National Aeronautics and Space Administration

Connecting Citizen Science with Remote Sensing

Juan L. Torres-Pérez, Amber McCullum, Britnay Beaudry, & Guest Presenters Peder Vernon Nelson and Russanne Low

Jan 31, 2023

Course Structure and Information

- Three, 1.5-hour sessions on January 24, 26, and 31
  - **English:** at 11:00am - 12:30pm EST (UTC-5:00)
  - **Spanish:** at 2:00 – 3:30pm EST (UTC-5:00)

- Each session will feature lecture and a Q&A session where instructors will be online to answer questions

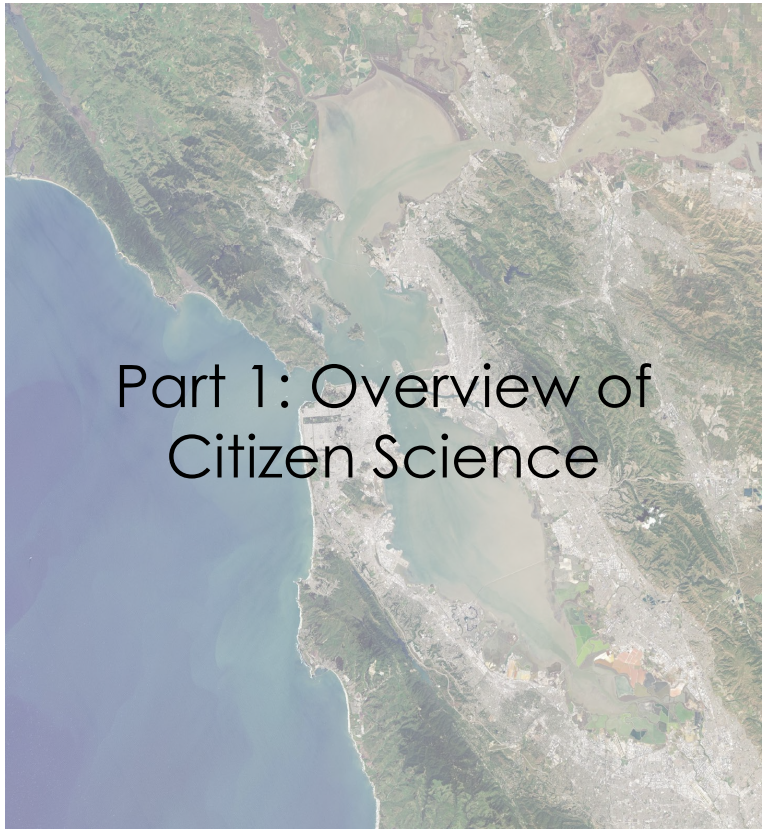
- Webinar recordings and PowerPoint presentations can be found after each session at: https://appliedsciences.nasa.gov/join-mission/training/english/arset-connecting-citizen-science-remote-sensing

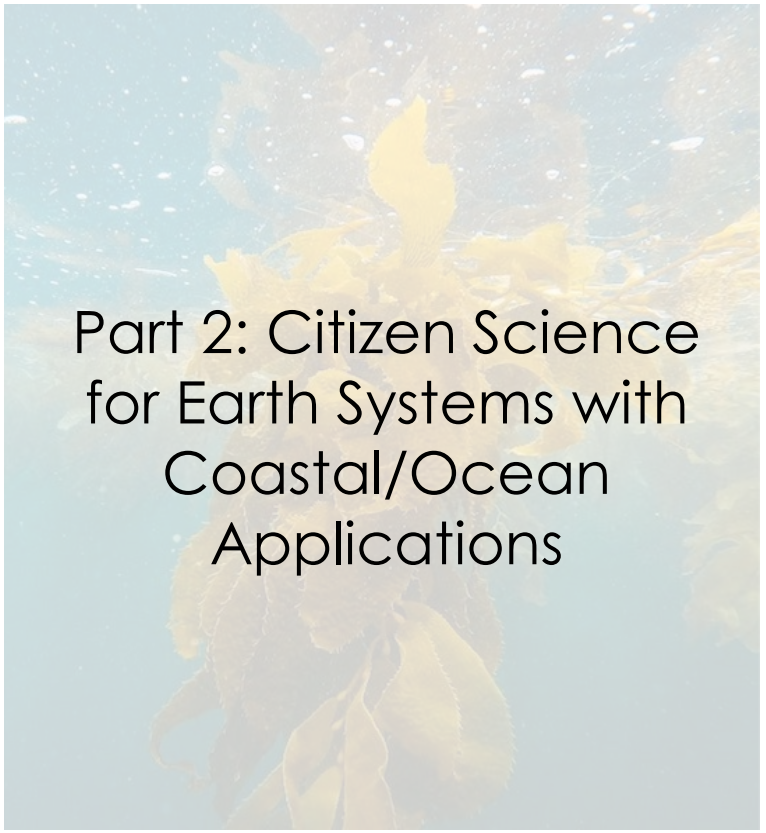
- For additional questions please email:
  - Juan L. Torres-Pérez (juan.l.torresperez@nasa.gov)
  - Amber McCullum (amberjean.mccullum@nasa.gov)
  - Britnay Beaudry (britnay.beaudry@nasa.gov)

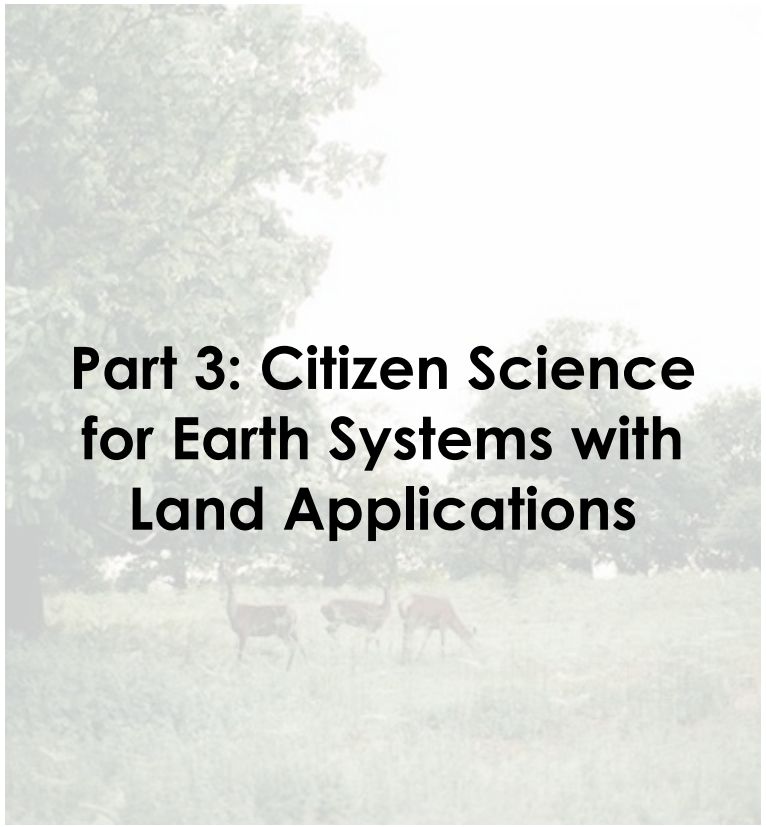
Homework and Certificates

- **Homework:**
  - One homework assignment (available at the end of Session three of this webinar series)
  - Answers must be submitted via Google Forms
  - **HW Deadline: February 14th**
- **Certificate of Completion:**
  - Attend all three live webinars
  - Complete the homework assignment by the deadline (access from ARSET website)
  - You will receive certificates approximately two months after the completion of the course from: marines.martins@ssaihq.com

Course Outline







Learning Objectives

By the end of this training, attendees will be able to:

- Outline key aspects of citizen science projects including:
  - Community engagement and effective communication
  - Motivations, ethics, and policies
  - Data quality assurance and accessibility
- Discover case study examples of the use of Earth Observations for NASA projects
- Summarize applications of Earth Observations for citizen science

Part 3 Agenda

- Brief highlights of popular citizen science projects that relate to Earth Observations
- Project examples:
  - Soundscapes to Landscapes
  - Snapshot Wisconsin
    - With contributions from Jennifer Stenglein, Wisconsin Department of Natural Resources
  - GLOBE Observer Mosquito Habitat Mapper and Land Cover Tools
    - With guest speakers Peder Vernon (Oregon State University; Science Lead, NASA GLOBE Observer Land Cover) and Russanne Low (Institute for Global Environmental Strategies, Arlington; Science Lead, NASA GLOBE Observer Mosquito Habitat Mapper)

  - Fresh Eyes on Ice and Arctic and Earth SIGNs
    - With contributions from Katie Spellman, Research Assistant Professor, University of Alaska Fairbanks, International Arctic Research Center
- Q&A

Popular Citizen Science Tools and Projects

National Phenology Network (NPN)

- A national-scale monitoring and research initiative
  - Collecting, organizing, and delivering phenological data, information, and forecasts
  - Support mgmt. and decision-making
- Nature's Notebook: A program designed for scientists and non-scientists to collect phenology observations for plants and animals

TRACKING Seasonal CHANGES IN PLANTS AND ANIMALS

Nature's Notebook

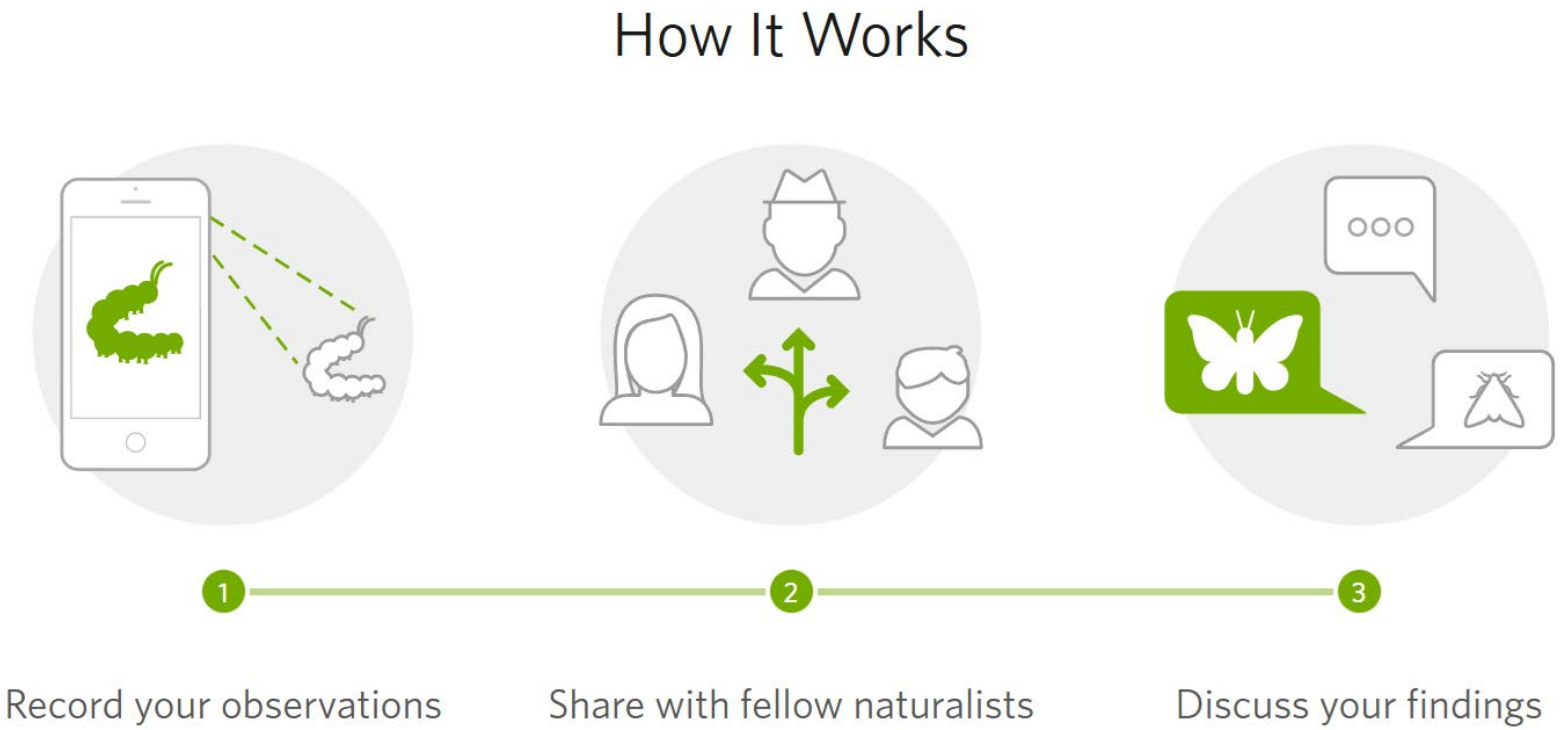
For scientists, naturalists, volunteers, land managers, park rangers, and YOU!

Nature's Notebook Data Locations. Image Credit: NPN

iNaturalist

https://www.inaturalist.org

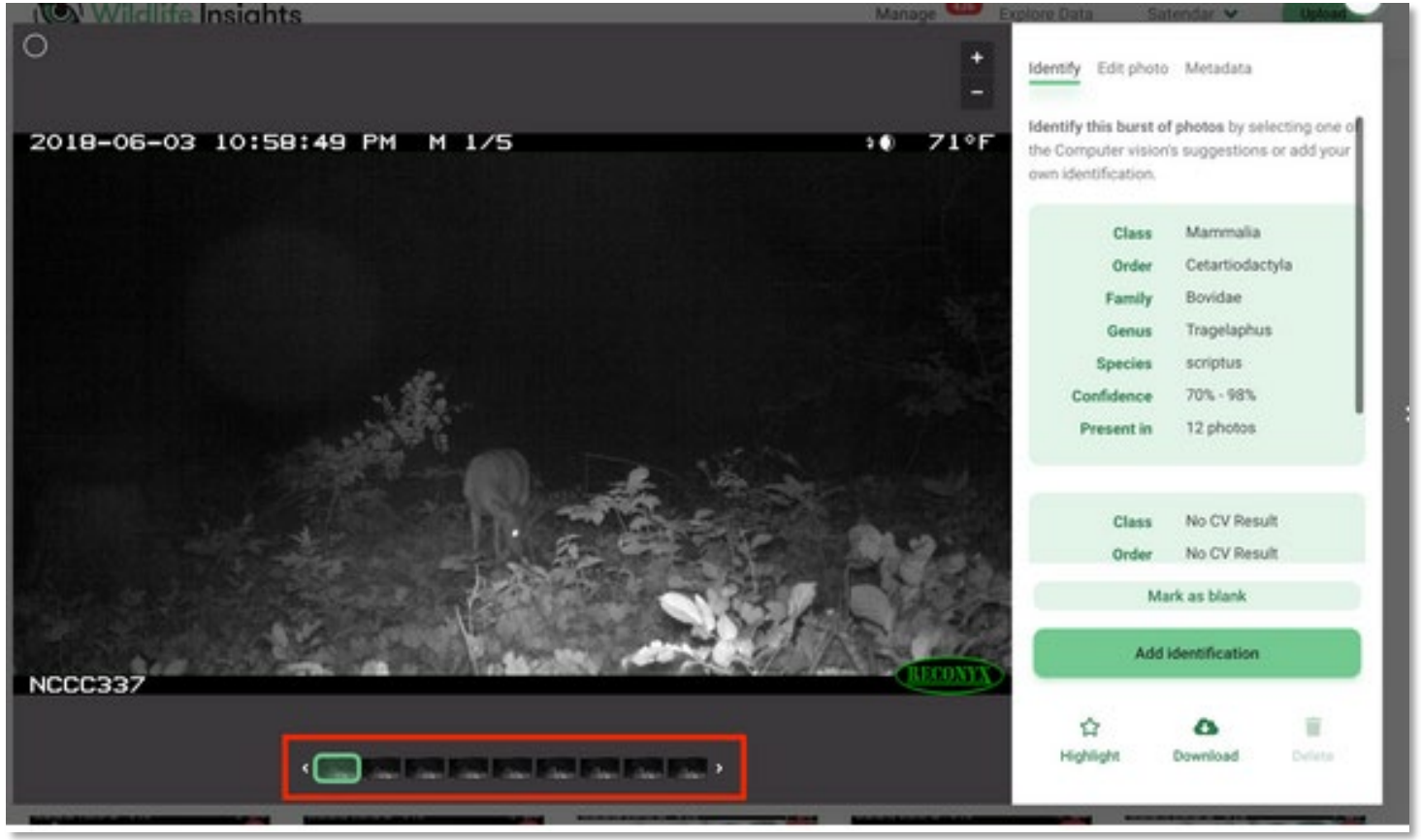
- Citizen science smartphone application for recording and sharing species information
- Connect with other observers
- Contribute to a specific project
- Hold events for field campaigns
- Share data with GBIF



Wildlife Insights

https://www.wildlifeinsights.org

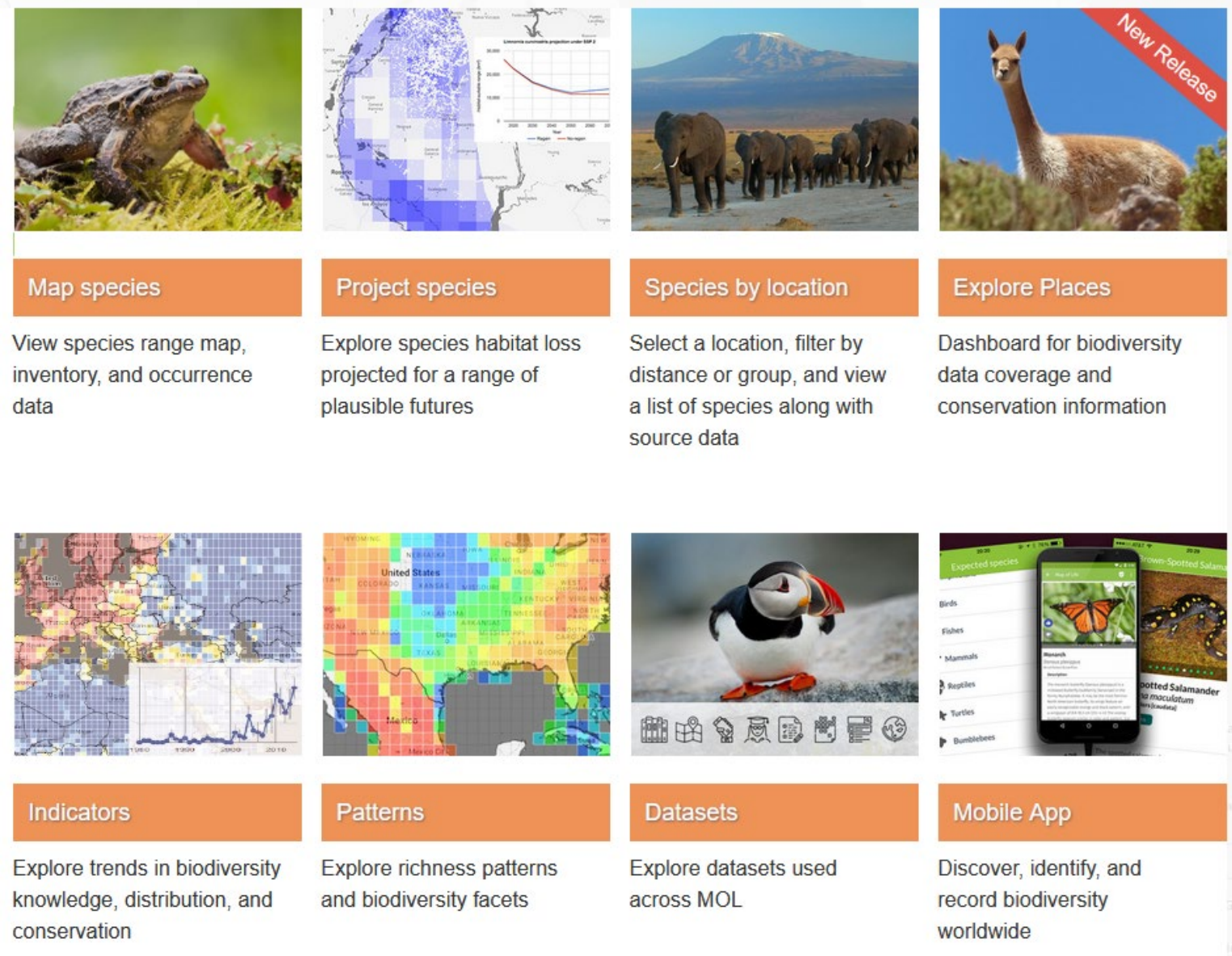
- Collection, dissemination, and analysis of camera trap data globally
- Combines field and sensor expertise, cutting-edge technology, and advanced analytics to enable people everywhere to share wildlife data and better manage wildlife populations
- Upload images to website for species identification with artificial intelligence



Map of Life (MOL)

https://mol.org

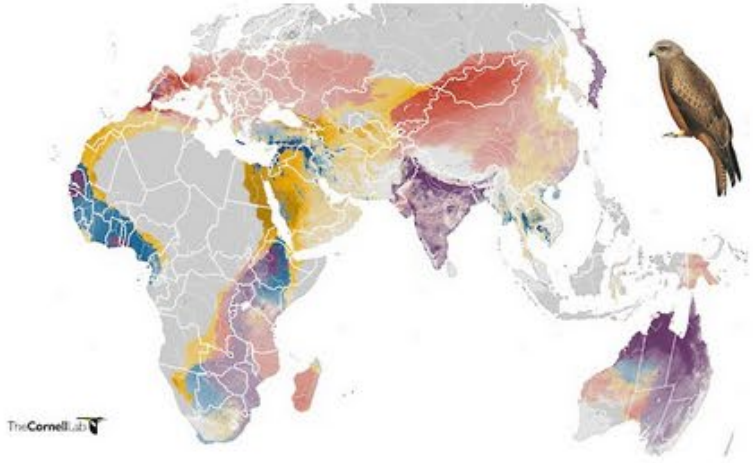
- Provides species range information and species lists for any geographic area
- Multiple tools for exploring species habitat and trends in biodiversity
- Mobile app for discovering, identifying, and recording biodiversity



eBird

https://ebird.org/home

- Gather and share bird information for science, conservation, and education
- Mange lists, photos, and recordings
- Real-time maps of species distributions
- Species alerts



eBird Status and Trends

Use eBird data and tools

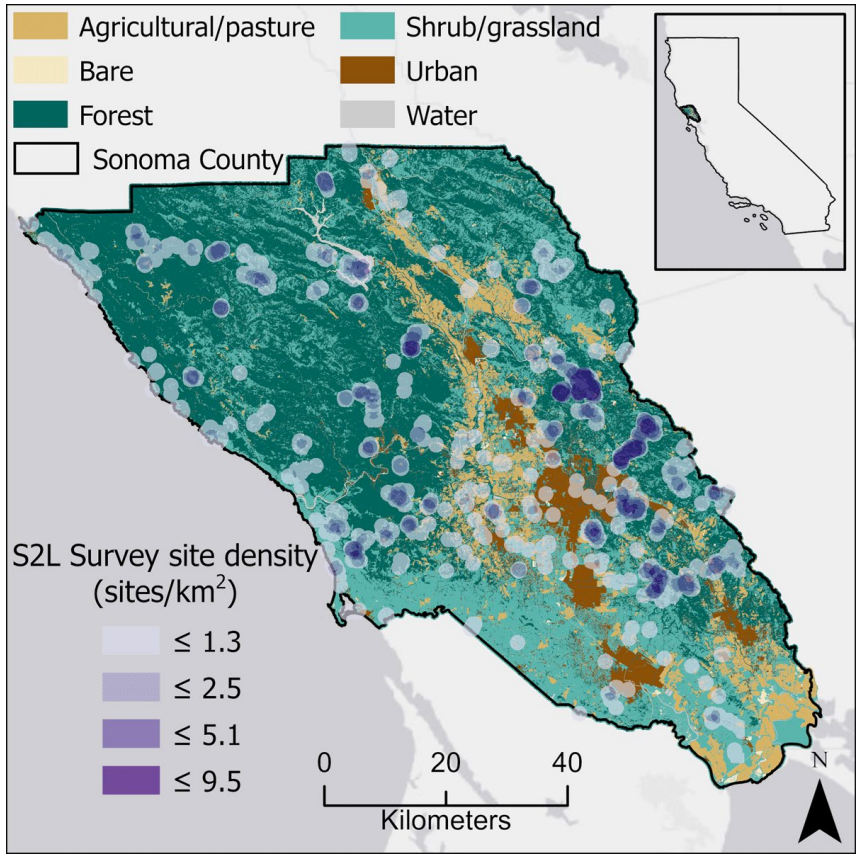
Research and conservation

Soundscapes to Landscapes

Soundscapes to Landscapes (S2L)

- A science-based project that seeks to advance the monitoring of bird diversity across large areas using data from new Earth-observing sensors and advanced modeling
- Need for well-distributed information on bird diversity
- Bioacoustics monitoring and machine learning
- Citizen scientists collect sounds in woodlands, grasslands, agricultural, and urban areas throughout Sonoma County

Study Area, Image Credit: Snyder, et al 2022



Soundscapes to Landscapes is funded by NASA's Citizen Science for Earth Systems Program (80NSSC18M0107).

