**NASA DEVELOP National Program**

**** NASA Goddard Space Flight Center

**Fall 2015**

**Short Title: Montana Ecological Forecasting**

**Subtitle:** Utilizing NASA Earth Observations to Forecast the Effects of Climate Change on Northern Goshawk Nesting Habitat

**VPS Title:** Forecasting Northern Goshawk Nesting Sites, One Model at a Time

**Project Team & Partners**

**Project Team:**

Erika Higa (Project Lead), erika.y.higa@nasa.gov

Sean McCartney

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**Advisors & Mentors:**

Dr. Ross Nelson (NASA GSFC)

Dr. John Bolten (NASA GSFC)

**Partner Organizations:**

USDA Forest Service (End-User), POC: Victor Murphy

Oulu University Researchers (End-User & Boundary Organization), POC: Nate Bickford

University of Nebraska at Kearney (Collaborator & Boundary Organization), POC: Nate Bickford

**Project Details**

**Applied Sciences National Applications Addressed:** Ecological Forecasting

**Study Area:** Lewis and Clark National Forest, MT

**Study Period:** February 1985 – June 2015

**Earth Observations & Parameters:**

GPM, DPR/GMI – Precipitation Measurements

Terra/Aqua, MODIS – Land Surface Temperature

Landsat 8, OLI – Land Cover Change

**Ancillary Datasets Utilized:**

* USDA Forest Service, Region 1 Aerial Insect and Disease Detection Survey (ADS), - Mountain Pine Beetle Infestation Data
* USDA Forest Service, Region 1 Existing Vegetation Map Products (VMap) - Vegetation Data
* USDA Forest Service, IW-FIA Predicted Forest Attribute Maps - Vegetation Data
* USDA Forest Service, DEM for Region 1 - Elevation Data
* Nate Bickford, Northern goshawk nest habitat locations - Nest Data

**Models Utilized:**

* Beijing Climate Center Climate System Model (BCC\_CSM1.1)
* Goddard Institute for Space Studies ModelE/Russell Model (GISS-E2-R)
* Hadley Global Environment Model 2 - Earth System (HadGEM2-ES)
* AT&T Research, Maximum Entropy for Habitat Suitability Modeling (Maxent)
* Clark Labs, Mahalanobis Typicality for Habitat Suitability Modeling
* Alexandre Hirzel, Biomapper for Habitat Suitability Modeling (Biomapper)

**Software Utilized:**

ArcGIS – Raster manipulation/analysis, image enhancement and map creation of Landsat imagery

Biomapper – Habitat suitability analysis and modeling

ENVI – Land classification of Landsat and MODIS imagery and raster processing

Maxent – Habitat suitability analysis and modeling

TerrSet – Raster manipulation/analysis, habitat suitability analysis and modeling

**Project Overview**

**80-100 Word Objectives Overview:**

This project explored the capability of using NASA Earth observations to forecast the effects of climate change on the nesting habitat of the northern goshawk (*Accipiter gentilis*) in the Lewis and Clark National Forest, Montana. The team examined different environmental variables that directly affect the northern goshawk nesting habitat and determined areas that are most suitable for nesting using multiple habitat suitability modeling software. Additionally, future climate trends were analyzed to forecast and understand the effects of potential mountain pine beetle encroachment on goshawk habitat by the year 2050.

**Abstract:**

The northern goshawk (*Accipiter gentilis*) is currently identified as both a Sensitive Species and a

Management Indicator Species in the Lewis and Clark National Forest (LCNF) land and resource management plans. Goshawks are important top-tier predators in the LCNF and changes in the forest habitat greatly affect their survival and population. We examined the potential of using NASA Earth observations to locate and model suitable nesting habitat for the goshawk. Currently, Nate Bickford and the USFS do not use remote sensing to identify or forecast goshawk nesting habitat, and the tools they use are limited to topographic maps and *in situ* data. We identified various environmental variables, measured through remote sensing, that were input into several habitat suitability models, using Biomapper, Maxent, and Mahalanobis Typicality, to identify areas of suitable habitat for nesting goshawks. Landsat 8 Operational Land Imager (OLI), Terra/Aqua Moderate Resolution Imaging Spectroradiometer (MODIS), and GPM Dual-frequency Precipitation Radar/Global Microwave Imager (DPR/GMI) imagery were used to create land cover, land surface temperature, and precipitation change maps to forecast how the goshawk nesting habitat is impacted by climate change. The results from this project will augment current decision making practices in forest management in the LCNF and assist in understanding how climate change will affect the goshawk nesting habitat in the future.

