**NASA DEVELOP National Program**

**Summer 2016 Project Proposal**

**BLM at Idaho State University GIS Training and Research Center**

**Eastern Idaho Disasters**

Utilizing NASA Earth Observations to Identifying Critical Wildlife Habitat Areas Threatened by Heightened Wildfire Susceptibility for Improved Conservation and Management Practices

**Project Overview**

***Objective:*** Identify critical wildlife habitat with increased wildfire susceptibility due to increases in cheatgrass and western juniper extent.

***Community Concern:*** Wildfires can be disastrous for declining, threatened, or endangered wildlife species. Fires have grown in size and frequency throughout the Great Basin and Intermountain West due to cheatgrass, an invasive annual grass, and the expansion of juniper. These plants have altered fire regimes and threatened the habitat of wildlife species such as the Greater Sage Grouse and Mule Deer. It is imperative that our end-users have actionable information identifying habitat areas that are most susceptible to wildfire so they can proactively target areas for fuel load reduction intervention to help these species survive.

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

***Study Location:*** Eastern Idaho

***Study Period:*** January 2014 to January 2016

***Advisors:*** Keith Weber (ISU GIS TReC), John Schnase (NASA GSFC), Mark Carroll (NASA GSFC)

***Source of Project Idea:*** After meetings with members of the BLM, Idaho Fish and Game, and Caribou-Targhee National Forest (USFS), a need was described to identify wildlife habitat areas that are threatened by wildfire. This is, in essence, a geospatial question best addressed with satellite remote sensing and GIS.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Bureau of Land Management (BLM) | Mike Kuyper, Natural Resource Specialist | End-User | No |
| National Park Service (NPS), Craters of the Moon National Monument and Preserve | Jim Bromberg, Vegetation Ecologist and Todd Stefanic, Wildlife Biologist | End-User | No |
| Idaho Department of Fish and Game | Scott Bergen, Senior Wildlife Research Biologist | End-User | No |
| USDA Forest Service, Caribou-Targhee National Forest | Chris Colt, Wildlife Biologist | End-User | No |

***End-User Overview***

***End-User’s Current Decision Making Process:***

Bureau of Land Management – The BLM works with other agencies like the U.S. Forest Service to

identify and protect areas that threaten the Greater Sage-Grouse and other sagebrush

dependent species. A large part of their decision making relies on field studies where they

gather geospatial data using transects, GPS, and on-screen digitizing. These data are used in

planning for conservation efforts as well as future land management practices.

Idaho Department of Fish and Game (IDFG) – IDFG is in the process of assessing seasonal ranges of ungulate and Greater Sage Grouse using GPS/PTT location technologies (i.e. GPS collars). Once deployed, these devices track an individual’s space use through time and monitor survival. In general these location data are compiled and used within a “resource selection function” modeling framework that incorporates prominent landscape features, vegetation, as well as multi-temporal satellite imagery (MODIS primarily) for the purpose of assessing annual and seasonal ranges as well as connectivity corridors between seasonal ranges when and where they occur. In the past, when a fire has occurred in the winter range, for example, IDFG has used Landsat OLI satellite imagery to assess the extent and severity of the fire, via dBNR, and then tracked vegetation re-growth in the area using NDVI and MODIS to determine if that area will be suitable for winter range across a suite of ungulate species. IDFG is currently utilizing these techniques statewide. The addition of habitat suitability modeling from other Earth observations will strengthen this agencies efforts in managing vegetation and habitats that have been affected by wildfires prior to the winter season.

Caribou-Targhee National Forest – Caribou-Targhee makes decisions based on quantifiable objectives that address three different geographic levels: Forest-wide, Ecological Subsection, and Prescription Area. Utilizing NASA Earth observations will introduce new ways to improve the decision making capabilities of this agency on these larger geographic levels. The United States Forest Service currently uses landscape dynamic simulation models for planning. These models like SIMPPLLE, LANDIS, and Spectrum help the Caribou-Targhee national forest analyze wildlife habitat, vegetation cover, and invasive or noxious plant species.

