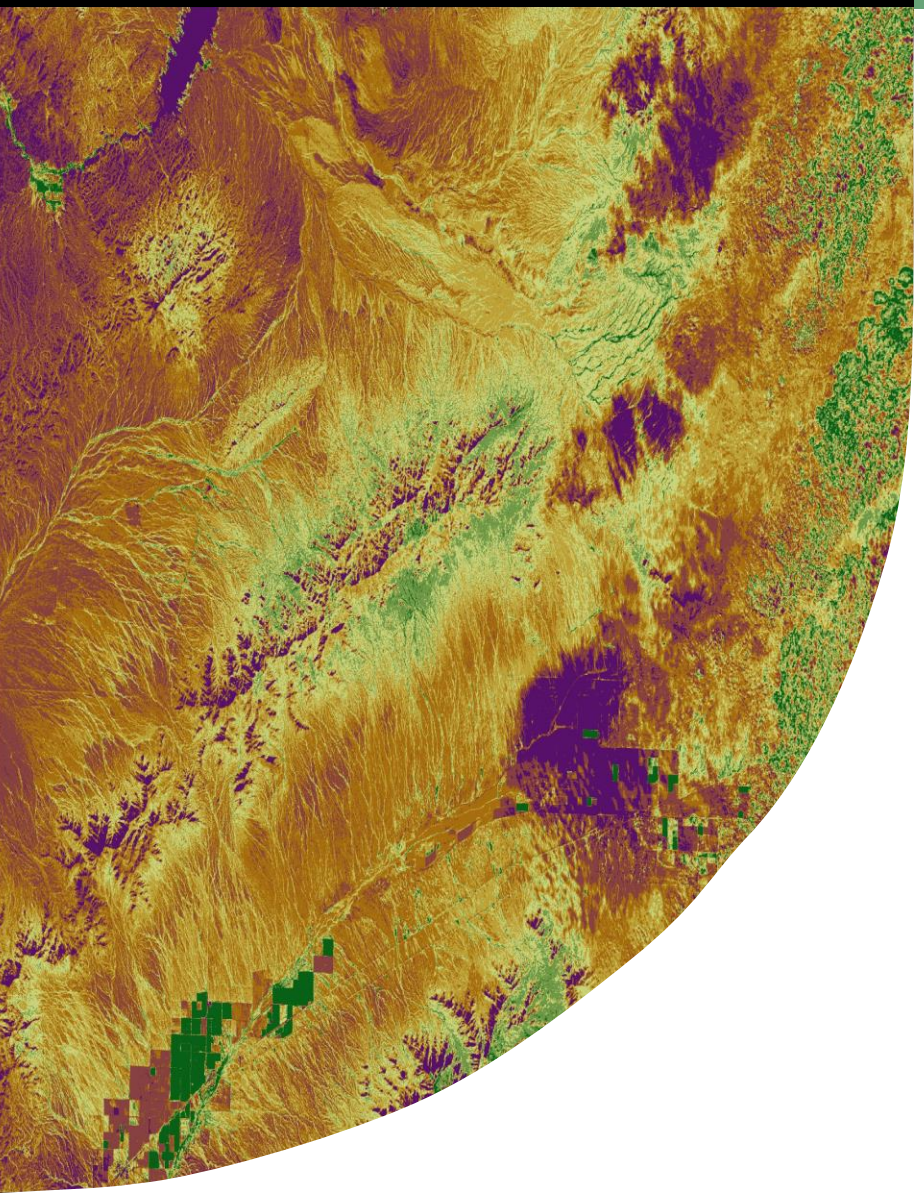
National Aeronautics and Space Administration



Sonoran Desert Ecological Conservation II

Identifying and Mapping Stinknet in Southern Arizona Using Landsat and Sentinel Data

Ella Brown, Ann Ehrlich,
Ben Malmgren, Marcellus Murray
(Analytical Mechanics Associates)

Maryland – Goddard | Summer 2025

DEVELOP

Stinknet Properties

- Native to South Africa
- Spreading throughout Arizona and California
- Thrives in disturbed areas
- Blooms in distinct yellow color

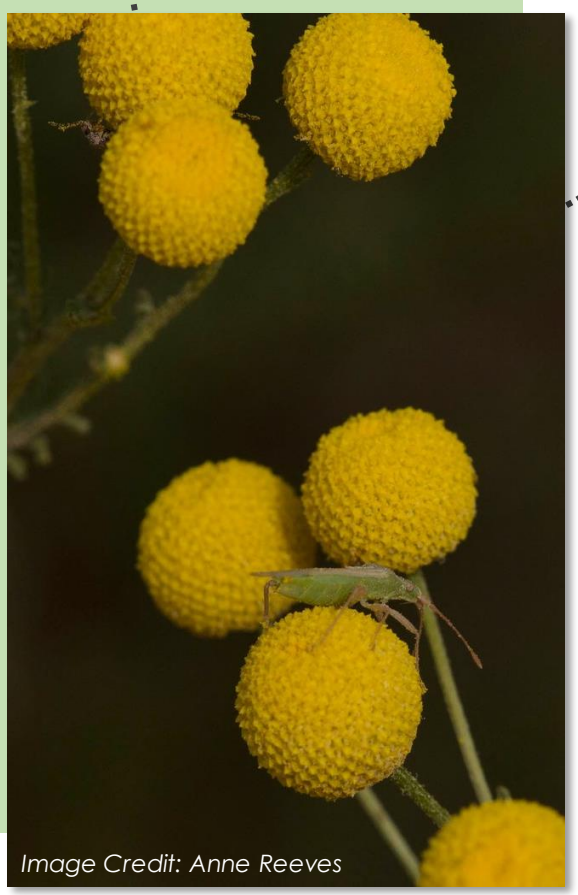


Image Credit: Anne Reeves

Green-Up


Image Credit: Survey123

Flowering

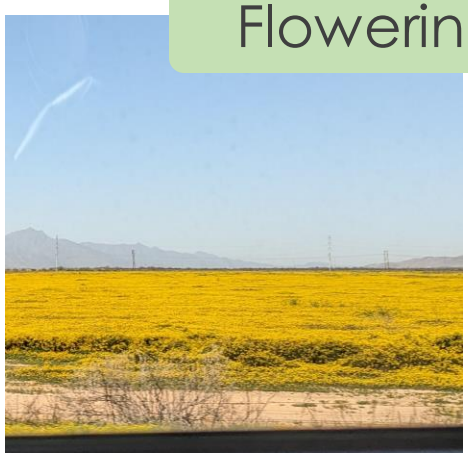


Image Credit: Survey123

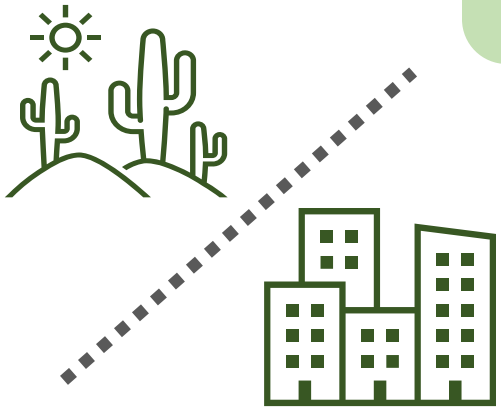
Senescence


Image Credit: Survey123

Community Concerns

Ecosystem Disruption
Native vegetation competition

Wildfire Vulnerability
Increased fuel load



Human Health
Skin and lung irritation

Objectives

Detection

Classify stinknet using Earth observation imagery at various resolutions

Distribution

Explore stinknet distribution using citizen science and INHABIT suitability model

