OBSERVATIONS, ECOLOGICAL MONITORING, AND TEMPORAL DATA

within the NatureServe Network

all that and a bag of chips

with slides from
Jimmy Kagan and
Emilie Henderson at INR

Lindsey Wise

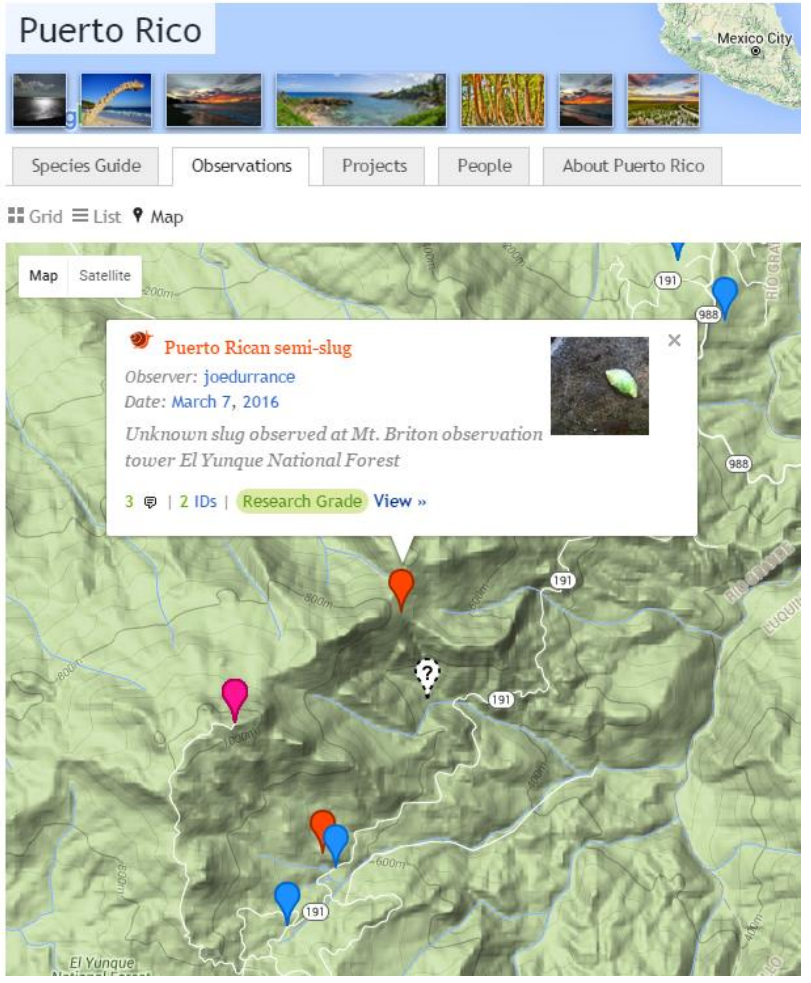
Oregon Biodiversity Information Center, April 2016

Outline

- What are we talking about here? Why does it matter?
- Recap of BWB 2015 Temporal Data Discussion
- Relevant Network teams
  - Data Backlog Review Team
  - Spatial Methodology Review Team
  - Species Distribution Modeling Network
- Mapping and Modeling
- Integration of Observations
- Application to Monitoring
- DISCUSSION