NPS Craters of the Moon National Monument and Preserve - Craters currently uses ArcGIS with habitat layers from various sources (NPS, IDFG, and BLM) in combination with staff knowledge. Frustration is encountered as many of the available GIS layers stop at the lava edge under the assumption that the ancient surface lava flows are devoid of wildlife habitat. In reality, numerous islands (kipukas) of wildlife habitat exist throughout the lava flows and need to be incorporated into broader habitat management considerations. Similarly, while Craters experiences up to five wildfires annually, wildfire susceptibility layers typically do not consider this area as burnable under the assumption that lava does not burn. This assumption overlooks the kipukas on Craters NPS lands. Leveraging NASA Earth observations will help these users understand changes in the habitats and vegetation that exist in these kipukas.

***End-User’s NASA Earth Observations Capacity:***

Bureau of Land Management – The GIS TReC at Idaho State University has worked in close collaboration with the BLM since 1999 on a variety of rangeland research projects that use NASA EO, with many focusing on the effect of wildfire on rangeland health. Since the beginning of DEVELOP’s Idaho Disasters project in the fall term of 2014, relationships and understanding of how useful remotely sensed data has continued to grow.

Idaho Department of Fish and Game – IDFG is currently using various types of raster based

imagery, models, and geolocation data to assess various ungulate and bird species (Greater

Sage Grouse) at local, regional, and statewide efforts. Typically, regional managers use ArcGIS

and Google Earth, on a daily basis. This project will leverage NASA Earth observations to help

improve the wildlife research divisions capacity to use more complex remote sensing techniques

(Imagine, ENVI, IDRISI, IDL) as well as improve their more novel techniques that are able to

incorporate open-source statistical platforms (R-stats, Q-GIS).

Caribou-Targhee National Forest – Remotely sensed imagery is used to help identify different

plant species and improve allocation of resources. The Burned Area Emergency Response

(BAER) uses satellite imagery to provide rapid delivery of information. Combining all of the

different types of data into a GIS that will aid in monitoring remote areas and threated habitats

will further the use and understanding of NASA Earth observations.

NPS Craters of the Moon National Monument and Preserve – Currently, Craters of the Moon relies heavily on field research when it comes to identifying different invasive weeds such as

cheatgrass. Current budgets don’t allow for comprehensive monitoring of remote areas as the kipukas require long distance foot travel over difficult terrain.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

***RECOVER: Please include information here***

***Boundary Organization Dissemination:***

RECOVER Science Team – This is a fire-specific decision support system that automatically brings together in a single analysis environment all the information necessary for post-fire rehabilitation decision-making. In response to a fire detection event RECOVER uses its rapid resource allocation capabilities to automatically prepare Earth observation data, derived decision products, and historic biophysical data so that when the fire is contained, Emergency Stabilization and Rehabilitation (ES&R) and Burned Area Emergency Response (BAER) teams will have a complete and ready-to-use browser-based RECOVER dataset and GIS analysis environment that is customized for the target wildfire.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

Communication between DEVELOPers and project partners will occur roughly every three weeks via teleconference or in person meetings. Lines of communication will remain open if questions arise but these meetings will primarily involve project updates and high level results. The center lead will be responsible for setting up the first project/participant in-person meeting within the first two weeks of the term, and then the project lead will take over.

***Transition Approach:***

Our end-users will have access to the data via the ISU GIS TReC Spatial data library. A link will be provided to them along with the final draft of the technical paper and VPS. Final images and maps will be handed off during closeout and an e-mail containing the same data will be sent so they can be used in planning as soon as possible. Currently there is no plan to produce a tool.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Spectral vegetation indices | Will be used to identify vegetation and create vegetation layers by performing NDVI and CTA analysis. These layers will be overlaid with ancillary datasets that identify critical habitats. |
| **Sentinel – 2** | Spectral Vegetation indices | Will be used to measure vegetation growth and identify vegetation (if images for study region are available during the growing season). These layers will be overlaid with ancillary datasets to identify critical habitats. |
| **MERRA – 2** | Soil wetness and evaporation, leaf area index | Measure soil wetness in the root zone and top soil layer as well as bare soil evaporation and leaf area index to help identify vegetation areas |
| **Aqua/MODIS** | Snow cover | Measure past snow cover and compare with habitat data to better understand areas are at the greatest need for land management if a wildfire did occur. |
| **STRM** | DEM | Derive 30 meter digital elevation model to aid in identifying suitable habitats |