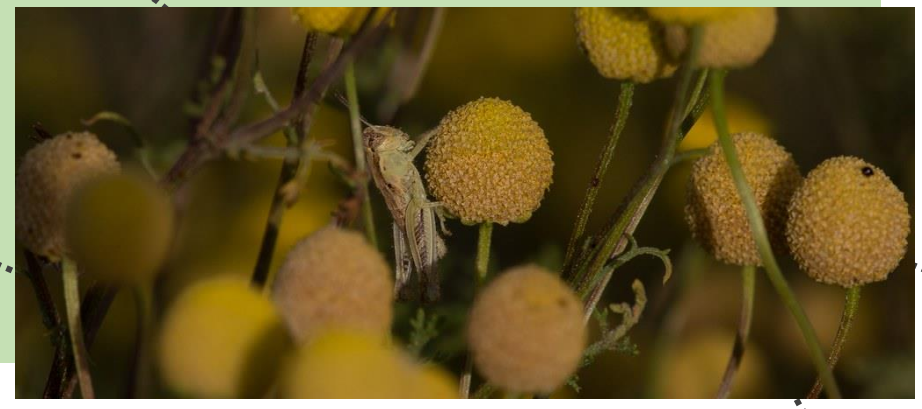


Image Credit: Anne Reeves

Partners

Image Credit: National Parks Gallery

Image Credit: U.S. Geological Survey

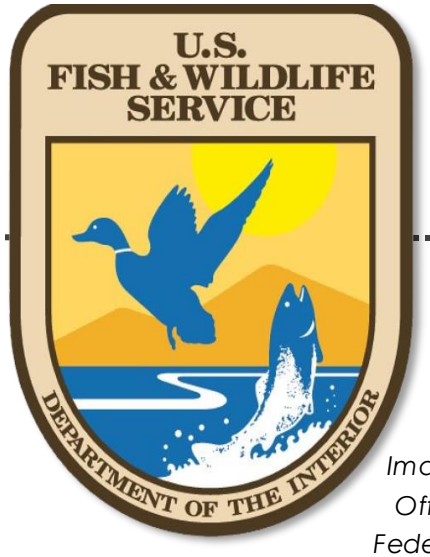
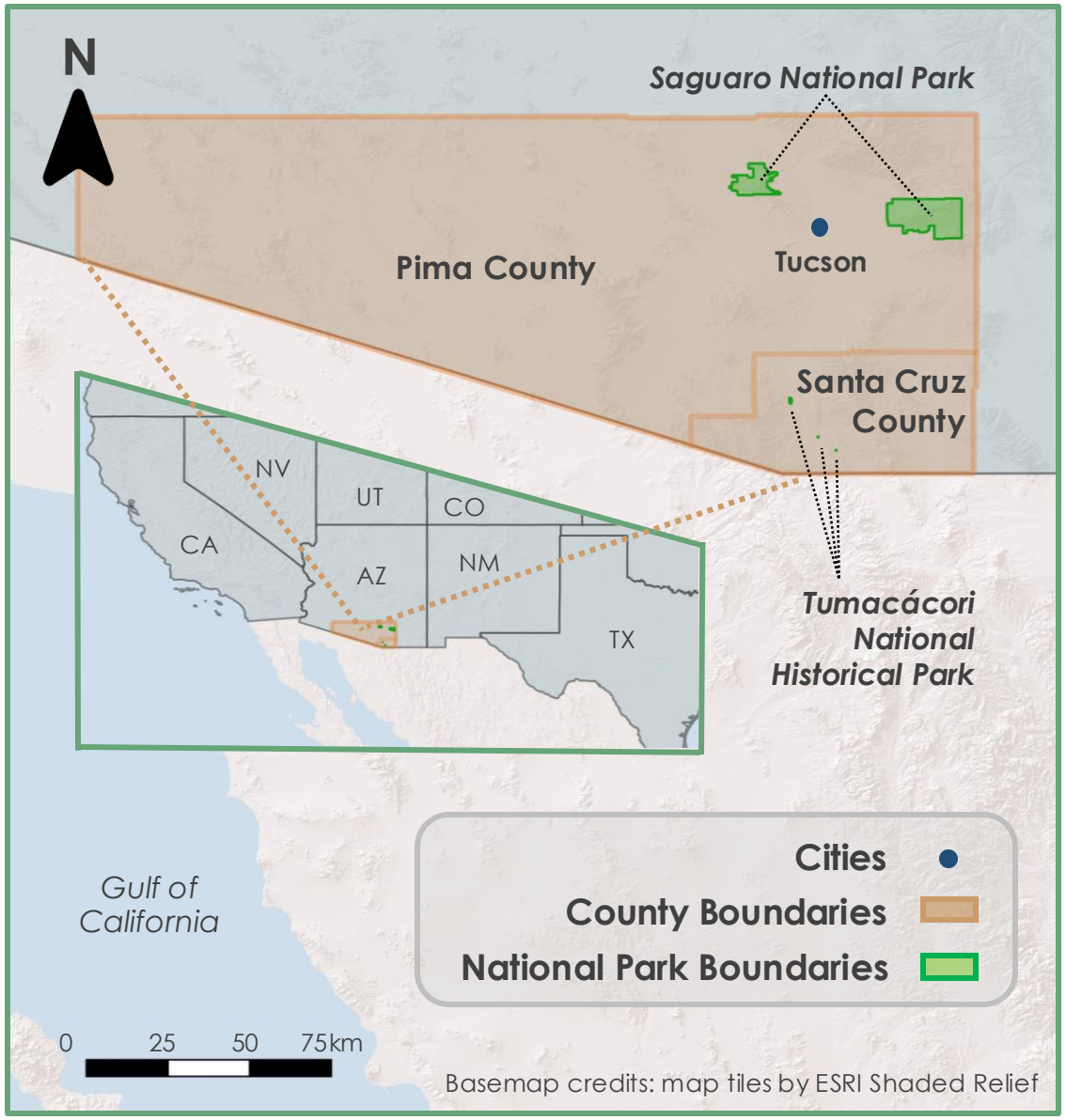


Image Credit: Office of the Federal Register

National Park Service	US Geological Survey	US Fish & Wildlife Service
Saguaro National Park Tumacácori National Historical Park	Western Geographic Science Center	Arizona National Wildlife Refuges
End Users	***Collaborator***	***Collaborator***



