**NASA DEVELOP National Program**

**2017 Fall Project Proposal**

**NASA Langley Research Center**

**Pacific Southwest Cross-Cutting II**

*Assessing and Improving Detection of Land Cover Changes in Habitat Conservation Plan Areas Using NASA Earth Observations*

**Project Overview**

***Project Synopsis*:** Project partners at the US Fish and Wildlife Service (USFWS) need to better assess and verify land use changes across broad geographic permitted Habitat Conservation Plan (HCP) areas. This project will create a decision-support tool to streamline assessment of land use changes using existing HCP boundaries and remotely sensed data from several Earth observations. Using Landsat, MODIS, and Sentinel data, this tool will identify locations of moderate land use changes and improve the effectiveness of USFWS field validation efforts. This tool has broader potential value to other USFWS programs that have monitoring responsibilities and can benefit from having a standard remotely-sensed change detection tool.

***Community Concern:*** The USFWS is responsible for monitoring millions of acres of private and publicly owned lands and easements. By creating HCP areas, the USFWS attempts to protect land and mitigate impacts to threatened and endangered species. However, limited resources in staff and expertise can result in inadequate follow-ups on independent monitoring. These checks are often critical to ensure conservation areas are undisturbed. Although HCPs are increasingly common and successful in the past few decades, there are no independent business processes or tools in place to evaluate these areas and determine the extent of potential disturbance.

***Source of Project Idea:*** This project developed out of a discussion between members of the US Fish and Wildlife Service and DEVELOP.

***National Application Areas Addressed:*** Cross-Cutting, Ecological Forecasting, Agriculture

***Study Location:*** USFWS Pacific Southwest Region, CA, NV, OR

***Study Period:*** January 1995 – May 2017

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| US Fish and Wildlife Service, Pacific Southwest Region, Ecological Services Program | Pat Lineback, Regional GIS Coordinator;  Dan Cox, Regional Habitat Conservation Coordinator | End User | No |
| US Fish and Wildlife Service, Midwest Region, National Wetland Inventory | Brian Huberty, Regional NWI and Remote Sensing Coordinator | Collaborator | No |

***End User Overview***

***End User’s Current Decision-Making Process:***HCPs were developed to protect and manage areas where desired economic development is in conflict with the needs of threatened and endangered species. Each plan is developed through collaboration between the USFWS and a landowner or other project proponent. Regulations restrict activities within HCP boundaries to minimize impacts to listed species while still allowing for land development. The current USFWS HCP area assessment process does not have a formal structure and any follow-up assessments are dependent on individual programs or office leads, and their time, expertise, and interest. This is confounded by the millions of acres that these individuals are responsible for monitoring without the benefit of a disturbance-detection system. Thus, follow-up is infrequent and nonstandardized. While the end user is familiar with NASA Earth observations, they are not currently using them for monitoring HCP areas.

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

*US Fish and Wildlife Service, Pacific Southwest Region, Ecological Services Program* – The end user is familiar with GIS and NASA Earth observations, and currently implements several types of remotely sensed data in their decision-making processes. However, the broader application of this project’s results must account for varied levels of GIS and remote sensing capabilities, and build capacity within biologists and programs involved with HCPs who lack proficiency with GIS applications.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*US Fish and Wildlife Service, Midwest Region, National Wetland Inventory* – The USFWS Midwest Region is contributing geospatial and subject matter expertise in the development of the end product tool. In addition, they are providing insight on how to best make the tool more editable to be applied to other case studies beyond HCPs.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team lead will be the main point of contact for the project during the term and the Center Lead will act as a secondary point of contact. The team will communicate with the project partners weekly via email to provide updates on project progress and to ask questions as needed. Biweekly teleconference or video calls will also be used to have more discussion about project methodology and results.

