National Aeronautics and Space Administration

Remote Sensing for Conservation and Biodiversity

Cindy Schmidt, Amber McCullum

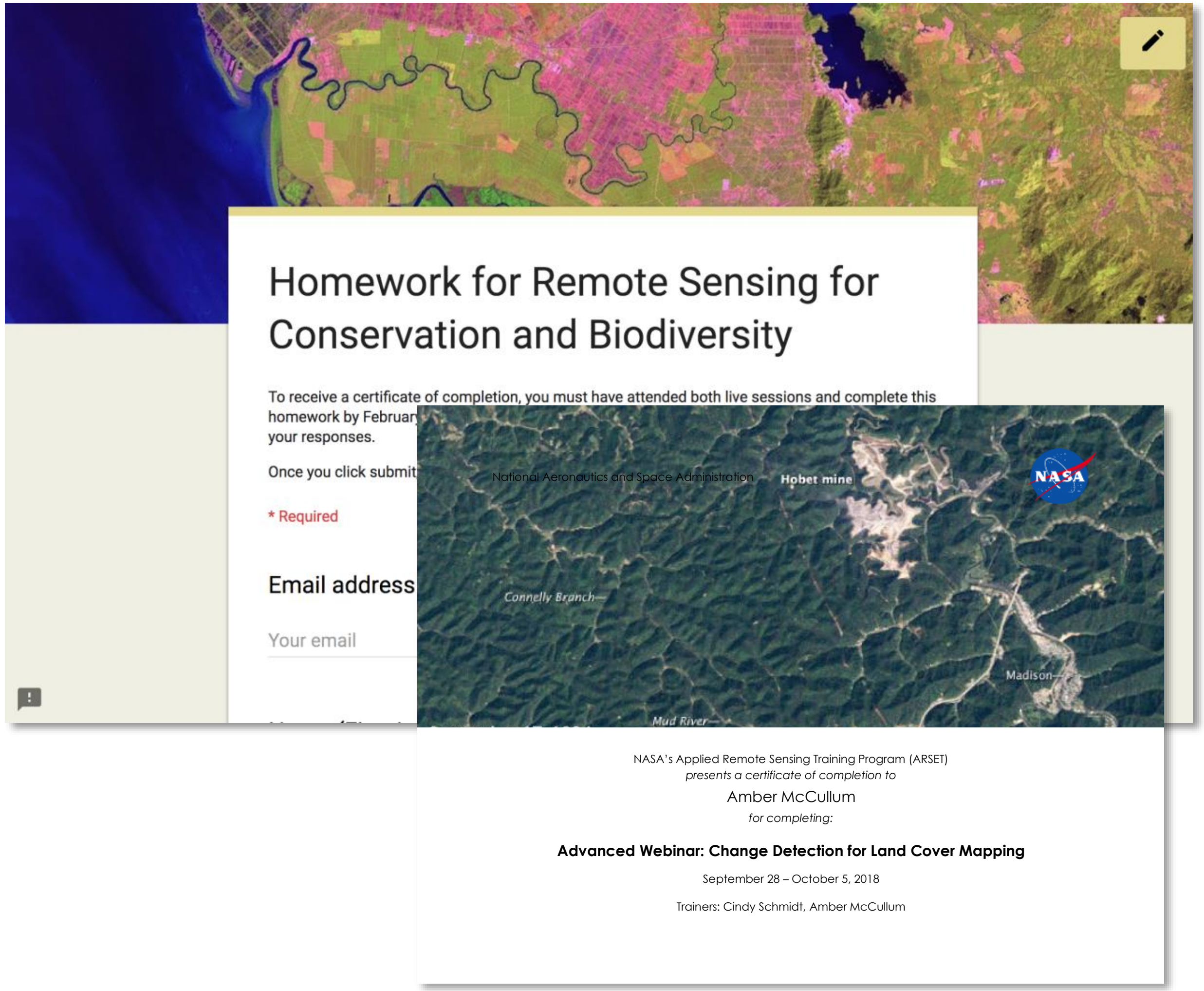
January 22, 2019

Course Structure

- Two, one-hour sessions on Jan. 22 and Jan. 24, 2019
- The same content will be presented at two different times each day:
  - Session A: 10:00-11:00 EST (UTC-5)
  - Session B: 18:00-19:00 EST (UTC-5)
  - **Please only sign up for and attend one session per week**
- Webinar recordings, PowerPoint presentations, and the homework assignment can be found after each session at:
  - https://arset.gsfc.nasa.gov/land/webinars/conservation-biodiversity-2018
- Q&A: Following each lecture and/or by email
    - cynthia.l.schmidt@nasa.gov, or
    - amberjean.mccullum@nasa.gov

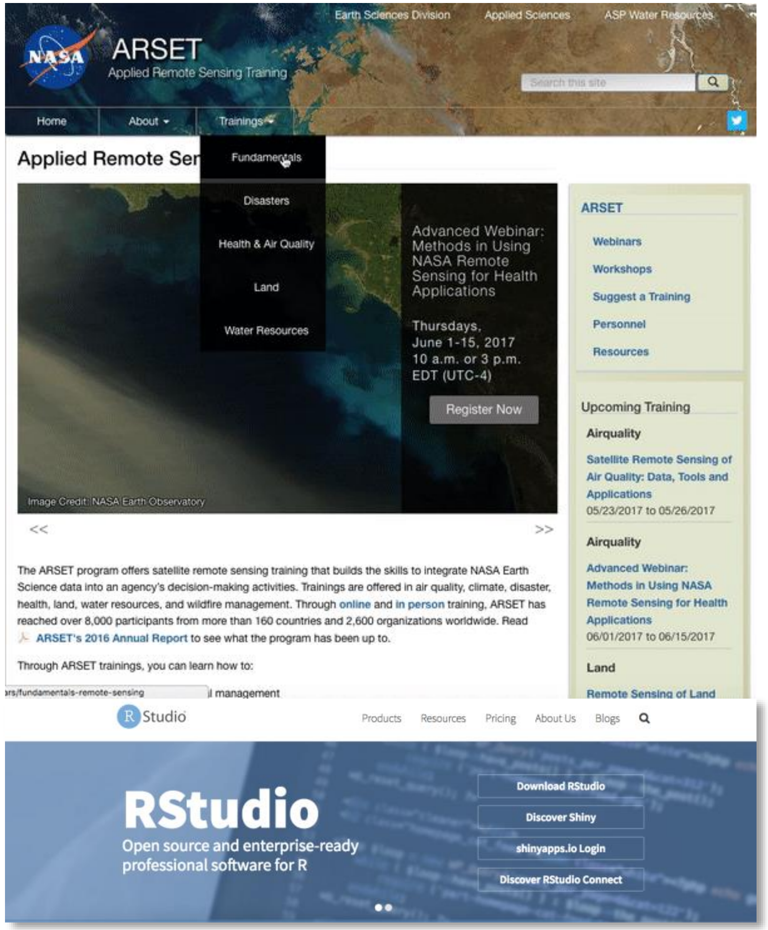
Homework and Certificates

- Homework
  - One homework assignment
  - Answers must be submitted via Google Forms
- Certificate of Completion:
  - Attend both live webinars
  - Complete the homework assignment by the deadline (access from ARSET website)
    - HW Deadline: Thursday Feb. 7th
  - You will receive certificates approximately two months after the completion of the course from: marines.martins@ssaihq.com



Prerequisites

ARSET Webinar *Introduction to Remote Sensing* or equivalent knowledge



Accessing Course Materials

https://arset.gsfc.nasa.gov/land/webinars/conservation-biodiversity-2018

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ARSET
Applied Remote Sensing Training

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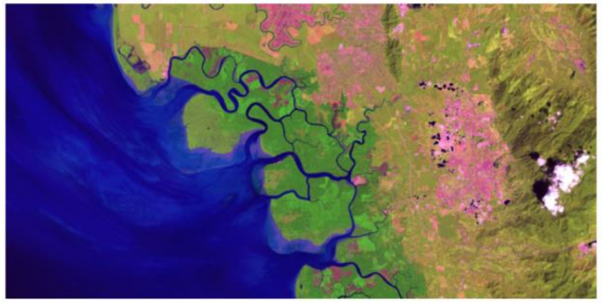
Remote Sensing for Conservation & Biodiversity



Land Management

- Online Trainings
- In-Person Trainings

Upcoming Training

Land

Remote Sensing for Conservation & Biodiversity
01/22/2019 to 01/24/2019

Dates: Tuesday, January 22, 2019 to Thursday, January 24, 2019
Times: 10:00 a.m. and 6:00 p.m. EST (UST-4)
Registration Closes: Tuesday, January 22, 2019

The United Nations Millennium Ecosystem Assessment states: "ecosystems are critical to human well-being - to our health, our prosperity, our security, and to our social and cultural identity." Conservation and biodiversity management play important roles in maintaining healthy ecosystems. Earth observations can help with these efforts. This online webinar series introduces participants to the use of satellite data for conservation and biodiversity applications. The series will highlight specific projects that have successfully used satellite data. Examples include:

- monitoring chimpanzee habitat loss
- decreasing whale mortality
- detecting penguins
- monitoring wildfires
- biodiversity observation networks

Learning Objectives:

By the end of this training, attendees will:

- be able to outline uses of remote sensing for habitat suitability, species population dynamics, and monitoring wildfires

Course Format:

- Two, one hour sessions
- The same session will be broadcast at both times, both in English

Prerequisites:

Fundamentals of Remote Sensing or equivalent knowledge

If you do not complete the prerequisite, you may not be adequately prepared for the pace of the training

Audience:

This training is designed for individuals and organizations interested in using satellite imagery for conservation and biodiversity.

Registration Information:

There is no cost for the webinar, but you must register to attend the sessions. Both sessions will be held in English. So that we can accommodate as many people as possible, **please only register for one session**.

- Register for Session A: 10:00-11:00 EST (UTC-4) »
- Register for Session B: 18:00-19:00 EST (UTC-4) »

Course Agenda:

Agenda.pdf

Session One: Remote Sensing for Conservation

January 22, 2019

This session will focus on remote sensing for habitat suitability, species population dynamics, and monitoring wildfires.