Study Area & Period

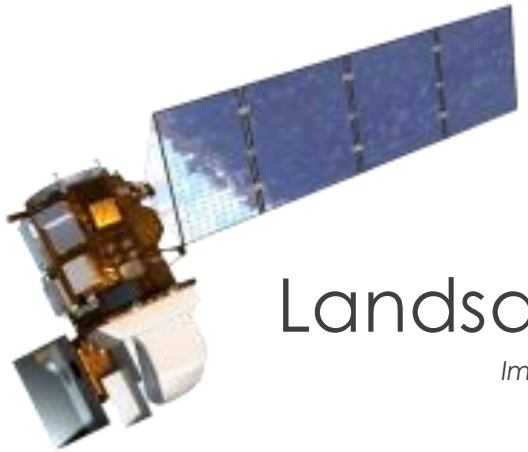
- **Pima County:** Saguaro National Park
  - Citizen science observations here
- **Santa Cruz County:** Tumacácori National Historical Park
  - Susceptible to stinknet infestation

- **2020 – 2025:** Spring bloom season
  - Peak yellowness

Earth Observations

Sentinel-2 MSI

Image Credit: NASA



Landsat 8 OLI

Image Credit: NASA

Image Credit: DonkeyHotey

Time Series Methodology

Data Acquisition

Point Observations
Location, date, patch size, removal status

Habitat Suitability
Ensemble model from USGS INHABIT

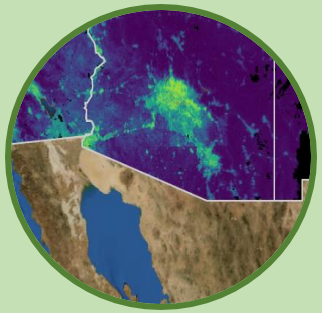


Image Credit: USGS

Data Processing

Standardization
Combining all data sets, matching date formats

Combining Data
Overlaying point observations with model

Image Credit: Ann Ehrlich

Analysis

Change Over Time
Cumulative bar charts, yearly line graph

Time Series
Aligning points and areas on time-enabled map

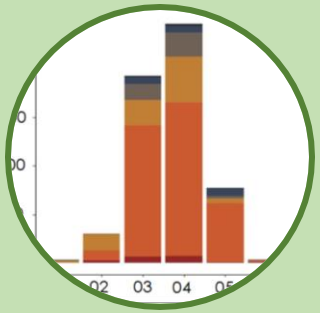


Image Credit: Ben Malmgren

Contributions

Seasonality
Peak observation times and abundance

Repetition
Growth areas and replication over years

Image Credit: Macro Mama

Classification Methodology

Data Acquisition

Image Mosaic
Sentinel-2 MSI, Landsat 8 OLI

Layering Data
Analyzing point data and spectral values

Image Credit: Copernicus

Data Processing

Training Points
Selecting observational data for training

Detection Model
Masking study area using thresholds for visualization

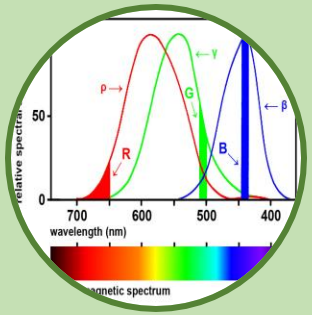


Image Credit: Magica

Analysis

Spectral Indices
Measuring NDVI and NDYI on point pixels

Binary Assessment
Use field observations to test masks

Image Credit: ck2az

Contributions

Thresholds
Establish ranges of values using histograms

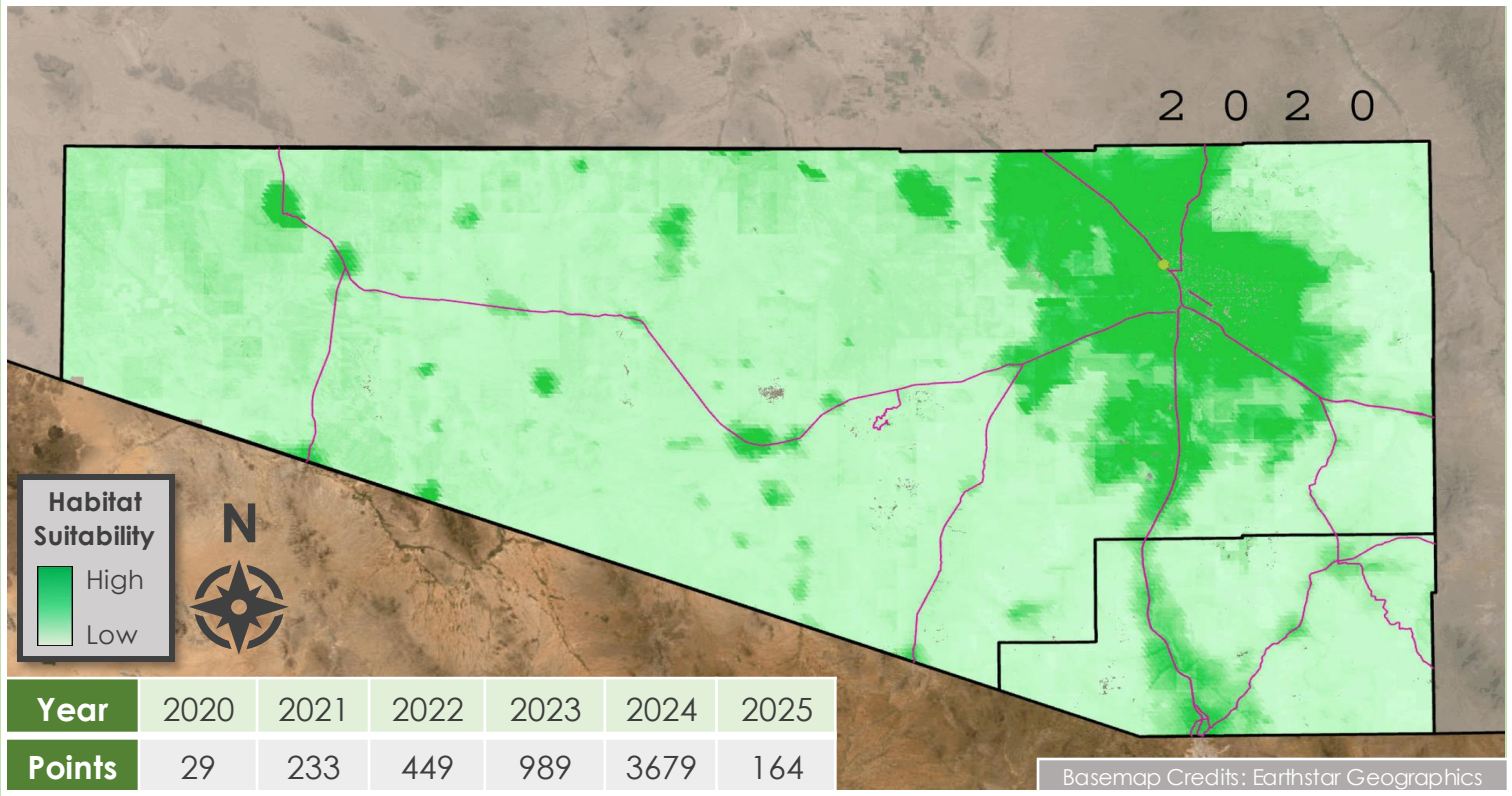
Accuracy
Formulated workflow for estimating accuracy