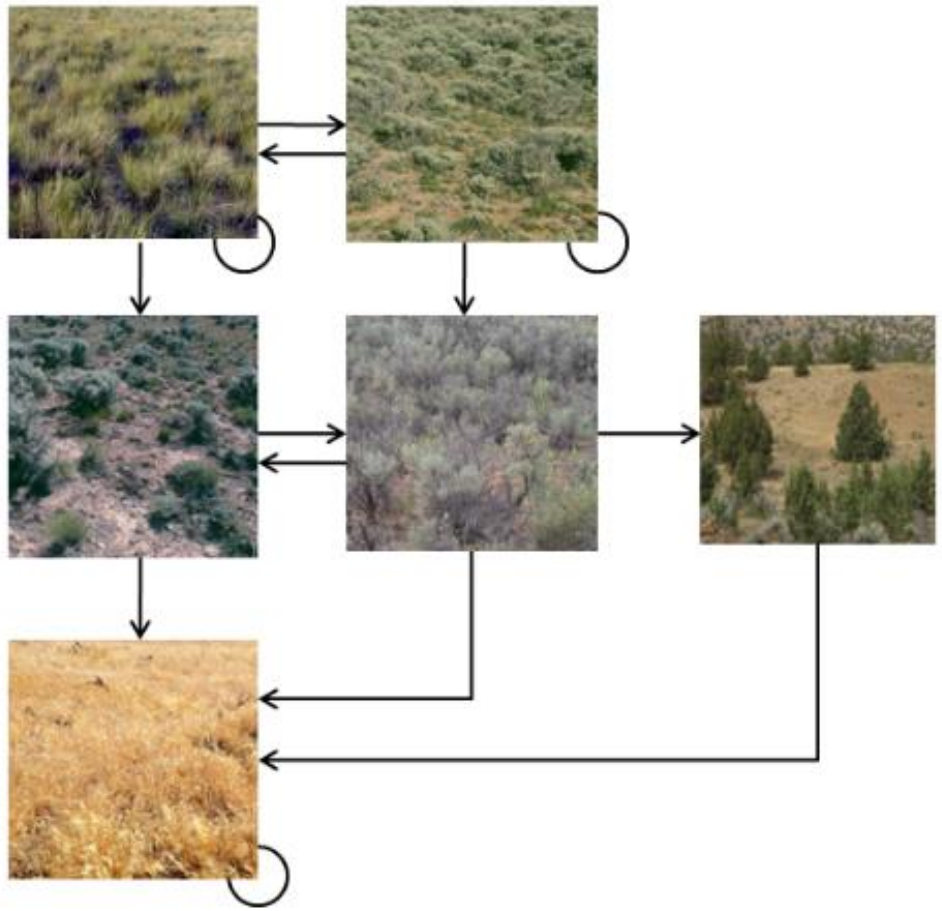
What are we talking about here?

- As a network, we are looking more and more towards OBSERVATIONS as a necessary source of information
- Observations can inform
  - Distributions
  - Habitat suitability
  - Recent vs Historical Range
  - Species models
  - Trends ?
- How best to incorporate into Network projects, products, services



Why is temporal data important?

- Indicators
- Element Rank Calculator
- Climate change
- Shrinking or expanding ranges
- Inform state and transition models
- Conservation and restoration priorities
- Management outcomes
- Monitoring species, habitats, ecosystem health



State and transition model example

National Directives

- President's Council of Advisors on Science and Technology report on Sustaining Environmental Capital (2011)
  - Need to "coordinate cross-scale and cross agency collaboration in monitoring" for biodiversity
- USFS Forest Planning Rule (2012) on Ecological Integrity & Ecosystem Services
  - To aid managers in describing ecosystems when conducting Forest Land Management Plan revisions and to provide a basis for monitoring ecosystem integrity and the diversity of plant and animal communities

NatureServe Network Directives

- Observation Data Standard (2006)
  - Obs are fundamental for scientific inventory, conservation planning, habitat mgmt, invasive species assessments, predictive range modeling, monitoring, and much more
- Strategic Plan (2012-2016)
  - Better communication of trends in the distribution and condition of species and ecosystems across the Americas
- Citizen Science Strategy (2014)
  - Threats are outpacing rate of professional monitoring; citizen-collected observation datasets can help fill this need
  - "Large volumes of up-to-date data are critical to any 'early warning system' capable of alerting us to declining populations or habitats"
  - Improve ability to detect trends

Recap of 2015 Temporal Data Discussion

- EO Ranks
  - take a lot of time and info, not all programs using them
  - could start with E vs H, scripts to apply based on LAST_OBS
- G and S Ranks
  - add a field to track WHY rank changed: new info vs actual change in status
- Threats
  - could add a Biotics table to track threats over time, tie to Element Rank Calculator threat sections

Data Backlog Working Group

Join the workshop on Thursday 2:00-3:00pm San Juan Ballroom 1

- Temporal aspect of EOs data is swamped when all data is rolled into EO; better to track at SF or VISIT levels?
  - threats, management, population counts (all w dates)
  - add an SF Rank and Rank Date to track health of diff. areas of EOs
- Build tools to roll-up info from VISIT/SFs to EO
- How will Kestrel relate to Biotics?
  - Workflow for creating SFs from Visits/Observations

Spatial Methodology Review Team

Join the workshop on Thursday 8:30am-Noon San Juan Ballroom 1

- Scoping ways to assess accuracy and precision of observations
  - Time: compare to phenology, seasonality of species
  - Location: much like with source features, buffer obs location based on spatial accuracy, how pt was mapped e.g., GPS vs site centroid
  - Species ID: could tag observers w level of expertise for various species categories e.g., professional wildlife biologist would have high accuracy in IDing animals
- Could generate rules to combine all these into an observation Confidence score

Spatial Methodology Review Team

Join the workshop on Thursday 8:30am-Noon San Juan Ballroom 1

Negative Obs and Determined Absence data

- Most programs interested in it, but need:
  - Standards
  - Data management system
  - Tools to collect data consistently (for partners also)
  - Ways to import existing datasets
  - Staff and resources
- But has so many uses! And Network could be the first to provide as a standardized product.