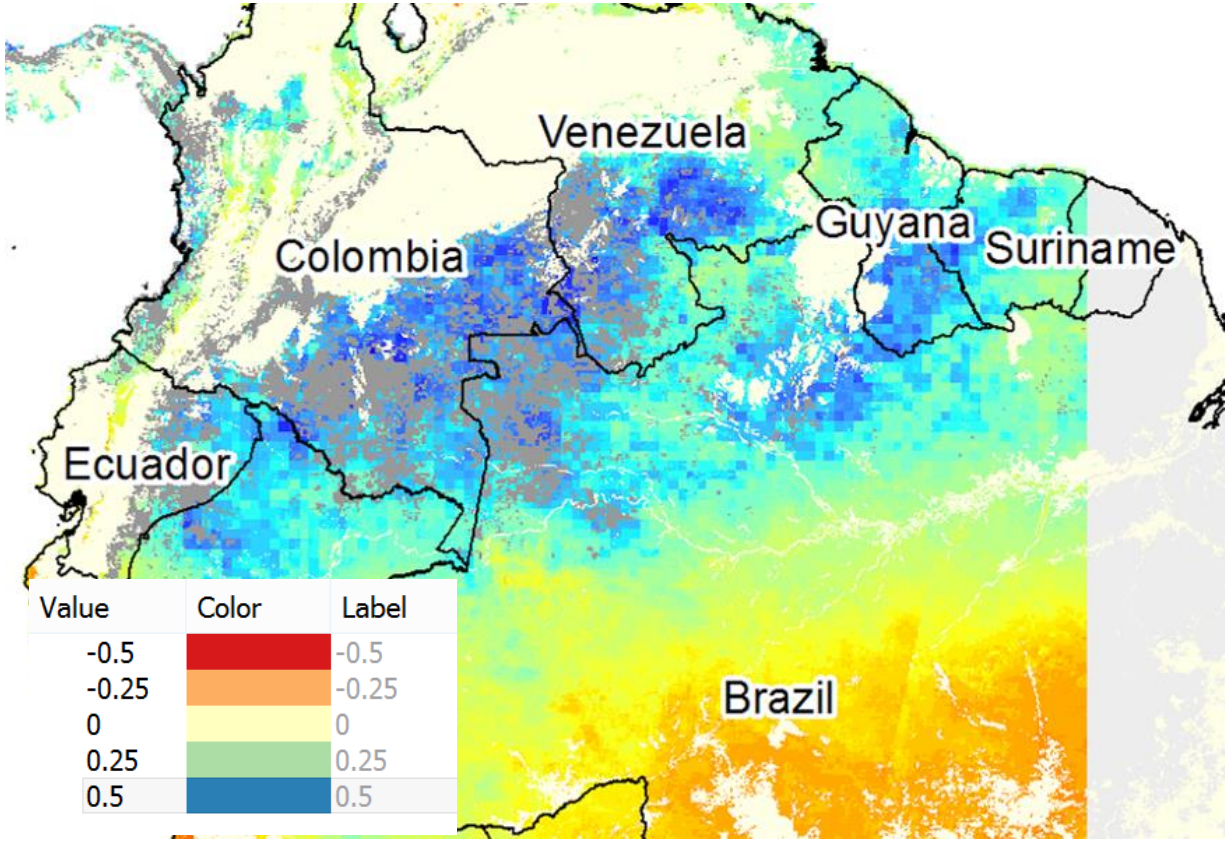
Session Two: Remote Sensing for Biodiversity

January 24, 2019

This session will focus on the Group on Earth Observations Biodiversity Observation Network (GEOBON), Marine Biodiversity Observation Network (MBON), and essential biodiversity variables.

Application Area: Land
Available Languages: English
Instruments/Missions: VIIRS, Terra, Landsat, Aura, NPP, MODIS, Aqua
Keywords: Conservation, Land-Cover and Land-Use Change (LCLUC), Satellite Imagery, Tools

Course Outline

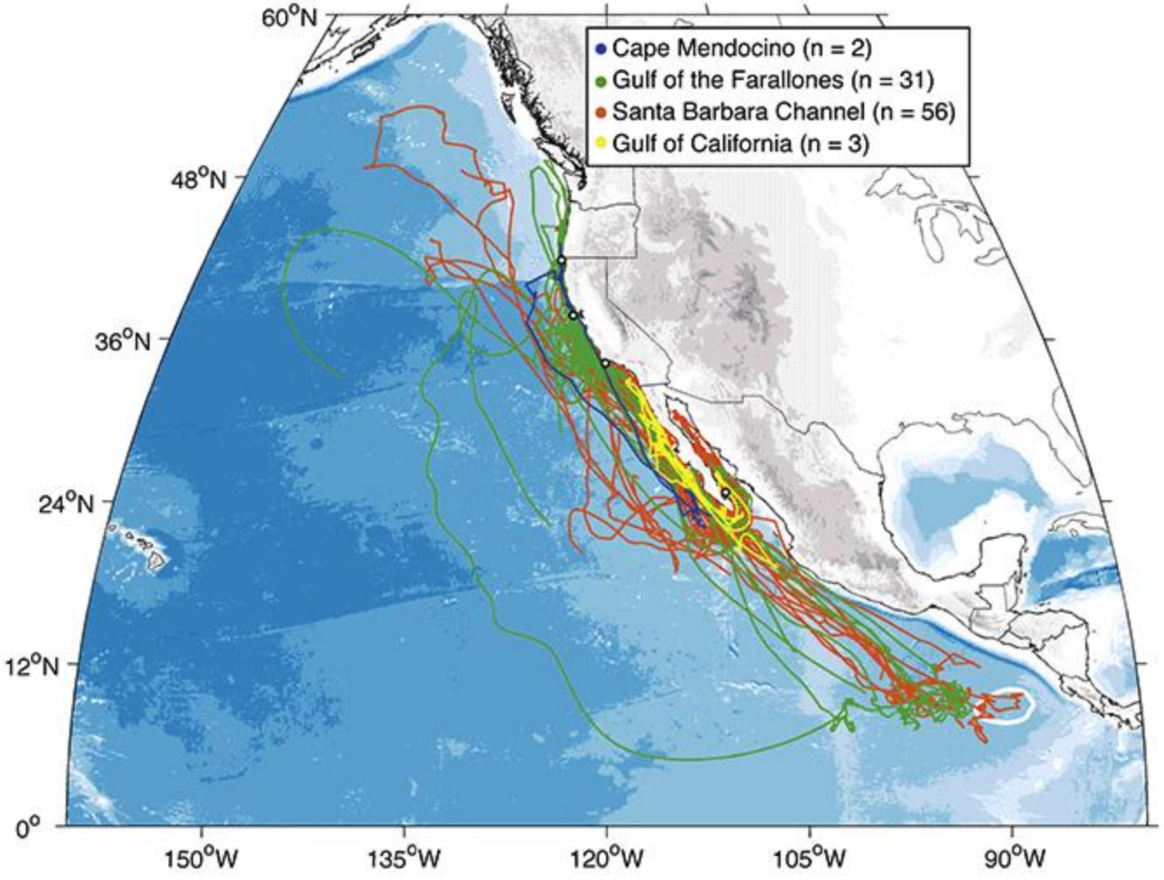


Session 1: Remote Sensing for Conservation

Session 2: Remote Sensing for Biodiversity

Session 1 Agenda

- Overview of remote sensing for conservation
- Habitat suitability
  - Uses of remote sensing data
  - Case study
- Species population dynamics
  - Uses of remote sensing data
  - Case studies
- Wildfire monitoring for conservation
  - Uses of remote sensing data
  - Case studies
- New satellite data for conservation

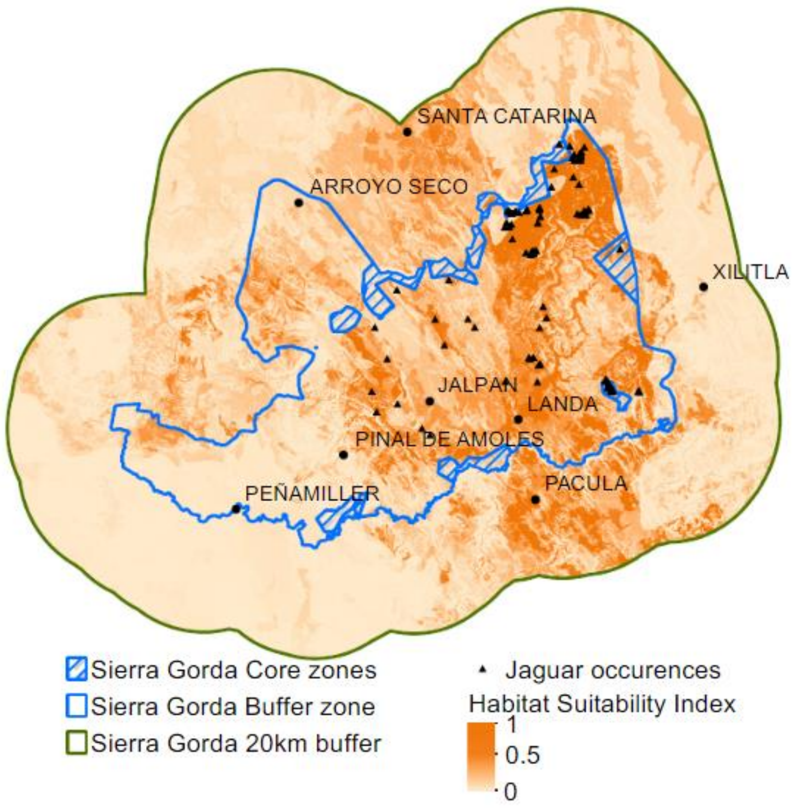


WhaleWatch, Helen Bailey, University of Maryland

Habitat Suitability

Habitat Suitability

- It is difficult to obtain actual species distributions, so suitable/potential habitat is identified
- Models are used to estimate potential habitat using data specifying species occurrences (presence-only) and other predictor variables that are important to the species.
- The models can be used to identify other regions with similar environmental conditions

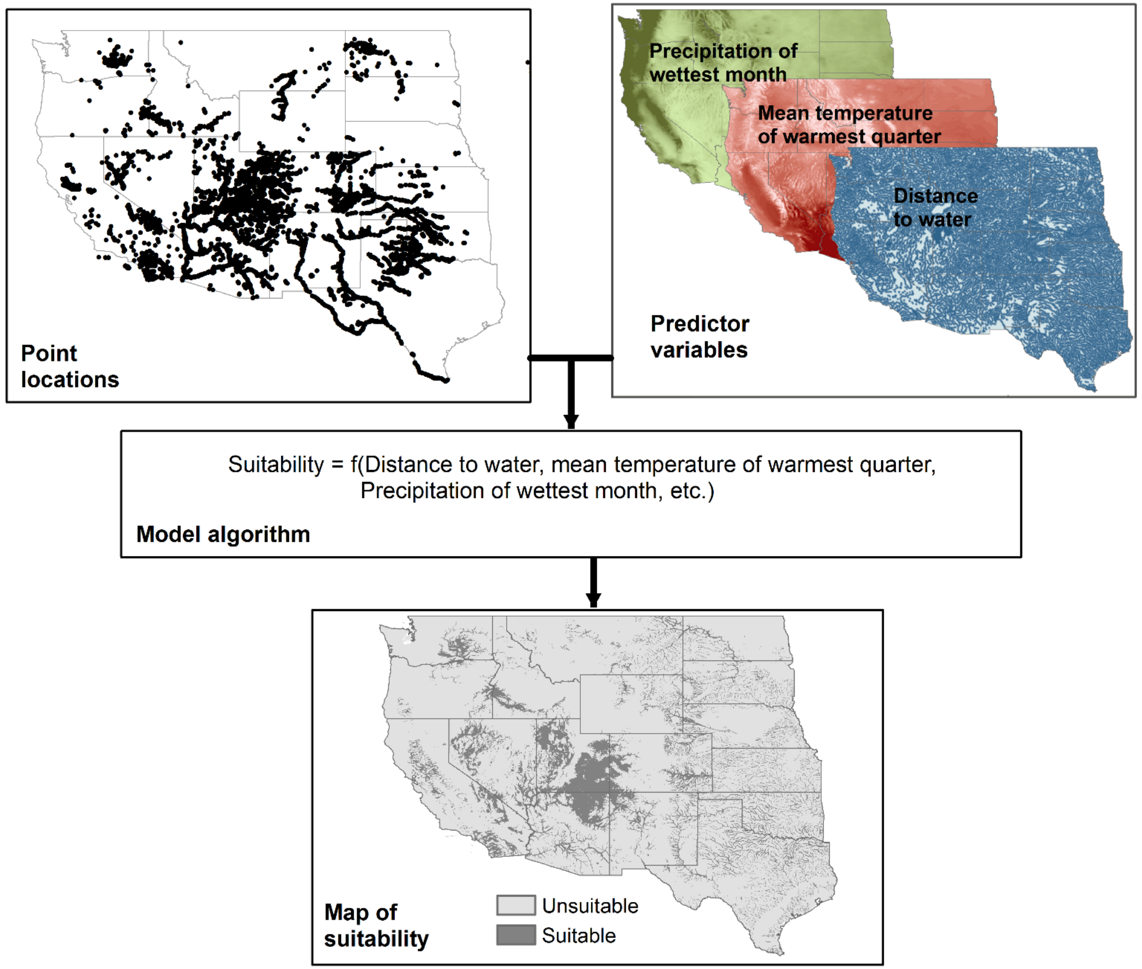


Habitat suitability map for jaguars in Mexico

Ramirez-Reyes et al. (2016),Effects of habitat suitability and minimum patch size thresholds on the assessment of landscape connectivity for jaguars in the Sierra Gorda, Mexico, Biological Conservation