Image Credit: pixabay.com

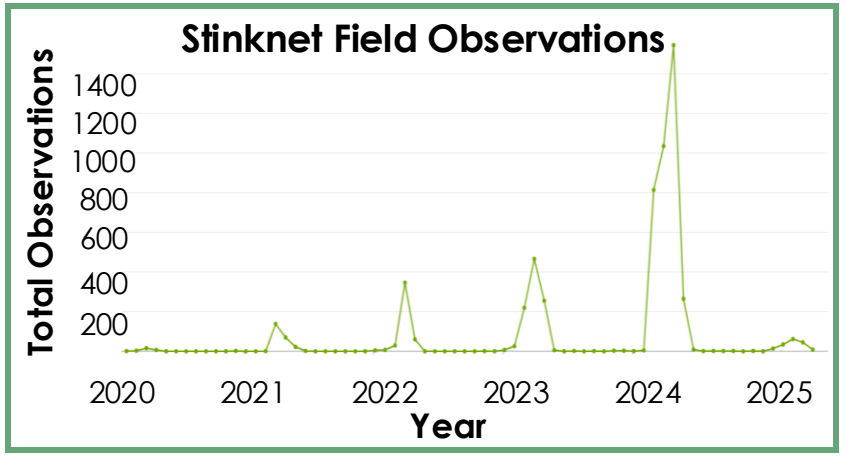
Time Series for Pima and Santa Cruz Counties of Cumulative Observations, 2020 – 2025

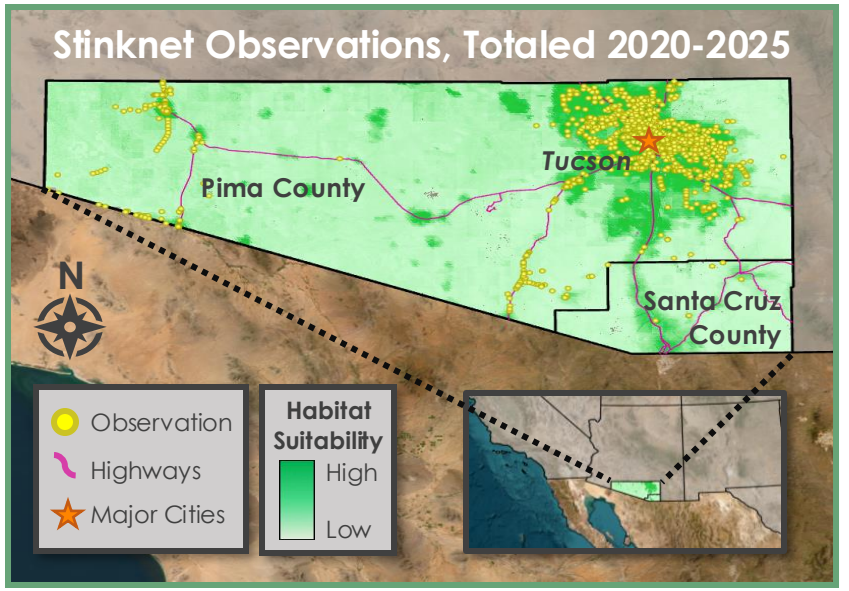
Time-Enabled Map with Steps by Six-Month Intervals

Point data from Pima County, iNaturalist, EDDMapS, and Survey123;
Suitability data from USGS INHABIT

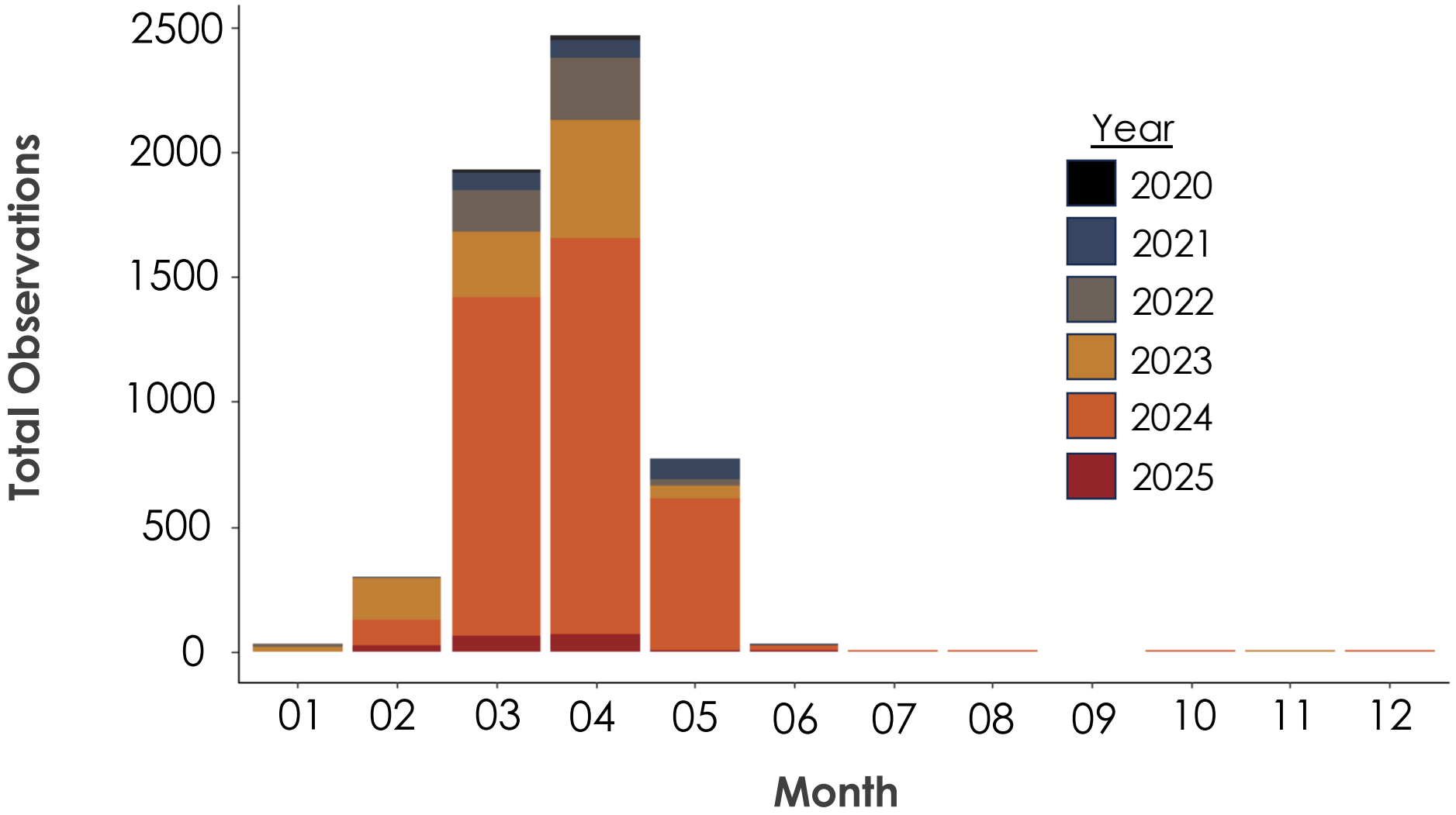


Year	2020	2021	2022	2023	2024	2025
Points	29	233	449	989	3679	164





Frequency of Stinknet Field Observations by Month in Pima and Santa Cruz Counties, 2020 – 2025