Species Distribution Models for Threatened Species

- Need a nat'l monitoring program for at-risk species and ecol. systems
- Presence/Absence data provided by obs a great asset
- Monitor changes in species ranges (terrestrial vertebrates, trees, shrubs); tap into LiDAR and other imagery resources
- Utilize existing range maps (GAP, USFS planning, State Wildlife Strategies)
- Range maps need peer review and update capacity
- Online tools essential to make this happen
- Great opportunity for citizen science

Slide from Masters and Kagan 2007, Developing A Better National Index of the Status of Biodiversity

Species Distribution Models for Threatened Species

G2G3

↓

G3G4

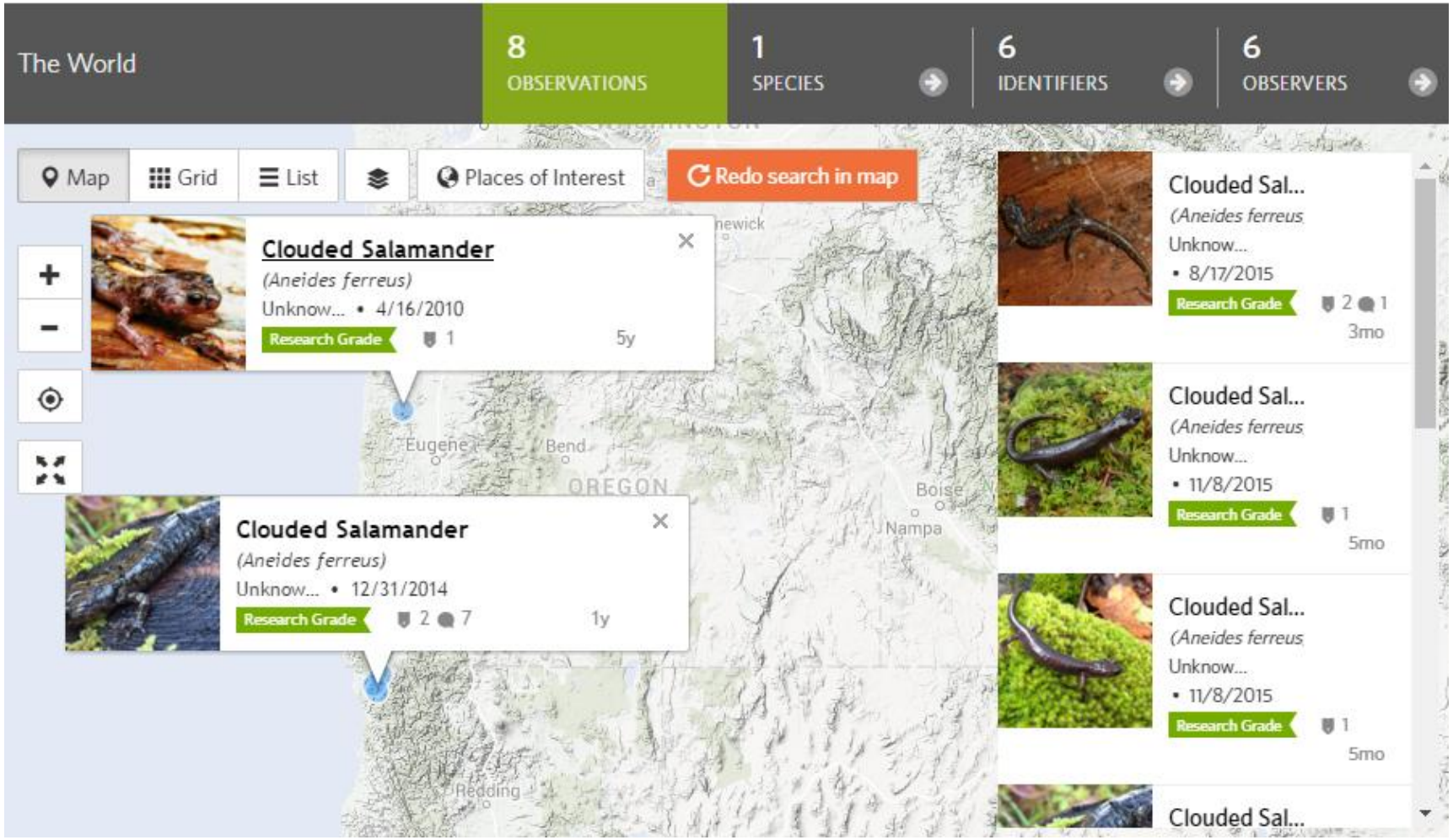
Aneides ferreus, Clouded Salamander

Recent observations suggest that the species is persisting in many areas and is not now of high conservation concern (R. B. Bury, 2013)

