**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

NASA Marshall Space Flight Center

**North Mexico Ecological Forecasting**

Using NASA Earth Observations to Monitor and Manage Ocelot Habitat Loss in North Mexico

**Objective:**

To track change in ocelot habitat from 1980-2015 to determine how urbanization, road development, habitat loss, habitat fragmentation, and other barriers have had an impact, as well as demonstrate the application of Suomi NPP VIIRS in place of MODIS so that the methodologies created from this project can be more sustainable.

**Community Concern:**

An ocelot (*Leopardus pardalis*) is an endangered species of cat that can be found from Texas to Northern Argentina in both humid tropical rainforests and dry scrublands. Ocelots need at least seven miles of dense vegetation in order to hunt for prey. Urban development, agricultural land use, road development, and other physical barriers, such as fences, have contributed to the separation of ocelot habitat patches and overall decrease in suitable ocelot habitat. This habitat fragmentation and resulting increase in inbreeding has contributed to the ocelot being identified as an endangered species. Mapping of the ocelot habitat is required to help monitor and manage existing habitat and to inform habitat restoration efforts.

**Partner Organizations:**

Mexican Secretariat of the Environment and Natural Resources (SEMARNAT, Secretaría de Medio Ambiente y Recusos Naturales) (Collaborator/Boundary Organization/End-User, POC: Dr. Arturo Caso, Area Director)

Pittsburgh Zoo & PPG Aquarium (Collaborator/Boundary Organization, POC: Ken Kaemmerer, Ocelot SSP Chair)

Pittsburgh Zoo & PPG Aquarium (Collaborator/Boundary Organization, POC: Dr. Josh Gaspard, Director of Science and Conservation)

Caesar Klegerg Wildlife Research Institute at Texas A&M University-Kingsville (Collaborator/End-User/Boundary Organization, POC: Michael Tewes, Frank D. Yturria Endowed Chair in Wild Cat Studies and Regents Professor)

The Denver Zoo (Collaborator/End-User, POC: Nanette Bragin, GIS Conservation Biologist)

South Texas Refuge Complex (Collaborator/End-User, POC: Mitch Sternberg, Zone Biologist-South Texas Gulf Coast)

Texas Department of Transportation (Collaborator/End-User, POC: Dr. John Young, Jr., Environmental Specialist)

East Wildlife Foundation (End-User, POC: Dr. Tyler Campbell, Chief Program Officer and Principle Scientist)

The Pittsburgh Zoo and PPG Aquarium have shown an interest in ocelot recovery. Contact was initiated when Leigh Sinclair (DEVELOP Center Lead) and Amberle Keith (DEVELOP Assistant Center Lead and Young Professional) asked Ken Kaemmerer (Pittsburg Zoo) to be a partner for this project. Mr. Kaemmerer suggested several additional partners – Michael Tewes (Texas A&M), Nanette Bragin (The Denver Zoo), Dr. Josh Gaspard (The Pittsburgh Zoo), Mitch Sternberg (South Texas Refuge Complex), Dr. John Young (Texas Department of Transportation), and Dr. Arturo Caso (SEMARNAT) – and suggested a teleconference meeting to discuss the project further. During the teleconference meeting, a conversation began about the use of satellite imagery for monitoring ocelot habitat. Incorporating the use of NASA’s Earth observations for ocelot habitat monitoring will help the project partners better understand where to manage the habitat loss. Also, utilizing NASA’s Earth observations in ocelot habitat monitoring will provide a more spatially complete picture of the ocelot’s habitat for enhanced ocelot habitat management decision-making.

**Letters of Support:** 1) Pittsburgh Zoo & PPG Aquarium (Collaborator/End-User, POC: Kenneth R. Kaemmerer, Ocelot SSP Chair and USFWS Ocelot Recovery Team); 2) Texas Department of Transportation (Collaborator/End-User, POC: Carlos Swonke, Director of Environmental Affairs Division); 3) Cincinnati Zoo and Botanical Gardens (Collaborator, POC: Shasta R. Bray, Ocelot Species Survival Plan Education Advisor and Interpretive Media Manager)

