**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

NASA Goddard Space Flight Center

**Montana Ecological Forecasting**

Utilizing NASA Earth Observations and LiDAR to Forecast the Effects of Climate Change on Goshawk Nesting and Post Fledgling Habitat

**Objective:**

To improve understanding of the environmental variables that affect Northern Goshawk (*Accipiter gentilis)* nesting and post-fledgling locations to support forecasting changes in goshawk distribution as a result of climate change.

**Community Concern:**

Goshawks are a top-tier predator found in boreal forests around the world. Amplified weather variation can be fatal to goshawks as well as their prey, having a cascading effect through trophic levels. The effects of climate change can already be seen in eastern Montana, which is enduring a mountain pine beetle infestation spurred by hotter and drier summers. These beetles destroy large tracts of forest that Northern Goshawks rely upon for nesting, hunting, and rearing their young. This project will provide further insight into the factors that are currently acting upon goshawks such as temperature and habitat structure to identify and forecast future nesting and post-fledgling habitats in response to climate change and mountain pine beetle kill. These top tier predators are important because they serve as a bio-indicator of ecosystem health since they are sensitive to changes in the lower trophic levels of the forest and climate change.

**Partner Organizations:**

University of Great Falls (Collaborator, Boundary Organization, POC: Nate Bickford, Researcher and Professor)

US Forest Service (End-User, POC: Victor Murphy, Forest Inventory Researcher)

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

DEVELOP GSFC representatives met Dr. Nate Bickford when he gave a talk at NASA GSFC in fall of 2014 and has been in contact with him via e-mail discussing the project and proposal. Dr. Bickford works with the US Forest Service in the Lewis and Clark National Forest on conservation strategy. This project will characterize the nesting habitats of Northern Goshawks using LiDAR and Earth Observing Systems, datasets and analyses currently not used by any of the partners. Since research has shown that goshawks are sensitive to climate change (particularly its effect on forest dynamics), changes in their nest locations each year provides critical information on how climate change is affecting forest composition, cover, and structure without the continued use of advanced datasets by these organizations. Nate Bickford’s colleague Victor Murphy, a forest service employee, will use this information to advise forest managers in managing the effects of climate change to forest habitat such as road closures, timber sales, etc.

Dr. Bickford also collaborates with researchers at Oulu University in Finland, who are doing similar research in boreal forests. These forests are similar to the ones in Montana but are closer to the Arctic Circle and may experience the effects of climate change sooner. Dr. Bickford and his colleagues will be able to apply the methods from this project to model habitat suitability for Northern Goshawks in their study region and predict how climate change will affect these large tracts of boreal forests.

**Decision Making Process:**

Currently the US Forest Service is not using remote sensing to identify or forecast goshawk habitat. The tools used now are basic topographical and forest type data along with a large amount of fieldwork. This type of analysis tells us very little about climate change issues. In addition, there is little understanding of how past climate change and habitat destruction has affected the nesting and post-fledging habitat distributions of Northern Goshawks. Goshawk nesting surveys have been carried out since 2006, and although parameters such as canopy density and tree height are known to influence nesting patterns, there are no maps and analyses that show these parameters to guide surveys and research efforts.

**Earth Observations:**

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| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 7, 8** | ETM+, OLI | Land cover, land use change, beetle deforestation |
| **Aqua / Terra** | MODIS | NDVI, surface temperature |
| **GPM** | DPR / GMI | Precipitation |
| **Airborne Platform** | LiDAR | Canopy structure, topography |

**NASA Earth Observations Highlighted:**

Landsat 7 and 8 multispectral imagery and Aqua and Terra MODIS will be used to create land cover maps to quantify forest change to understand how forest change is affecting nesting patterns of Goshawks. Surface temperature from MODIS and habitat quality, as defined by NDVI (MODIS) and precipitation (GPM), will be used to associate environmental variables with nestling and post-fledgling habitat using a principal components analysis.

**Ancillary Datasets:**

Goshawk nest and post fledging habitat locations, Nate Bickford

Ground truth vegetation data, Nate Bickford

Prey densities from habitat areas, Nate Bickford

Airborne LiDAR from 2005, www.opentopography.org (original PI: Mrian McGlynn)

**Models:**

NCAR CCSM3 IPCC Climate Change Commitment Scenario Ensembles (POC: Gary Strand, NCAR Earth System Laboratory)

**Decision Support Tools & Analyses:**

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision Impacts** | **Current Partner Tool/Method** |
| Habitat Suitability Model | Guide researchers to find goshawk nests to monitor distribution | Topographic maps |
| Land cover change maps | Conservation strategy – protect tracts of land that are optimal habitat for goshawks | Mostly ground observation |
| Maps of future habitat suitability | Conservation strategy – protect tracts of land that are optimal habitat for goshawks | None |

*Habitat Suitability Model* – LiDAR data (canopy structure, forest density, tree height) and NASA satellite observations (temperature, precipitation, vegetation indices) will be used to determine suitable habitat for Goshawk nesting and post-fledging sites using principal components analysis.

*Land Cover Change Maps* – Landsat 7, Landsat 8, and MODIS data will be used to derive forest/non-forest land cover maps over time in relation to goshawk nests. This map can be used to understand how goshawk nesting sites have moved in response to land cover change, which can provide support in protecting tracts of land.

*Maps of Future Habitat Suitability* – Climate change will have an impact on goshawk habitat, which is already being seen now with mountain pine beetle growth. Understanding future climate trends and its effect on goshawks will help understand the future of this species and provide merit for listing it on the Endangered Species Act. Maps of future habitat suitability will be created for the years 2020, 2050, and 2100.

**Project Details:**

**National Application Area Addressed:** Ecological Forecasting

**Source of Project Idea:** DEVELOP GSFC Center Lead attended a talk at GSFC given by the potential project partner, who is seeking NASA collaborators.

**Study Location:** Lewis and Clark National Forest, Montana

**Period being studied:** Februarythrough June,2006 to 2015

**Advisor:** Dr. Ross Nelson (NASA GSFC)

**Participants Requested:** 4

**Project Timeline:** 2 Terms: 2015 Fall to 2016 Spring

**Multi-Term Objectives:**

* **Term 1 (Proposed Term)** – The first term will be spent analyzing the LiDAR and remote sensing variables that best reflect and predict goshawk nesting sites. Once this relationship is understood, participants will use climate models to predict changes in goshawk nesting as a result of climate change.
* **Term 2** – The second term will be similar to the first term, but instead of analyzing nesting site locations, the project will focus on post-fledgling locations. During the post-fledgling period, juveniles have left the nest but are still largely dependent on their parents. This life stage is one of the most sensitive and suffers the highest mortality in goshawks.

**Software & Scripting Requested:**

* ArcGIS – Raster/vector processing and manipulation, statistical analysis
* ENVI / ERDAS Imagine – Raster processing, image classification of Landsat and MODIS data, LiDAR processing
* R – principal components analysis

**Notes:** Nesting and post-fledging surveys have been carried out by Nate Bickford and his team in the Lewis and Clark National Forest in Montana since 2006. He has identified forest density, tree height, and canopy cover parameters that are ideal for Goshawk nesting and post-fledging sites, but does not have a way to extrapolate to identify these ideal conditions across the entire forest. This lack of data makes it extremely difficult to locate nests, and the use of LiDAR and NASA Earth observations can create these maps to show suitable nesting habitat distributions. This research and habitat suitability model could then be applied to other study locations with ongoing Goshawk research, including Alaska and Finland.