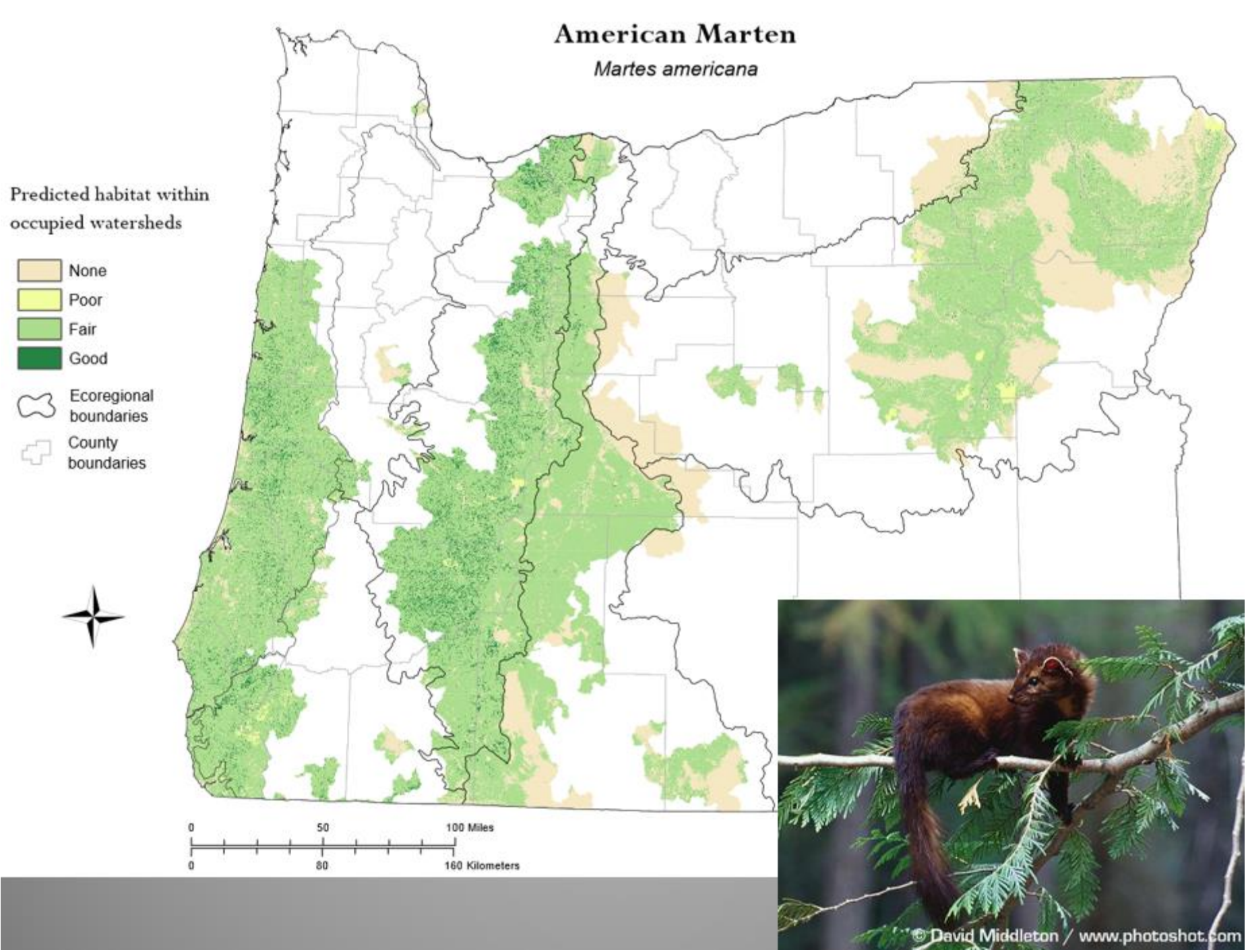
Habitat Map

Historic Habitat Map

Species Distribution Models for Threatened Species



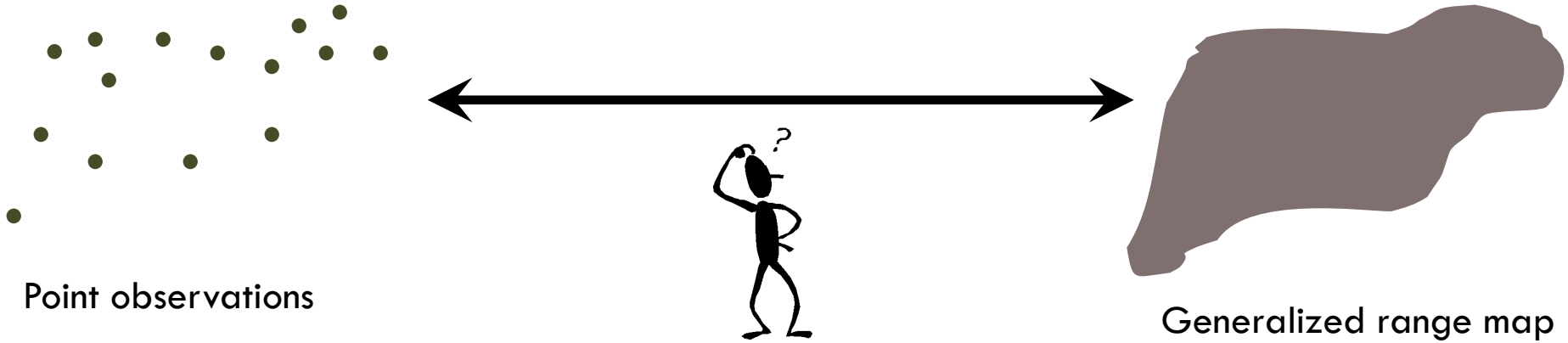
Some recent confirmed observations of Clouded Salamander on iNaturalist



Join the workshop:
Species Distribution Models for Threatened and Endangered Species