Species Distribution Models

- The models use raster-based layers such as land use/land cover, elevation, and others as predictors of suitable habitats
- The predictor data is combined with ground-collected presence-absence or abundance data in empirical statistical models
- Predictor data could include: precipitation, temperature, elevation, land cover, vegetation indices, etc.



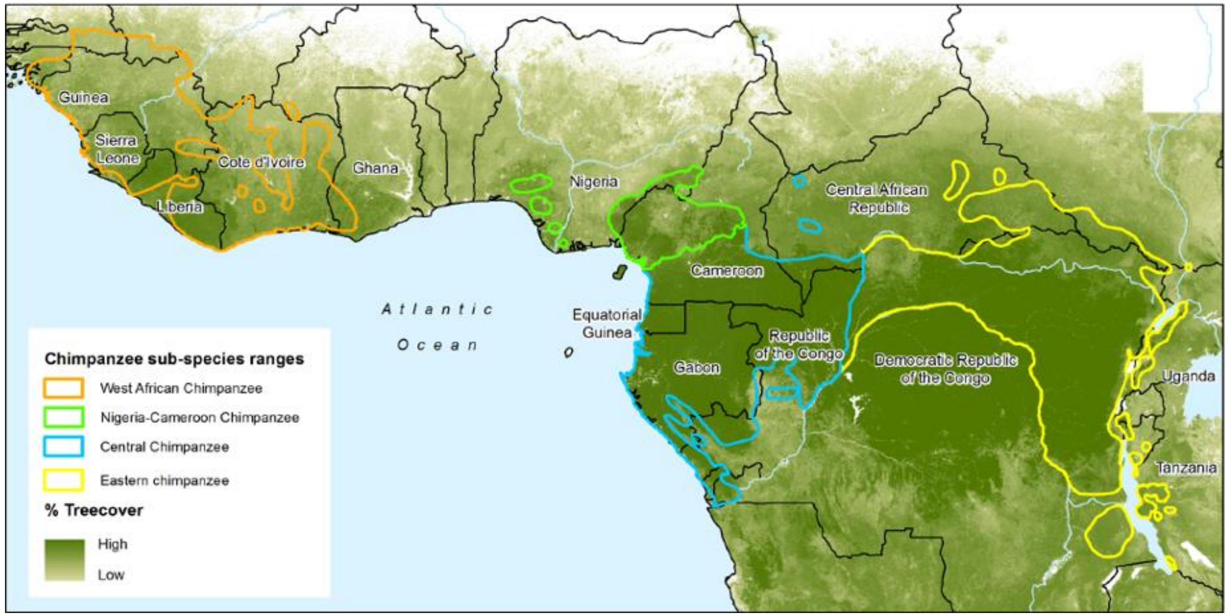
Jarnevich, C. S., T. J. Stohlgren, S. Kumar, J. T. Morrisette, and T. R. Holcombe, 2015, Caveats for Correlative Species Distribution Modeling: Ecological informatics, v. 29, p. 6-15.

Case Study

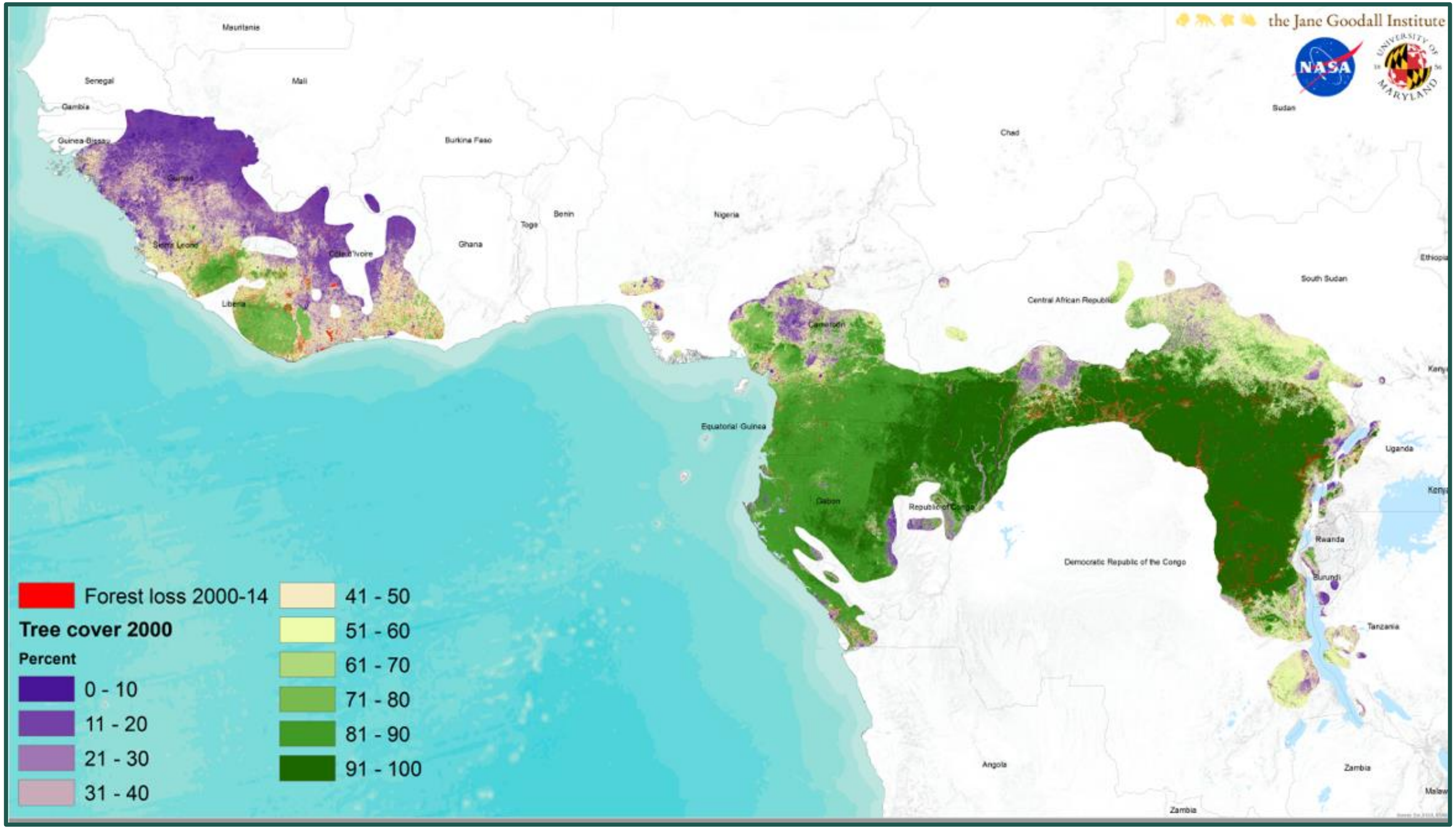

A Decision Support System to Monitor and Inform Chimpanzee Habitat Management
Lilian Pintea[1], Samuel Jantz[2], Nick Salafsky[4], Janet Nackoney[2], Matthew Hansen[2]
[1] the Jane Goodall Institute, Vienna, VA, USA
[2] Department of Geographical Sciences, University of Maryland, College Park, MD, USA
[3]Foundation of Success, MD, USA
the Jane Goodall Institute
UNIVERSITY OF MARYLAND
GLAD
FOUNDATIONS OF SUCCESS

DSS Objective & Geographic Scope

- Develop a practical DSS (Decision Support System) to be used by the Jane Goodall Institute and partners to annually monitor and forecast chimpanzee habitat conditions to support decision making from local to species range scales in Africa.
- DSS covers geographic ranges of all four sub-species of chimpanzees.
- Will enable systematic monitoring of habitat change over time.