Soundscapes to Landscapes (S2L) Approach

Step 1. Establish workflow and project coordination structure

Step 2. Recruit citizen scientists - volunteers, students, landowners

Step 3. Train citizen scientists

Step 4. Collect field data: field work, mapmaking, data upload

Step 5. Collect bioacoustics data: bird call regions of interest (ROIs); anthrophony, biophony, and geophony (ABG) ROIs; soundscape

Step 6. Engage citizen scientists through reporting

Step 7. Train deep learning algorithm using labeled data

Step 8. Process all audio recordings through deep learning algorithm for automated species and ABG detection

Step 9. Compile remote sensing habitat characteristics

Step 10. Generate species distribution maps and landowner reports

Workflow for S2L Project: Image Credit: Snyder, et al 2022

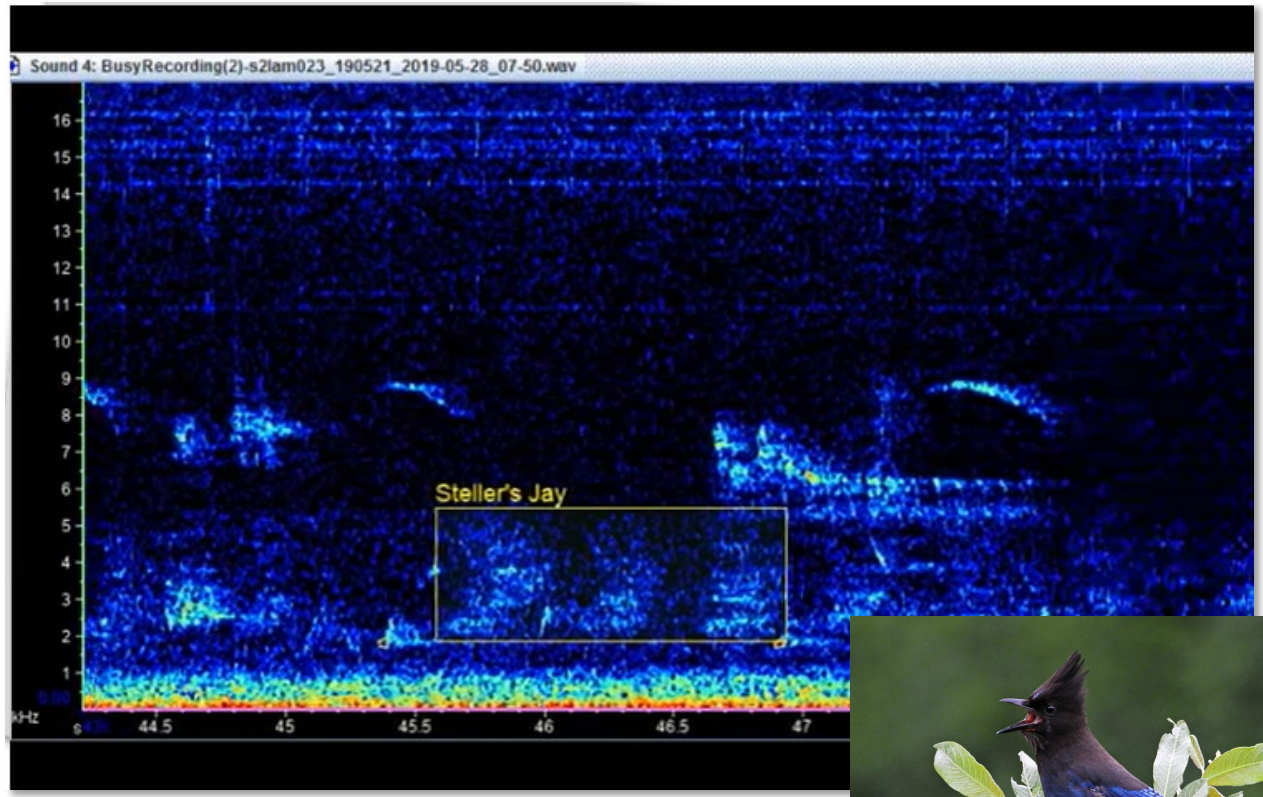
Recruitment and Training of Citizen Scientists

- Citizen Scientists:
  - Community Volunteers
  - Student Interns
- Recruitment:
  - Word-of-Mouth
  - Project Website
  - Social Media
- Training:
  - In-Person Prior to Field Campaigns
  - Online via YouTube Videos

Image Credit: Clark et al 2019, presentation for NASA Ecoforecasting Team Meeting

Data Collection and Analysis

- Autonomous Recording Units (ARUs)
- Stratified Random Sampling Design
  - Gaia GPS and ArcGIS Survey 123
- Annual Campaigns from 2017 – 2021, March to Early July
- Bioacoustic Reference and Validation Data: Airbimon
- Analysis and Deep Learning using Convolutional Neural Networks (CNN)

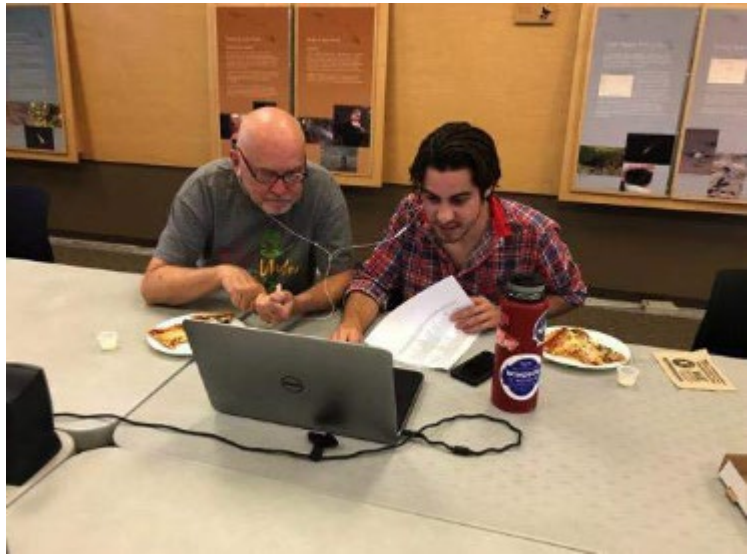


Recording from 2017, Blue line shows the part of the recording being heard, with distinct bird sounds mapped in yellow boxes Image Credit: https://soundscapes2landscapes.org/

Stellers Jay, Image Credit eBird

Citizen Science Retention, Reporting, and Lessons Learned

- Sustained engagement with community
- Offered a variety of activities to participants
- Low-cost sound ARUs – more sampling in space and time
- Web-based platform assisted with bioacoustics analysis
- No single platform will meet all the needs of a project – need for development of bioacoustic citizen science platforms



5 Years
259 Citizen Scientists
12,431 Hours of Audio Recordings
230,066 Samples of Bird Vocalizations

Canopy Structure from GEDI

- Use of the Global Ecosystem Dynamics Investigation (GEDI) LiDAR in Species Distribution Models (SDMs)
  - Canopy structure
- Additional variables, phenology, climate, etc. to predict probability of occurrence of 25 common bird species
  - Canopy Structure: Second most important variable
  - GEDI data improved model performance

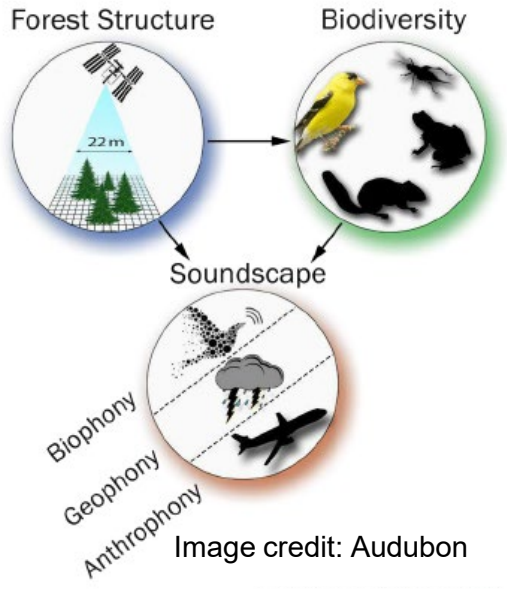
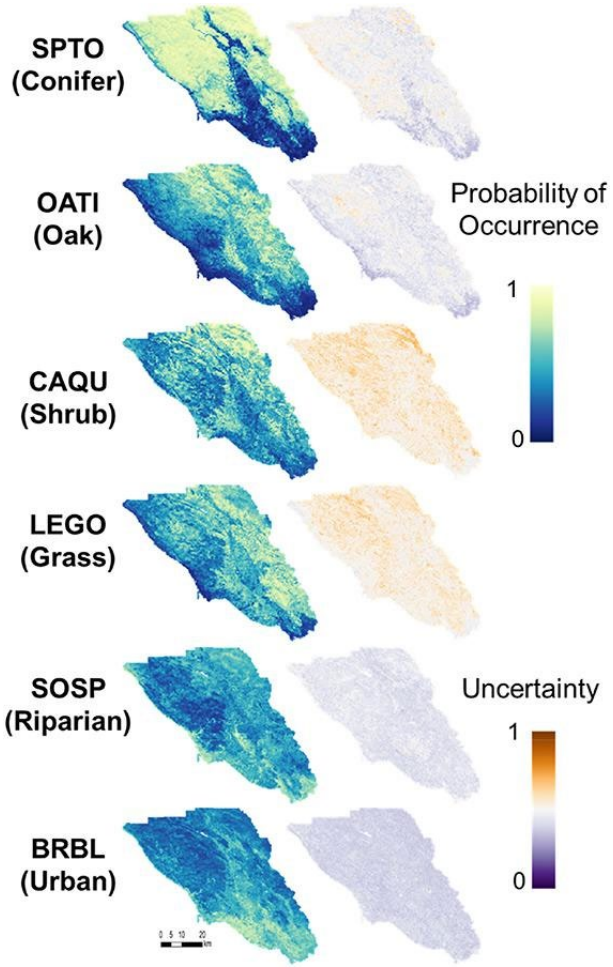
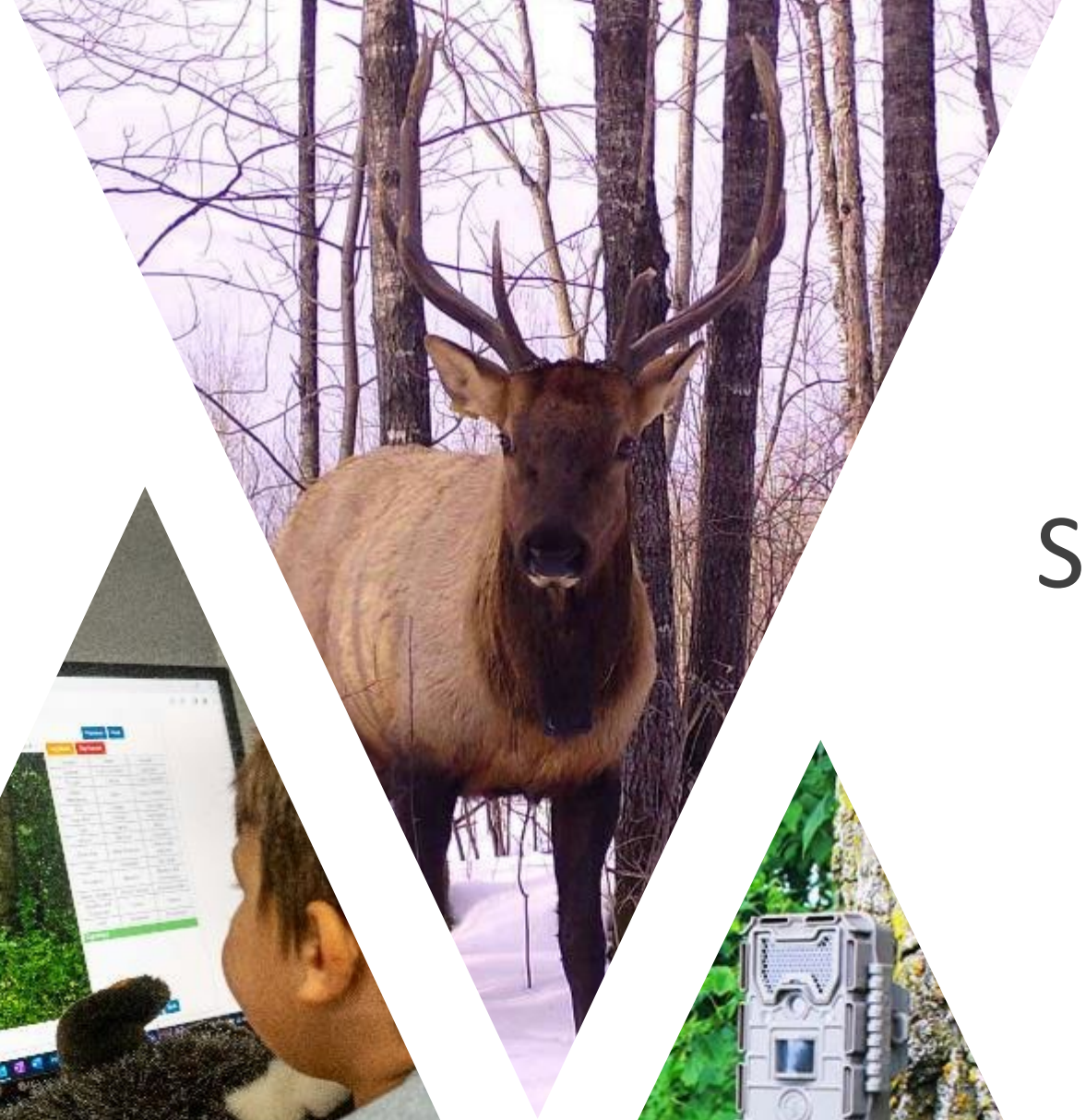


Image credit: Audubon



Ensemble maps of weighted average probability of occurrence and associated uncertainty of the mean for one species from each habitat association at 250 m spatial resolution. Image Credit: Burns et al., 2020

Snapshot Wisconsin



SNAPSHOT WISCONSIN

JENNIFER STENGLEIN
RISTINE ANHALT-DEPIES

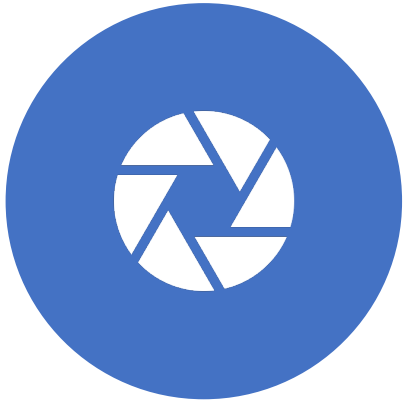
JOHN CLARE
NEIL GILBERT
PHIL TOWNSEND
BEN ZUCKERBERG

SNAPSHOT WISCONSIN

A COMMUNITY SCIENCE PROJECT FOR MONITORING WILDLIFE THROUGH A STATEWIDE NETWORK OF TRAIL CAMERAS

dnr.wi.gov, keyword “ Snapshot Wisconsin”

TOGETHER FOR WILDLIFE



PEOPLE-POWERED RESEARCH

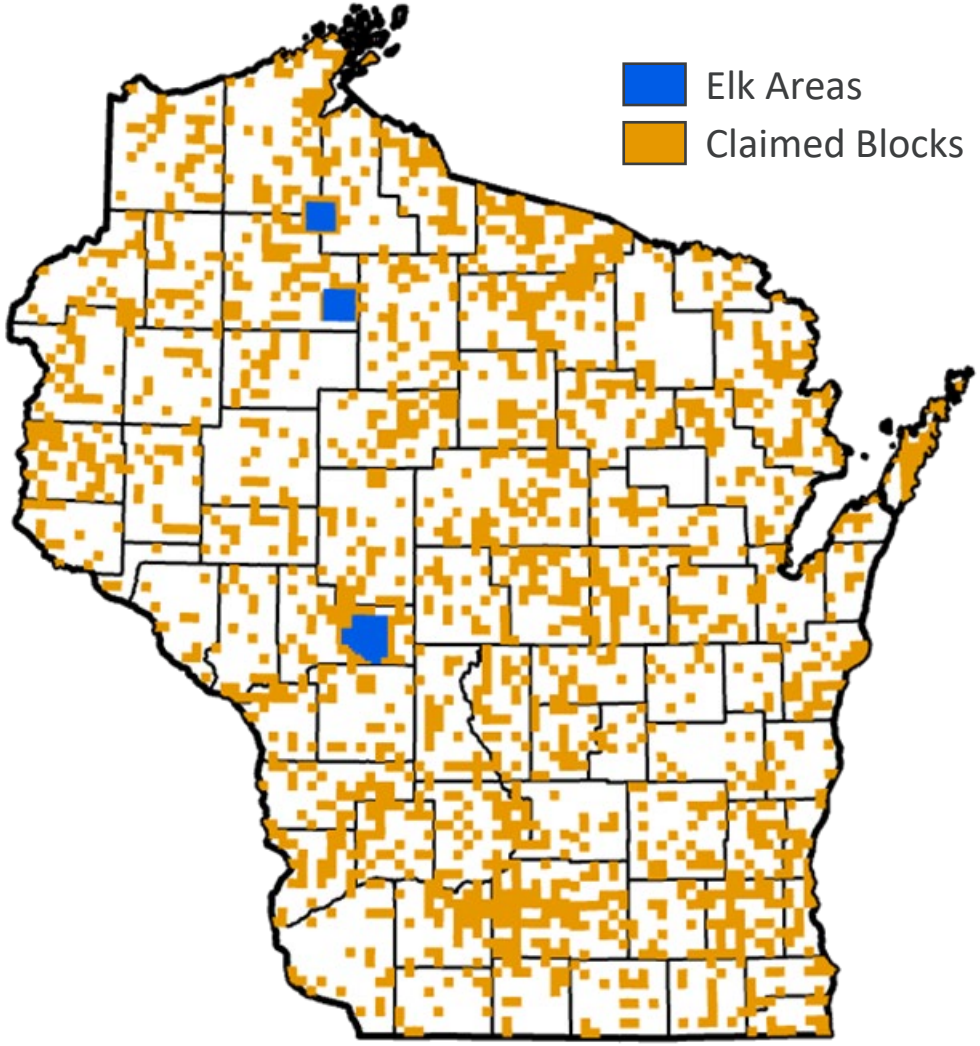
IMPROVED DATA FOR WILDLIFE DECISIONS

CUTTING-EDGE WILDLIFE SCIENCE

dnr.wi.gov, keyword “ Snapshot Wisconsin”

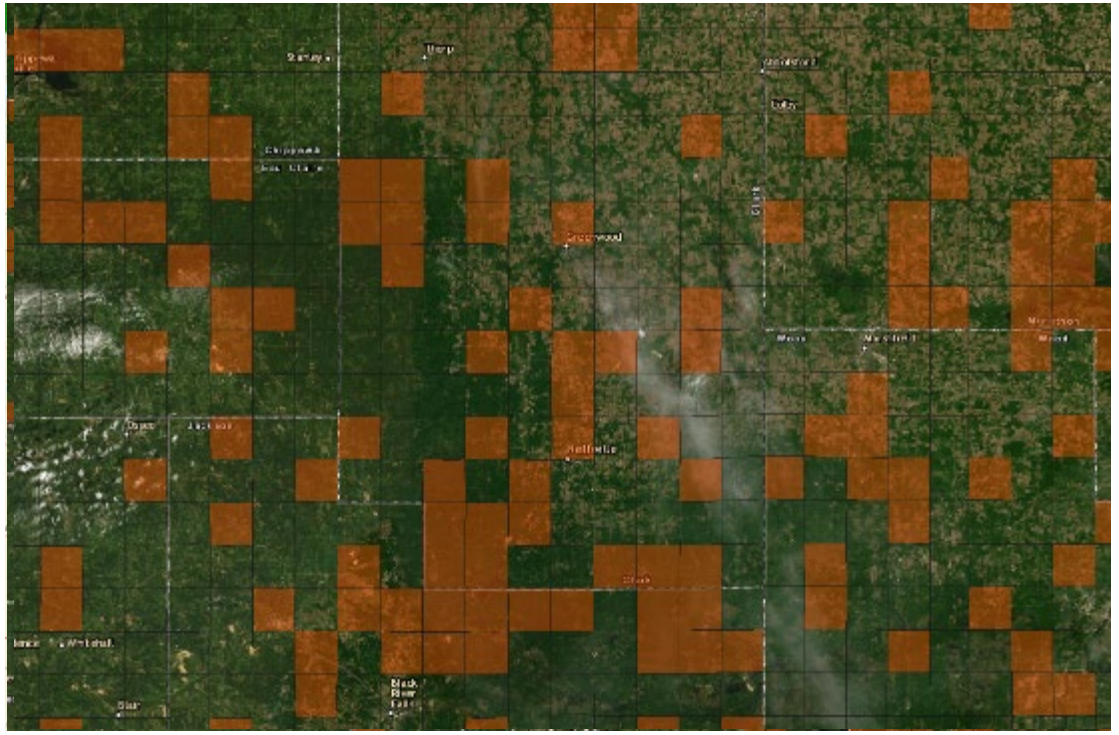
PROJECT STATUS

- Launched statewide in 2018
- 1,868 volunteers
- 2,093 trail cameras
- 72 million photos



dnr.wi.gov, keyword “ Snapshot Wisconsin”

VOLUNTEERS HOST TRAIL CAMERAS



dnr.wi.gov, keyword “ Snapshot Wisconsin”