***Transition Plan*:** An initial project hand-off will occur at the end of the term, during which maps and other visuals will be given to the partners. The decision-support tool will be released to the partners once the software release process is completed.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Surface reflectance | Landsat products will be used to assess land use change through spectral indices in specific testing regions in the Pacific Southwest, and to create normalized burn ratio for masking fires. |
| **Landsat 7 ETM+** | Surface reflectance | Landsat products will be used to assess land use change through spectral indices in specific testing regions in the Pacific Southwest, and to create normalized burn ratio for masking fires. |
| **Landsat 8 OLI** | Surface reflectance | Landsat products will be used to assess land use change through spectral indices in specific testing regions in the Pacific Southwest, and to create normalized burn ratio for masking fires. |
| **Sentinel-1 C-Band Synthetic Aperature Radar (C-SAR)** | Backscatter | Sentinel-1 products will be used to compare with Landsat-based results. |
| **Sentinel-2 MultiSpectral Imager (MSI)** | Surface reflectance | Sentinel-2 products will be used to compare with Landsat-based results. |
| **Terra MODIS** | NDVI | Terra MODIS will be used the assess vegetation phenology through the ForWarn dataset. |

***Ancillary Datasets:***

USDA Forest Service ForWarn NDVI – assess changes in NDVI

***Software & Scripting:***

Google Earth Engine API – manipulate data, create methodology

Esri ArcGIS – manipulate data, create visuals

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Landscape Anomaly Detection Tool | This decision-support tool will assess landscape disturbances in HCP areas. Areas flagged with moderate- to large-scale disturbance will help focus program managers’ *in situ* monitoring efforts. | ForWarn, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 C-SAR, and Sentinel-2 MSI data will be processed to create spectral indices and then differenced from a threshold standard to determine moderate and large changes. | III |
| Land Use Change Maps | Annual land use change maps will be used to assess potential trends in land use change across HCP areas. They will also be used to determine the validity of the decision-support tool. | ForWarn, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 C-SAR, and Sentinel-2 MSI data will be processed to create spectral indices and then differenced from a threshold standard to determine moderate and large changes. | I |

***End-User Benefit*:** The USFWS does not currently have an efficient way to evaluate HCP areas for disturbance. This decision-support tool would be the first step in establishing an independent assessment of HCP area resiliency to moderate- and large-scale disturbances using remotely sensed data, which will save USFWS staff travel time and efforts. Furthermore, the tool can be reformatted to use other inputs beyond HCP areas, and thus could be utilized broadly across the agency.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Summer to 2017 Fall

***Multi-Term Objectives:***

* **Term 1:** 2017 Summer (LaRC) – Pacific Southwest Cross-Cutting
  + The first term of this project focused on developing a detection methodology for moderate- and large-scale disturbance for specific locations within the USFWS Pacific Southwest region. Additionally, this term assessed the various data sources (MODIS, Landsat, and Sentinel) for the most effective data to continue using for the decision-support tool. External services were added to enhance identification capabilities within the tool (e.g., fire polygons, cropscape, and NAIP). The creation of initial maps and time series will be used to enhance partern feedback on the tool.
* **Term 2 (Proposed Term):** 2017 Fall (LaRC) – Pacific Southwest Cross-Cutting II
  + The second term of this project will focus on further refining the methodology for the decision-support tool. More specifically, additional selection tools, outside validation inputs, and exporting features are desired by the end user. The first objective is to add external services beyond those incorporated in the first term. The second objective is to create a cleaner user interface to allow users with less programming experience to efficiently utilize the tool. Time permitting, the team will scale up to larger sampling areas, apply the tool to different sampling regions (e.g., vegetation cover types) from the first term, and assess high resolution imagery through services like Digital Globe. A tertiary objective for the team will be to create a tutorial and workflow for dissemination within the USFWS for continued use of the tool. This detailed workflow will support the USFWS extending this research to other usecases in the future.

***Previous Terms:***

2017 Summer (LaRC) – Pacific Southwest Cross-Cutting

***Related DEVELOP Work:***

2017 Spring (LaRC) – Glacier National Park Climate II: Analyzing and Mapping Landscape Disturbance across Glacier National Park Using a Landsat Time Series

2016 Fall (LaRC) – Glacier National Park Climate I: Utilizing NASA Earth Observations to Quantify Landsat Disturbances Related to a Changing Climate in Glacier National Park