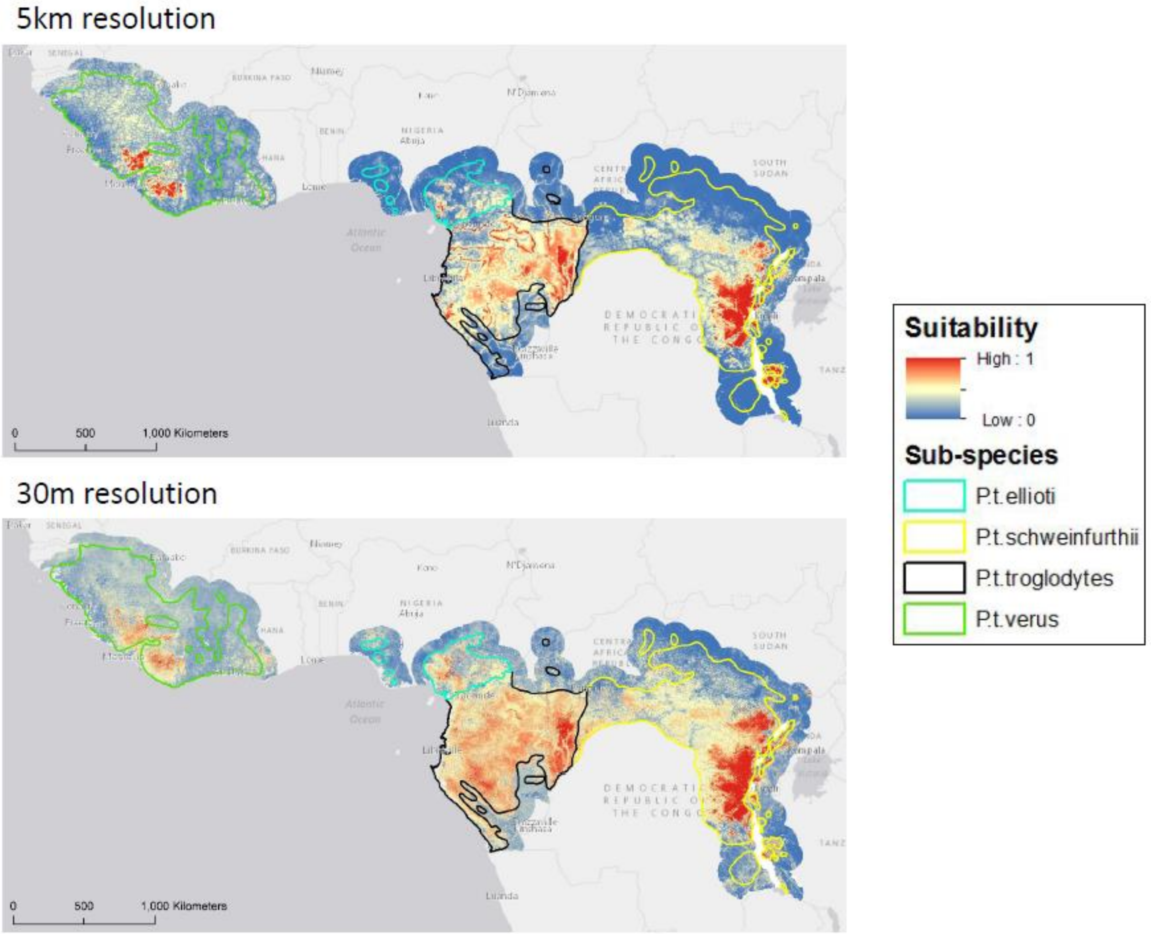


Monitoring Chimpanzee Habitat Loss



Habitat Suitability Map

- A habitat suitability map (at two different spatial resolutions) was developed using presence data and predictor variables such as bioclimatic data, forest cover products, human population density, proximity to roads and proximity to navigable rivers



Jantz et al. (2016) Landsat ETM+ and SRTM data provide near real-time monitoring of chimpanzee (Pan troglodytes) habitats in Africa, Remote Sensing

Satellite-Derived Input Data

15 Landsat ETM+ based "dynamic" variables derived from Hansen et al. (2013) data.

Spectral
Band 3 median reflectance 2000-2005
Band 4 median reflectance 2000-2005
Band 5 median reflectance 2000-2005
Band 7 median reflectance 2000-2005
Normalized difference (band4/band3)
Normalized difference (band4/band5)
Normalized difference (band4/band7)
band3/band5
band3/band7
band5/band7
Forest structure
Percent canopy cover
Canopy height
Percent bare ground
Disturbance and fragmentation
Proximity to forest loss (minimum 0.5 ha)
Proximity of interior forest to forest edge (minimum 1 ha patch size)
Topographic
Elevation
Slope
Proximity to steep slopes (>15º)
Proximity to rivers

5 Shuttle Radar Topography Mission based "static" variables.

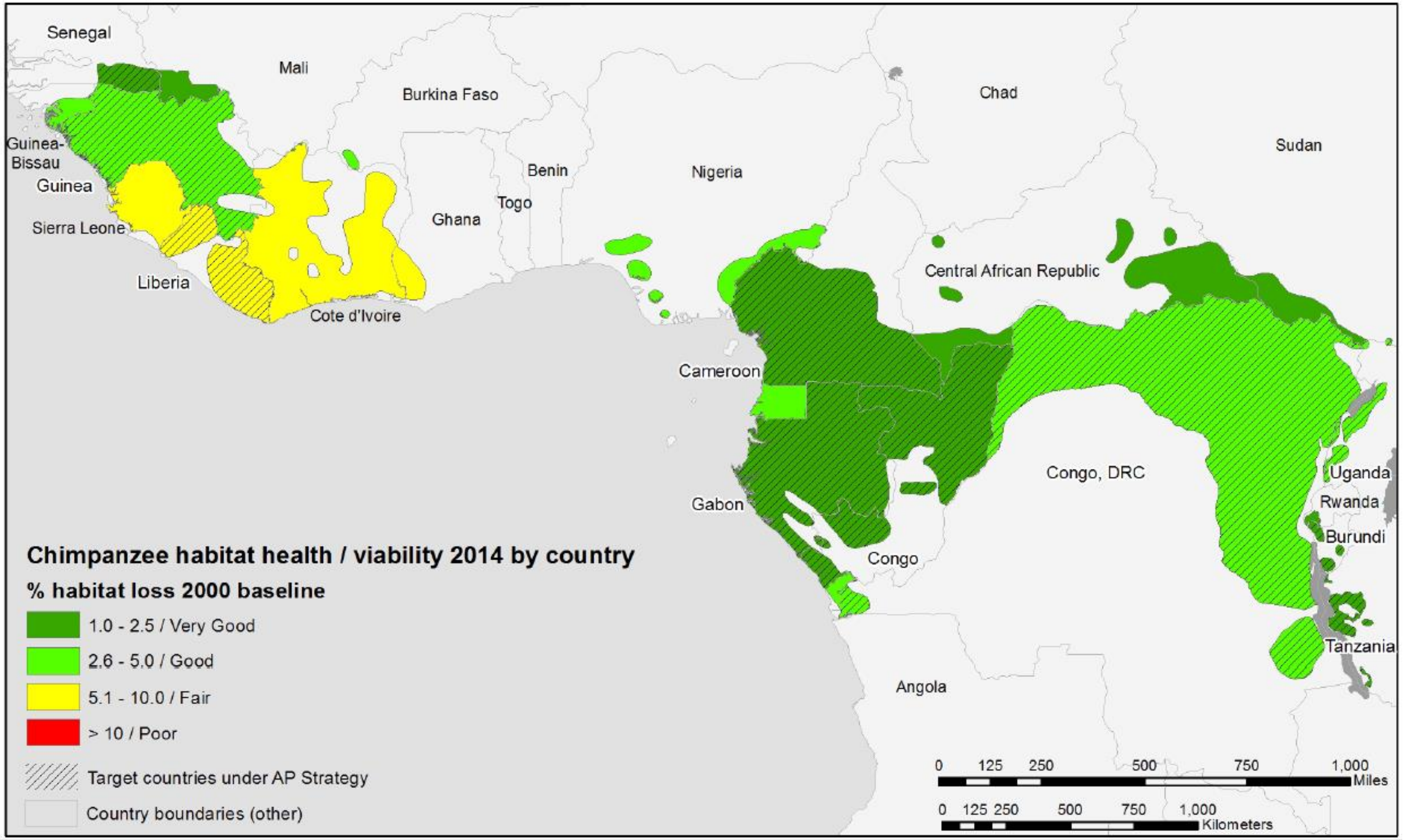
Crowdsourcing Data from Community Monitoring, Ranger Patrols, Research Surveys, and UAVs



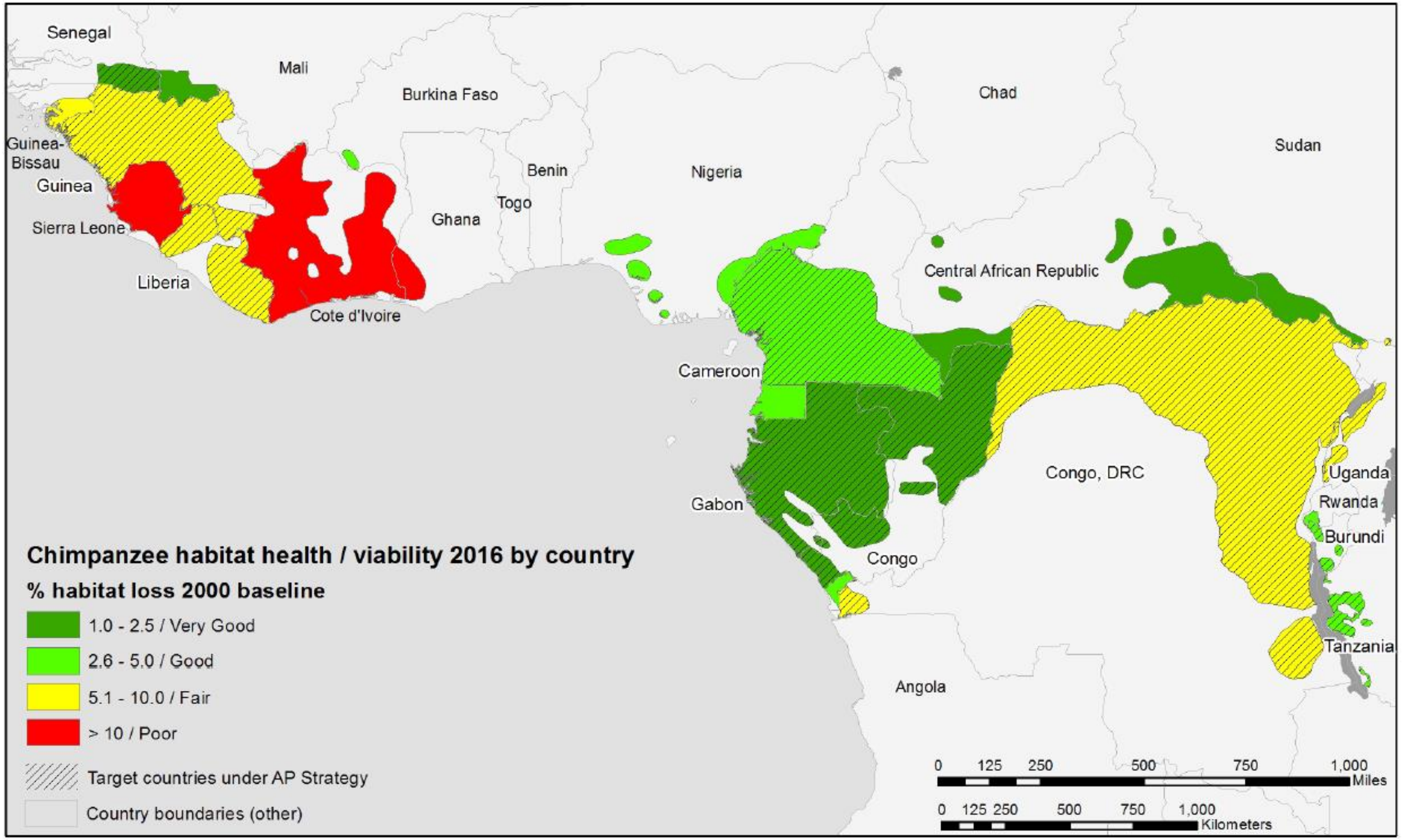




Habitat Suitability Results (2014)



Habitat Suitability Results (2016)



Species Population Dynamics

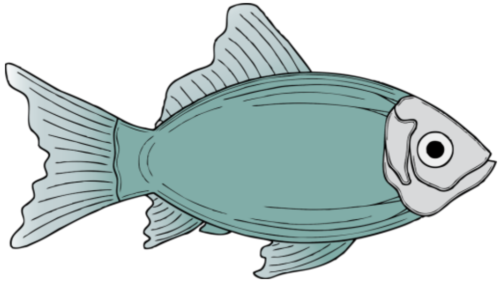
Species Population Dynamics

Variation of species geographic distributions and abundances in space and time

Challenges:

- How do we get that information at scales appropriate for use of satellite remote sensing??
- How do we get that information for very mobile species?