TRAIL CAMERA HOSTS CLASSIFY PHOTOS

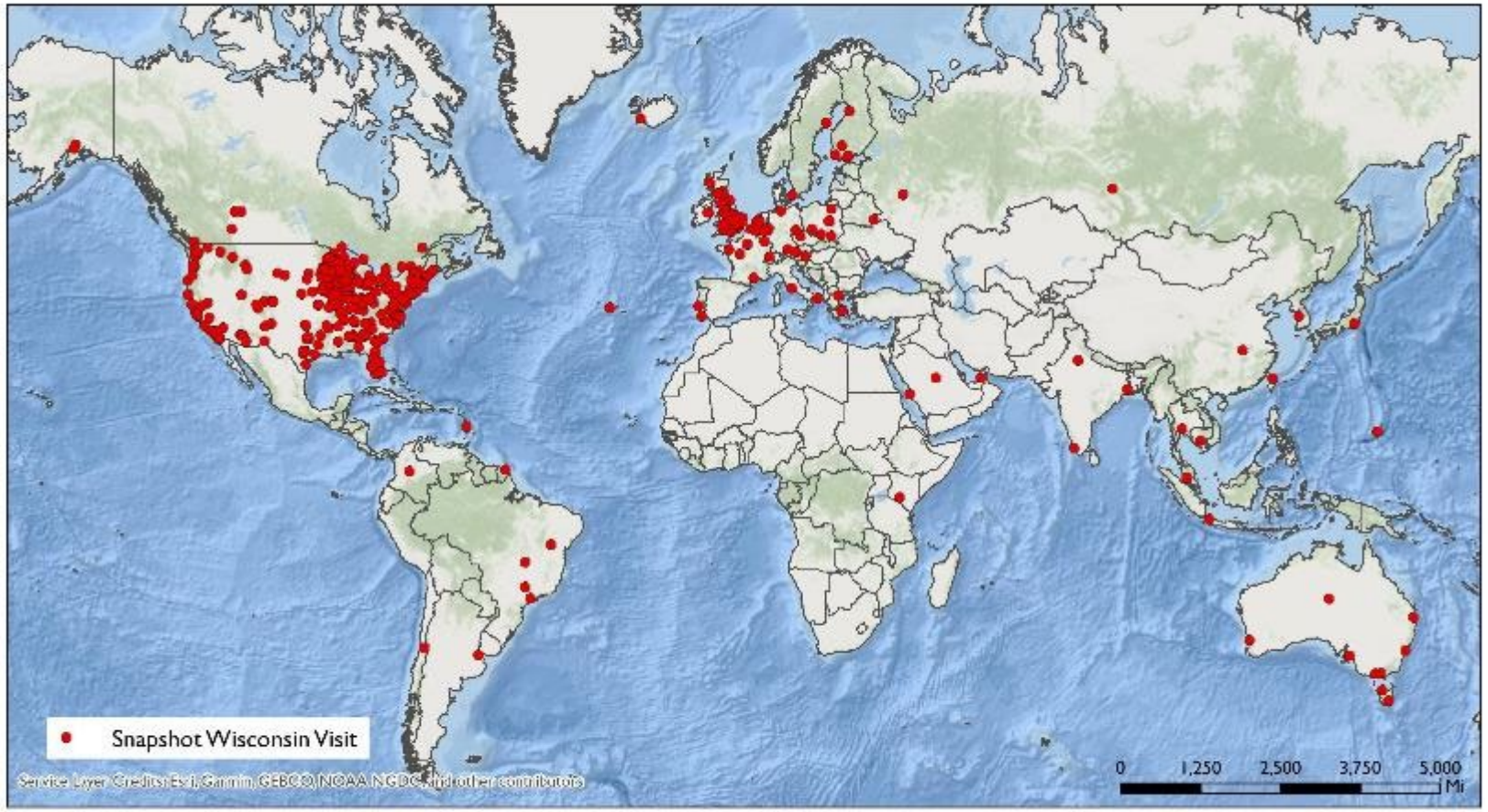
dnr.wi.gov, keyword “ Snapshot Wisconsin”

VOLUNTEERS FROM AROUND THE WORLD CLASSIFY PHOTOS VIA CROWDSOURCING

ZOONIVERSE

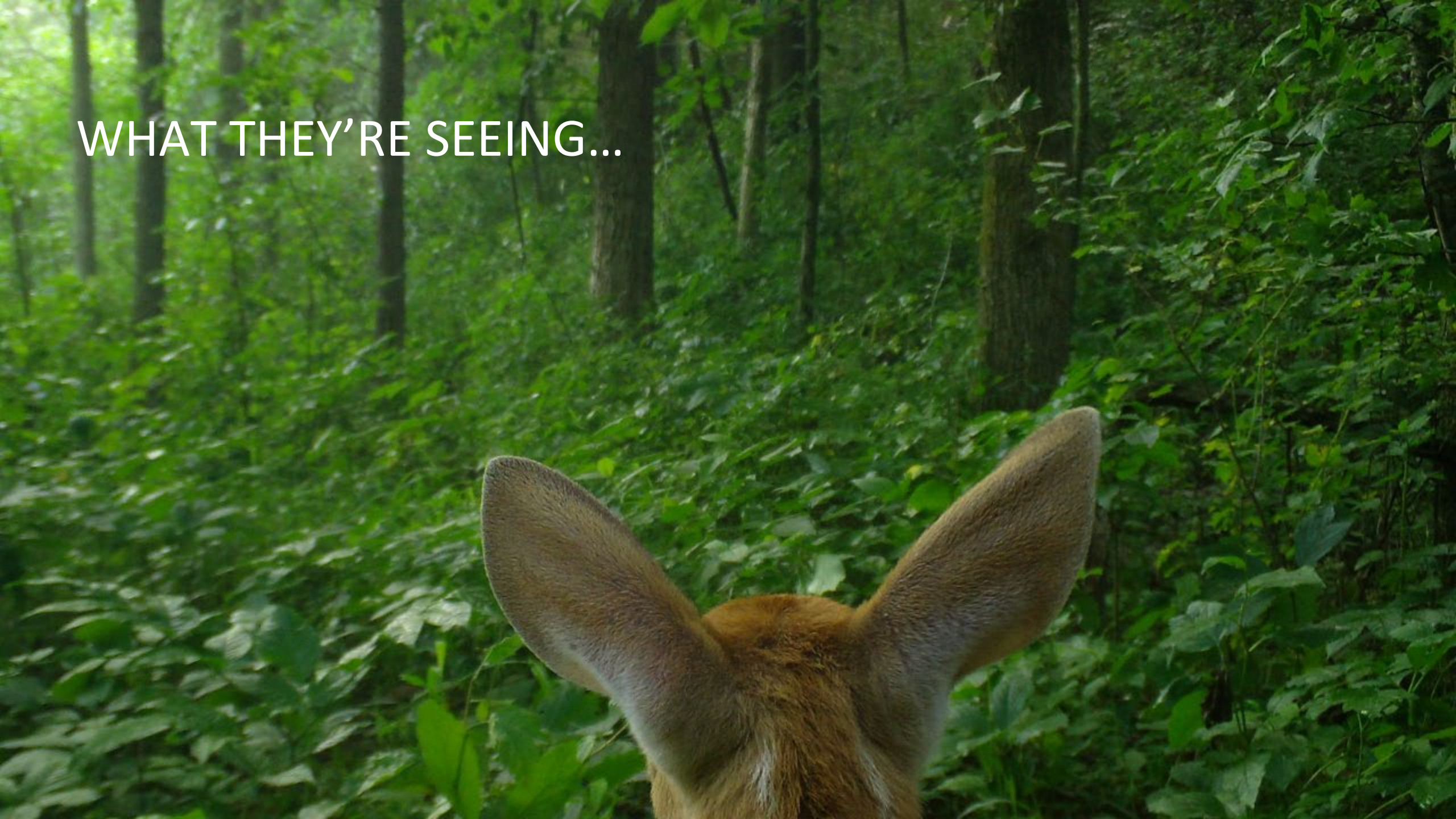
ZOONIVERSE

A GLOBAL EFFORT

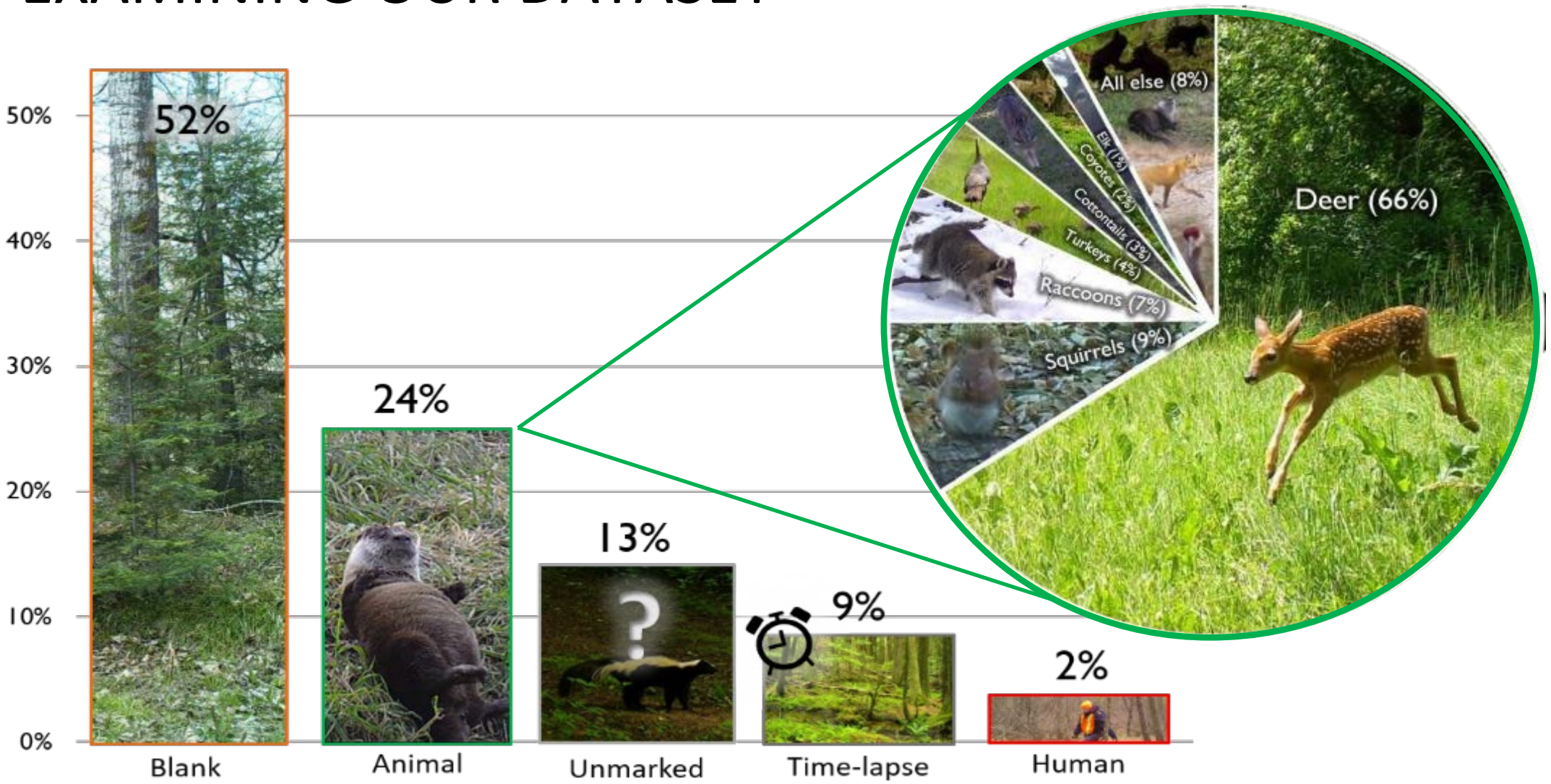


SnapshotWisconsin.org

WHAT THEY’RE SEEING…

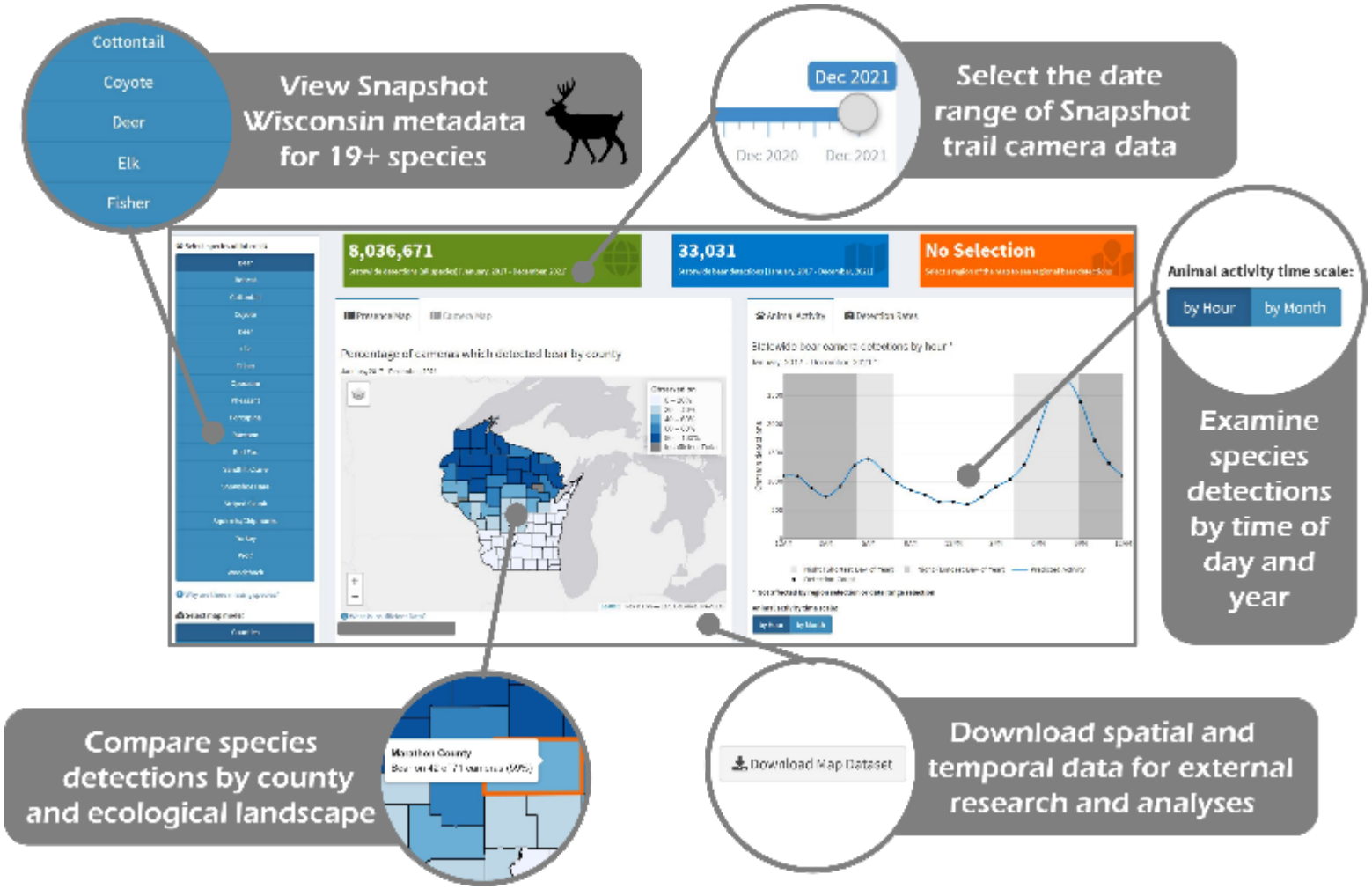


EXAMINING OUR DATASET



dnr.wi.gov, keyword “ Snapshot Wisconsin”

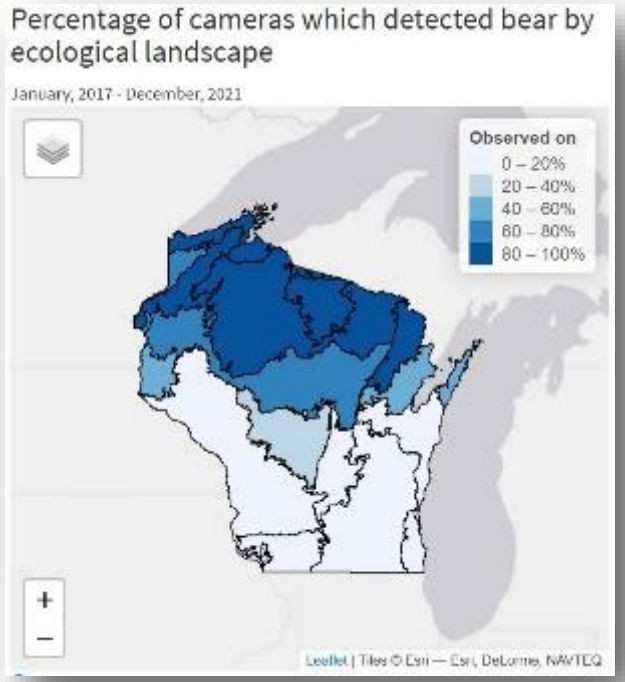
DATA ARE AVAILABLE ONLINE

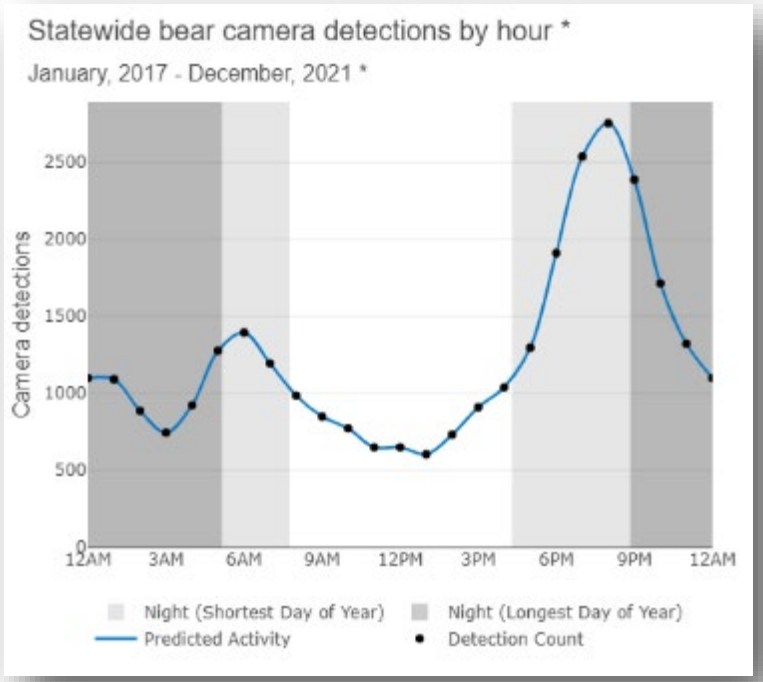


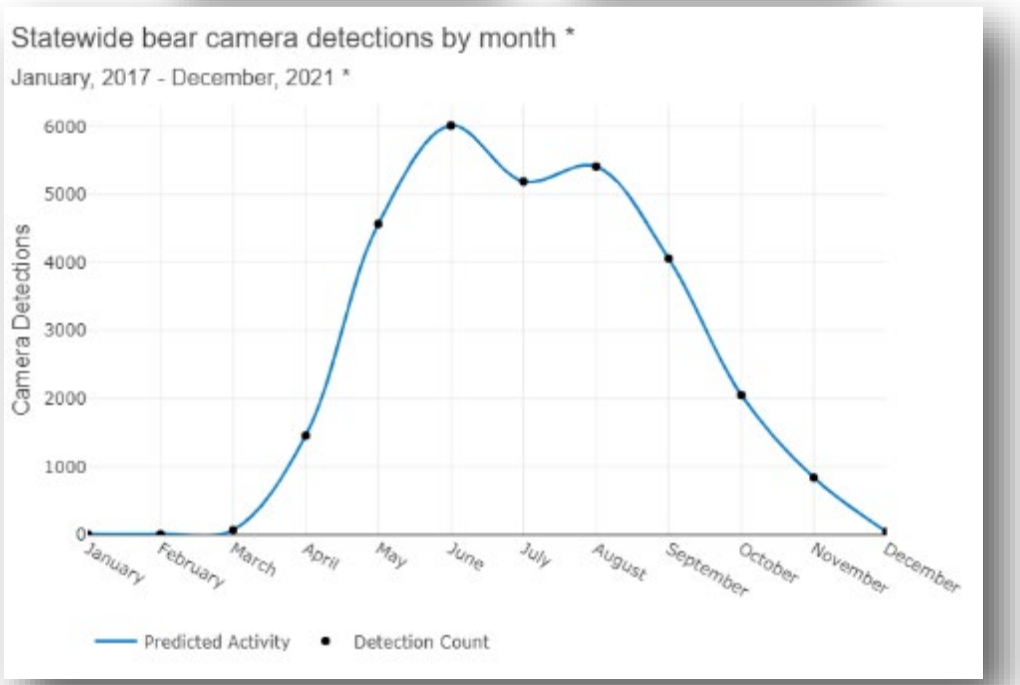
DataDashboard.SnapshotWisconsin.org

FOR 19 SPECIES, DATA IN SPACE AND TIME

- Bear
- Bobcat
- Cottontail
- Coyote
- Deer
- Elk
- Fisher
- Opossum
- Pheasant
- Porcupine
- Raccoon
- Red Fox
- Sandhill Crane
- Snowshoe Hare
- Striped Skunk
- Squirrels/Chipmunks
- Turkey
- Wolf
- Woodchuck



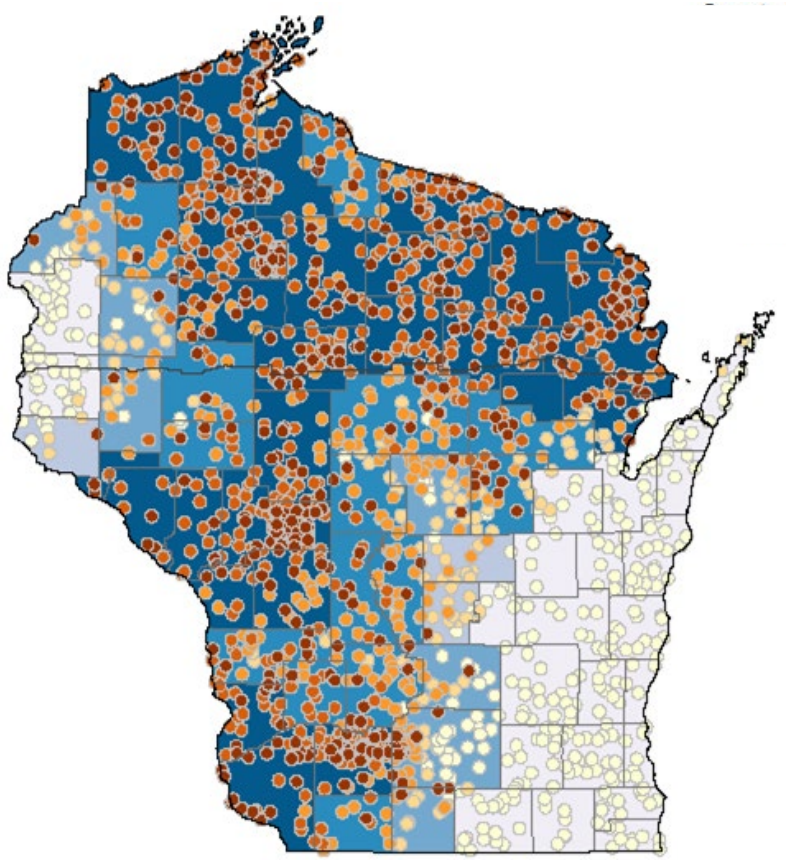




DataDashboard.SnapshotWisconsin.org

IMPROVED DATA FOR WILDLIFE DECISIONS

- Trends in Space and Time
  - Fisher, Bobcat
- Sex and Age Structure
  - Fawn-to-Doe Ratios
  - Elk Calf-to-Cow Ratios
- Independent Population Estimates
  - Elk
- Rare Species Presence
  - Cougar, Marten, Moose, Whooping Crane



Bobcat Relative Abundance

dnr.wi.gov, keyword “ Snapshot Wisconsin”

CUTTING EDGE WILDLIFE SCIENCE COMBINING EARTH OBSERVATIONS WITH TRAIL CAMERA DATA

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

ELSEVIER

Integrating harvest and camera trap data in species distribution models

Neil A. Gilbert[a,*], Brent S. Pease[b], Christine M. Anhalt-Depies[c], John D.J. Clare[a,d], Jennifer L. Stenglein[c], Philip A. Townsend[a], Timothy R. Van Deelen[a], Benjamin Zuckerberg[a]

Behavioral Ecology

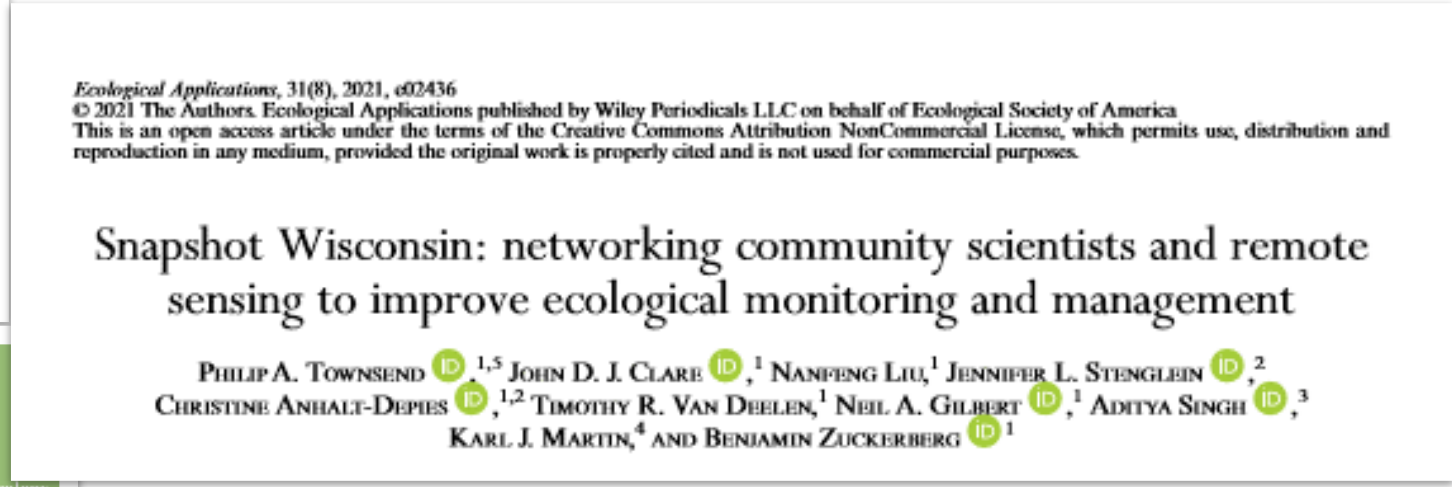
The official journal of the ISBE International Society for Behavioral Ecology