**Decision Making Process:**

Currently, remote sensing is not being utilized by any of the project partners to monitor the decrease of the ocelot habitat. Previous research on the cat typically consists of using radio collars and traps to track their movement. Other management practices that the partners are using include the occasional collection of aerial imagery, translocating up to four ocelots from Mexico to south Texas each year, restoring native vegetation in the area that is preferred by the ocelots, and planning wildlife crossing structures. The use of field techniques can be costly and time consuming for the researchers, and can be traumatic and put the ocelots’ safety at risk with the use of sedation – which can have negative side effects. This project will provide documentation of locations of suitable habitat left for the ocelot. Using the results of this project, the partners will be able to ground-truth the maps and then extend the methodology further into Central America. The project will use the methodologies that were created during the summer 2015 term to encompass part of northwest Mexico, a small portion of the historical ocelot habitat range. This project will also focus on making the methodologies more sustainable for the partners. This will help the project partners to better approximate ocelot population densities and the current amount of remaining suitable habitat. This knowledge will provide support for prioritizing conservation and research efforts.

**Earth Observations:**

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| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 4,5,7,8** | MSS, TM, ETM+, OLI | Spectral vegetation indices, land cover classifications, land cover change, leaf area index |
| **Aqua / Terra** | MODIS | Spectral vegetation indices |
| **Suomi NPP** | VIIRS | Land cover change, spectral vegetation indices |

**NASA Earth Observations Highlighted:**

The preferred habitats for the ocelot are semi-arid deserts in south Texas and the leafy jungle canopies in Mexico and Central America. This project will calculate vegetation indices, land cover classifications of these environments to show the loss of the ocelot habitat by highlighting the spectral, temporal, and spatial resolution capabilities of the Landsat series, which includes the use of the TM, ETM+, and OLI. Using the MODIS sensor, onboard Terra and Aqua, vegetation indices will be created to capture the temporal resolution of the study area in the event of high cloud cover in the Landsat images. Suomi VIIRS will be used to detect land cover changes and spectral vegetation indices that will demonstrate to the project partners the capabilities of the satellite so that they can have a more sustainable methodology.

**Ancillary Datasets:**

Ocelot habitat data, International Union for Conservation of Nature (ICUN), to determine the current locations of the ocelot habitat; Human population data, NASA’s Socioeconomic Data and Applications Center (SEDAC), proximity to forested areas, grasslands, or ideal habitat of the ocelot; Roads of Mexico and Central America GIS data, ESRI World Street Map, to determine the locations of roads relative to preferred ocelot habitat, 250m Land cover dataset, Commission for Environmental Cooperation

**Models:**

* Princeton University Maximum Entropy Distribution Model (Maxent) (POC: Jeffry Ely, Team Lead of Great Basin Climate)
* Spatial Data Modeler (POC: Gary Raines, Author of the Python script)
* PatchMorph Patch Delineation Algorithm Tool (POC: Evan Girvetz, Postdoctoral Research Associate, University of Washington)
* Fuzzy Logic (POC: Daryl Ann Winstead, Team Lead of the Texas & Arizona Ecological Forecasting)

**Decision Support Tools & Analyses:**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Habitat Change Map | Where the Texas A&M University and SEMARNAT researchers should focus ground-truthing and prioritize conservation efforts | Field surveys |
| Potential Habitat Map | Where conservation groups should focus efforts to connect habitat patches | Field surveys |

*Habitat Change Map* – This map will be derived by first identifying suitable ocelot habitat by creating land cover classifications to identify scrublands, jungle, agricultural, and urbanized areas using Landsat TM, ETM+, OLI, Suomi VIIRS and Terra and Aqua MODIS. Using the classifications and human population data, land cover change will be calculated in ArcGIS to identify how land use has changed over time. Participants will assess the current percent cover of ocelot habitat.

*Potential Habitat Map* – This map will be created by combining the results of the Habitat Change Map and ground data in Maxent. This will identify areas that are suitable for ocelot inhabitation. With this knowledge, partners can focus conservation efforts to connect ocelot habitat patches. This product will also help partners identify source locations of ocelots for translocation efforts.

**Project Details:**

**National Application Area Addressed:** Ecological Forecasting

**Source of Project Idea:** While watching informative videos on the ocelots, a participant became aware that the species has become endangered; especially in the United States. Initial research on the topic indicated that the use of satellite imagery would greatly benefit project partners with cost and time management.