Example: Fish in rivers:



We know fish live in rivers, but where and how many?

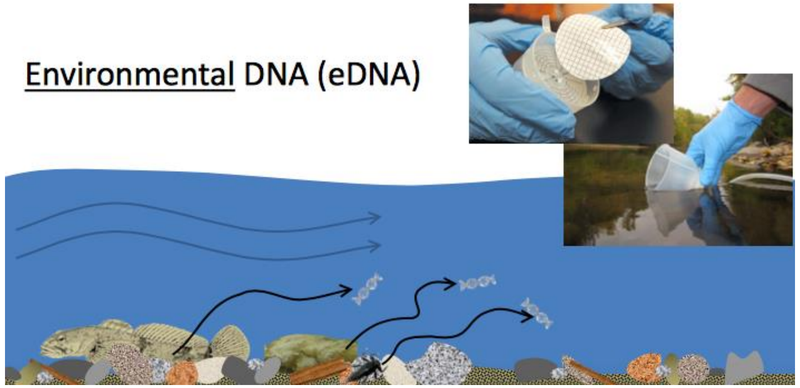
Collecting Species Data

There are several ways to collect species data for use with remote sensing:

Direct observations

Telemetry

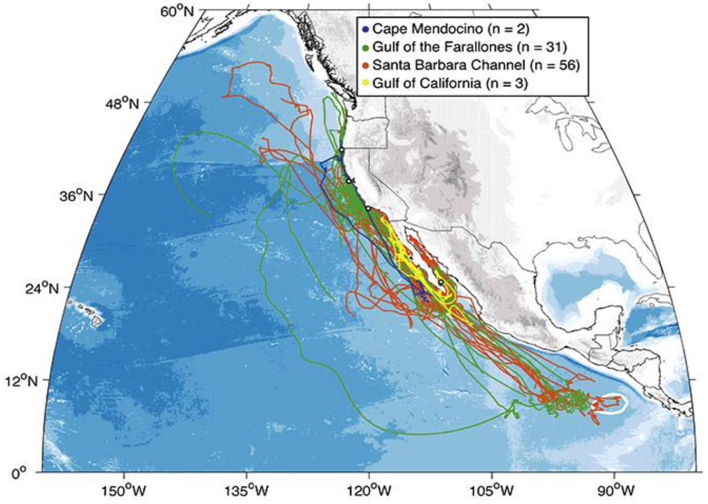
Camera traps



Case Study: WhaleWatch

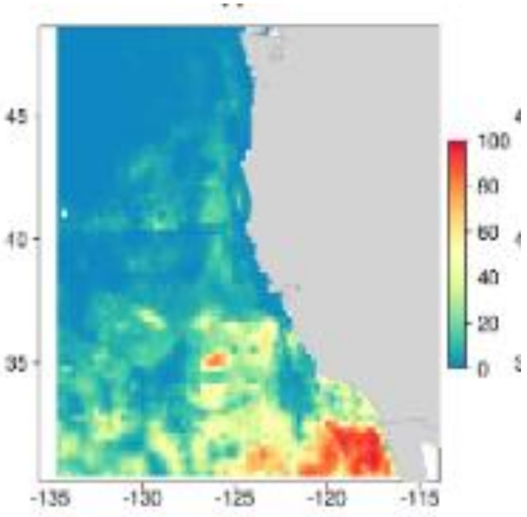
PI: Helen Bailey, University of Maryland

- Tool to help decrease whale mortality due to collisions with shipping and fishing gear
- Matched whale tag data with satellite measurements of sea surface temperature, chlorophyll concentration and sea surface height
- Tool calculates the likelihood of where whales will be present



Actual location of blue whales

Sea-surface temperature, Sea-surface height, Chlorophyll-a concentration



Likelihood of Blue whale occurrence for January 2017

Case Study: Climate Change, River Habitats and Salmonid Fishes

PI: Gordon Luikart, University of Montana

- How do demography and genetic factors interact with environmental factors across populations to assess vulnerability to climate change?

- What is eDNA?
  - Environmental DNA
  - DNA collected from the environment (i.e. water samples)instead of directly from organisms

Demographic and genetic data from eDNA

PI: Gordon Luikart, University of Montana

Case Study: Climate Change, River Habitats and Salmonid Fishes

PI: Gordon Luikart, University of Montana

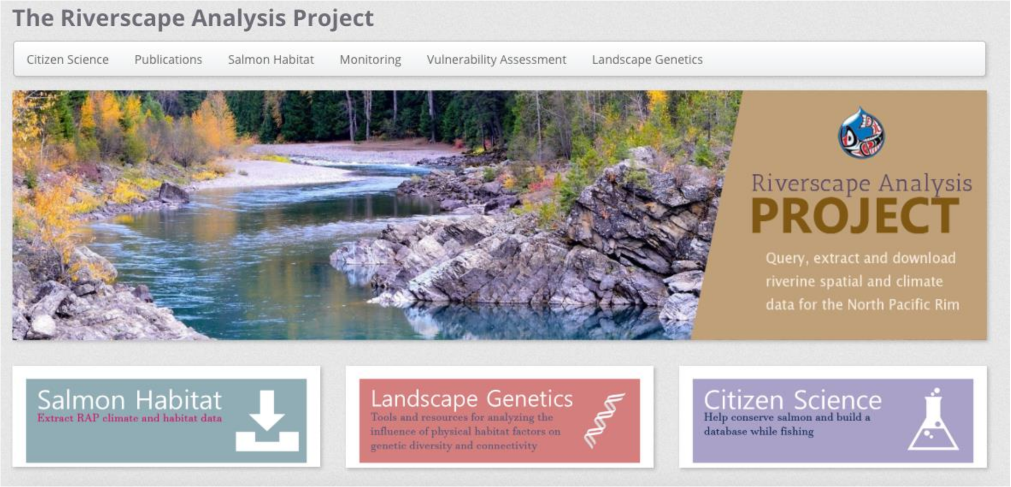
- Variation in Salmonid population productivity is related to environmental conditions and habitat quality/quantity
- Remote sensing variables are used to characterize environmental conditions

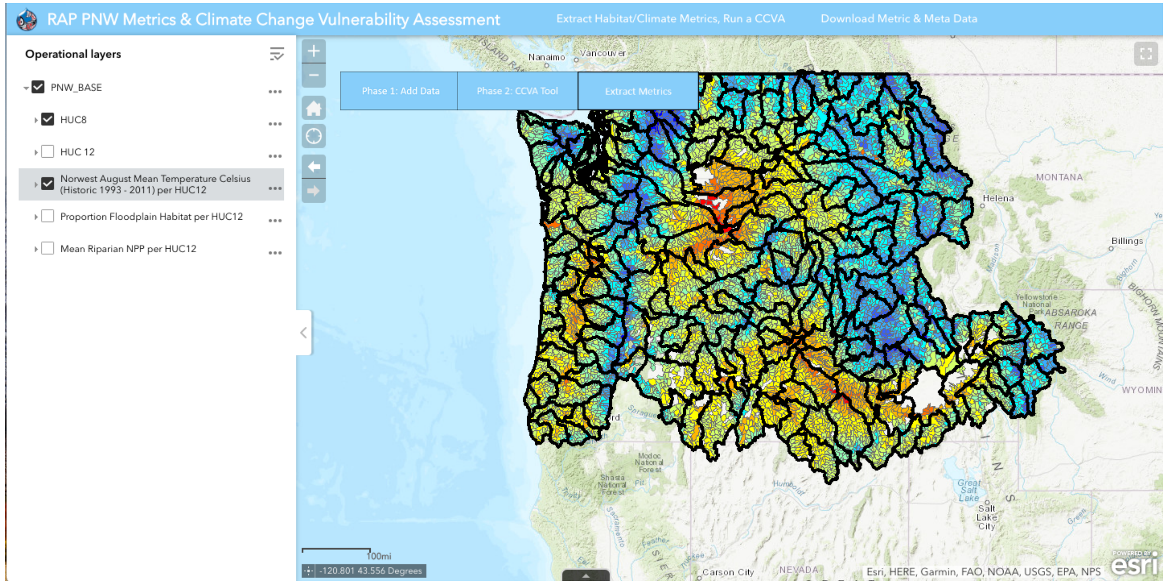
Climate Data	RS Mission/ Product
Freeze-Thaw Timing	**NASA SSM/I, AMSR-E**
Open Water	**NASA AMSR-E**
NorWeST Stream Temperature	**NASA Landsat TM** & NAIP
USFS Stream Flow	n/a
Future predictions Air Temperature, Precipitation, Runoff	NASA **NEX-DCP 30**

Habitat Quality Data	RS Mission/ Product
Drainage Density, Amount, and Sinuosity	**NASA SRTM** & NHDPlusv2
Productivity	**NPP**
Disturbance: NOAA CHAMP, Human Footprint, and NLCD 2011	**NASA GRUMP, GPWv3, DMSP, Landsat** (Landcover - % disturbance and % forested)
Channel and Valley Slope	**NASA SRTM**
Others: Glaciers, Dams, Elevation, Waterbodies	various

Riverscape Analysis Project (RAP)

- Web-based support tool for salmonid conservation in the Columbia River Basin (US Pacific Northwest)
  - Includes basic Climate change vulnerability assessment tools
  - Landscape genetic tools
- http://www.ntsg.umt.edu/rap/
- *Stay tuned for a webinar in 2019 on remote sensing in freshwater habitats!!*