Behavioral Ecology (2022), 33(2), 446–454. https://doi.org/10.1093/beheco/arab154

Original Article

Behavioral flexibility facilitates the use of spatial and temporal refugia during variable winter weather

Neil A. Gilbert,[a,©] Jennifer L. Stenglein,[b] Timothy R. Van Deelen,[a] Philip A. Townsend,[a] and Benjamin Zuckerberg[a]



Ecological Applications, 31(8), 2021, e02436
© 2021 The Authors. Ecological Applications published by Wiley Periodicals LLC on behalf of Ecological Society of America
This is an open access article under the terms of the Creative Commons Attribution NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

Snapshot Wisconsin: networking community scientists and remote sensing to improve ecological monitoring and management

Philip A. Townsend,[1,5] John D. J. Clare,[1] Nanfeng Liu,[1] Jennifer L. Stenglein,[2] Christine Anhalt-Depies,[1,2] Timothy R. Van Deelen,[1] Neil A. Gilbert,[1] Aditya Singh,[3] Karl J. Martin,[4] and Benjamin Zuckerberg[1]

PNAS RESEARCH ARTICLE | ECOLOGY

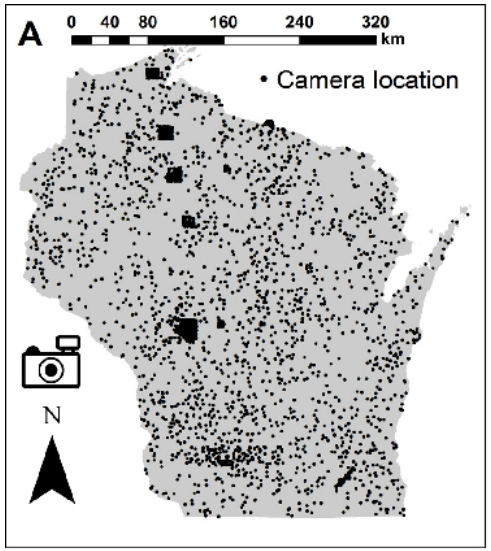
Human disturbance compresses the spatiotemporal niche

Neil A. Gilbert[a,1], Jennifer L. Stenglein[b], Jonathan N. Pauli[a], and Benjamin Zuckerberg[a]

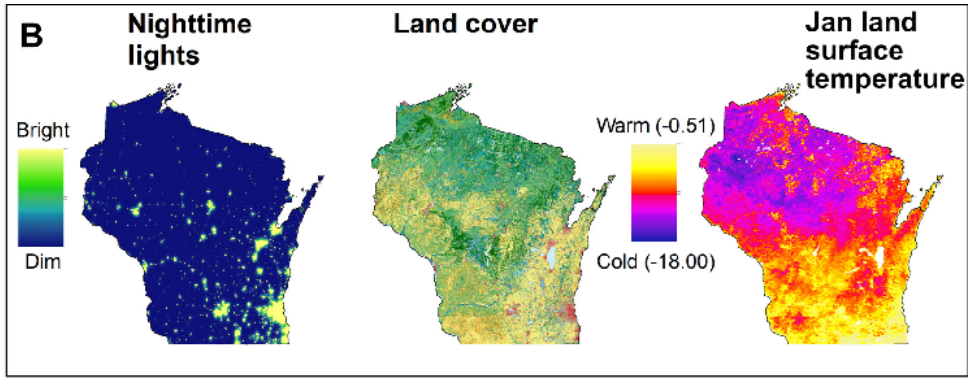
Edited by Pablo Marquet, Pontificia Universidad Catolica de Chile, Santiago, Chile; received April 11, 2022; accepted November 8, 2022

COMBINING EARTH OBSERVATIONS WITH TRAIL CAMERA DATA

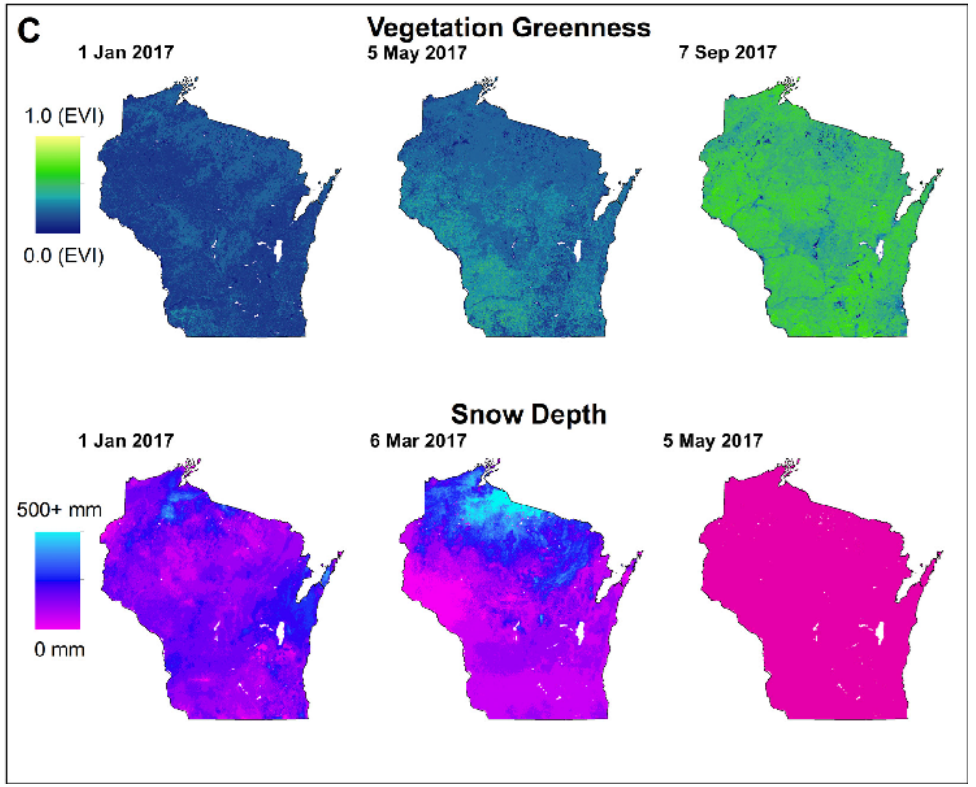
Snapshot Wisconsin camera locations



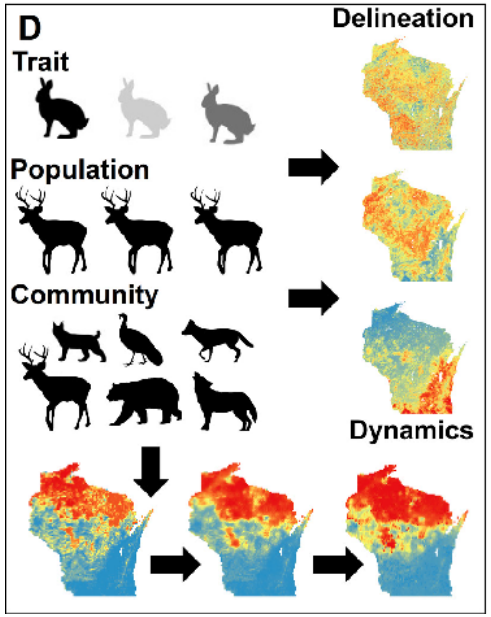
Static satellite remotes sensing data layers used for prediction/inference



Dynamic spatial predictors at finer temporal resolution

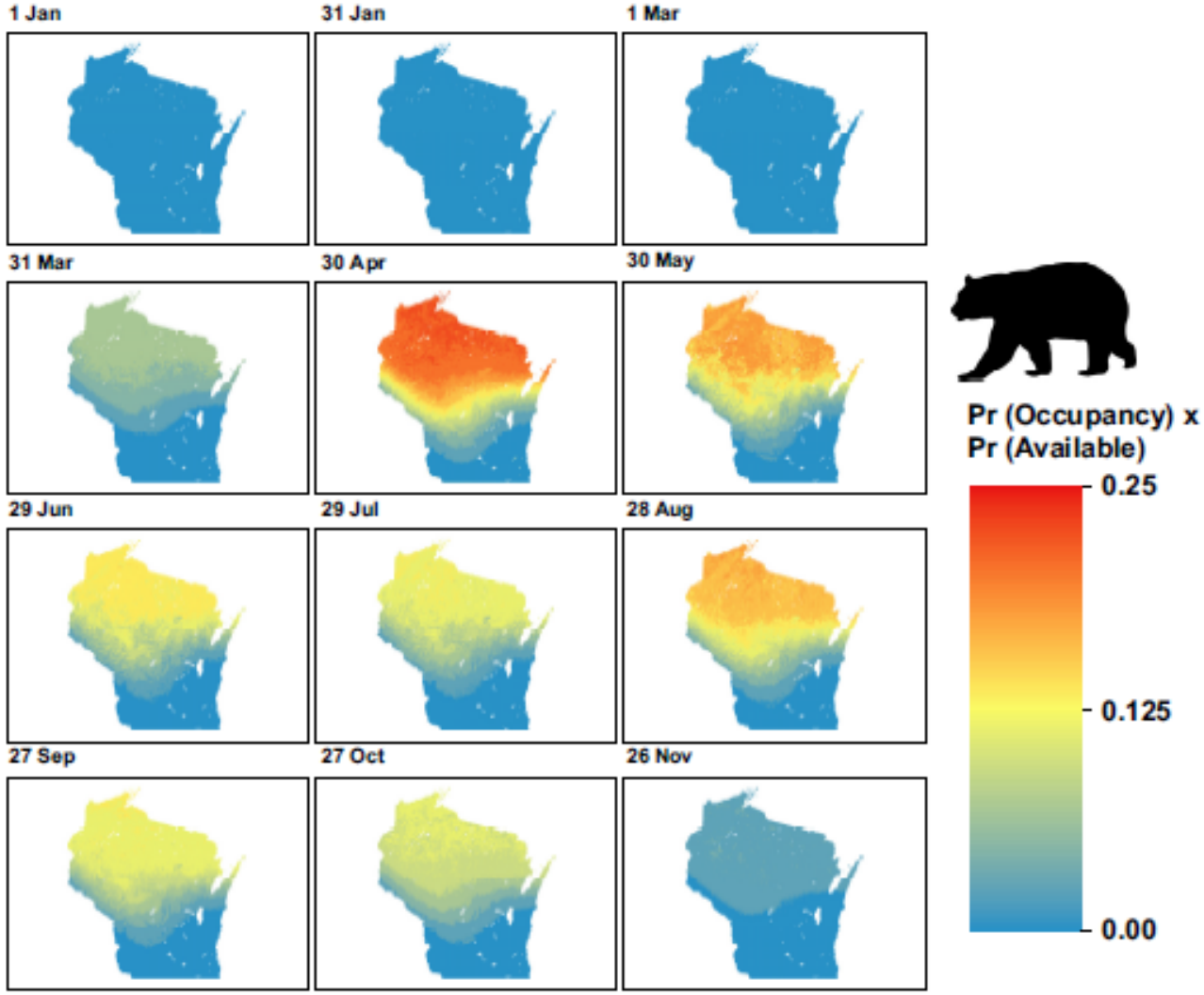


Combining camera data on species traits, populations, and assemblages with spatial data from satellite remote sensing enables biodiversity variables to be delineated, monitored, and forecast



Townsend et al. 2021, Ecological Applications

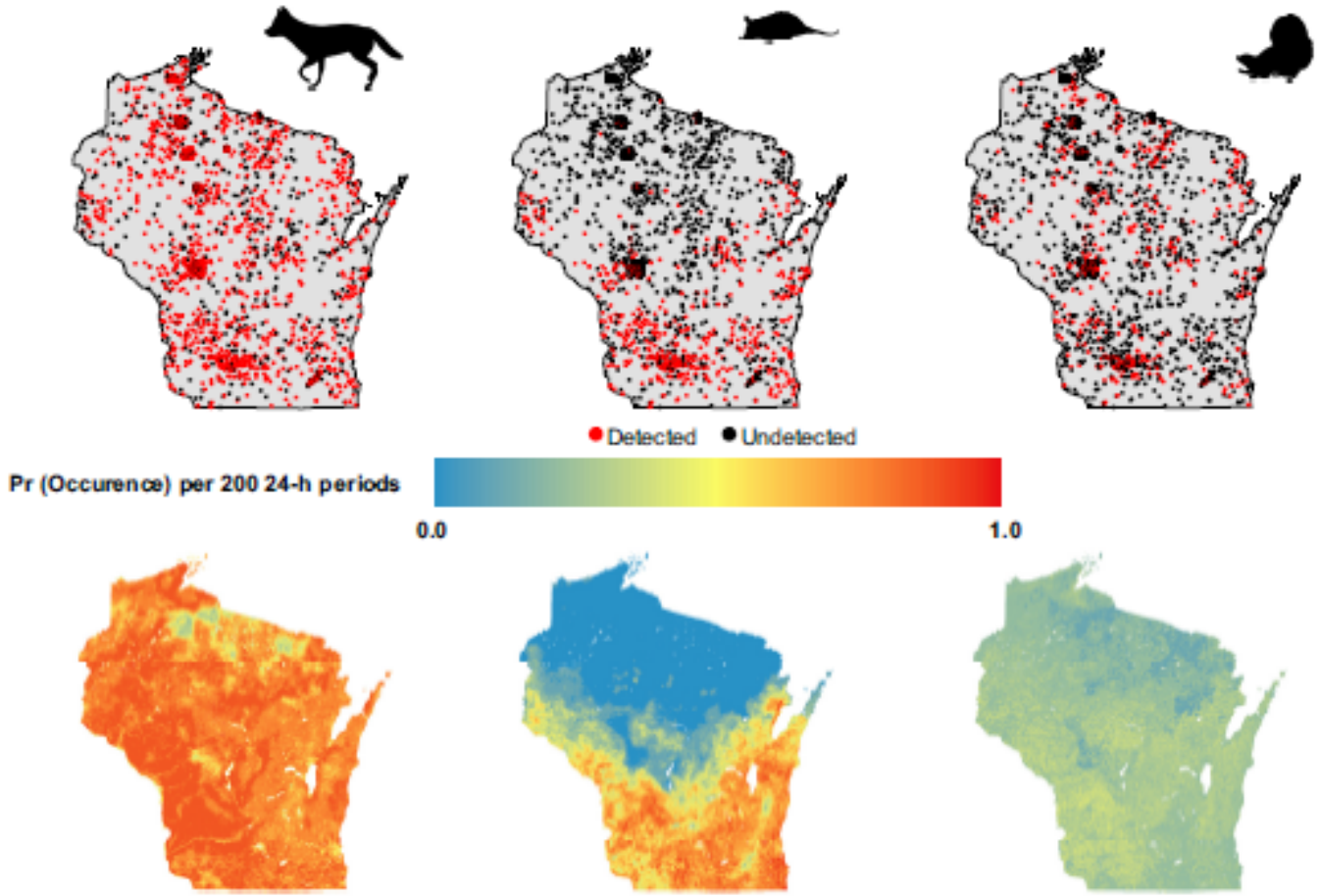
INCREASING TEMPORAL RESOLUTION



- Continuous satellite remote sensing and Snapshot Wisconsin data predict daily bear occurrence over the course of a year.
- Predictions are derived from a multi-scale occupancy model, as the product of asymptotic occupancy probability (the probability of ever using a cell) and the daily probability of a bear being “available” for detection (i.e., active within the cell on a given day).

Townsend et al. 2021, Ecological Applications

EXPANDING BIOLOGICAL EXTENT



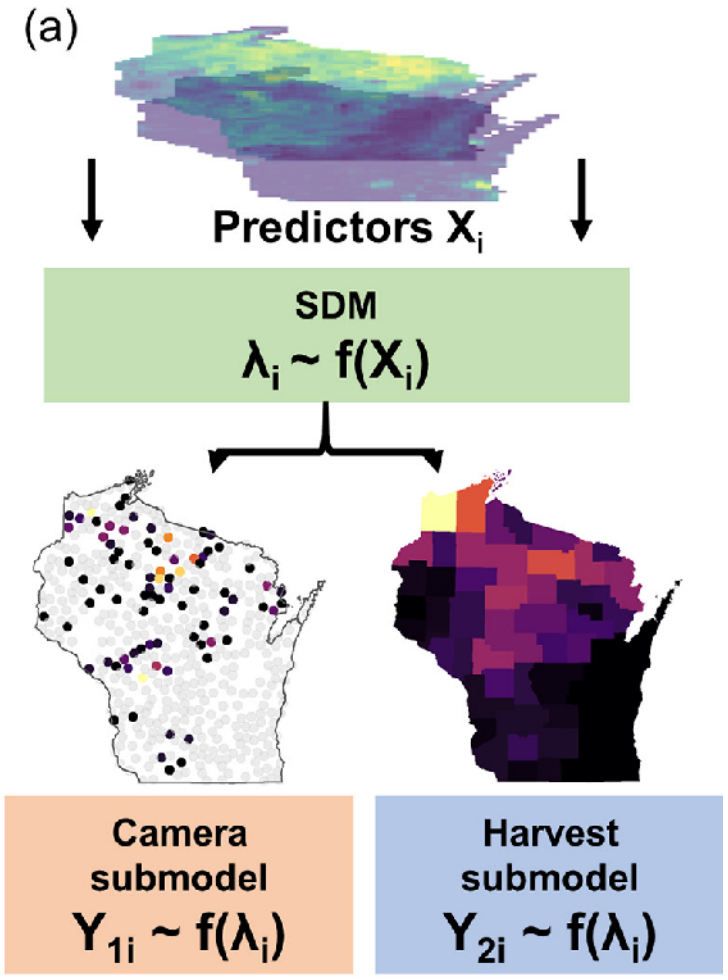
Satellite remote sensing and Snapshot Wisconsin data predict occurrence probabilities for species that are not otherwise monitored by Wisconsin DNR: coyote, opossum, and striped skunk.

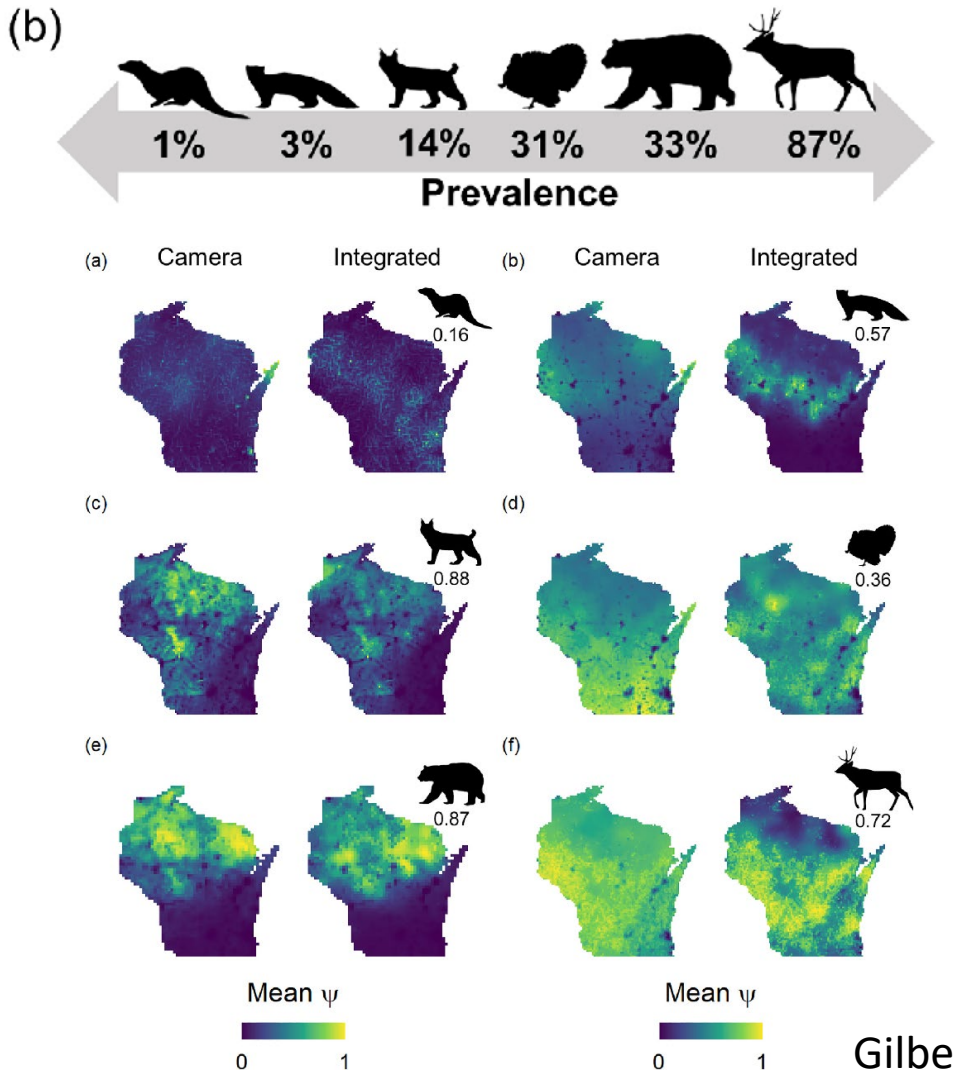
Snapshot Wisconsin observations (detection/non-detection) across 2015–2018

Predicted observed occurrence probability standardized for an effort of 200 trap-nights

Townsend et al. 2021, Ecological Applications

EXPANDING INFERENCE THROUGH INTEGRATED MODELING





- Integrated species distribution modeling incorporates trail camera and harvest data with landcover predictors and predicts species-environment relationships for 6 Wisconsin species.
- Occurrence probability predictions as mapped across Wisconsin were different when using integrated data as compared with camera data alone, especially for fisher and deer.

Gilbert et al. 2021, Biological Conservation

BEHAVIORAL FLEXIBILITY BY DEER DURING VARIABLE WINTER WEATHER

- Gilbert et al. 2022 used remote sensing and Snapshot Wisconsin data of deer from two winters and found behavior shifts in time and space related to cold and warm extremes.
- Documented behavioral shifts presumably reduce exposure to extremes and may render species more resilient to increasingly variable winter climates.

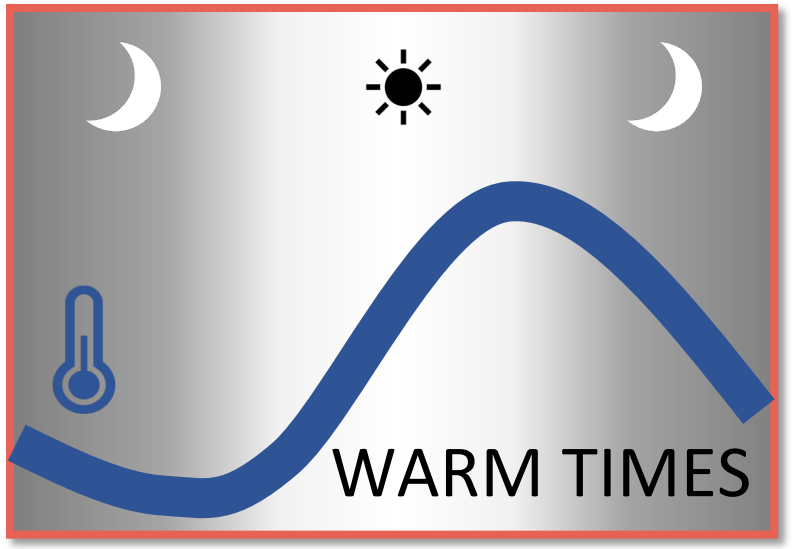
Prediction:

During cold extremes, deer become more diurnal, move less, and show stronger anchoring to refugia habitats such as coniferous forest.