Wednesday
8:30am-Noon
San Juan Ballroom 1

Mapping and Modeling



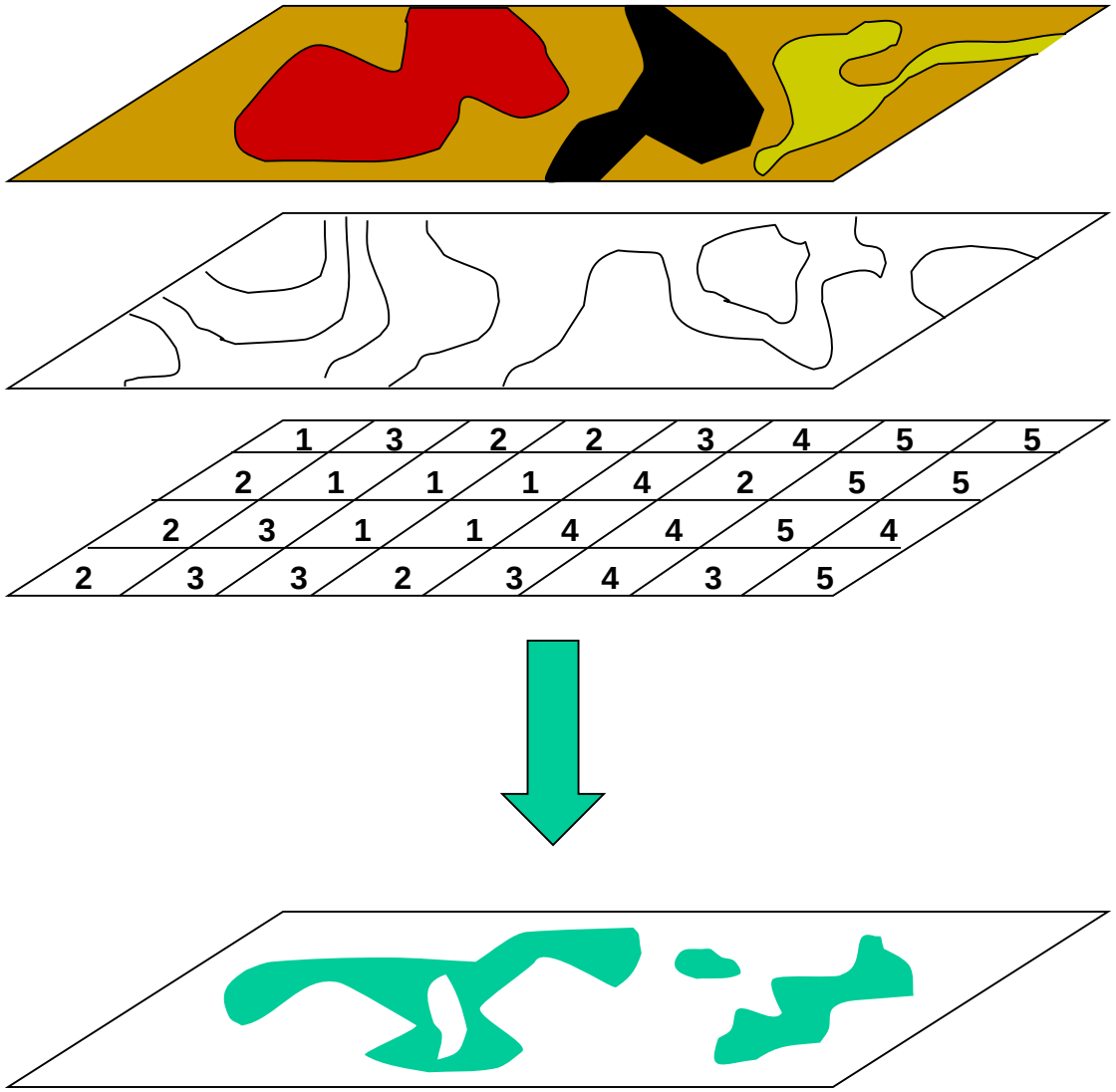
A better alternative to dot maps and range maps :

Build a model of the environmental conditions at points of known occurrence… } **MODELING**

… then identify and map all areas where those conditions occur within the study area. } **MAPPING**