**Study Location:** Northwestern Mexico, Path & Rows: 26/42, 26/43, 26/44, 27/42, 27/43, and 27/44. Northeastern Mexico, Path & Rows: 37/38, 36/38, 35/38, 36/39, and 35/39 (time permitting)

**Period being Studied:** January to March for 1996, 2005, and 2014

**Advisor:** Dr. Jeffrey Luvall (NASA at NSSTC)

**Participants Requested:** 3-4

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

**Multi-Term Objectives:**

* **Term 1** – The objectives of this project was to establish a methodology using land cover change in south Texas and south Arizona to determine how urbanization, agriculture, and, habitat loss and fragmentation, and road development have had an impact on the ocelot.
* **Term 2 (Proposed Term)** – The goal of this term is to first identify and classify suitable habitat in north Mexico by using land cover classifications. This will follow the methodologies created during the summer 2013 term, the Habitat Percent Map, the Habitat Probability Map, and refining the technique so that the methodologies are more sustainable for the partners. There will also be a comparison between the land classifications and *in-situ* data to determine areas that would aid in translocation efforts.
* **Term 3** – The goal of this term is to create a habitat percent map and a habitat probability map for Belize, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama showing locations of prime ocelot habitats by using land classification and in-situ data. There will also be a comparison between the land classifications and *in-situ* data to determine possible corridors for the ocelots.

**Previous Related DEVELOP Work:**

Summer 2015 (Marshall Space Flight Center) - Texas and Arizona Ecological Forecasting: Utilizing NASA Earth Observations to Monitor and Manage Ocelot Habitat Loss

Summer 2015 (University of Georgia) - Ocmulgee River Ecological Forecasting II: Utilizing NASA’s Earth Observations for Forecasting Land Use Change and Wildlife Disturbances Along the Ocmulgee River Corridor

Spring 2015 (University of Georgia) - Colombia Ecological Forecasting III: Utilizing NASA Earth Observations to Enhance the Conservation Efforts of Colombia’s Most Endangered Primate, the Cotton-top Tamarin (*Saguinus oedipus)*

Fall 2013 (University of Georgia) - Costa Rica Ecological Forecasting: Utilizing NASA Earth Observations to prioritize reforestation efforts in the Pájaro Campana Biological Corridor in Costa Rica

Fall 2013 (Goddard Space Flight Center) - Myanmar Ecological Forecasting: Utilizing NASA Earth Observations to Monitor, Map and Analyze Mangrove Forests in Myanmar for Enhanced Conservation

**Software & Scripting Requested:**

* ArcGIS 10.2.1 - Raster manipulation/analysis, vector data processing, map creation of Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Aqua and Terra MODIS for land cover classifications, land cover change, and vegetation indices
* ENVI Classic and 5.0 - Raster manipulation/analysis, vector data processing, map creation of Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Aqua and Terra MODIS for land cover classifications, land cover change, and vegetation indices
* Dnppy model - Processing of Landsat data into TOA
* R - Calculation of suitable habitat in conjunction with Maxent

**Notes:**

This approach will take advantage of known ocelot habitat characteristics. The ocelot’s habitat usually consists of tall and thick vegetation such as forests or grassland. This project will build on the methodologies that were created during the summer 2015 term to encompass the rest of the ocelot habitat so that the project’s partners can focus ground-truthing efforts and future research. The efforts for this project will use land cover classifications from 1996, 2005, and 2014, from January to March, and then make a land cover change analysis during that time period.

It should also be noted that the project partners from Texas A&M University and SEMARNAT do some collaborative work on ocelot conservation efforts. The results of this project will help their combined efforts in assessing management of the species.

Methodology and statistics can be found in the following articles:

Carlos A. López González, David E. Brown and Juan P. Gallo-Reynoso (2003). The ocelot Leopardus pardalis in north-western Mexico: ecology, distribution and conservation status. Oryx, 37, pp 358-364. doi:10.1017/S0030605303000620.

Di Bitetti, M. S., Paviolo, A. and De Angelo, C. (2006), Density, habitat use and activity patterns of ocelots (Leopardus pardalis) in the Atlantic Forest of Misiones, Argentina. Journal of Zoology, 270: 153–163. doi: 10.1111/j.1469-7998.2006.00102.

US Fish and Wildlife Service: http://www.fws.gov/endangered/esa-library/pdf/ocelot.pdf

Commission for Environmental Cooperation: <http://www.cec.org/Page.asp?PageID=1226&SiteNodeID=498>

Leaf Area Index (LAI) using Landsat imagery: [http://www.sciencedirect.com/science/article/pii/0034425795001956#](http://www.sciencedirect.com/science/article/pii/0034425795001956)