**Community Concerns:**

* Northern goshawks are a top-tier predator and serve as a bioindicator of ecosystem health. As climate change causes a change in forest habitat and insect blight, this negatively affects goshawk nesting sites.
* Mountain pine beetle outbreak infects trees where goshawks commonly nest, and hotter and drier summers and milder winters spur this infestation.
* Cold wet springs can delay the timing when goshawks lay their eggs and this can be fatal to the survivorship of fledglings when they hatch at later months than usual.

**Current Management Practices & Policies**:

Under Montana’s State Wildlife Action Plan (SWAP), the northern goshawk, and its associated habitat, are identified as a species and community type of “Greatest Conservation Need”. The goshawk is also listed as a sensitive species in all National Forests and on all Bureau of Land Management lands and is designated as a Montana Species of Concern. Current monitoring protocols within the Lewis and Clark National Forest are unable to accurately estimate goshawk population size and trend. Because of a lack of baseline population data, there is not a species-specific management plan. General vegetation management practices within the forest, including increased timber harvest, can negatively impact available nesting habitat. The end-users for this project, Nate Bickford and the US Forest Service, currently do not utilize remote sensing methods to analyze and forecast goshawks nesting sites. Instead, they conduct time-consuming field observations of nest site locations and take note of the surrounding vegetation.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Habitat suitability model | Landsat 8 OLI; GPM DPR/GMI; Terra/Aqua MODIS | Three separate habitat suitability models will provide new methodologies for end-users to locate new nesting areas in order to better monitor goshawk distributions in the LCNF. |
| Habitat suitability maps | Landsat 8 OLI; Terra/Aqua MODIS | These maps will help conservation researchers to find potentially new nesting sites in order for them to better monitor goshawk distributions in the LCNF. The identified suitable habitats in these maps will also help forest managers decide on best forest management practices. |
| Land cover change maps | Landsat 8 OLI; Terra/Aqua MODIS; GPM DPR/GMI | These end-products will show the change in land cover due to climate change and other forest disturbances, and these maps will be used to understand how goshawk nesting sites have moved in response to land cover change. This information can be used by forest managers to better monitor and protect goshawk habitat. |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

What category do the tools your project is creating fall within? [Category I to V]

Category I

If your decision support tools fall within Category IV, fill out this section:

**Software Title:** Insert here (ex. DEVELOP National Program Python Package)

**Software Abbreviation:** Insert here (ex. dnppy)

**Technical Point of Contact:** Insert full name, permanent email, and node here. Also include whether employed through SSAI or Wise County. (Team member who knows the most about the software.)

**Brief Description of the Software:** Insert here (ex. The dnppy package will be used to functionalize common programming tasks in the geospatial community, specifically for working with NASA data products. It will include functions for processing satellite data and assist in structuring analysis to reduce the startup time for DEVELOP teams to learn programming and create tools for end users.)

**Type of Code:** *Executable Code* and/or *Source Code* (Select one or both)

**Will the software include any embedded computer databases?** *Yes* or *No* (Select one)

**Does the software use or call any open software or libraries?** *Open Source* and/or *Proprietary/Commercial* (Select one or both)

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Ex. Arcpy module | Ex. group license through ArcGIS | http://www.esri.com/software/arcgis |
| Ex. Python | Ex. Open source license | http://opensource.org/licenses/Python-2.0 |
|  |  |  |

**Full Software Description and Plan**

**Introduction/Objective:**

What motivated the creation of this software, what problem does it address?

**Applications and Scope:**

Where and how will this software be used to influence decisions?

**Capabilities:**

What can it do better than what was previously available?

**Interfaces:**

How is one expected to use the software? For example, command line, GUI, script execution, etc.

**Assumptions, limitations, & Errors:**

What areas that the software could be improved upon in the future? This is where limitations of the theory, model, science, etc should be briefly documented. If the tools only work for a specific scenario, say so.

**Testing:**

What validation techniques and testing strategy will be used to build confidence in the software?