During warm extremes, deer become more nocturnal and crepuscular, move more, and are more likely to use open habitats.

Gilbert et al. 2022, Behavioral Ecology

BEHAVIOR: THE FIRST LINE OF DEFENSE

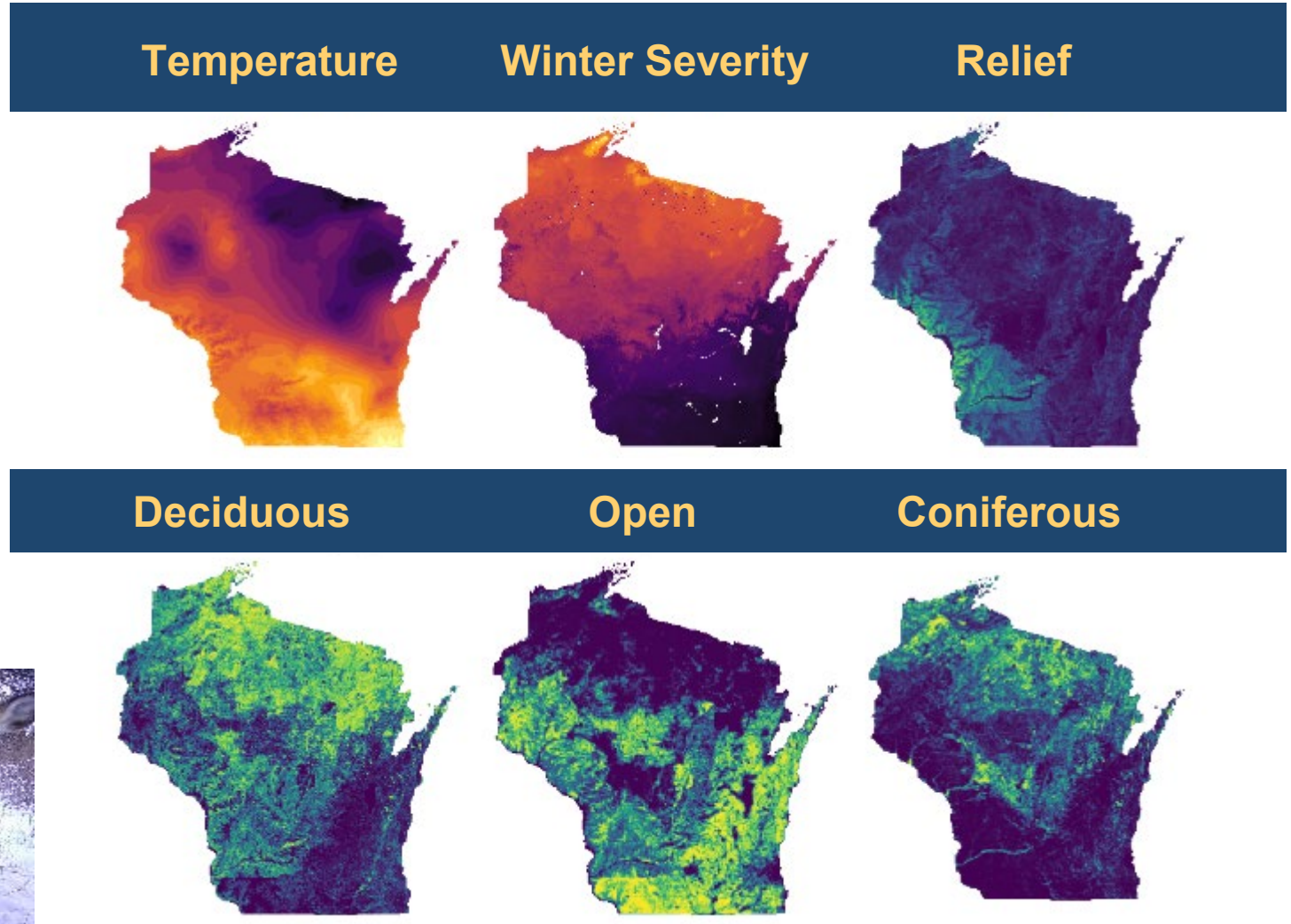


Winter stresses deer because of difficulty finding food and moving through deep snow. Deer may change their behavior to find warmer places and become active at warmer times of the day.

Gilbert et al. 2022, Behavioral Ecology

COMBINING TRAIL CAMERA DATA WITH EARTH OBSERVATIONS

- To understand the use of temporal refugia, they modeled deer activity (at daily resolution) during night, dawn, day, and dusk as a function of weather predictors.
- To understand the use of spatial refugia, they modeled deer activity at camera locations (at daily resolution) as a function of landscape characteristics, weather conditions, and landscape–weather interactions.

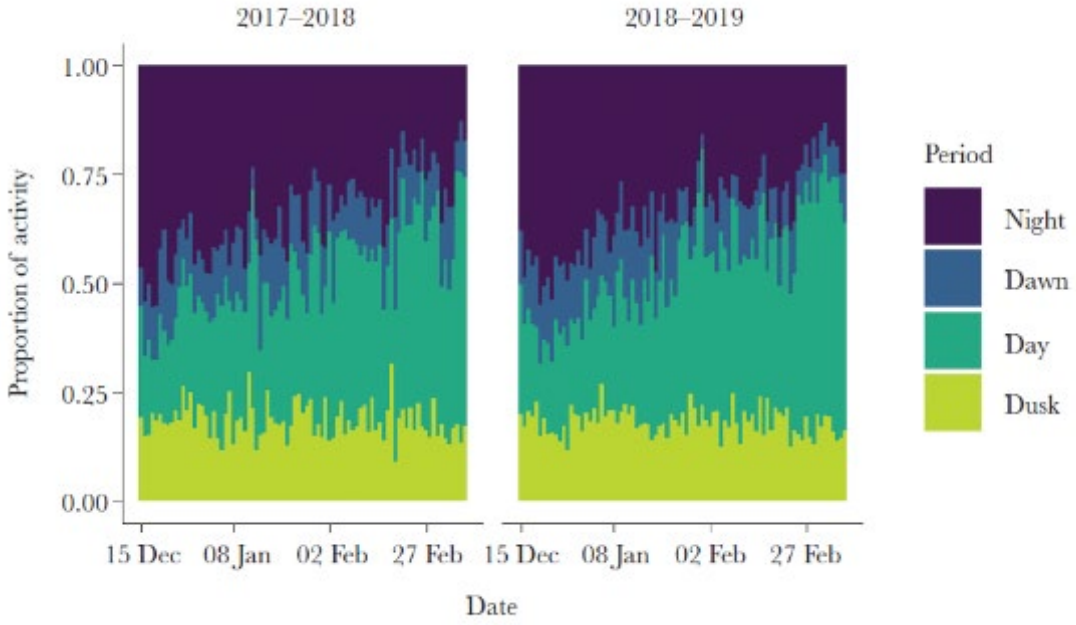


Gilbert et al. 2022, Behavioral Ecology

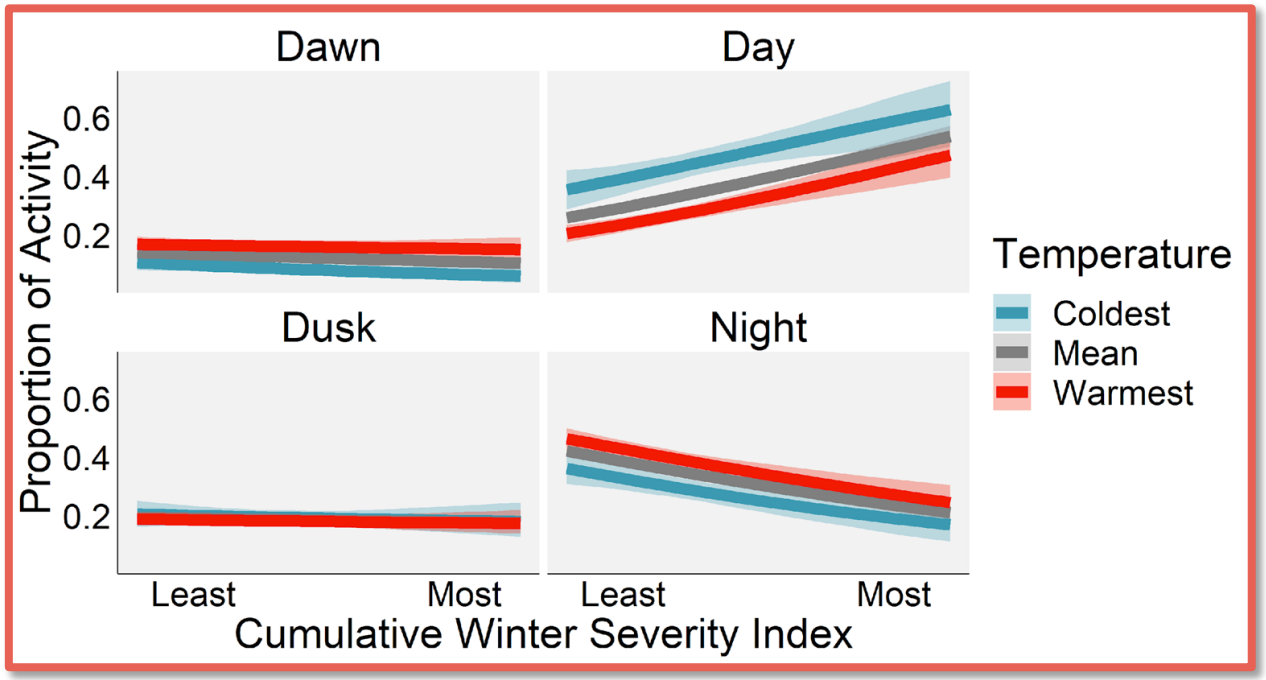
DEER USE TEMPORAL REFUGIA

Proportions of deer activity falling within night, dawn, day, and dusk periods over two winters.

There is a decrease in nighttime activity and increase in daytime activity as the winter progresses.



Deer showed more daytime and less dawn and night activity, respectively, under cold temperatures, deep snow, and severe winter conditions.

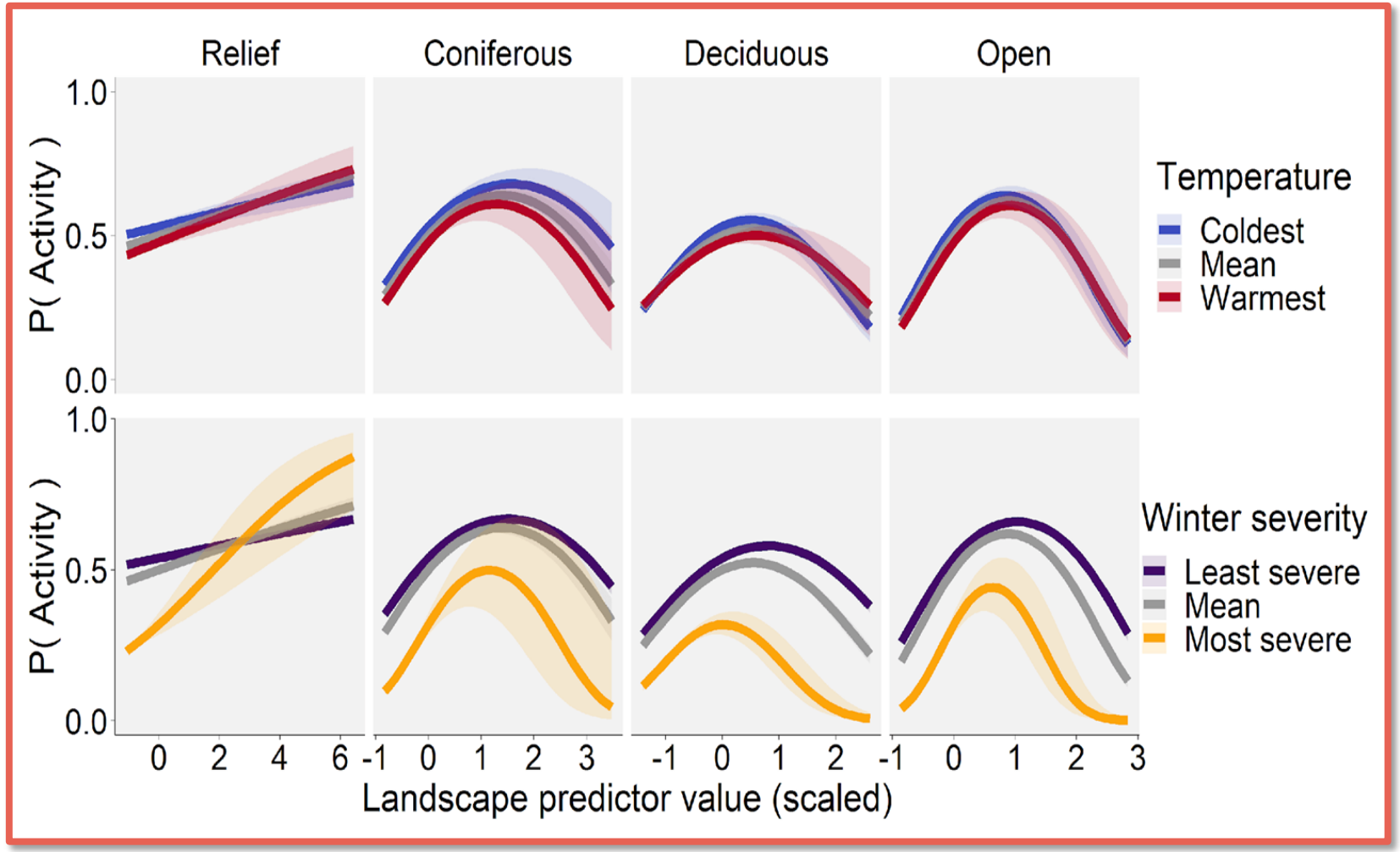


Gilbert et al. 2022, Behavioral Ecology

DEER USE SPATIAL REFUGIA

During cold extremes, deer were slightly more active in conifer-dominated landscapes.

Under high cumulative winter severity, deer were generally much less active, with highest activity occurring in landscapes with abundant topographic relief and intermediate levels of coniferous forest, deciduous forest, and/or open habitat.



Gilbert et al. 2022, Behavioral Ecology

UNDERSTANDING POTENTIAL BEHAVIORAL RESPONSE TO CLIMATE CHANGE

The documented use of temporal and spatial refugia by deer suggest that behavior might be key in adapting to increasing climatic variability and the greater likelihood of extreme weather.

Gilbert et al. 2022, Behavioral Ecology

- Snapshot Wisconsin Trail Camera Data
- Earth Observation Data
- Improved Ecological Monitoring
- Wildlife Management Decision Support
- Cutting-Edge Wildlife Science

PEOPLE-POWERED RESEARCH

ACKNOWLEDGEMENTS

SNAPSHOT AT WISCONSIN DNR

Scott Hull
Dave MacFarland
Mackenzie Druskins
Claire Viellieux
Jessica Knackert
Ryan Bemowski
Josh Sullivan
Alisa Vaynrub
Kevin Spaulding
Mackenzie McBride
Pharaoh Graham

COLLABORATORS & PARTNERS

ZOONIVERSE

RMEF

WSST

University of Wisconsin Stevens Point

Natural Resources Foundation of Wisconsin

WISCONSIN UNIVERSITY OF WISCONSIN-MADISON

NASA

1000's of volunteers without whom this project would not be possible!

NASA GLOBE Observer Mosquito Habitat Mapper and Land Cover

National Aeronautics and Space Administration

Rusty Low
Science Lead, GO Mosquito Habitat Mapper
Institute for Global Environmental Strategies
rusty_low@strategies.org

Peder Nelson
Science Lead, GO Land Cover
Oregon State University
peder.nelson@oregonstate.edu

Key Questions

- **Where are land-cover and land-use changing? (Measurement, Variability)**
- **What changes are occurring in global land-cover and land-use? (Forcing)**
- **What are the impacts of climate variability and changes on LCLUC? (Impacts, Responses)**
- **What are the consequences of changing land-use activities for ecosystems? (Consequences, Responses, Adaptation)**
- **What are the consequences of land-cover and land-use change for human societies? (Consequences, Vulnerability, Resilience)**
- **How will land-cover change over time? (Modeling, Prediction)**
- **What are the projected changes in land-cover and their potential impacts? (Modeling, Prediction)**

Key Questions

- Where are land-cover and land-use changing? (Measurement, Variability)
- What changes are occurring in global land-cover and land-use? (Forcing)
- What are the impacts of climate variability and changes on LCLUC? (Impacts, Responses)
- What are the consequences of changing land-use activities for ecosystems? (Consequences, Responses, Adaptation)
- What are the consequences of land-cover and land-use change for human societies? (Consequences, Vulnerability, Resilience)
- How will land-cover change over time? (Modeling, Prediction)
- What are the projected changes in land-cover and their potential impacts? (Modeling, Prediction)

- **How can we obtain the velocity, volume, and variety of in-situ data we need to support remote sensing research objectives?**

Key Questions

- Where are land-cover and land-use changing? (Measurement, Variability)
- What changes are occurring in global land-cover and land-use? (Forcing)
- What are the impacts of climate variability and changes on LCLUC? (Impacts, Responses)
- What are the consequences of changing land-use activities for ecosystems? (Consequences, Responses, Adaptation)
- What are the consequences of land-cover and land-use change for human societies? (Consequences, Vulnerability, Resilience)
- How will land-cover change over time? (Modeling, Prediction)
- What are the projected changes in land-cover and their potential impacts? (Modeling, Prediction)

- How can we obtain the velocity, volume, and variety of in-situ data we need to support remote sensing research objectives?
- **….and while supporting NASA's Transform to open data mission?**


DO SCIENCE
IN THE PALM OF YOUR HAND
Download the GLOBE Observer app
observer.globe.gov
NASA
Your planet is changing. We're on it.
EARTH
RIGHT NOW

GLOBE Observer Citizen Science

1. How you can use the tool to obtain data you need
2. Mosquito Habitat Mapper and Land Cover
3. Collecting mosquito data
4. One significant contribution of citizen science
5. How to access the data
6. Data exploration resources

One platform
4 easy to use protocols

Supporting NASA Science and UN Sustainable Development Goals

1. How to Use the Tool

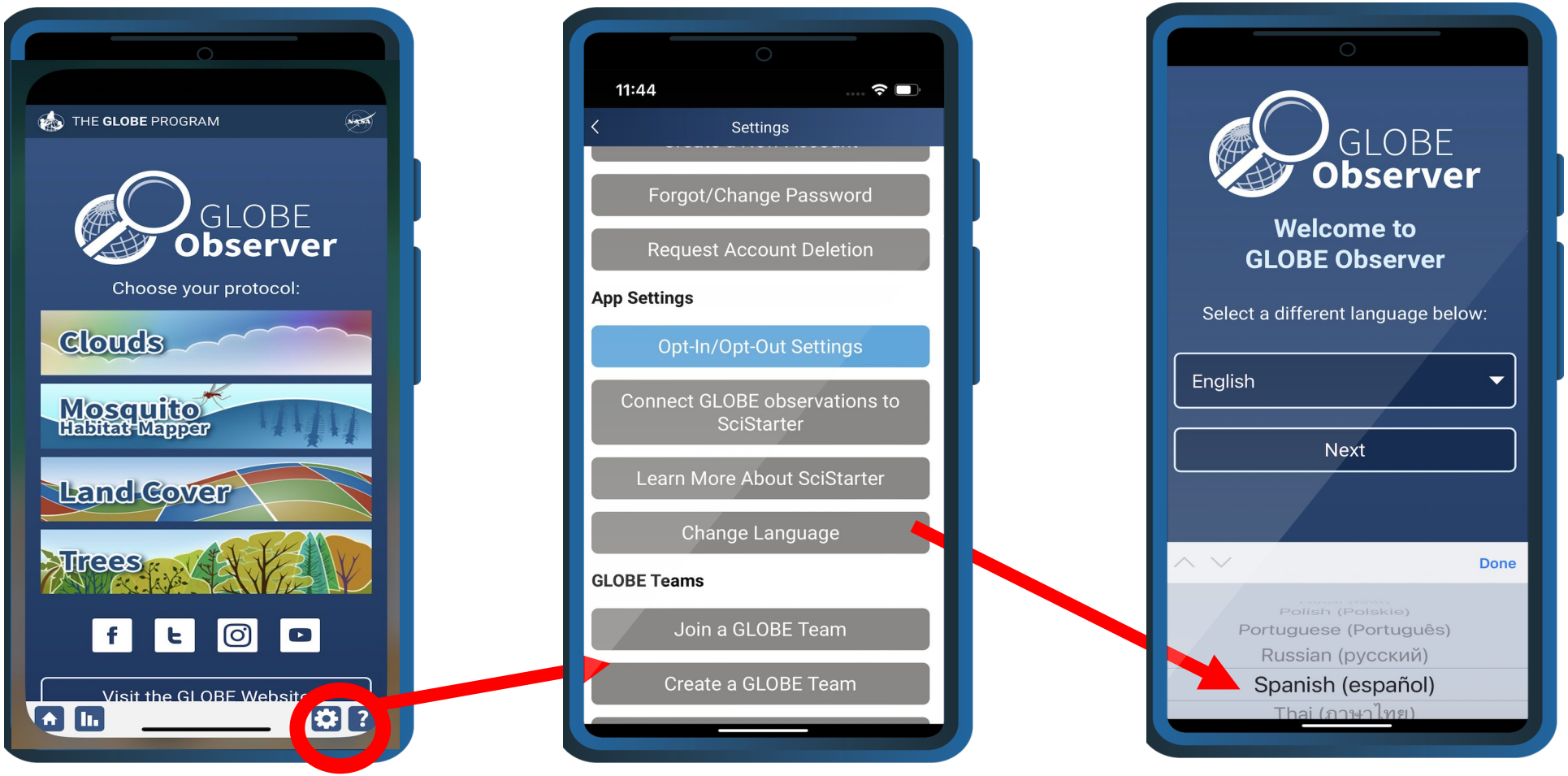
Download the app for free, complete the registration,
and start observing!

Create a GLOBE Observer Account

- Download the app to a smartphone or tablet.
- Create an account using your email address.
- Check your email for your password.
- Sign into GLOBE Observer with your email and password.