Kagan and Beauvais slide

Deductive models: **spatial expressions of expert opinion, verbal habitat descriptions, or other qualitative data**



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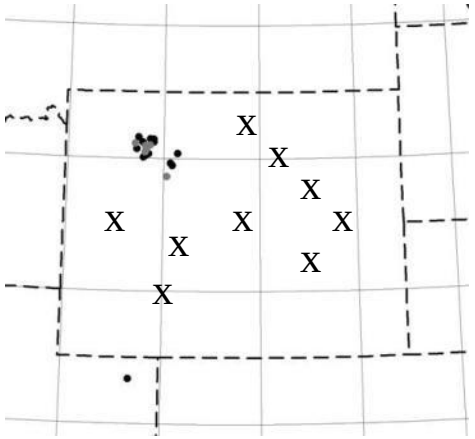
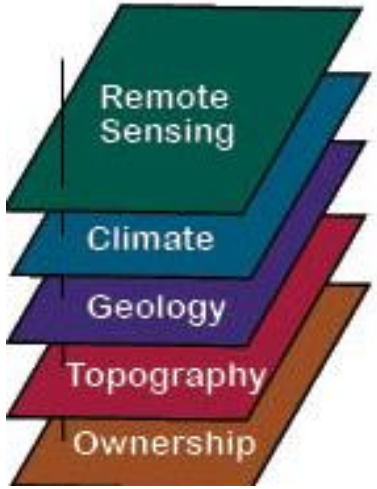
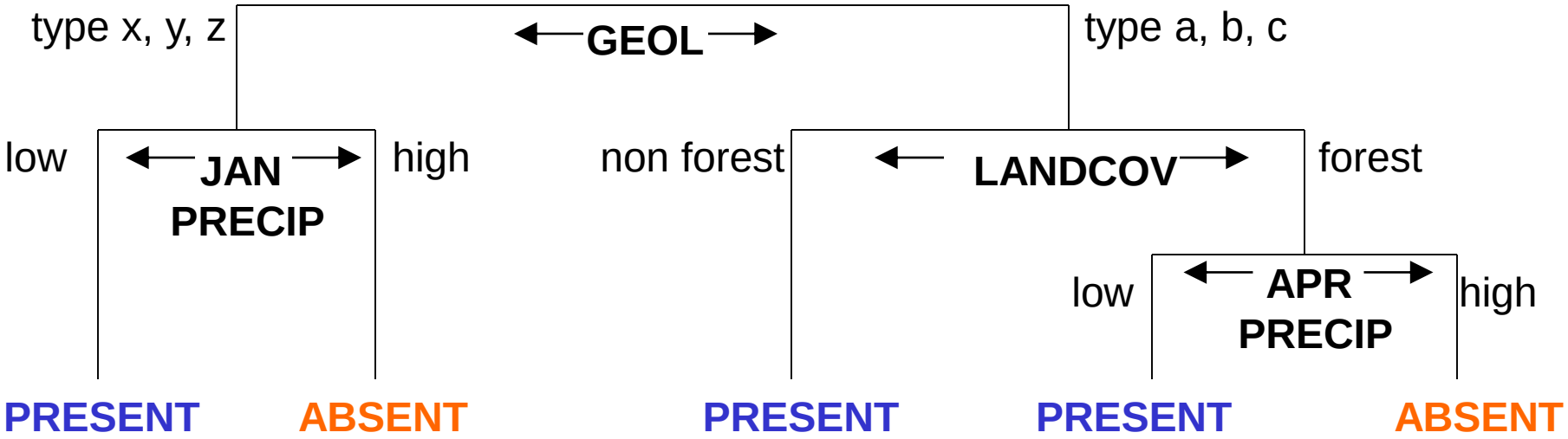
Inductive models: CART ANALYSIS, Random Forest

