System (NLDAS-2) – Environmental predictor variables data: mosaic precipitation, soils, surface water

USGS National Elevation Dataset (NED) – Digital elevation model

NPS Field datasets – Vegetation presence data sets

USGS Field datasets – Watershed Boundary Dataset (WBD), National Hydrography Dataset (NHDPlus), Height Above Nearest Drainage (HAND)

***Modeling:***

Random Forests (POC: Dr. Catherine Jarnevich, USGS Fort Collins Science Center)

Support Vector Machines (POC: Dr. Catherine Jarnevich, USGS Fort Collins Science Center)

***Software & Scripting:***

Esri ArcGIS – Image processing, end product generation

ENVI/IDL – Image calibration, LandTrendr coding

R – Statistical analyses, raster processing

Google Earth Engine API – Large scale image analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Hydrology, Sediment Features, and Riparian Vegetation Map** | This product will help our partner pinpoint predicted areas of available hydrological and riparian vegetation changes. | This product will integrate data from Landsat, SRTM, Sentinel-2, and partner collected field data to determine hydrological and riparian vegetation changes in the region. | N/A |
| **Hydrology, Sediment Features, and Riparian Vegetation Google Earth Engine User Interface** | This product will allow the partner to utilize an interactive Google Earth Engine user interface which will allow hydrologists and land managers in the NPS to actively map and monitor hydrological and riparian vegetation changes in the region. | This product will be an interactive Google Earth Engine user interface designed to allow managers to evaluate and monitor hydrological and riparian vegetation changes in the region. | III |
| **Modeling and Interface Tutorial** | Enable end users to replicate this study in future years and for additional study locations. | The tutorial will cover data processing, fitting statistical models to the data, and interpretation of model output along with utilizing the Google Earth Engine designed interface. | N/A |

***End-User Benefit*:** This project will save the NPS and the Recovery Program time and money by further refining monitoring and field survey efforts. The project will enable analysis across larger scales and new study sites that would not be possible without full utilization of NASA Earth observations. End products will be integrated in the NPS and Recovery Program decision making and management processes to more effectively facilitate hydrology management and endangered species conservation within the region.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 terms: 2018 Summer to 2018 Fall

* **Term 1(Proposed Term):** 2018 Summer (CO) – Dinosaur National Monument and Canyonlands National Park Water Resources
  + The summer term will focus on a single National Park within UT or CO. The first term will develop the methodology necessary to accomplish the goal of creating an interactive Google Earth Engine user interface tool which can be employed by hydrologists and land managers in the NPS to effectively map and monitor changing river conditions.
* **Term 2**: 2018 Fall (CO) – Dinosaur National Monument and Canyonlands National Park Water Resources II
  + The fall term will expand upon and ultimately refine the methodologies outlined in the first term. The scope of the project will be broadened to include more National Park units in UT and CO. Lastly, the DEVELOP team will generating an interactive Google Earth Engine user interface tool and shepherd it through the software release process.

***Related DEVELOP Work:***

2017 Fall (ARC) – Lassen Volcanic National Park Disasters II: Evaluating Fuel Loading at a Landscape Scale in High Elevation Alpine Forests of Lassen Volcanic National Park

2017 Fall (CO) – Colorado River Basin Water Resources II: Utilizing NASA Earth Observations to Evaluate the Distribution of Russian Olive and its Impact on Evapotranspiration in the Upper Colorado River Basin

2017 Summer (CO) – Colorado River Basin Water Resources: Utilizing NASA Earth Observations to Evaluate Invasive Species Cover in Riparian Areas of the Colorado River Basin

2017 Spring (CO) – Arizona Water Resources: Utilizing NASA Earth Observations to Delineate Riparian Corridors and Evaluate Invasive Species Cover in the Verde River Watershed

2016 Fall (LaRC) – Western United States Water II: Assessing Landscape Vulnerability to Drought and a Changing Climate in National Parks of the Western United States

2016 Summer (LaRC) –Western US Water LaRC Summer 2016: Utilizing NASA Earth Observations to Analyze Vegetation Productivity Shifts Relative to Climate Change and Drought in Capitol Reef National Park

2014 Spring (CO) – Colorado Water Resources: Utilizing Landsat 8 and MODIS for Mapping Extent, River Stage, and Impacts of the 2013 Colorado Floods