1. How to Use the Tool

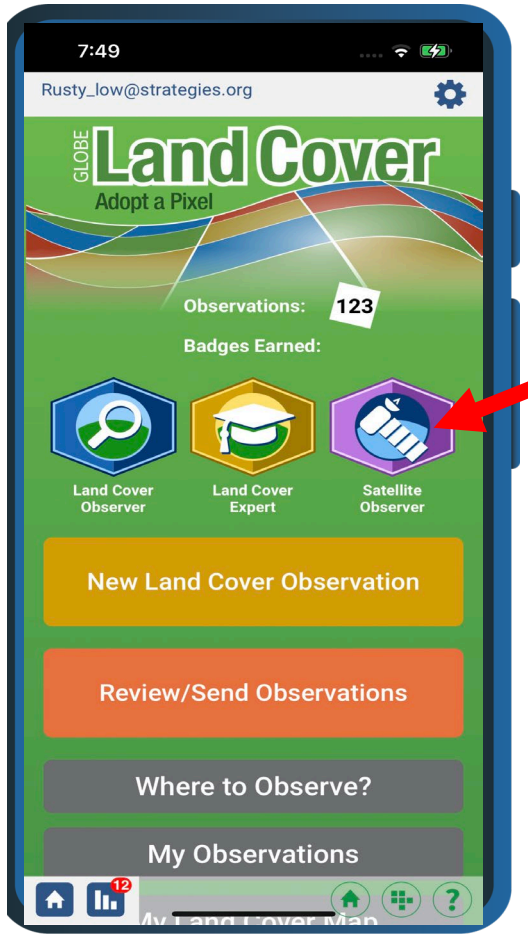
- Choose your language
- Create a team
- Engage students and the public in open data through your research



Access Team Data Here: https://www.globe.gov/globe-data/retrieve-data

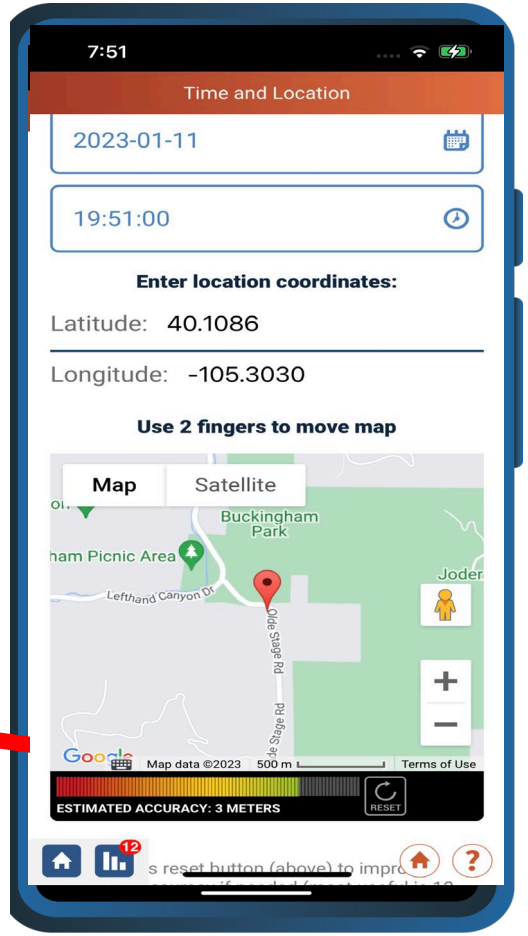
1. How to Use the Tool

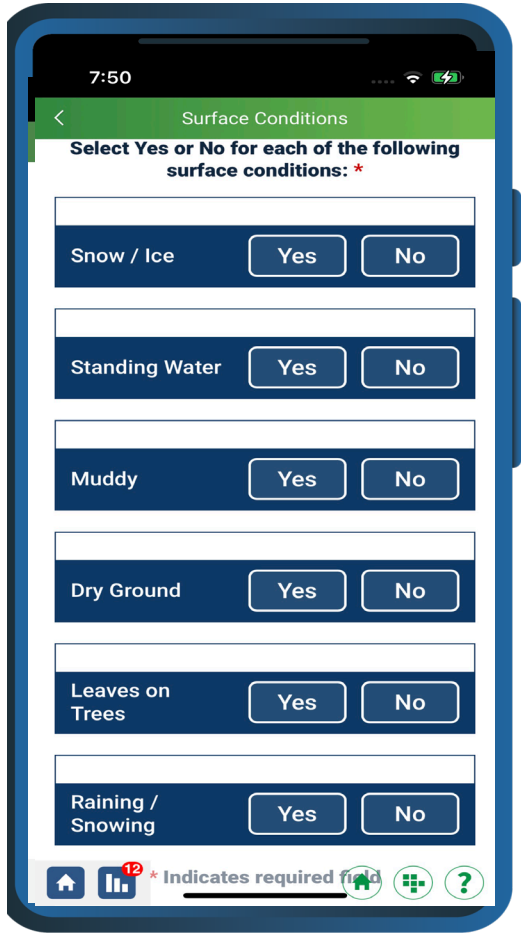
The steps in the app are the scientific observation protocol.



Click on short, in app tutorials to get started

Press "reset" until you have your best available geolocation accuracy (4-12 m)





Begin your Observation

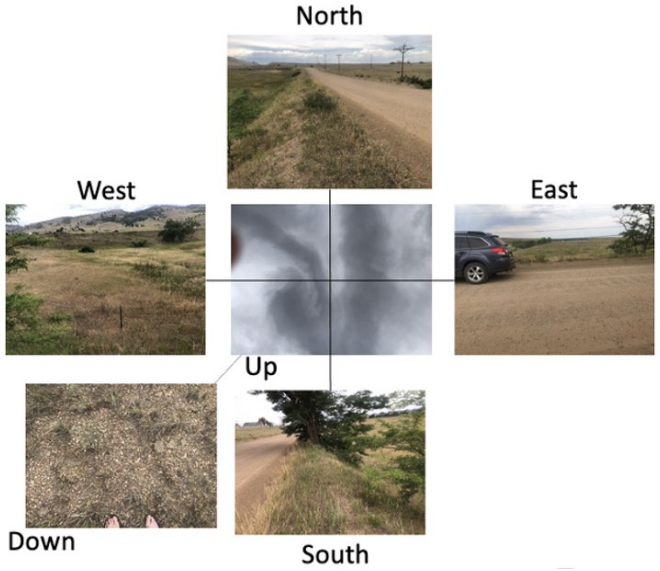
Capture your Geolocation

Describe Conditions

1. How to Use the Tool

Document your observations with voucher photographs.

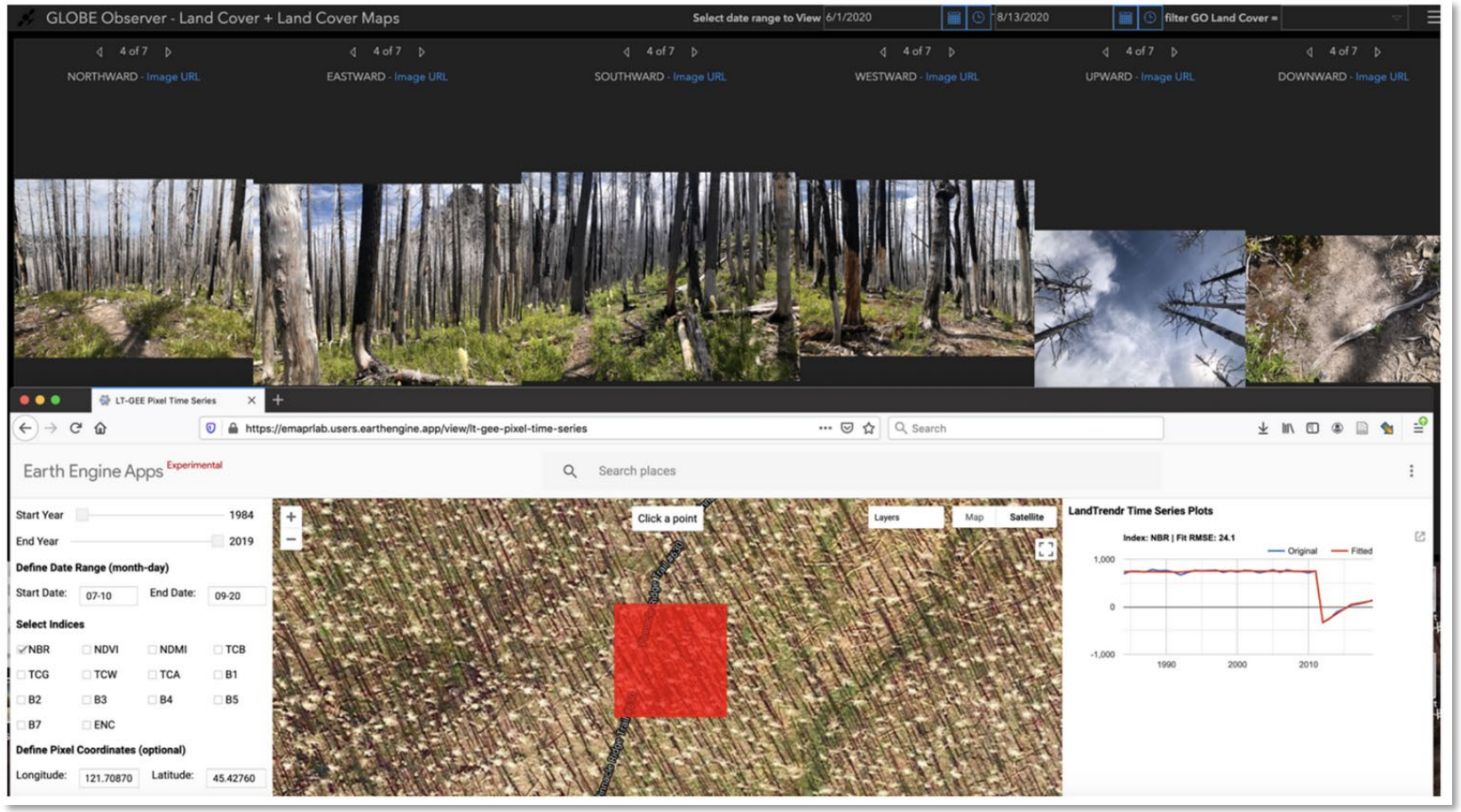
Take landcover photos in-app: In each direction, use the built- in compass to position the direction icon in the shaded area.



- Your 6 photos of will document the landcover and sky conditions for the time of your observation.
- Save your data to the app, make more observations as desired.
- Wait until you have a strong internet signal to upload.

1. How to Use the Tool

Why is the data important?
Citizen science data supports understanding and interpretation of satellite data.

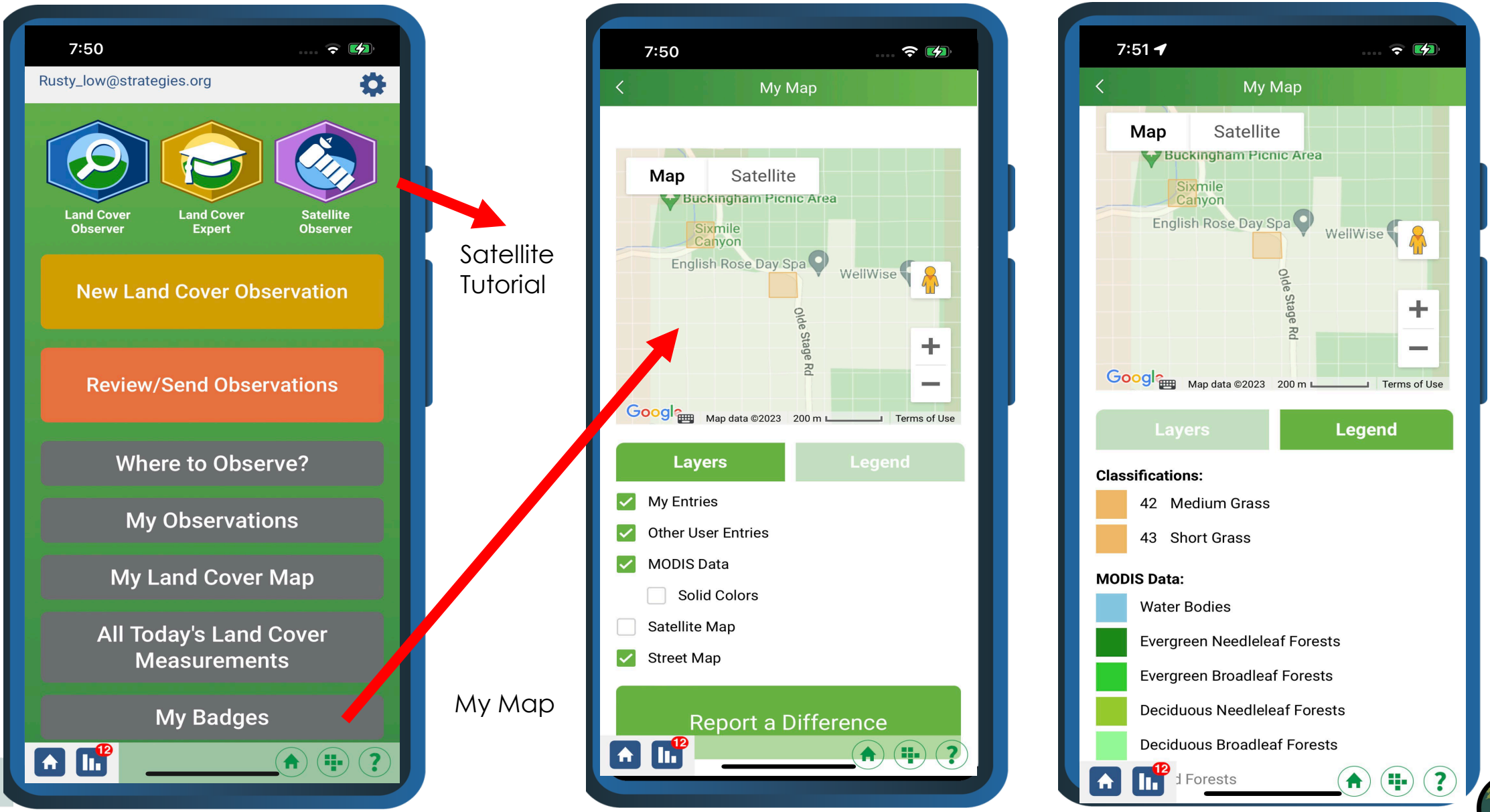


https://observer.globe.gov

The tool above is featured in an advanced ARSET training:
https://appliedsciences.nasa.gov/join-mission/training/advanced-webinar-investigating-time-series-satellite-imagery

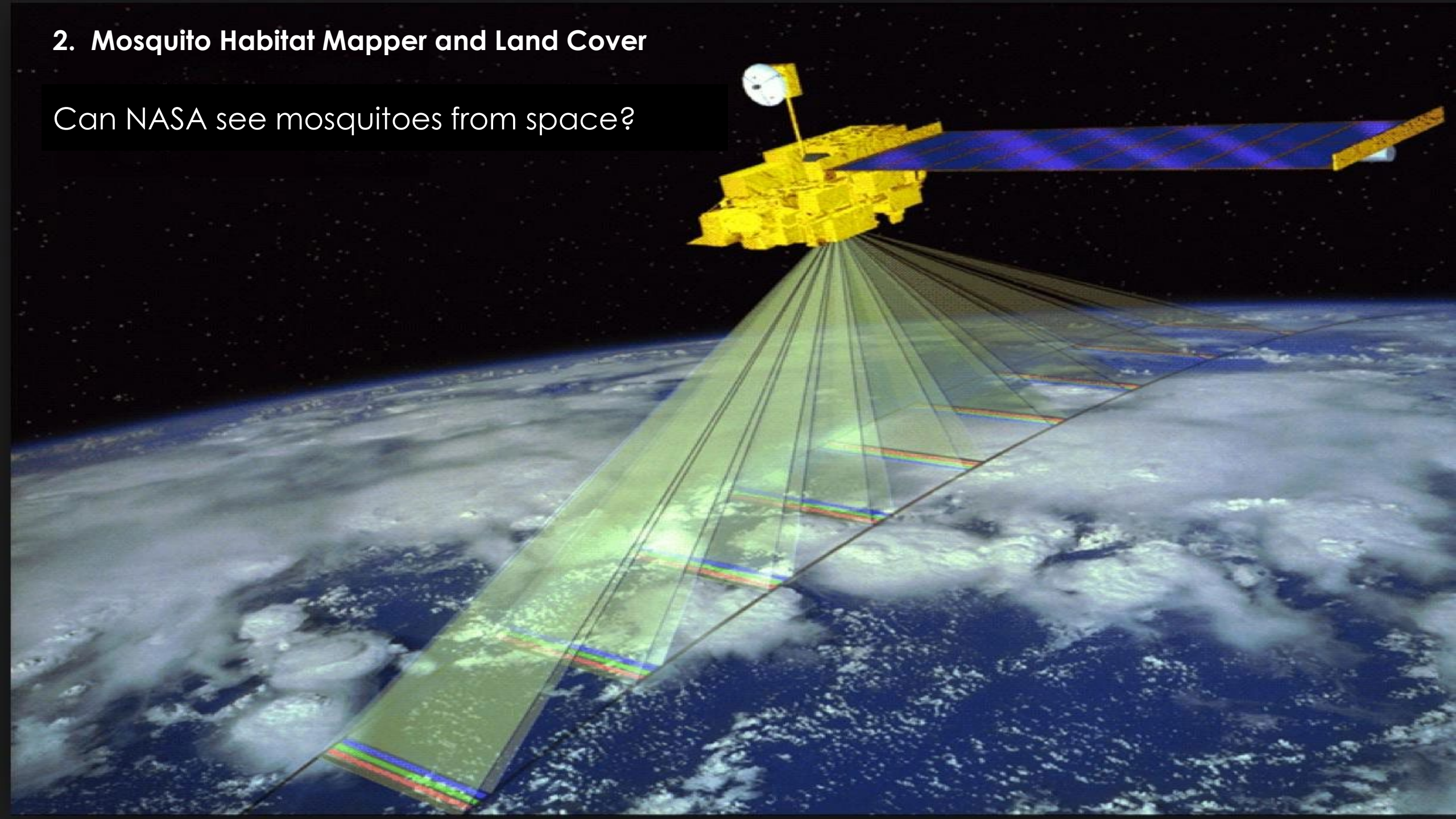
1. How to Use the Tool

Compare your in-situ data to MODIS land cover map in-app.



2. Mosquito Habitat Mapper and Land Cover

Can NASA see mosquitoes from space?



2. Mosquito Habitat Mapper and Land Cover

Citizen scientists make the connection between satellite data and mosquitoes.

https://observer.globe.gov

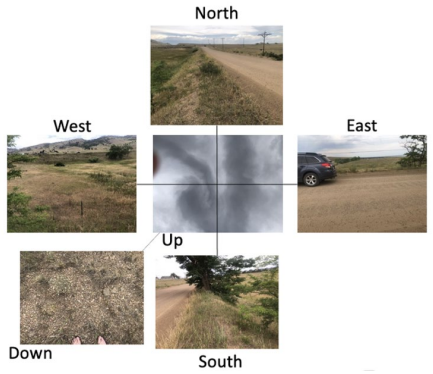
2. Mosquito Habitat Mapper and Land Cover

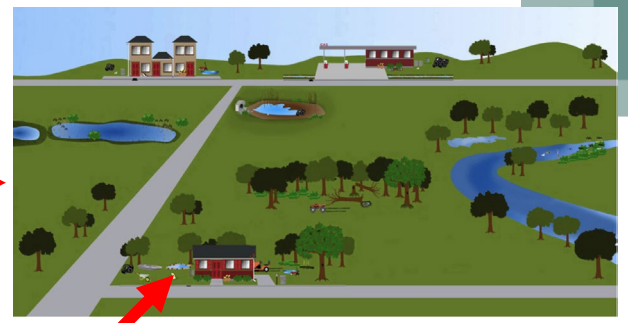
Together, GO MHM and LC tools report data on scales of 100 m to micrometers.

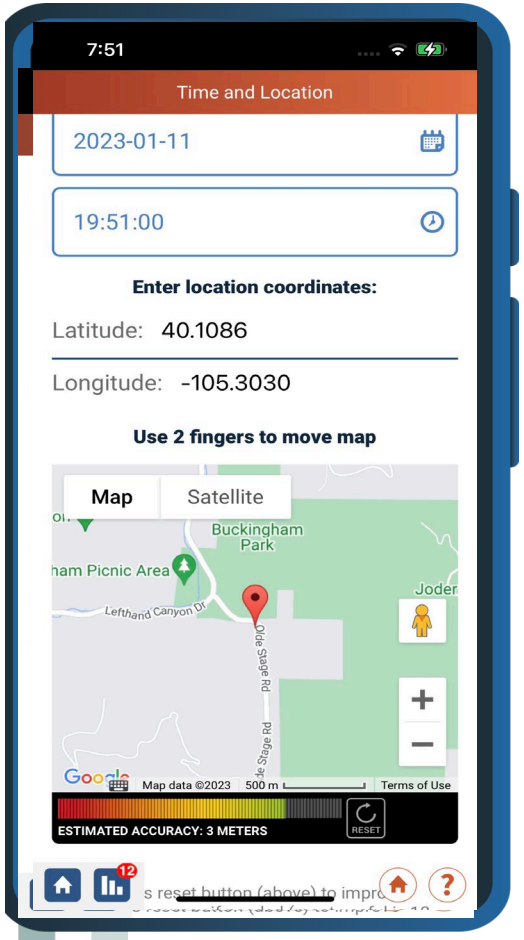
Image from: https://extension.entm.purdue.edu/mosquito_tool/index.html

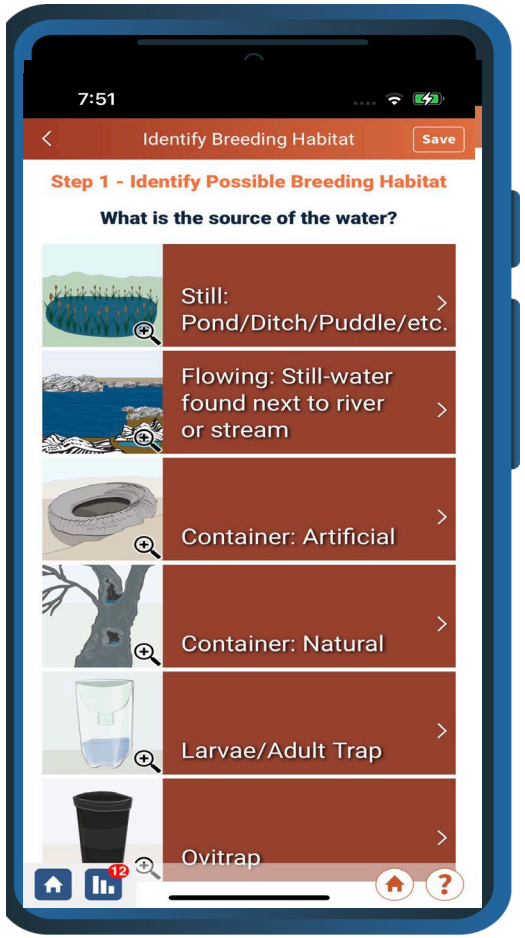
2. Mosquito Habitat Mapper and Land Cover

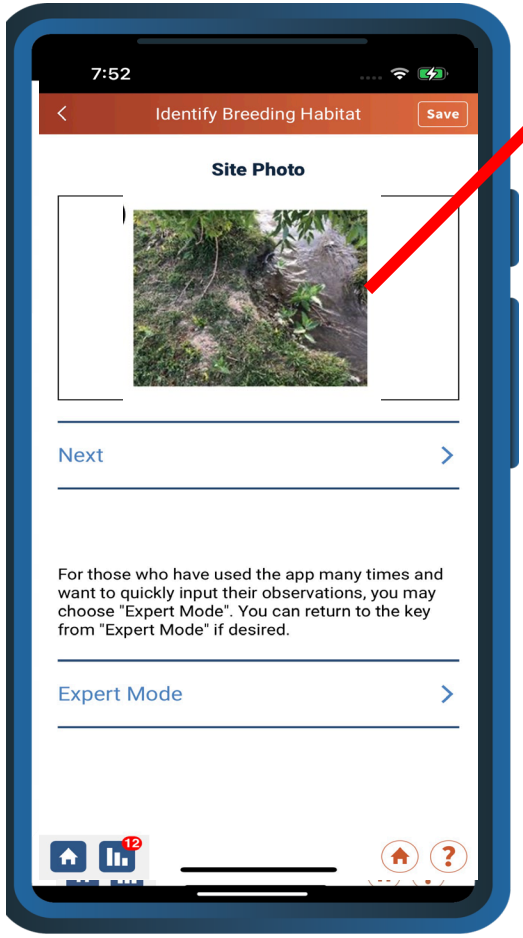
Your co-incident land cover data will provide the environmental context of the mosquito habitat documented using the app.