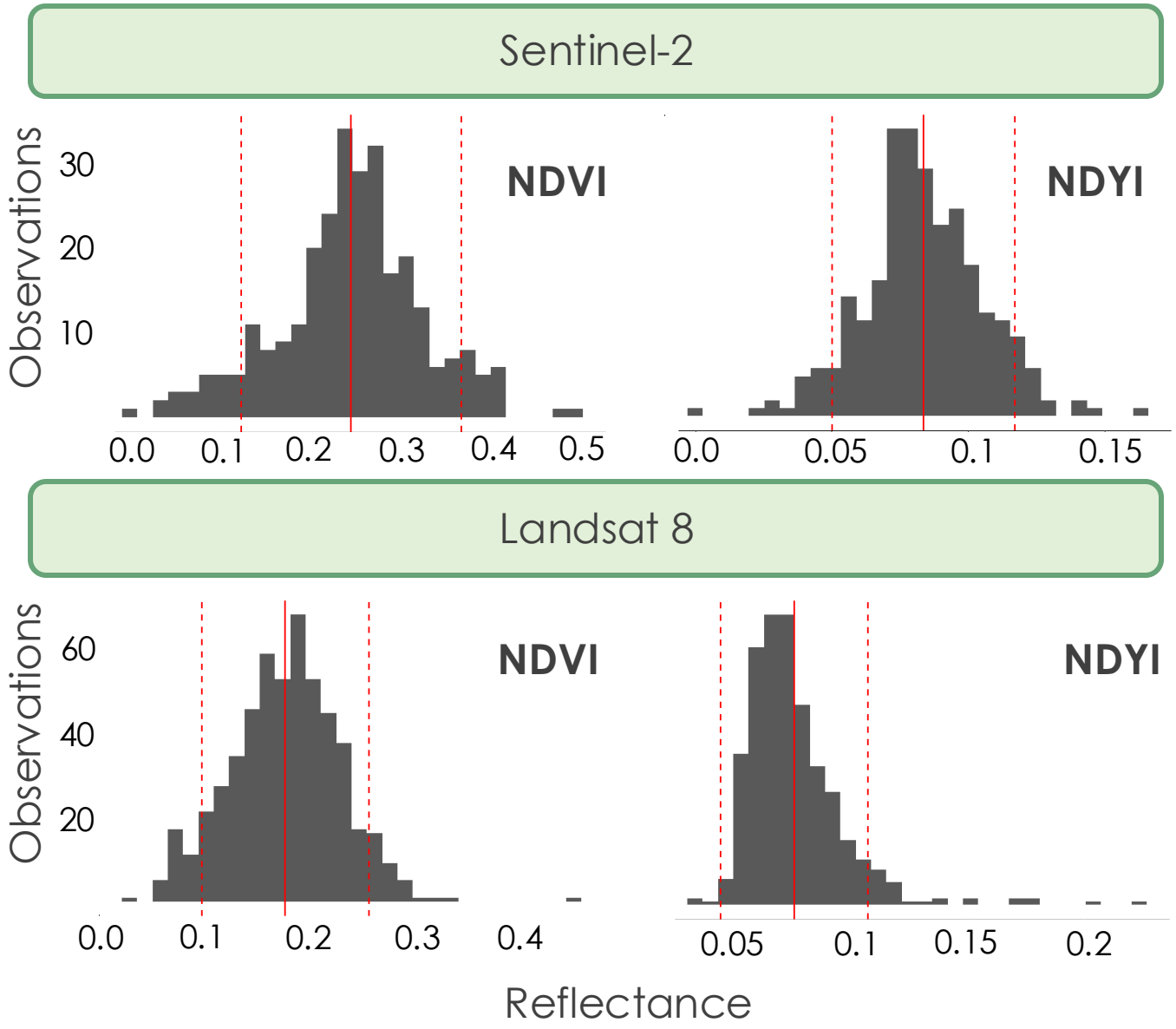


Threshold Processing

Imagery	Sentinel-2	Landsat 8
Resolution	10-meter	30-meter
NDVI	0.123 - 0.366	0.098 - 0.257
NDYI	0.05 - 0.117	0.044 - 0.107

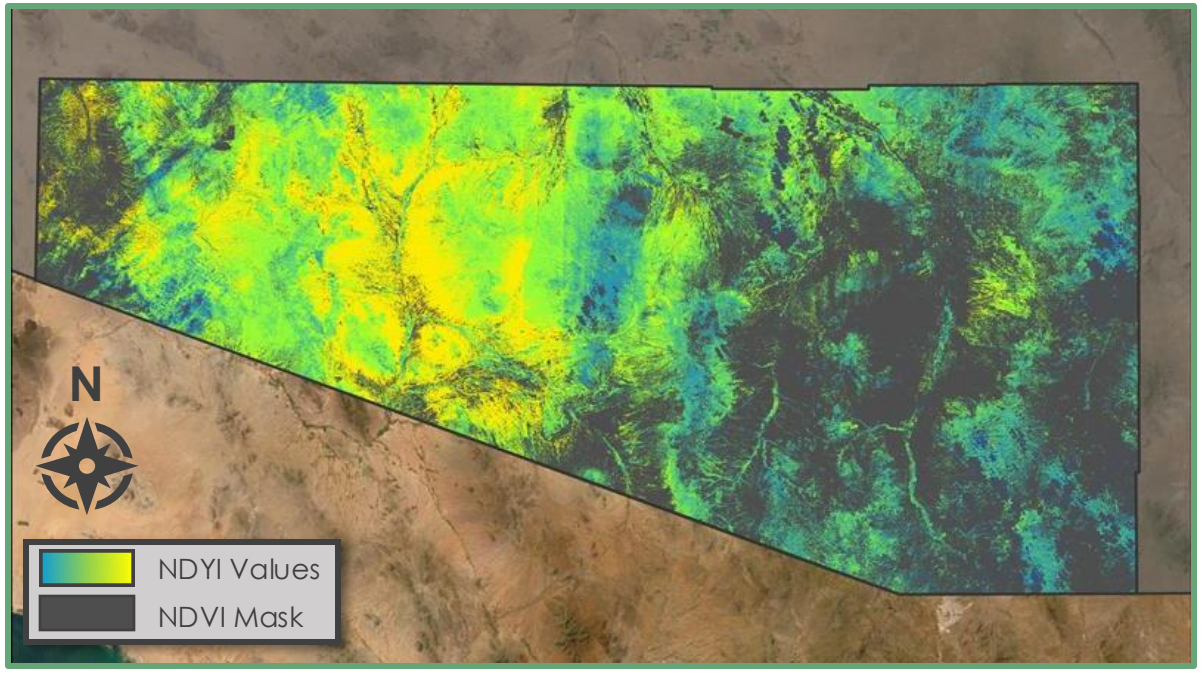
Determine minimum and maximum range value by using +/- 1.5 standard deviations from the mean