***Ancillary Datasets:***

RECOVER – Habitat – Identify critical habitat areas of Sage Grouse

RS/GIS Laboratory – Mule Deer Mapping Project – Identify Mule Deer habitats

Idaho Fish and Wildlife – WAFWA – Identify Mule Deer wintering range habitat

Historic Fire polygons – RECOVER Geodatabase, ISU GIS TReC

USFS Caribou-Targhee NF – Existing vegetation map – RSAC

National land Cover Database 2011 – MRLC

USGS – GAP

NAIP Digital CIR – Point Classification

AgriMet – Historical meteorological records used for perception data

***Models:***

Fire Susceptibility Model (POC: Zachary Simpson, Project Lead BLM\_ISU)

Habitat Suitability Model (POC: Brittany Zajic, Geoinformatics Fellow - JPL)

Habitat and Biodiversity Modeler (POC: Sean McCartney, Center Lead - Goddard)

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Habitat Suitability Model | This model will improve our partners’ understanding of where suitable habitats are located and aid in their decision making processes for habitat conservation and restoration. | Current BLM and FS sage-grouse and mule deer habitat data along with snow cover data from MODIS and vegetation information derived from Landsat 8 will combine into a model that can be used identify suitable habitats that are at greatest risk of wildfire due to surrounding vegetation | 2 |
| At-Risk Wildlife Habitats Map | This map will improve our partners’ allocation of resources by identifying habitats that are threatened by wildfire. It will aid them in pre- and post-fire land management planning and restoration. | Critical habitat datasets overlaid with vegetation data will be used in combination with habitat suitability modeling to identify habitats that are threatened by wildfire. | 1 |

***End-User Benefit:***

Bureau of Land Management – The results of this project will provided the BLM with information

that can be used in conservation plans for key sagebrush habitats. It will aid in identifying

threatened habitats, improve their understanding of how NASA Earth observations can be used to help in planning and preservation, and will save both time and money compared to their current practice of gathering field data.

Idaho Department of Fish and Game – The information gained from this project will help in future assessments of habitats threatened by wildfire. By combining data from a multitude of organizations, this project aids in assessing whether or not an area is a suitable habitat. This information can be helpful in decision making when trying to identify migration corridors.

Caribou-Targhee National Forest – The results of this project will improve this agency’s understanding of how to use remotely sensed images to further their monitoring of vegetation and habitats threatened by wildfire. It will also provide BAER teams with more information about where threatened habitat areas are. This will be beneficial in their post-fire evaluations and in making recommendations about stabilization treatments.

NPS Craters of the Moon National Monument Preserve - This product could make assessment of remote habitats much more efficient and accurate. It would allow Craters to get a much bigger bang for the buck by more efficiently using its limited resources to target where management (invasive weed control) can and should be targeted. This project will also increase understanding of the tools and capabilities available to analyze vegetation and wildlife habitat around the monument and its most remote areas.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Summer 2016

***Related DEVELOP Work:***

Summer 2015 (BLM ISU) – Idaho Disasters III: Using Landsat 8 Earth Observations to Identify Increased Fire Susceptibility Due to Invasion of Cheatgrass (*Bromus tectorum*)

Fall 2015 (BLM ISU) – Southeast Idaho Disasters: Juniper Encroachment and Management in the Western U.S. Relative to Catastrophic Wildfires

Fall 2015 (Stennis) – Southern Rockies Ecological Forecasting: Utilizing NASA Earth Observations to Identify and Predict Suitable Mule Deer Habitats to aid Southern Rockies Landscape Conservation Cooperative in Habitat Conservation and Restoration Planning