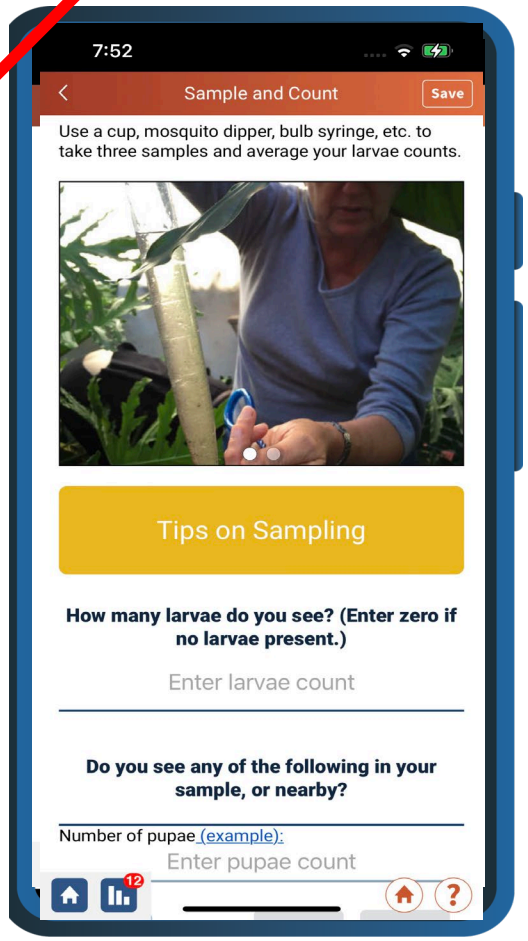






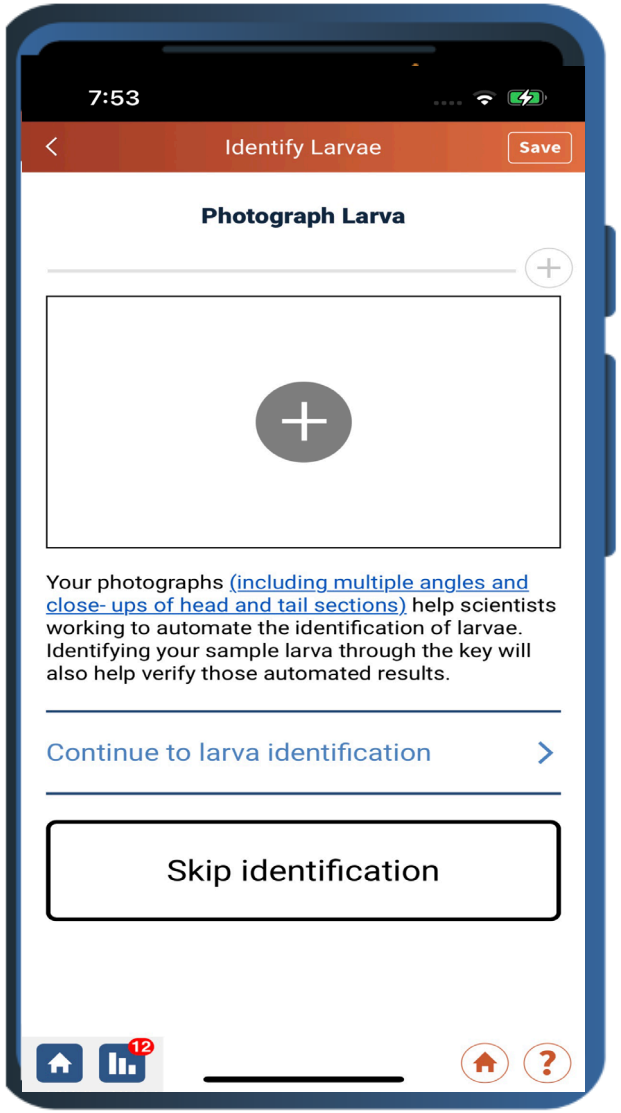


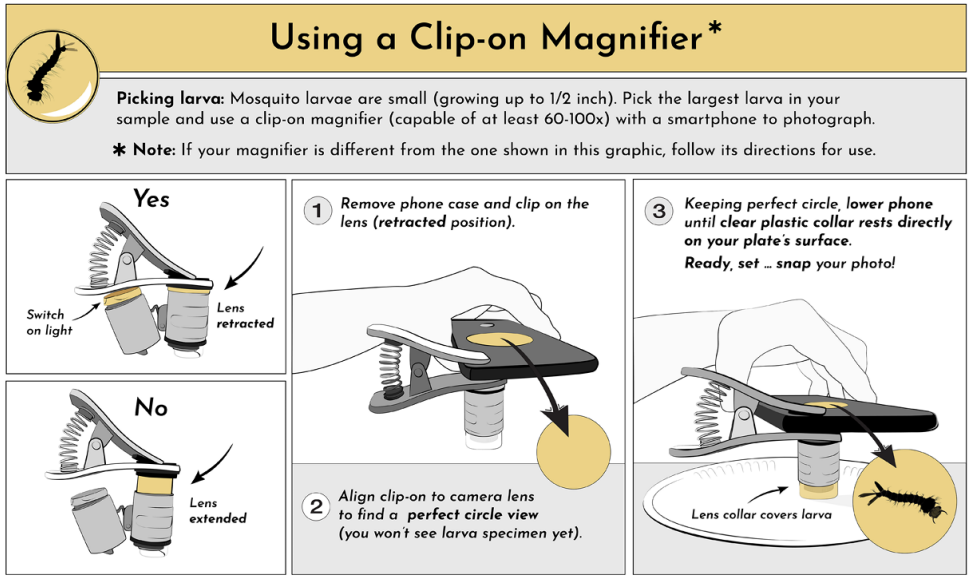


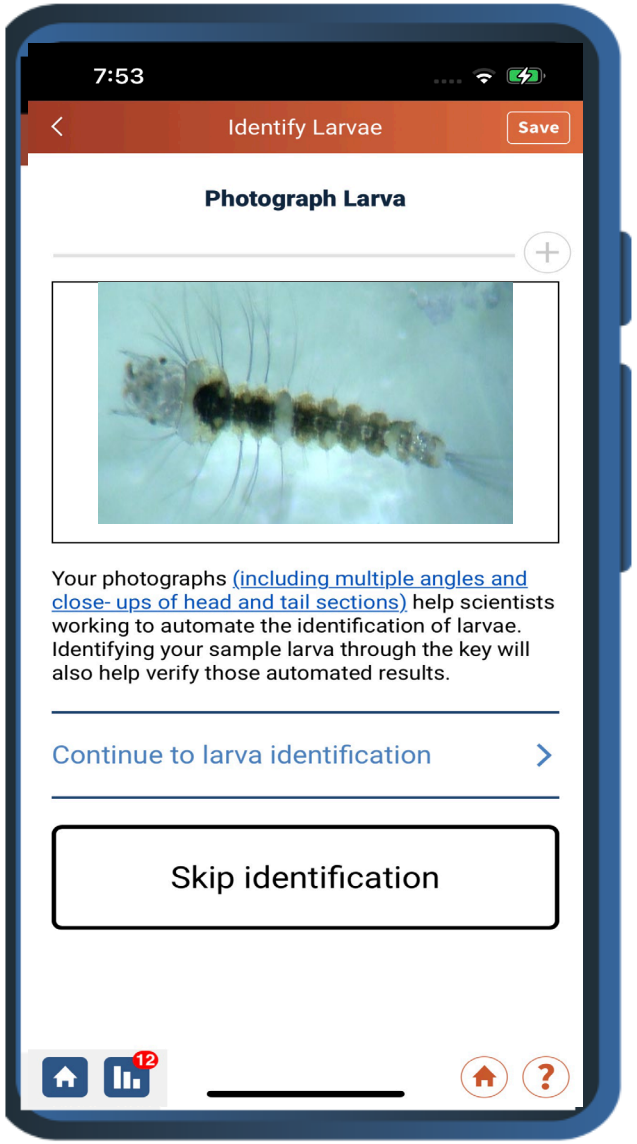


3. Mosquito Data Collection

Taking voucher photographs

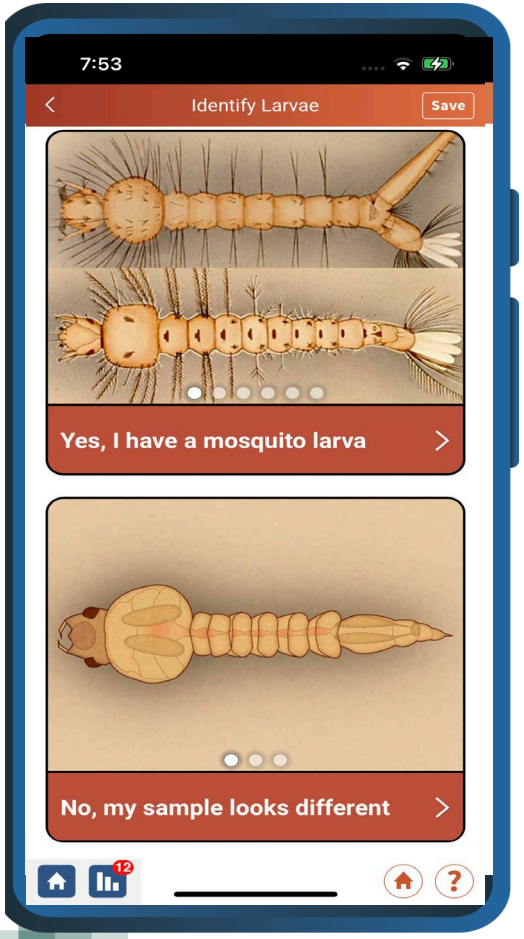


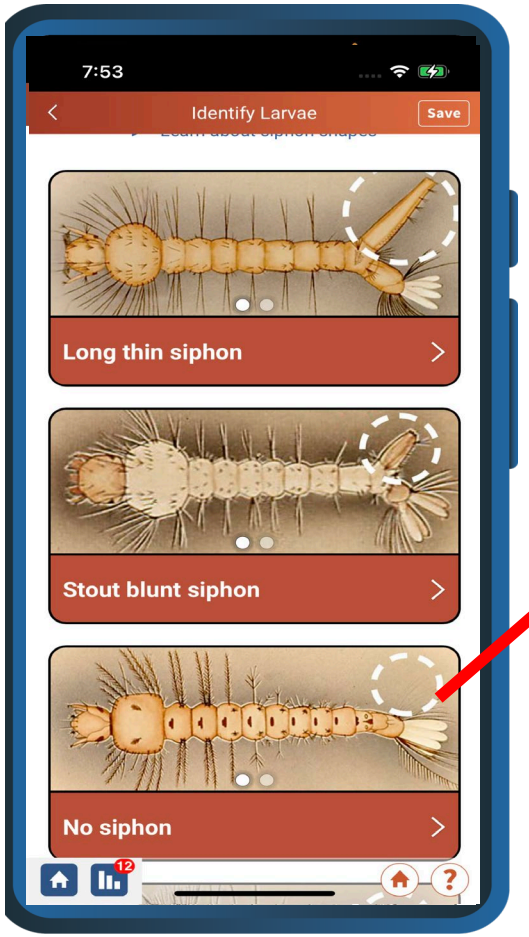


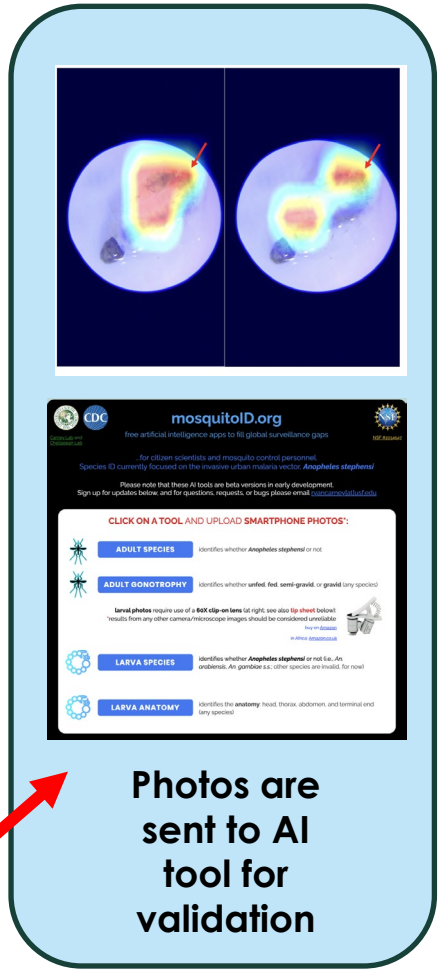


3. Mosquito Data Collection

Use the key to identify your specimen



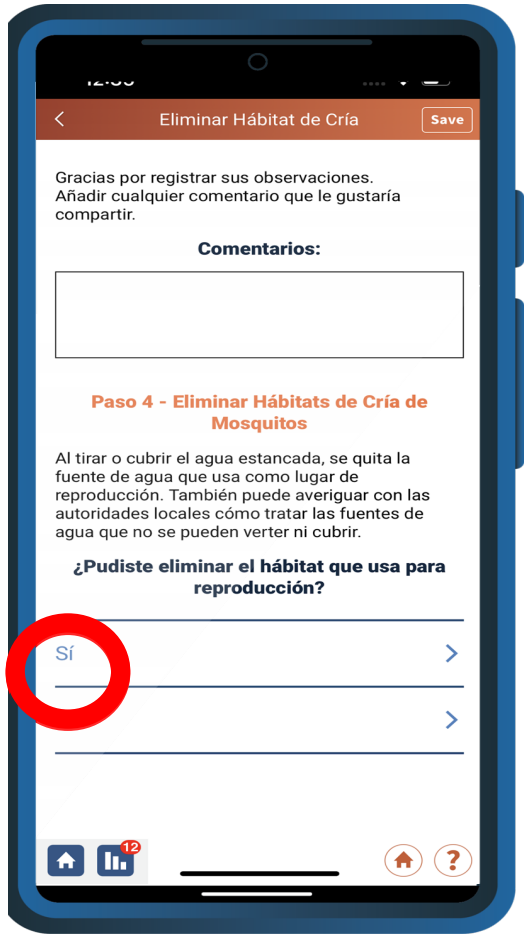




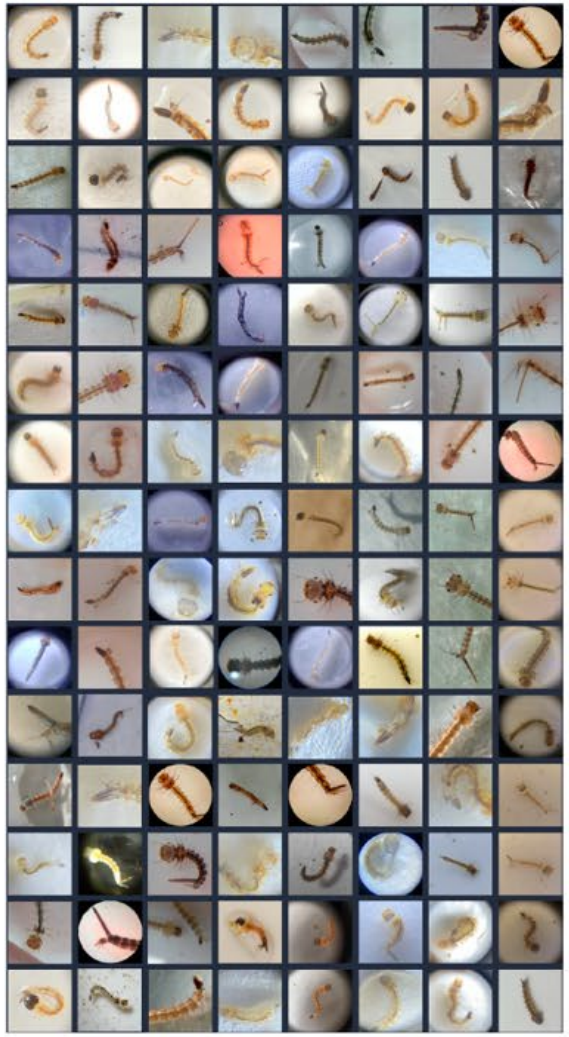
Photos are sent to AI tool for validation

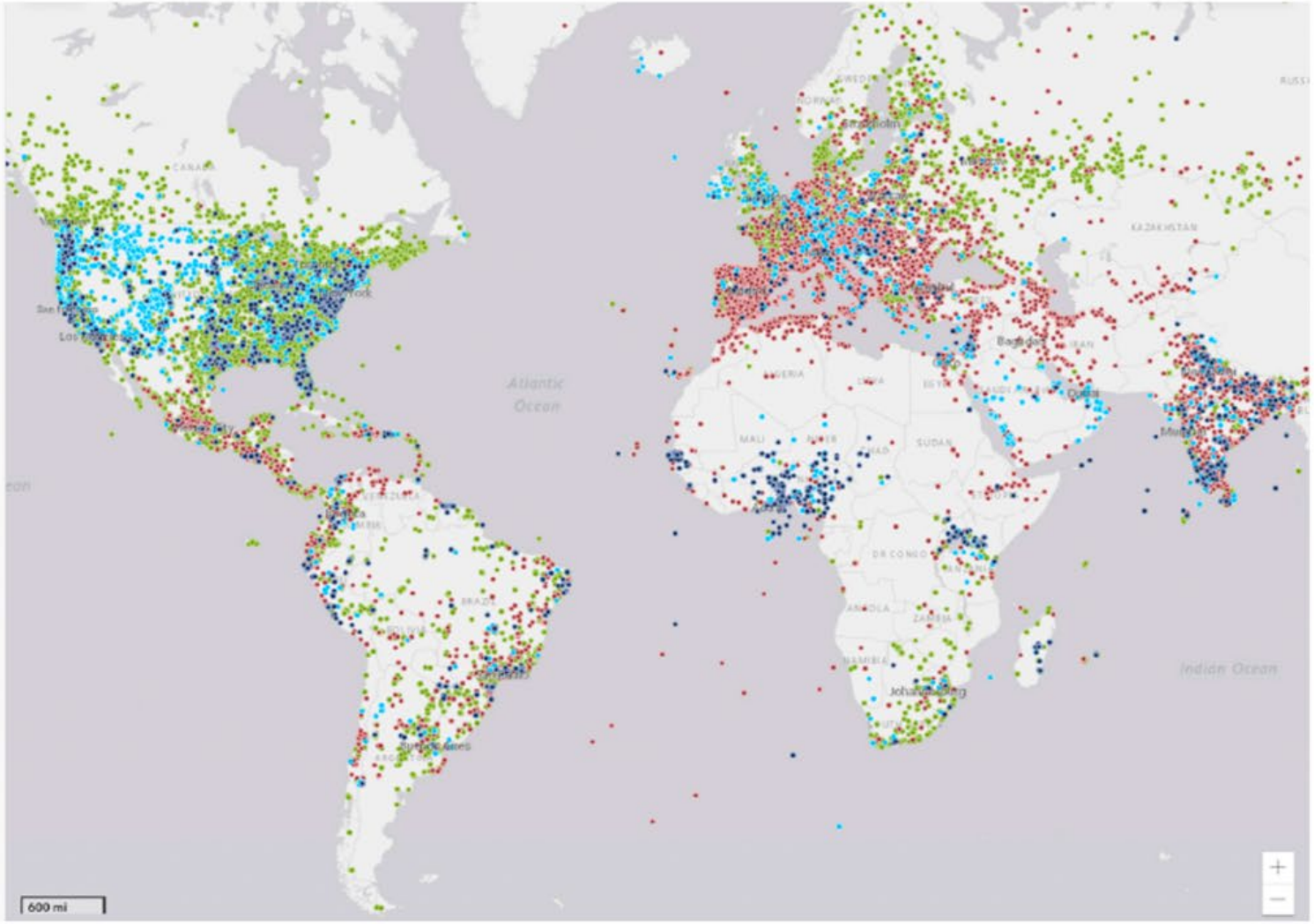
Validation Step

Not just data… action!



3. Mosquito Data Collection

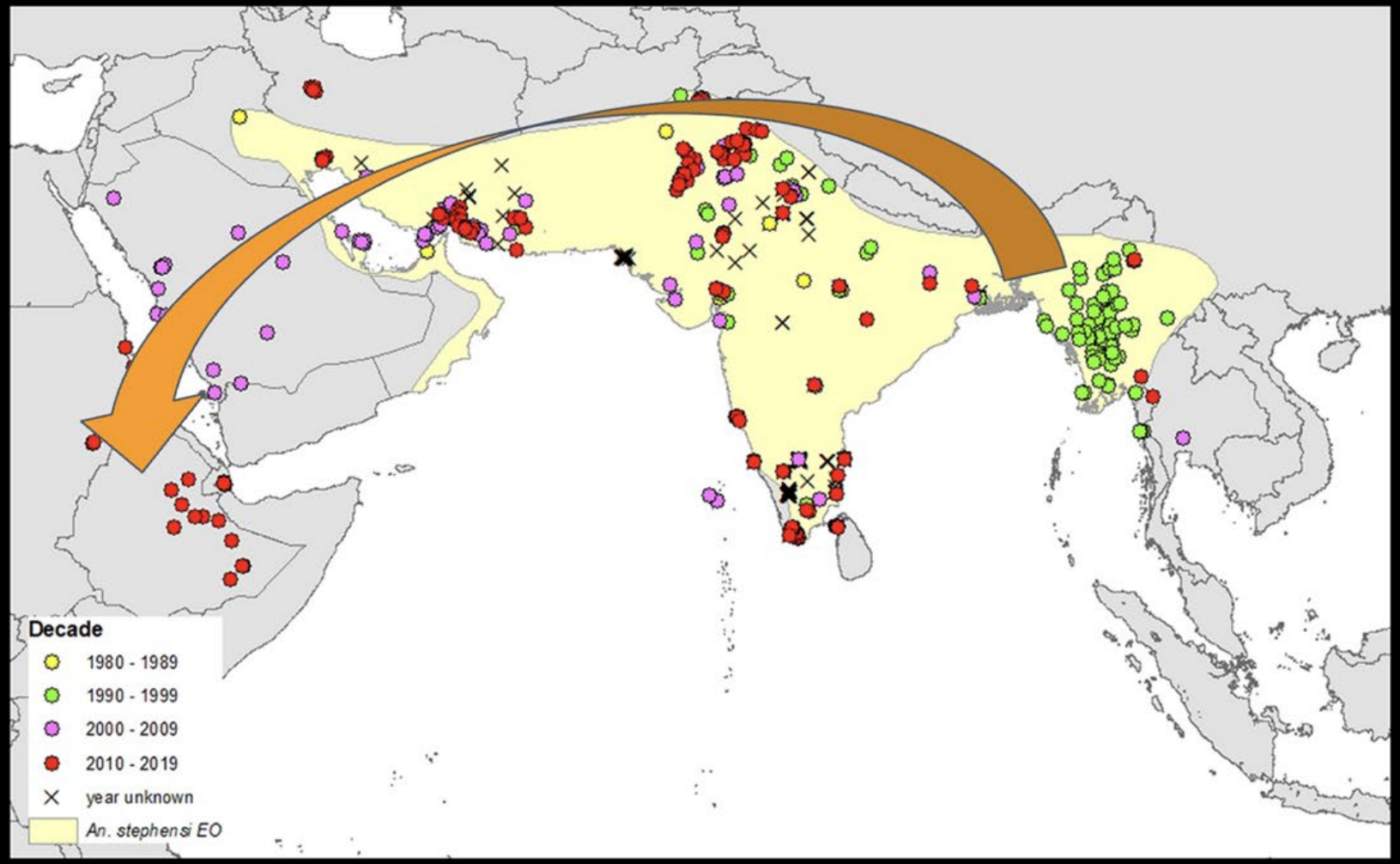




Citizen science larvae photos (left) and locations of citizen science data observations (blue=GLOBE Observer Mosquito Habitat Mapper, red=Mosquito Alert, green=iNaturalist. Source: Carney et al. 2022

4. Citizen Science Data Use Case

The problem



A new malaria vector in Africa: Predicting the expansion range of *Anopheles stephensi* and identifying the urban populations at risk (Sinka et al. 2020)

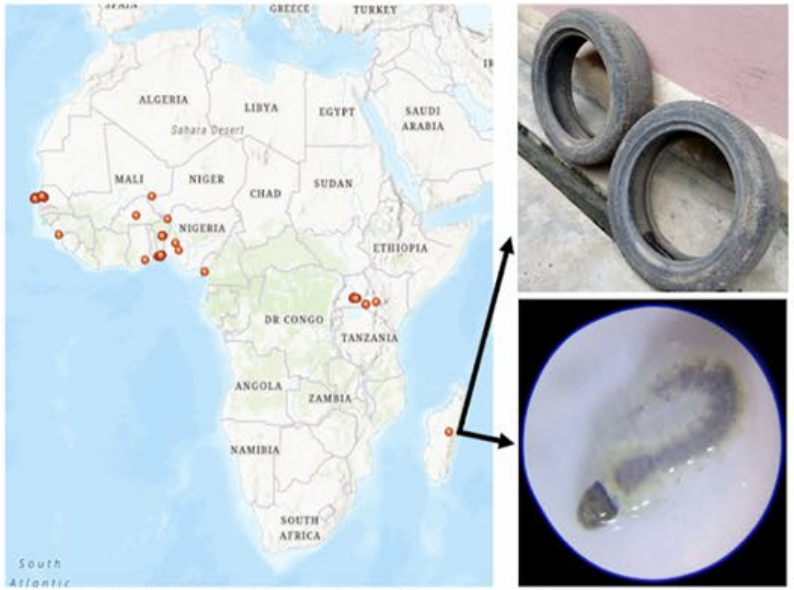
Game Changer for malaria prevention in Africa:

- Day biters
- Container breeders
- Resistant to all adult mosquito insecticides
- Competent vector for both *Plasmodium falciparum* and *P. vivax*

4. Citizen Science Data Use Case

GLOBE mosquito habitat mapper

- citizen scientist report March 8, 2020
- *Anopheles sp.* found in a tire
- Antananarivo, Madagascar (-18.9228, 47.5535)



Citizen scientist reports of *Anopheles spp.* found in containers from May 31, 2017 – Jan 27, 2022

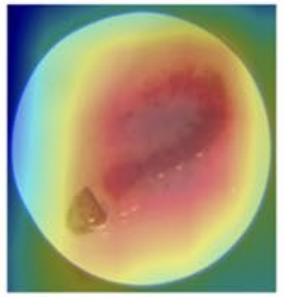
upload via browser on phone or computer

mosquitoID.org

beta version to launch April 2022

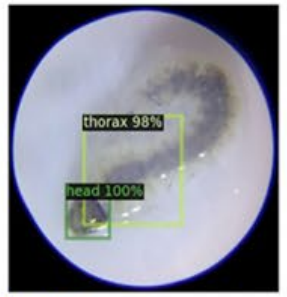
artificial intelligence models:

"explainable AI": heat maps show weights of the pixels used in algorithm classification:

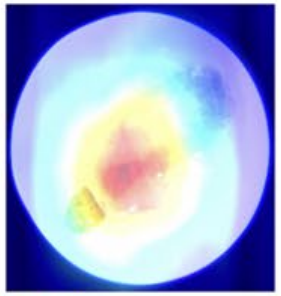


model #1: ID *stephensi* vs *gambiae*

"localization": regional bounding boxes



model #3: ID anatomical regions



model #2: ID male vs female

RESULTS:

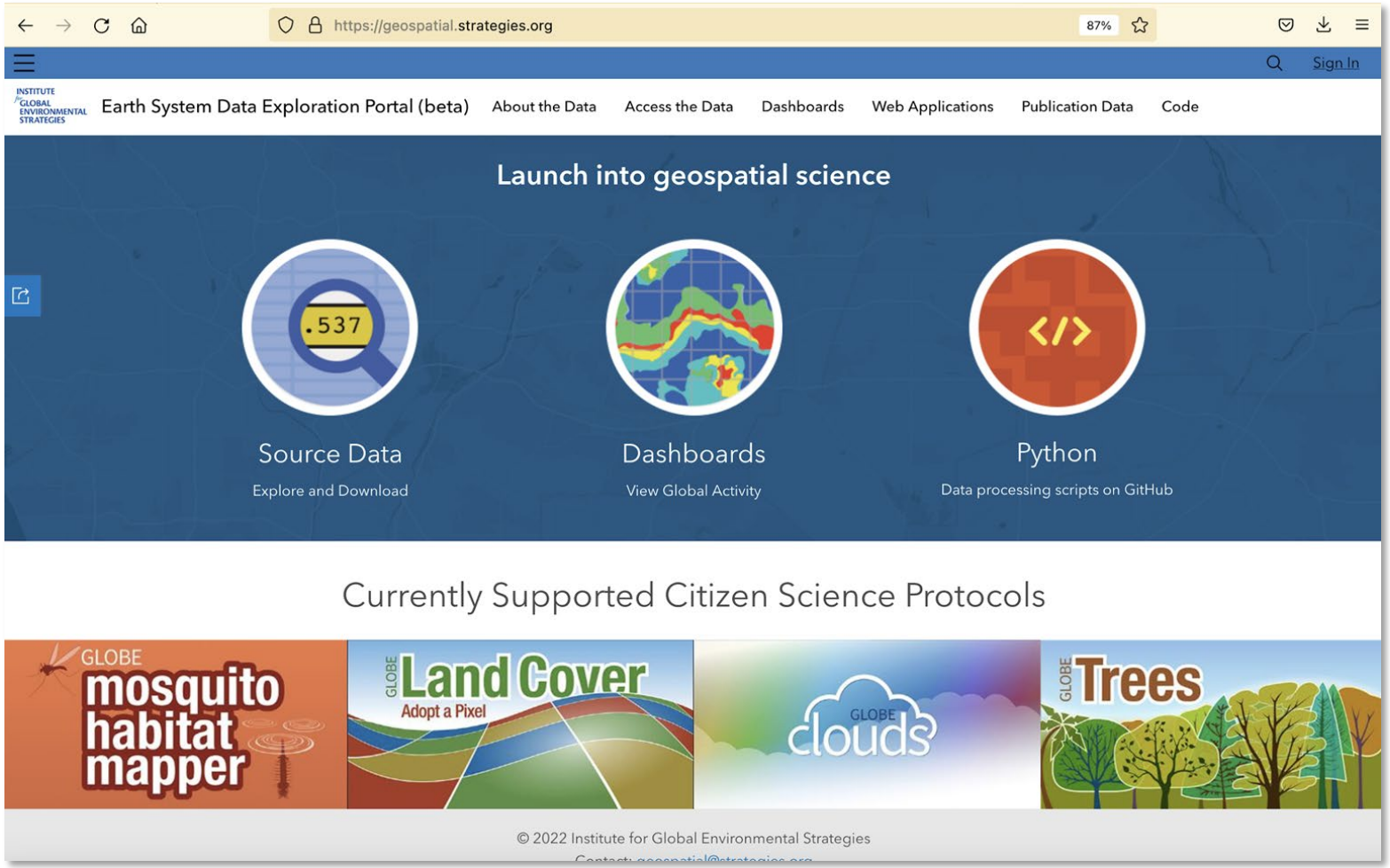
An. stephensi

male

PATENT PENDING US 63/140,505; PCT/US22/17089

Leveraging Citizen Science and Artificial Intelligence to Enable Next-Generation Surveillance of Invasive Mosquito Vectors". National Science Foundation under Grant No. IIS-2014547

5. Data Access

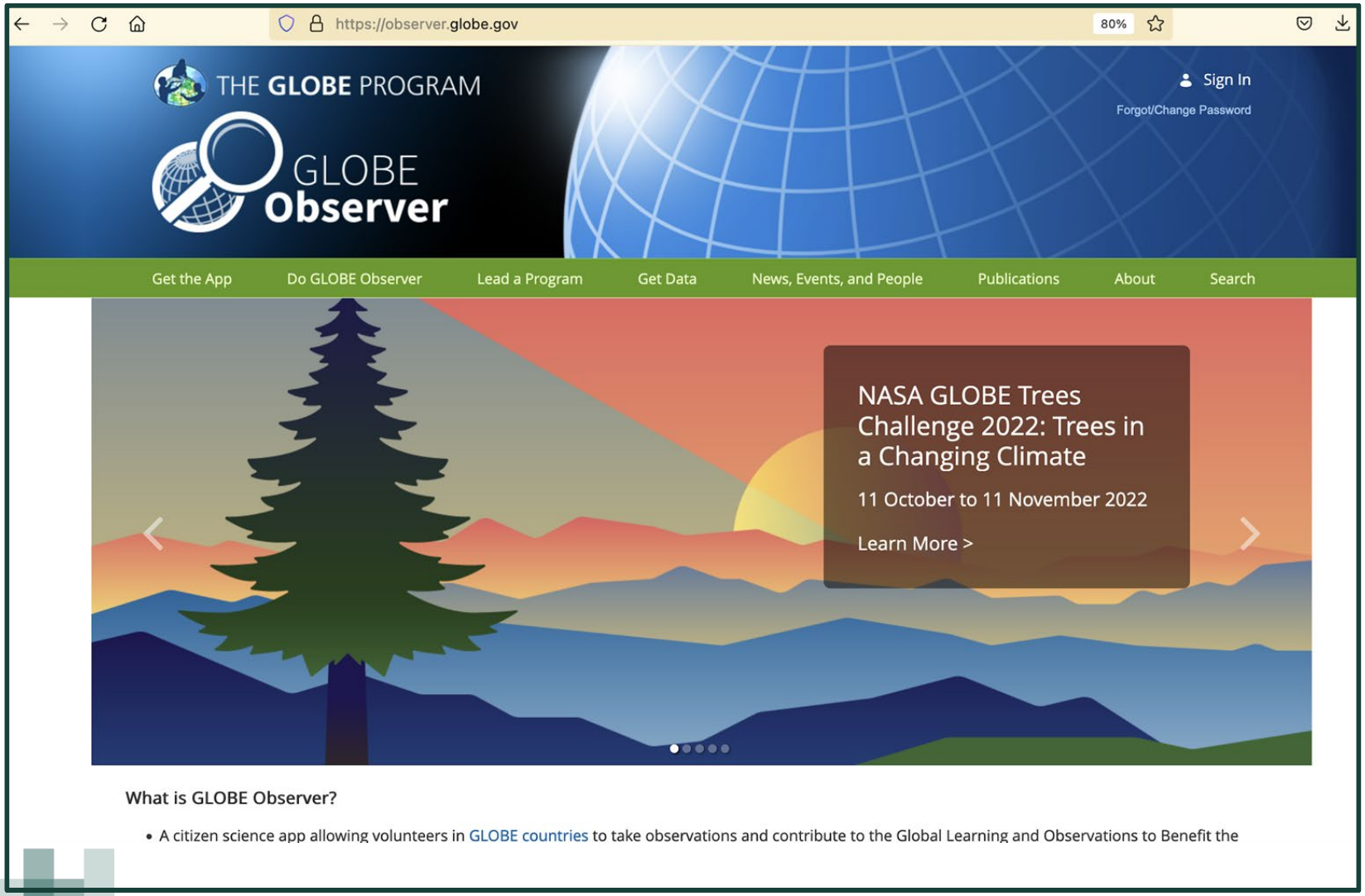


https://geospatial.strategies.org/

Access and explore enriched and curated data sets

5. Data Access

All the information you need is available on the GLOBE Observer website.



Raw Data Access:

https://vis.globe.gov/GLOBE/

https://www.globe.gov/es/globe-data/retrieve-data

https://geospatial.strategies.org/

https://Mosquitodashboard.org

Please Contact Us:

rusty_low@strategies.org

peder.nelson@oregonstate.edu

https://observer.globe.gov/

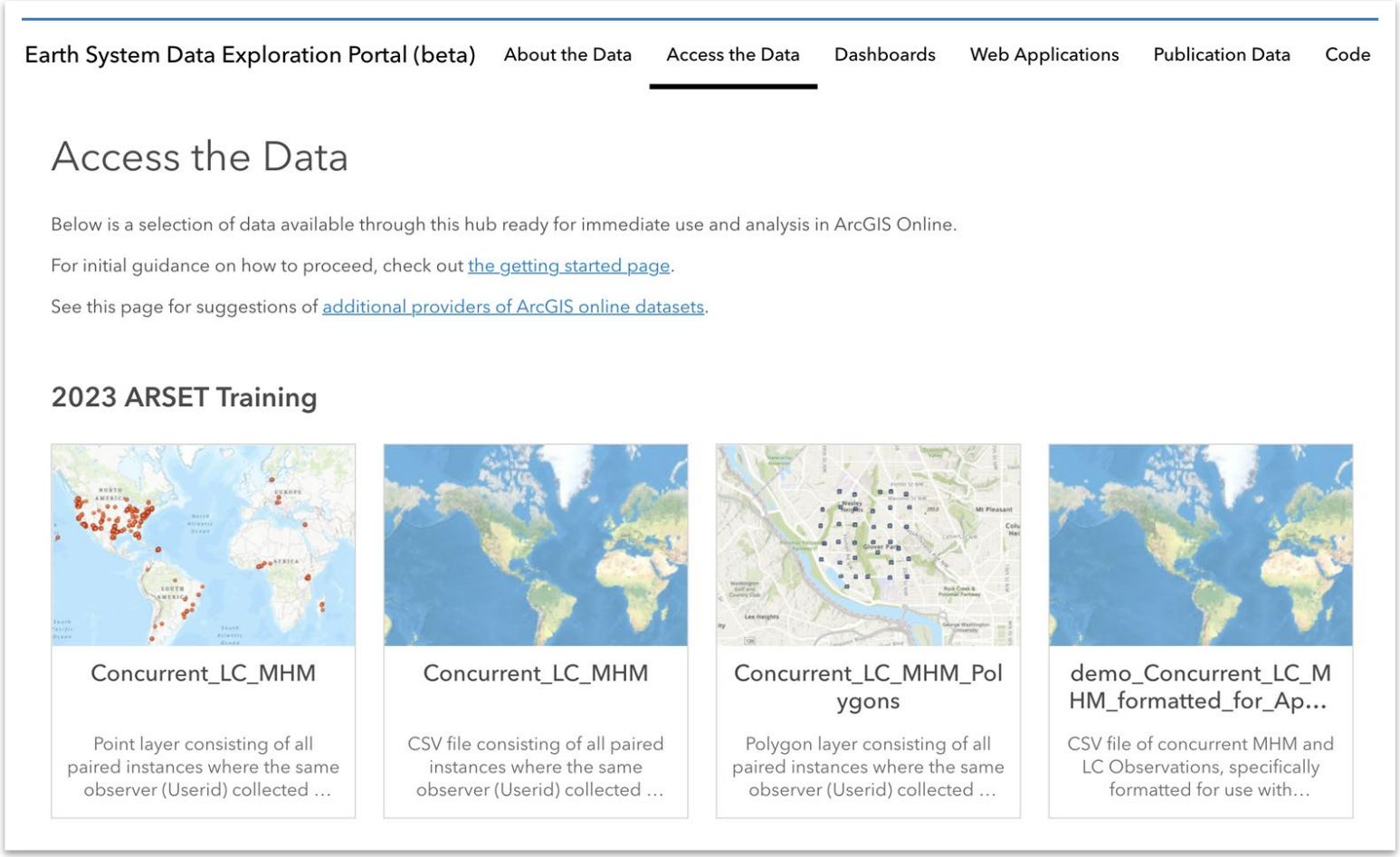
6. Data Exploration

Examine GLOBE Observer Land Cover and Mosquito Habitat Mapper Co-Located Data

1. Identify locations to explore

1. Navigate to https://geospatial.strategies.org/pages/access-the-data
2. Under the ARSET 2023 heading, *select* the 'demo_Concurrent_LC_MHM' CSV file, and *download* to your computer.

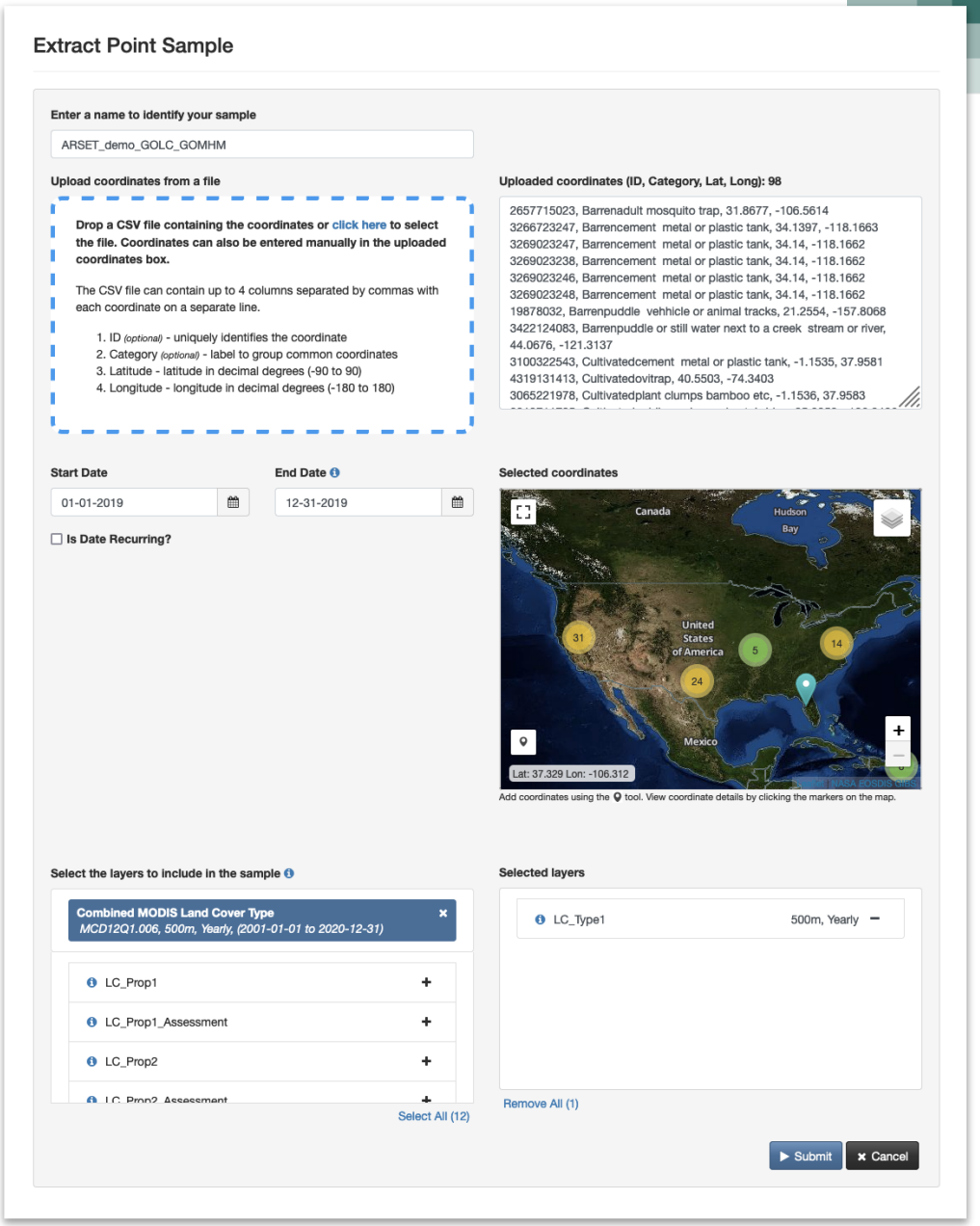
This CSV data file consists of GLOBE Observer Mosquito Habitat Mapper (MHM) and GLOBE Observer Land Cover (LC) observation data. CSV file consisting of all paired instances where the same observer (Userid) collected a Mosquito Habitat Mapper observation within 100 meters and 1 hour of collecting a Land Cover observation. startdate=2019-01-01 and enddate=2019-12-31. Data has been hand refined for 99 records for this demo.



6. Data Exploration

2. Enrich with Remote Sensing Analysis Ready Samples

1. Navigate to https://appeears.earthdatacloud.nasa.gov/.
2. If you are new to AppEEARS, start with this helpful tutorial: https://lpdaac.usgs.gov/resources/e-learning/introduction-appeears-point-sampler/
3. Sign In (or register for this free account)
4. Under the 'Extract' menu, *select* 'Point'.
5. Select 'Start a New Request', which will take you to a screen with 'Extract Point Sample'
6. Extract Point Sample
    a. Input a name to identify your sample like "Concurrent_LC_MHM"
    b. Use the 'Upload coordinates from a file" box to upload the csv that has been simplified and formatted for use: Concurrent_LC_MHM_formatted_for_AppEEARS.csv
    c. Enter the Start Date = 05-01-2017, End Date = 12-31-2022
    d. Under 'Select the layers to include in the sample', search for the 'Combined MODIS Land Cover Type (MCD12Q1.006, 500m, Yearly, (2001-01-01 to 2020-12-31), select the 'LC_Type1'.
    e. Click the 'Submit' button in the lower right. Check for any error messages. If successful, you will receive an email indicating the status of your submission.



*Screenshot : AppEEARS, **App**lication for **E**xtracting and **E**xploring **A**nalysis **R**eady **S**amples*
https://appeears.earthdatacloud.nasa.gov/

6. Data Exploration

3. Explore the Data

1. In your experience, where would you expect to find mosquito habitats on the landscape?

1. What are the land cover types identified where mosquito habitats are co-located? What is the most frequent MODIS land cover type identified in this demo? You can find the definitions and labels of the land cover types for MODIS here: https://lpdaac.usgs.gov/products/mcd12q1v006/

1. Is there anything surprising about the returned results, or does it confirm your hypothesis/expectations?

1. You can now examine other spectral measurements and data products in conjunction with mosquito habitat data https://appeears.earthdatacloud.nasa.gov/products. Some ideas:

- Elevation: https://lpdaac.usgs.gov/products/srtmgl3v003/
- Temperature: https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1840
- NDVI: https://lpdaac.usgs.gov/products/myd13a1v061/
- Soil Moisture: https://nsidc.org/data/spl3smp/versions/8

1. On the basis of your explorations, have you seen any patterns that suggest avenues for further research?

Daymet: Daily Surface Weather Data on a 1-km Grid for North America, Version 4

References

Amos, H.M., Starke, M.J., Rogerson, T.M., Colón Robles, M., Andersen, T., Boger, R., Campbell, B.A., Low, R.D., Nelson, P., Overoye, D. and Taylor, J.E., (2020). GLOBE Observer data: 2016–2019. *Earth and Space Science*, *7*(8), p.e2020EA001175.

Carney, R.M.; Mapes, C.; Low, R.D.; Long, A.; Bowser, A.; Durieux, D.; Rivera, K.; Dekramanjian, B.; Bartumeus, F.; Guerrero, D.; et al. Integrating Global Citizen Science Platforms to Enable Next-Generation Surveillance of Invasive and Vector Mosquitoes. Insects 2022, 13, 675. https://doi.org/10.3390/insects13080675

Kohl, H.A., Nelson, P.V., Pring, J., Weaver, K.L., Wiley, D.M., Danielson, A.B., Cooper, R.M., Mortimer, H., Overoye, D., Burdick, A. and Taylor, S., 2021. GLOBE Observer and the GO on a Trail Data Challenge: A Citizen Science Approach to Generating a Global Land Cover Land Use Reference Dataset. *Frontiers in Climate*, *3*, p.620497. https://doi.org/10.3389/fclim.2021.620497

Low, R.D., Schwerin, T.G., Boger, R.A., Soeffing, C., Nelson, P.V. et al. (2022). Building International Capacity for Citizen Scientist Engagement in Mosquito Surveillance and Mitigation: The GLOBE Program's GLOBE Observer Mosquito Habitat Mapper. Insects 13(7), p.624. https://doi.org/10.3390/insects13070624

Data and Tool Links:

GIS Dashboard: mosquitodashboard.org
Mosquito AI tools: mosquitoID.org
GLOBE Observer Citizen Science observer.globe.gov
GLOBE Mission Mosquito Campaign: globe.gov/web/mission-mosquito
Earth System Explorers Geospatial Portal: geospatial.strategies.org

Data Citation:
Kohl, H.A., Nelson, P.V., Pring, J. GLOBE Land Cover Dataset-GO on a Trail 2019, The GLOBE Program, https://observer.globe.gov/get-data/landcover-data

INSTITUTE for GLOBAL ENVIRONMENTAL STRATEGIES

The material contained in this document is based upon work supported by the National Aeronautics and Space Administration (NASA) cooperative agreement award NNX16AE28A to the Institute for Global Environmental Strategies, Arlington, VA, and the National Science Foundation, award IIS- #2012547 to the University of South Florida, Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funders.

NSF

nesec NASA Earth Science Education Collaborative

NASA Partner

Arctic and Earth SIGNs and Eyes on Ice

Resources

- https://science.nasa.gov/citizenscience
- https://www.citizenscience.gov/
- https://citizenscience.org/
- NASA ESDS Citizen Science Data Working Group White Paper
- https://www.earthdata.nasa.gov/esds/competitive-programs/csesp
- Penn State Department of Agricultural Economics, Sociology, and Education: Engagement Toolbox

Contacts

- Trainers:
  - Juan L. Torres-Pérez: juan.l.torresperez@nasa.gov
  - Amber McCullum: amberjean.mccullum@nasa.gov
  - Britnay Beaudry: britnay.beaudry@nasa.gov

- Training Webpage: https://appliedsciences.nasa.gov/join-mission/training/english/arset-connecting-citizen-science-remote-sensing

- ARSET Webpage: https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset

Consult Our Sister Programs:

Follow Us on Twitter
@NASAARSET


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!