Points of known presence, points of suspected absence



Spatial layers of environmental conditions





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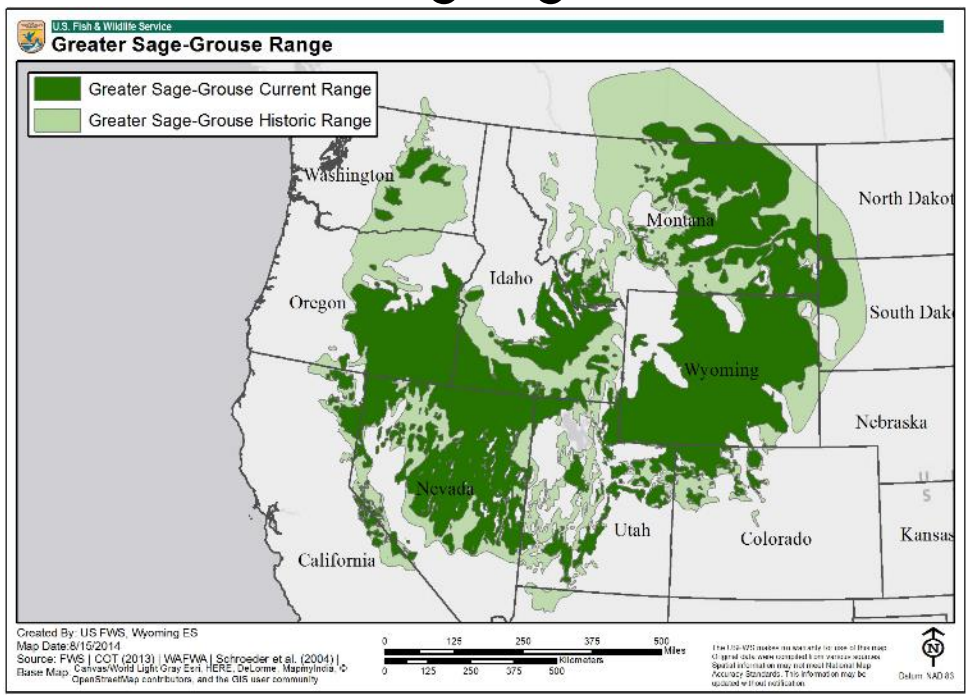
Modeling Sage-Grouse Habitat

- Greater Sage-Grouse nearly listed on US Endangered Species List
- Instead of listing, many public-private agreements to manage lands for grouse conservation
- Lots of work now to plan, manage, and monitor sage-grouse habitat and population health

USFWS images



Model for Sage-Grouse Habitat Workflow

- Model and map vegetation from survey plots, and GIS layers describing:

  Topography, Climate, Soil, Imagery

- Model and map greater sage-grouse seasonal habitat from known grouse locations (telemetry, and leks), background points, and GIS layers describing:

  Topography, Climate, Soil, Vegetation

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Sage-Grouse Habitat Inputs

Plot Data (2694 plots from years 2001 – 2015)