Identified ranges of spectral values indicating stinknet presence

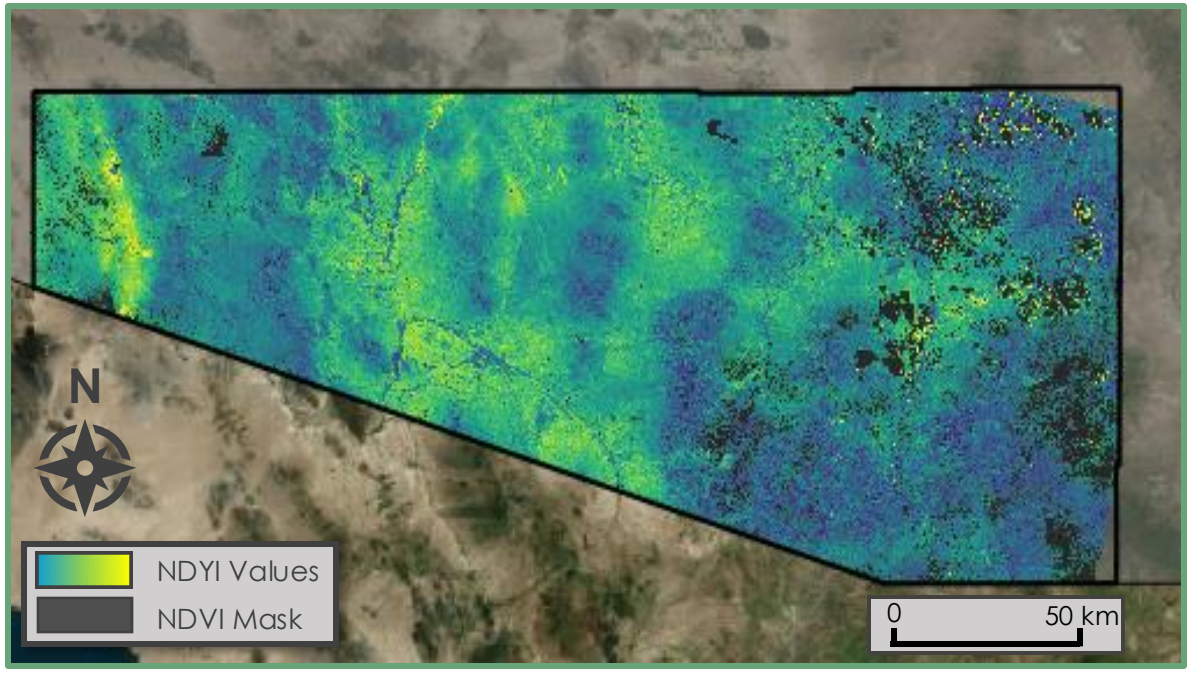


Application of Masking For March 13, 2024

Sentinel-2

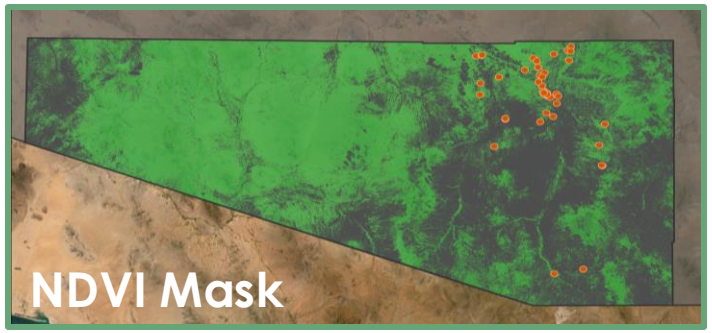


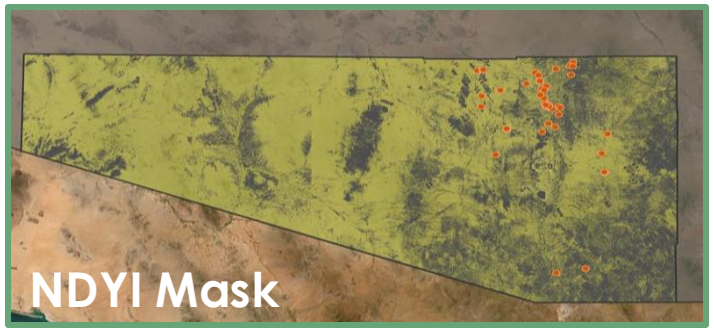
Landsat 8

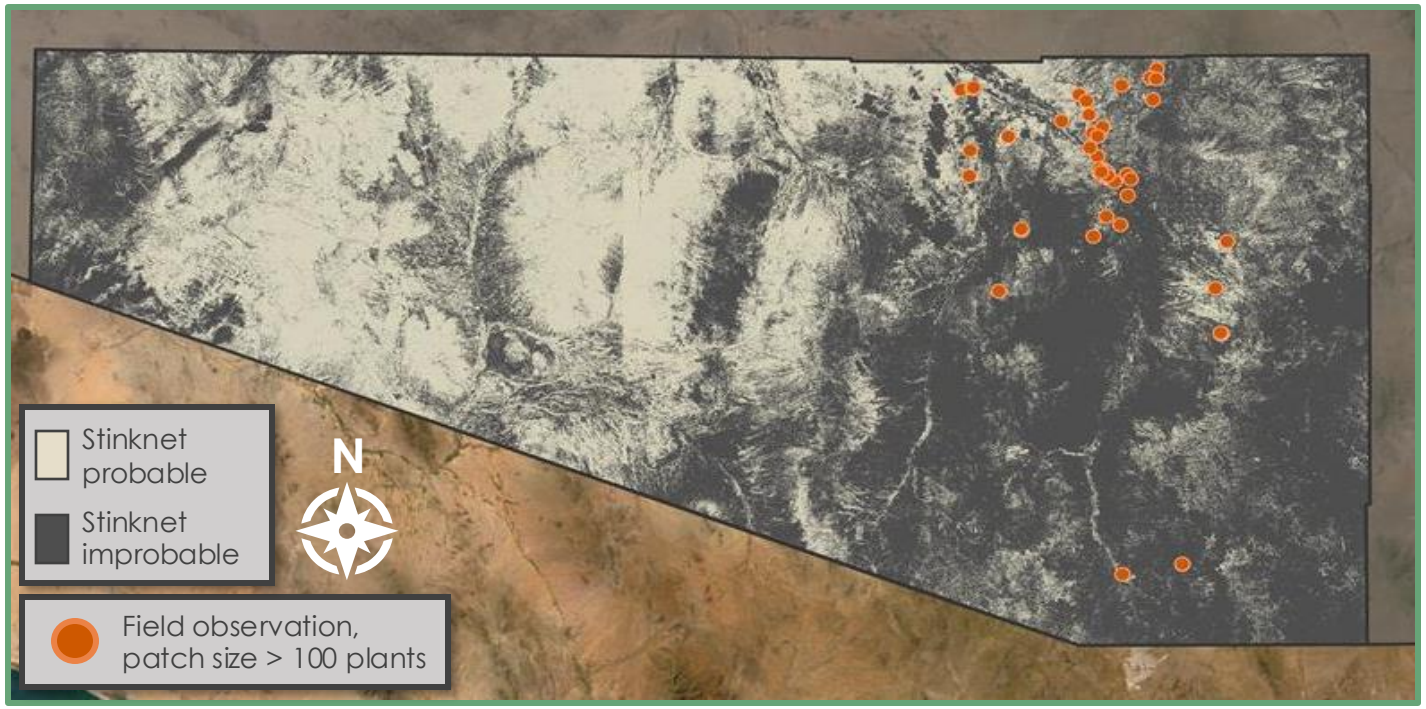


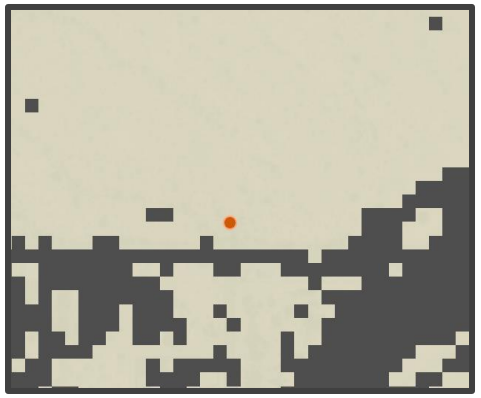
Layering the NDVI mask over NDYI values on a color scale,
with yellow indicating areas that contain more yellow (associated with stinknet blooms)

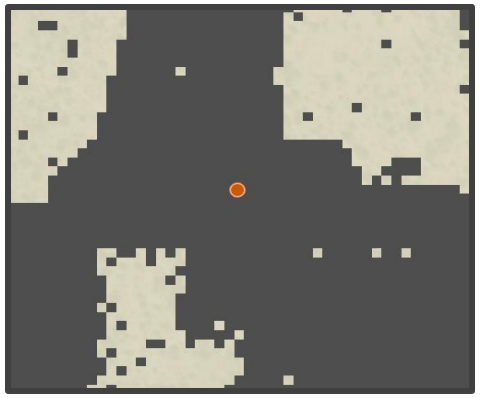
Assessing Stinknet Classification Maps Using Sentinel-2 Imagery, March 13, 2024