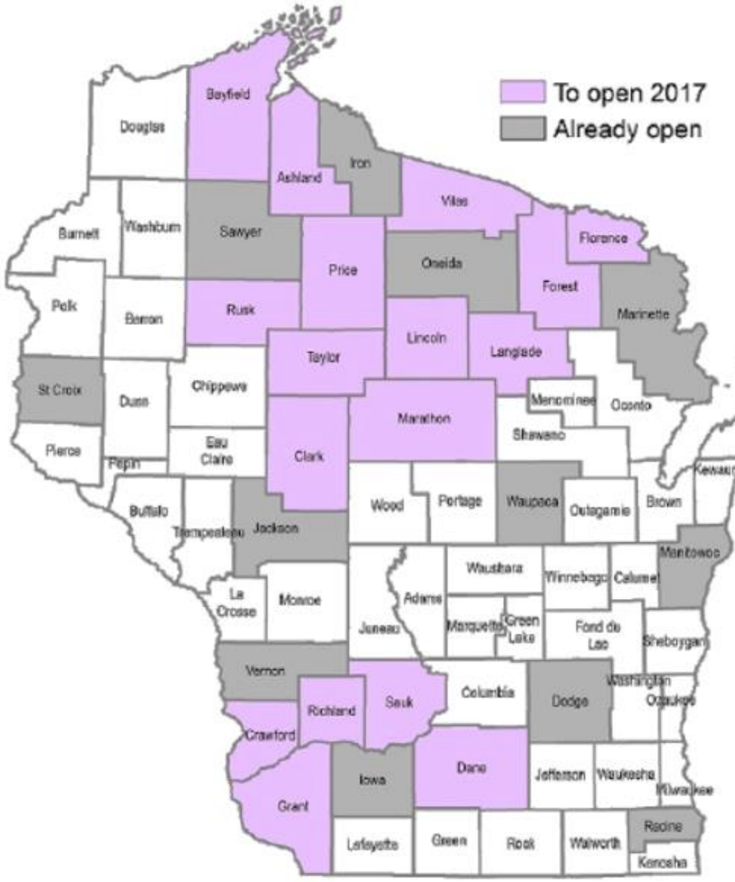
Case Study: Snapshot Wisconsin

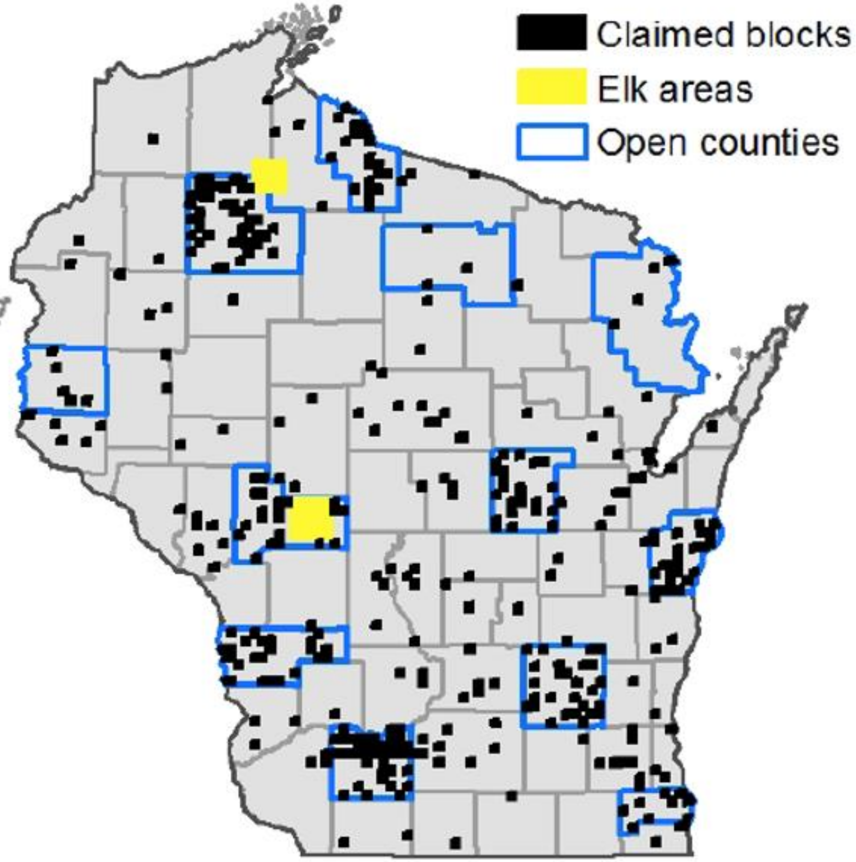
PI: Phil Townsend, University of Wisconsin

- Monitoring wildlife with trail cameras and a crowdsourcing platform in Wisconsin
- Combining information about animal species from trail cameras with remote sensing data to characterize habitat

SNAPSHOT WISCONSIN

600 Volunteers, 800 Cameras, 10 Million Photos





Project statistics

998 Enrolled volunteers maintain

1,152 Cameras, returning

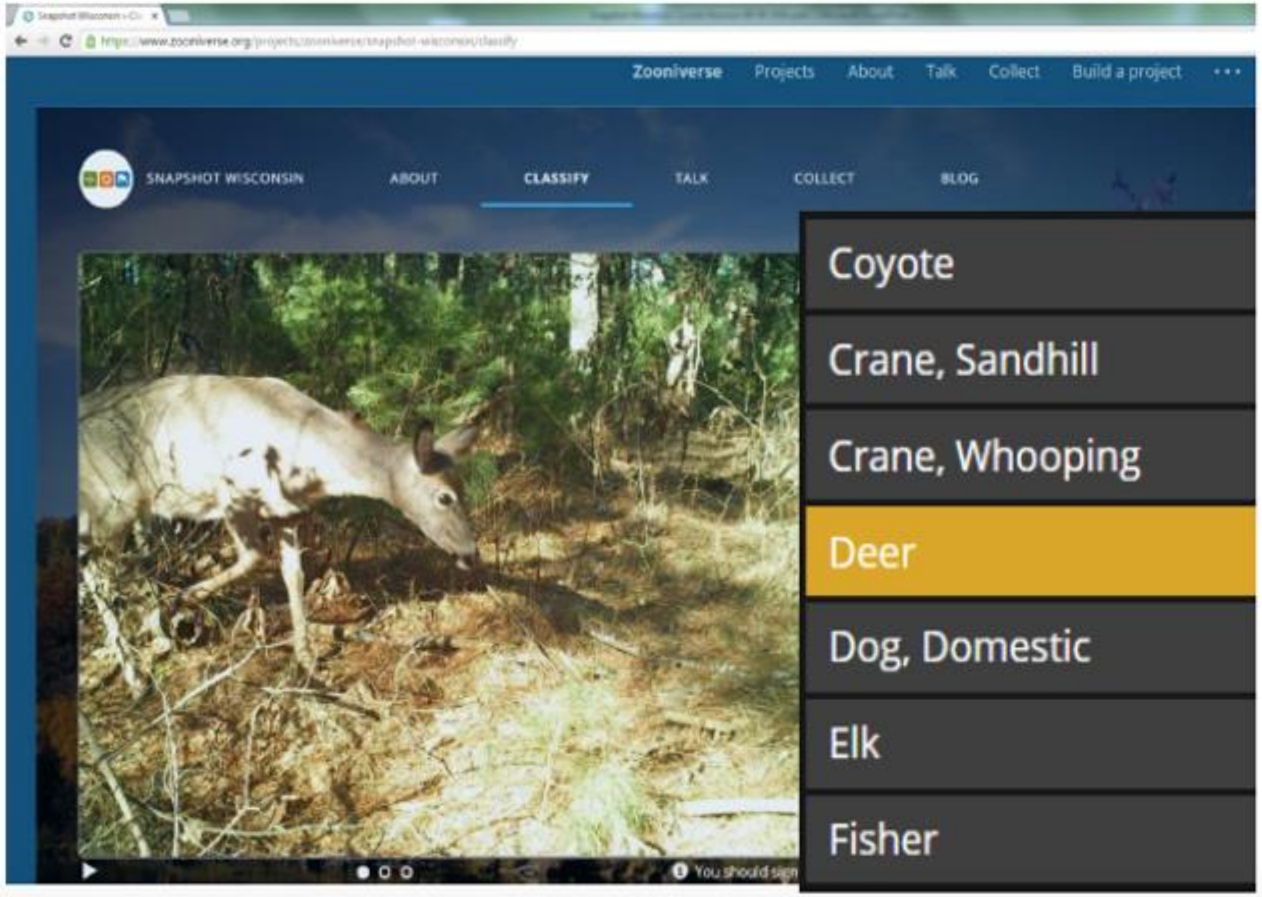
20,411,915 Photos

(Updated May 23, 2018)

Crowdsourcing with Zooniverse

5,000 volunteers, 1 million classifications, Online Global Community

snapshotwisconsin.org

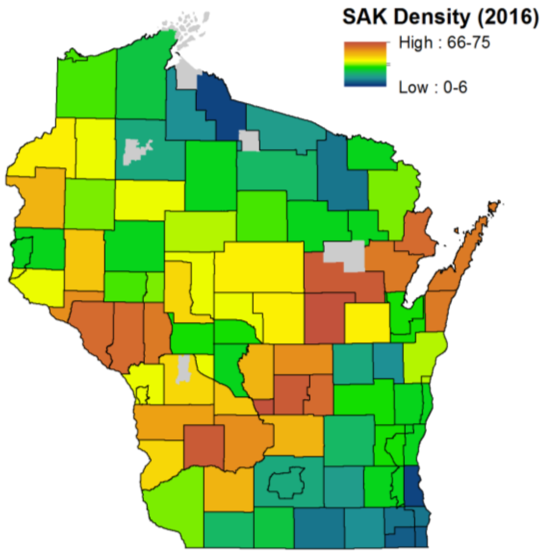


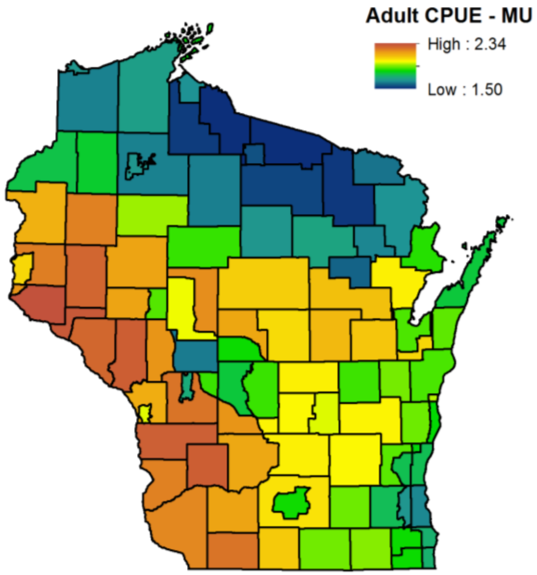



Estimating animal distributions

- Deer populations are currently estimated using fall harvest (hunting) statistics, assumptions related to doe productivity and other factors

- Combining camera trap data with remote sensing data results in better estimates of deer population size and locations



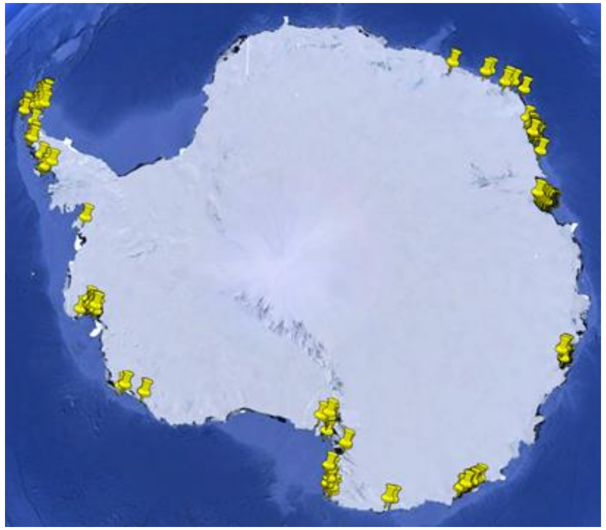


Comparison of deer abundance estimates using fall harvest statistics (left) with using camera trap and remote sensing data (right)