**Project Needs/Requests**

***Participants Requested:*** 4

***Software & Scripting:***

ArcGIS – Habitat suitability mapping, Image analysis

IDRISI TerrSet – Imagery processing, Image analysis, Habitat and Biodiversity Modeling

Google Earth Engine – Image gathering and analysis

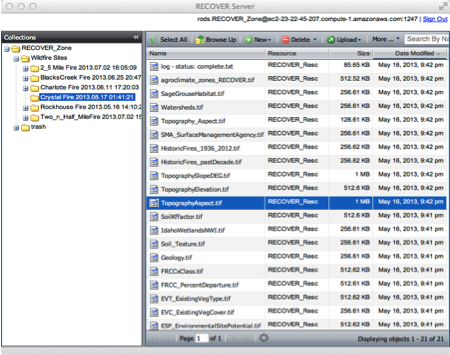
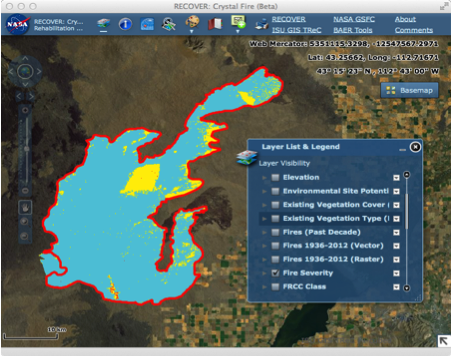
**Notes & References:**

***Notes:*** RECOVER is a site-specific decision support system that automatically brings together in a single analysis environment all the information necessary for post-fire rehabilitation decision-making. In response to a fire detection event, RECOVER uses the rapid resource allocation capabilities of cloud computing to automatically collect Earth observational data, derived decision products, and historic biophysical data so that when the fire is contained, Burned Area Emergency Response (BAER) teams will have a complete and ready-to-use RECOVER dataset and GIS analysis environment that is customized for the target wildfire.

The RECOVER system was originally developed for use in savannah ecosystems and focused on the post-wildfire decision processes of the BAER teams. During RECOVER's evaluation phase, our agency partners recommended that the capabilities of the recovery system be extended to (1) enable RECOVER's use in forested ecosystems and (2) enable RECOVER's use in pre- and active-fire decision processes.

The RECOVER DSS is made up of a RECOVER Server and a RECOVER Client (Fig. 1). The RECOVER Server is a specialized server deployed at ISU’s GIS TReC and in the Amazon Elastic Compute Cloud. The RECOVER Client is a full-featured Adobe Flex Web Map GIS analysis environment. When provided a wildfire name and geospatial extent, the RECOVER Server aggregates site-specific data from pre-designated, geographically distributed data archives. It then does the necessary transformations and re-projections required for the data to be used by the RECOVER Client. It exposes the tailored collection of site-specific data to the RECOVER Client through web services residing on the Server.

Figure 1. RECOVER Server and Client interfaces. For YouTube demonstrations, please see:  
 <http://www.youtube.com/watch?v=LQKi3Ac7yNU> RECOVER Server  
 <http://www.youtube.com/watch?v=SGhPpiSYpVE> RECOVER Client



In a typical scenario-of-use, RECOVER uses the rapid resource allocation capabilities to automatically gather various Earth observation and ancillary data products. Additional data can be added manually if needed, and the entire data collection is refreshed throughout the burn so that when the fire is contained, BAER teams have at hand a complete and ready-to-use RECOVER dataset that is customized for the target wildfire. The RECOVER server continues to gather data after the fire to support long-term monitoring of ecosystem recovery.

Our extensive use of web services allows RECOVER’s site-specific data to be consumed by state-of-the-art web-based GIS applications, such as the RECOVER’s Adobe Flex Client. This makes it possible for our agency partners to avail themselves of RECOVER’s analytic capabilities on any computer running a web browser, without having to acquire and maintain standalone GIS software. In addition, RECOVER’s web services architecture facilitates the future development of client applications that run on mobile devices. Most modern smart phones, tablets, etc. actually consist of just the display and user interface components of sophisticated applications that run in cloud data centers. This is the mode of work that RECOVER is intended to eventually accommodate.