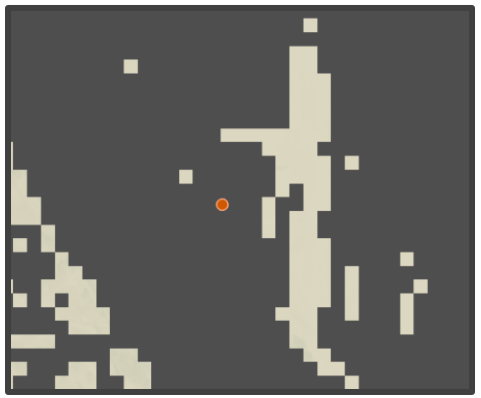


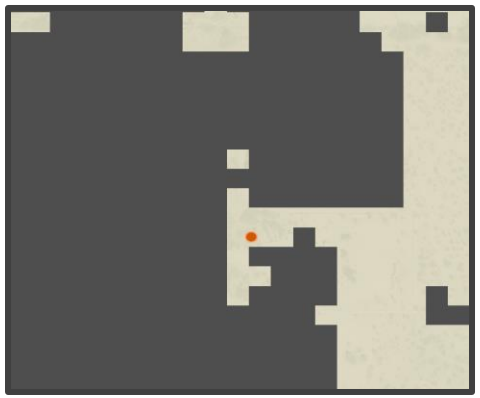






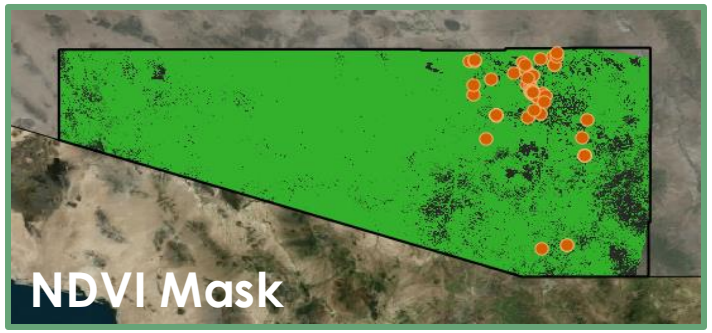


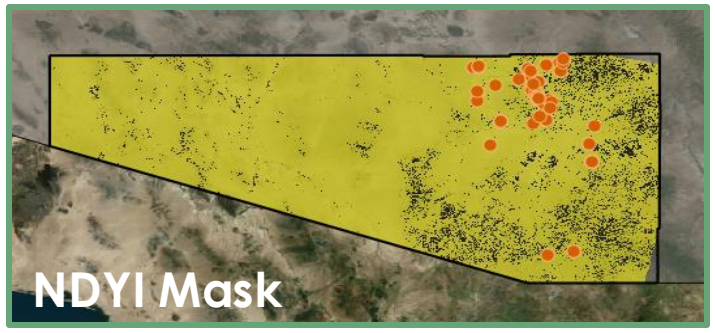


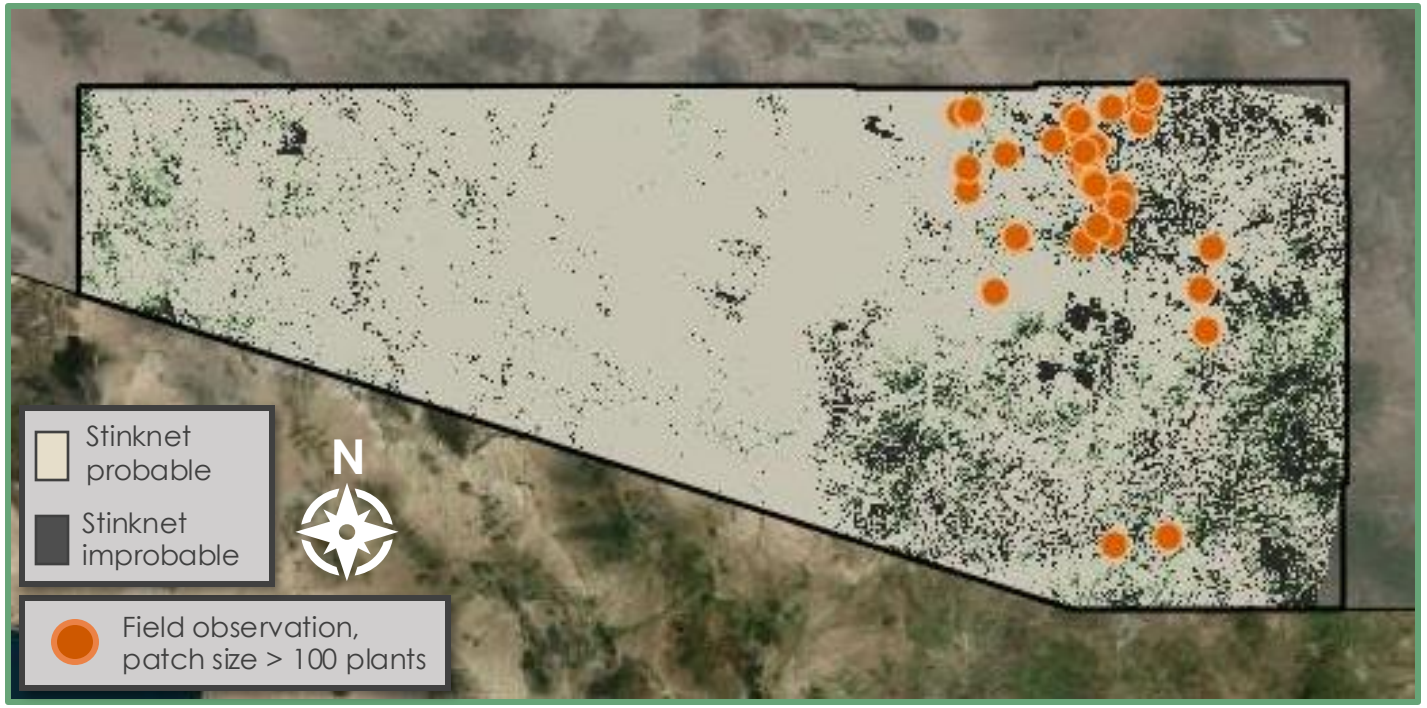


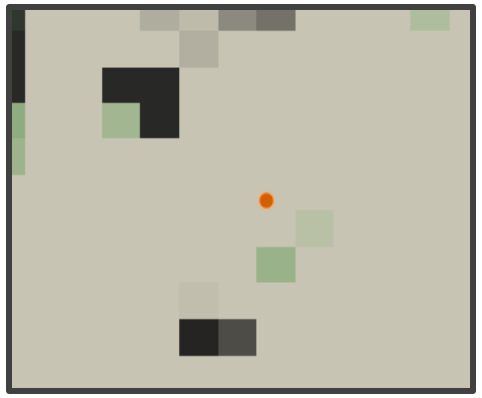
True Positive Rate: **22/59 (37.3%)**

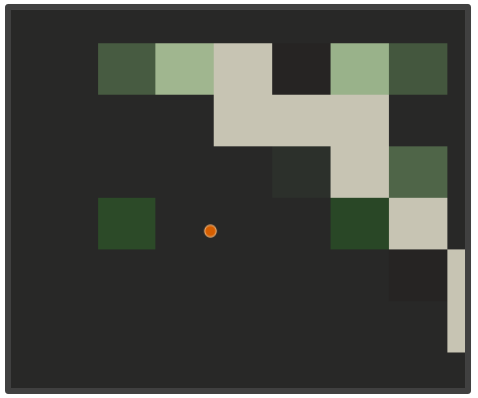
Assessing Stinknet Classification Maps Using Landsat 8 Imagery, March 13, 2024

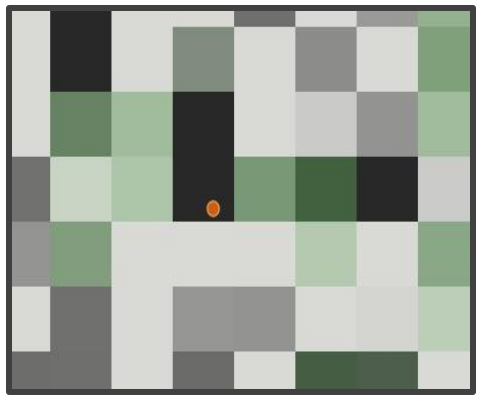


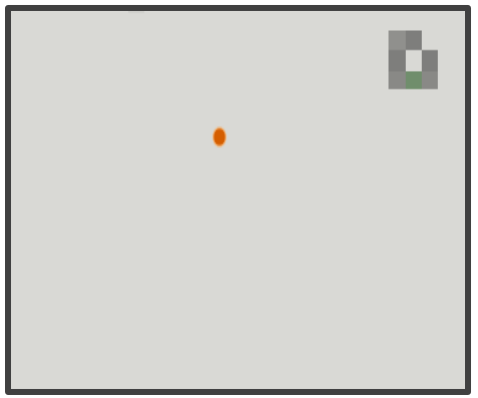












True Positive Rate: **38/59 (64.4%)**

Errors and Uncertainties

Field Data Accuracy

- Possibility of movement logging points
- Potential delay logging data
- Coordinate errors in analysis

Pixel Refinement

- Use indices to refine stinknet maps
- Assess how to classify pixels with mixed land cover

Seasonality

- Growth and senescence trends
- Inter and intra-annual precipitation trends

Cover Types

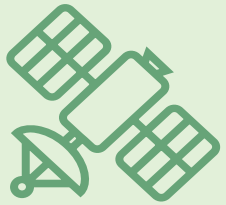
- Insufficient ground reference data
- Training data only from stinknet occurrence—not randomized

Feasibility & Partner Implementation

- Infeasible to accurately differentiate stinknet from other ground cover using coarse imagery
- Results may be improved with citizen science data on senescence periods
- Can implement in more precise locations with higher-resolution imagery
  - i.e. Drone, aircraft, balloon
  - Visually identify stinknet and verify citizen science reports
  - Calculate more accurate thresholds

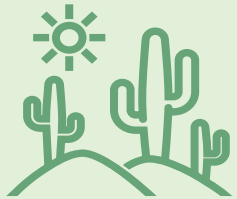
Image Credit: Peter Robey

Conclusions



Thresholding classifications based on citizen science reports and satellite imagery were ineffective at reliably identifying stinknet

Classification accuracy were not fully evaluated due to a lack of field observations for validation



Other methods and/or satellite data may enhance the ability to map stinknet patches, especially during peak bloom years

Acknowledgements

Project Users and Collaborators

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- Frankie Foley (National Park Service, Saguaro National Park)
- Sharlot Hart (National Park Service, Tumacácori National Historical Park)
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Fellows

- Spencer Harman (Maryland – Goddard)

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