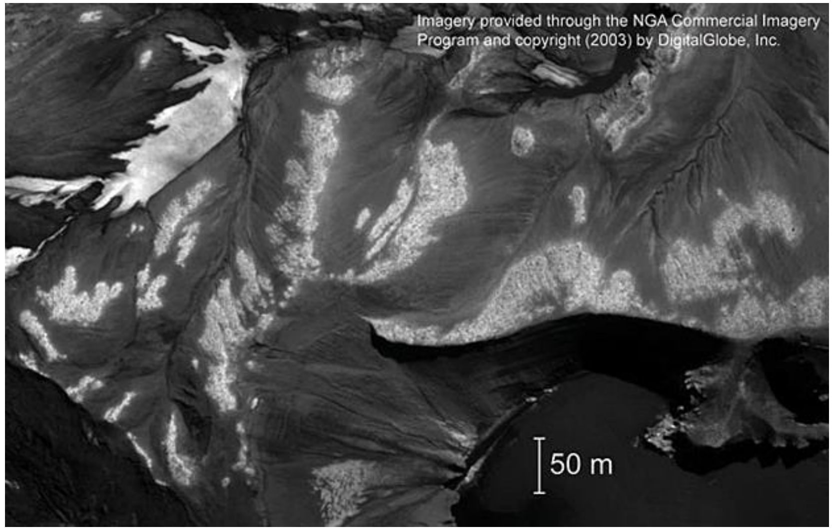
Case Study: Detecting Penguins in Antarctica

PI: Heather Lynch, Stony Brook University

- Landsat imagery was used to explore for penguins and seabirds over the entire continent of Antarctica
- Imagery can be used to detect guano from large colonies to determine location and abundance



Locations of Adélie penguin colonies identified using Landsat



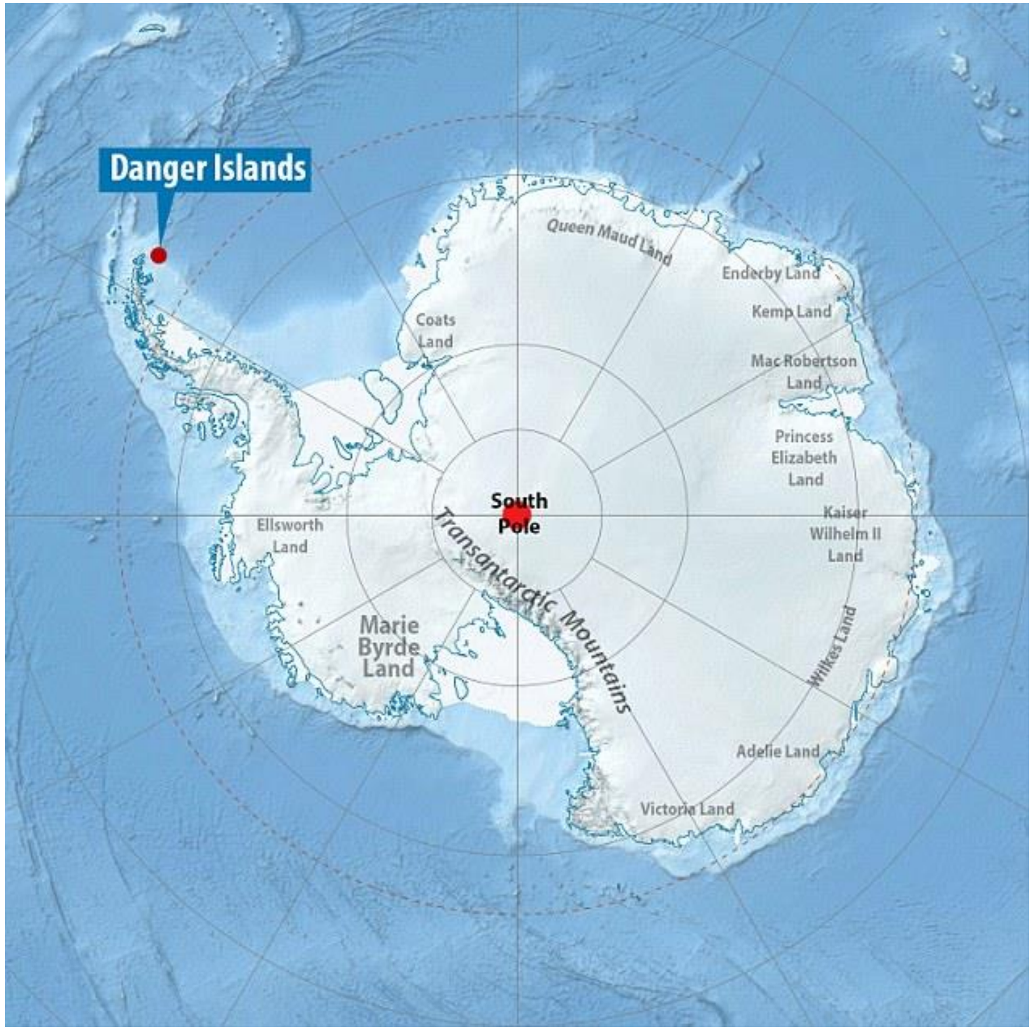
High spatial resolution image of guano on rocks in Antarctica

Images courtesy of Heather Lynch

Case Study: Detecting Penguins in Antarctica

PI: Heather Lynch, Stony Brook University

- The team discovered several penguin and petrel "mega-colonies"
- They acquired funding to send a team to the Danger Islands based on Landsat detection of a mega colony of penguins
- The Danger Island colonies were not considered a high priority for conservation but this is now being revised as a direct result of these discoveries



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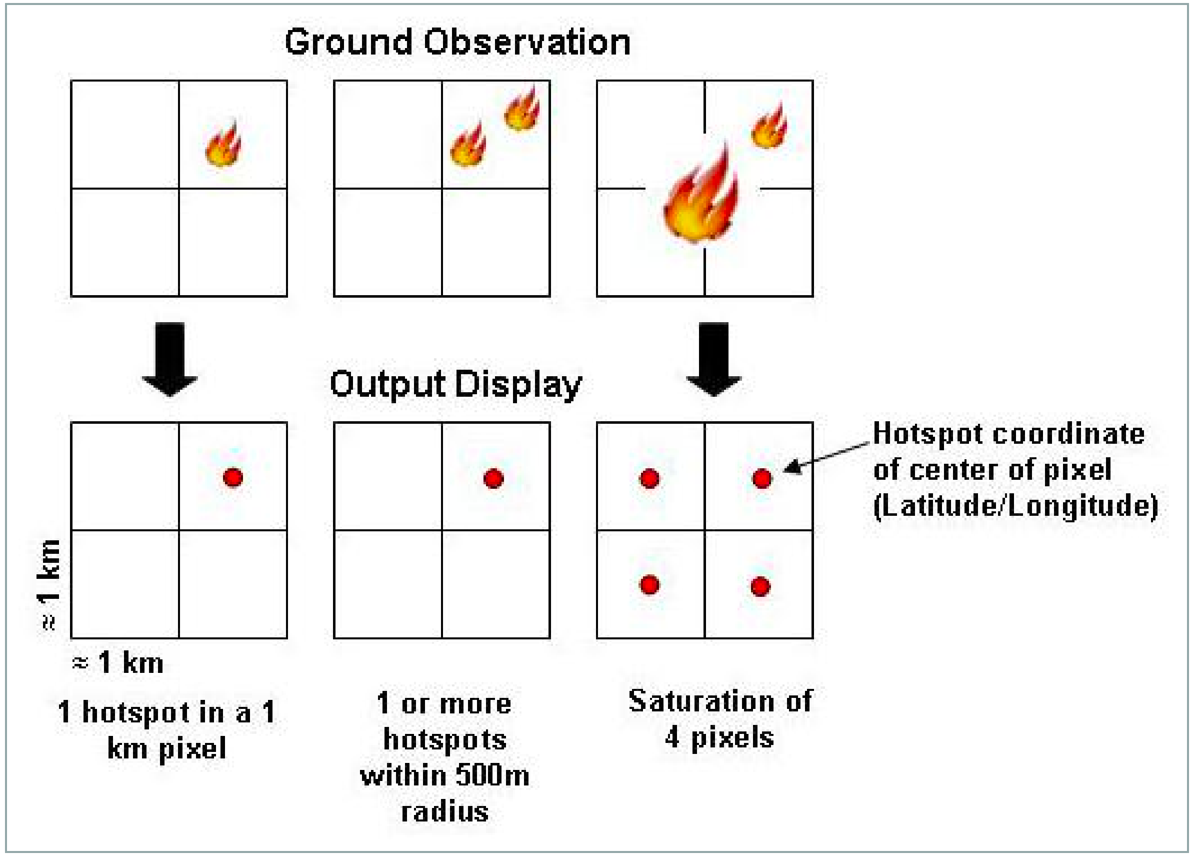
Wildfire Monitoring for Conservation

Satellite Imagery for Wildfire Monitoring

- MODIS Active Fire Products
  - Spatial Resolution: 1km
  - Available for the last 24 and 48 hours, and 7 days
- What size fires can be detected?
  - Depends on many different variables (scan angle, sun position, amount of smoke, etc.)
  - MODIS routinely detects fires 1000 m2 in size
  - Under very good observing conditions, flaming fires $^{1}/_{10}{}^{th}$ this size can be detected

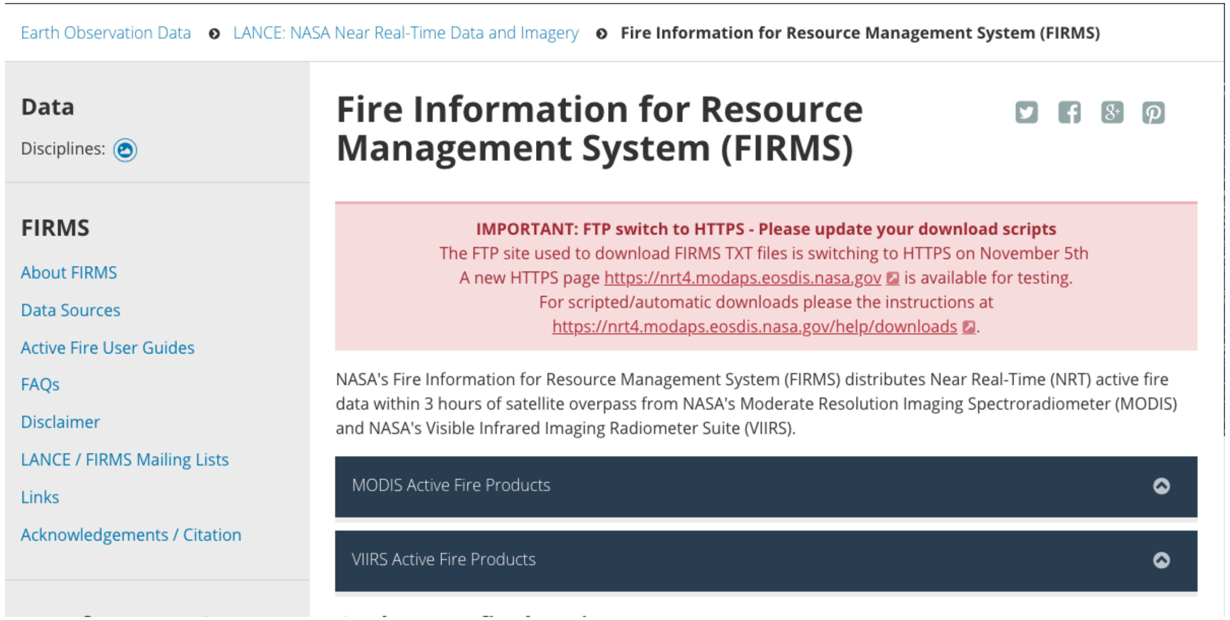


Satellite Imagery for Wildfire Monitoring

- VIIRS Active Fire Products
  - Spatial resolution: 375m and 750m
  - Available every 24 and 48 hours, and 7 days
- Provides a greater response over smaller fires
- Improved nighttime performance

Fire Information for Resource Management System (FIRMS)

- Distributes Near-Real Time active fire data within 3 hours of satellite overpass
- Web-based fire map
- Fire email alerts
- Active fire data download (SHP, TXT, KML)
- Archive download
- https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms



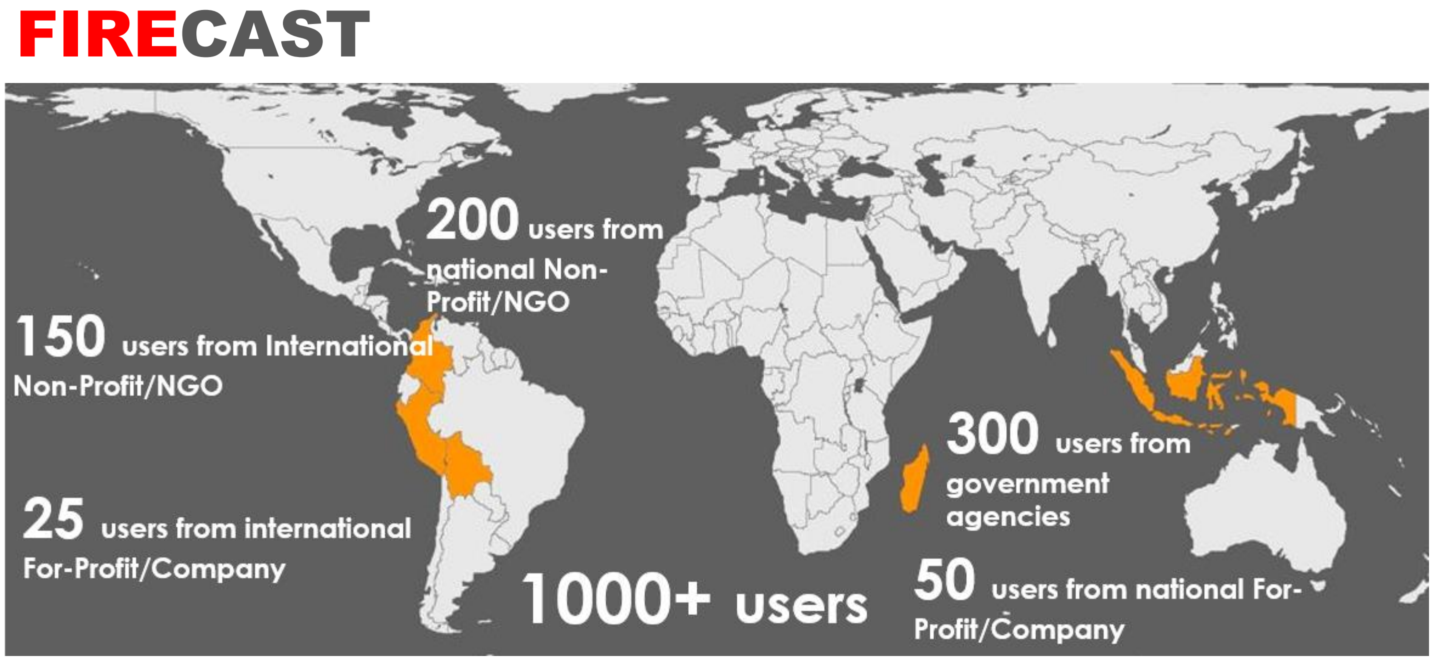
FIRECAST

Forests in Crisis

- 7 million ha of tropical forest are lost every year
- Resulting in biodiversity loss, carbon emissions, and degradation of ecosystem services
- The main drivers in the tropics are
  - Agricultural fires
  - Commodity expansion (palm oil, soy, pulp)
  - Mining
  - Timber extraction

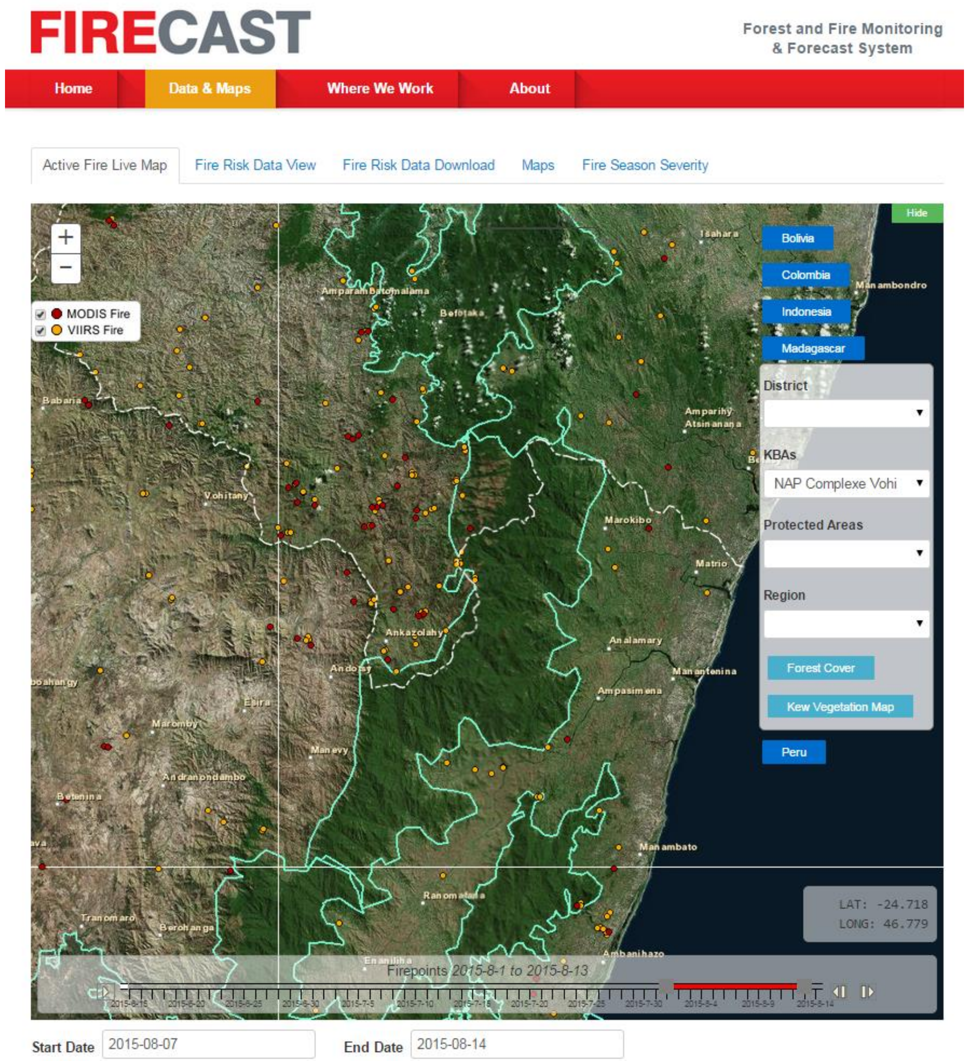
Solution

- FIRECAST uses satellite observations to track ecosystem disturbances such as fires, fire risk conditions, deforestation and protected area encroachment, and delivers information to decision makers through email alerts, maps and reports



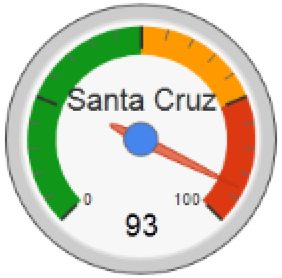
FIRECAST Products

- Active Fire Detection
  – Hourly MODIS and VIIRS active fire alerts
- Fire Risk Forecasting
  – Satellite-based estimates of weather conditions to generate a daily indicator of forest flammability risk
- Fire Season Severity Forecasting
  – Sea surface temperature in the North Atlantic and Pacific help forecast the intensity of fire activity several months before the fire season
- https://firecast.conservation.org

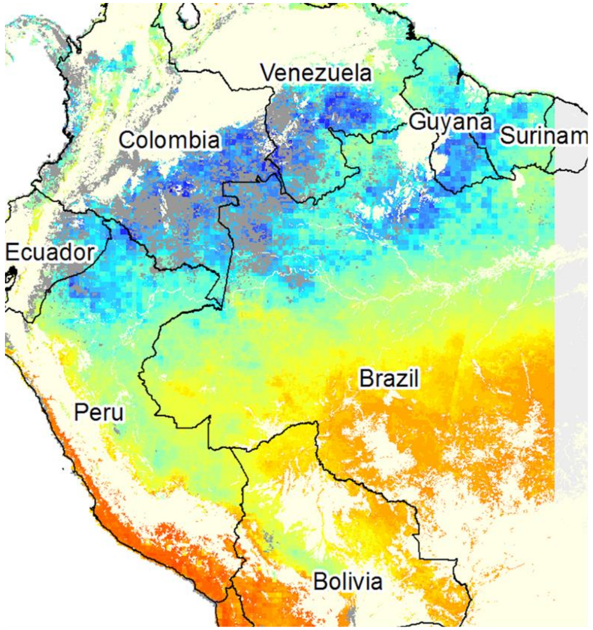


Case Study: Bolivian NGO

- Fundación Amigos de la Naturaleza (FAN) has been using FIRECAST's daily forest flammability risk data as an input into a national flammability alert system.
- FAN also works with 34 Bolivian communities, teaching them the ecosystemic, health and economic risks of burning agricultural fields during peak fire conditions



Daily fire risk index



Case Study: Peru

- Alto Mayo Reserve
- FIRECAST is integrated with in situ monitoring and UAV (drone) reconnaissance to investigate and report illegal logging

Summary

- Satellite remote sensing data can be used for assessing habitat suitability
- Species data collected directly or remotely can be combined with satellite remote sensing to understand their habitat and movement
- Satellite remote sensing wildfire products and tools can be used to understand how wildfire will impact protected areas

Land Management Webinars
https://arset.gsfc.nasa.gov/land/webinars

Introduction to Remote Sensing for Conservation Management

Remote Sensing of Forest Cover and Change Assessment for Carbon Monitoring

Introduction to Remote Sensing for Coastal and Ocean Applications

Introduction to Remote Sensing for Scenario-Based Ecoforecasting

Advanced Webinar: Techniques for Wildfire Detection and Monitoring
Advanced Webinar: Land Cover Classification with Satellite Imagery
Advanced Webinar: Accuracy Assessment of a Land Cover Classification
Advanced Webinar: Change Detection for Land Cover Mapping

From Earth Observations to Earth Applications: Satellite Applications for Biodiversity Conservation

Contacts

- ARSET Land Management & Wildfire Contacts
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  – Amber McCullum: AmberJean.Mccullum@nasa.gov
- General ARSET Inquiries
  – Ana Prados: aprados@umbc.edu
- ARSET Website:
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