- Landfire Plot Reference Database
- Ecoplots
- AIM plots from BLM
- Institute for Natural Resources field surveys

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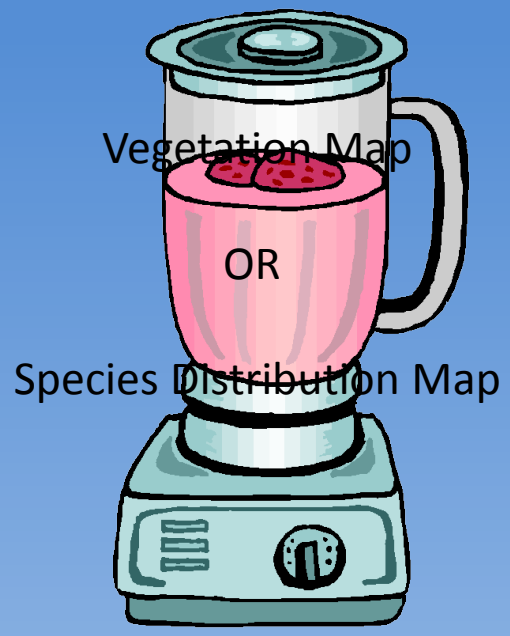
Vegetation Plot Data

Or

Species Location Data

Raster data describing the environment:

Topography
Soil
Climate
Imagery (Landsat, Naip)
Or
Vegetation



Statistical model

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Methods: modeling techniques

- Sage-grouse habitat: Random Forest
  - Model prediction ~ habitat probability

- Vegetation: Random Forest Nearest Neighbor <u>Imputation</u>
  - Model prediction = best vegetation plot

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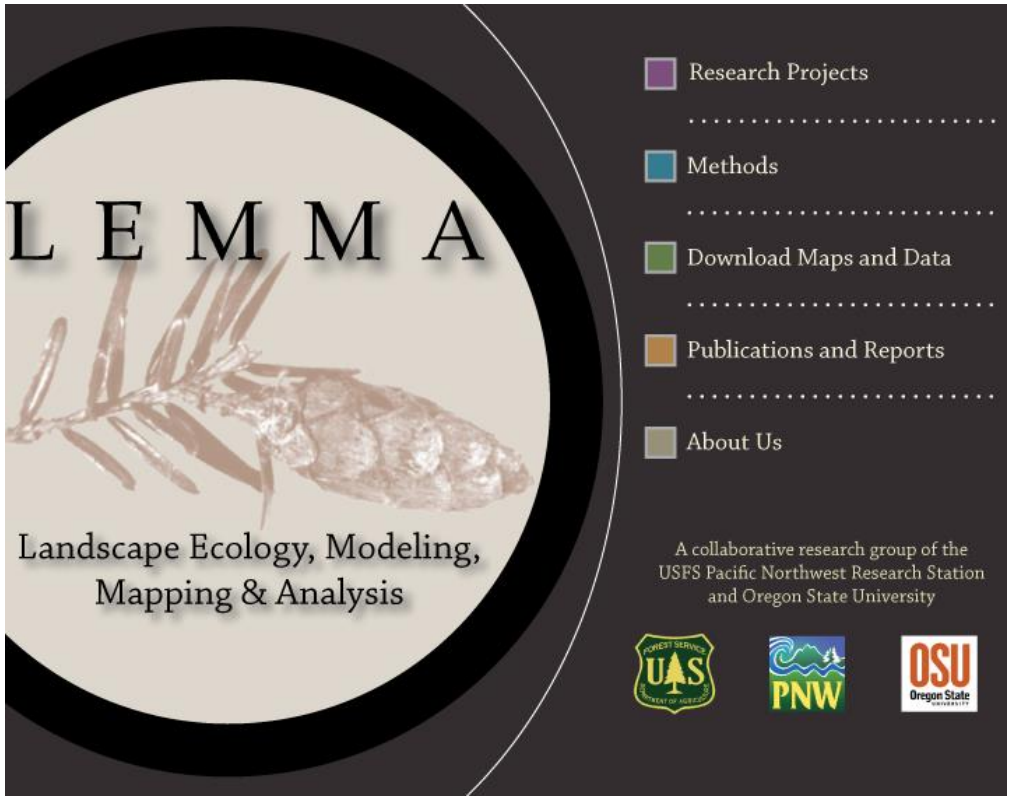
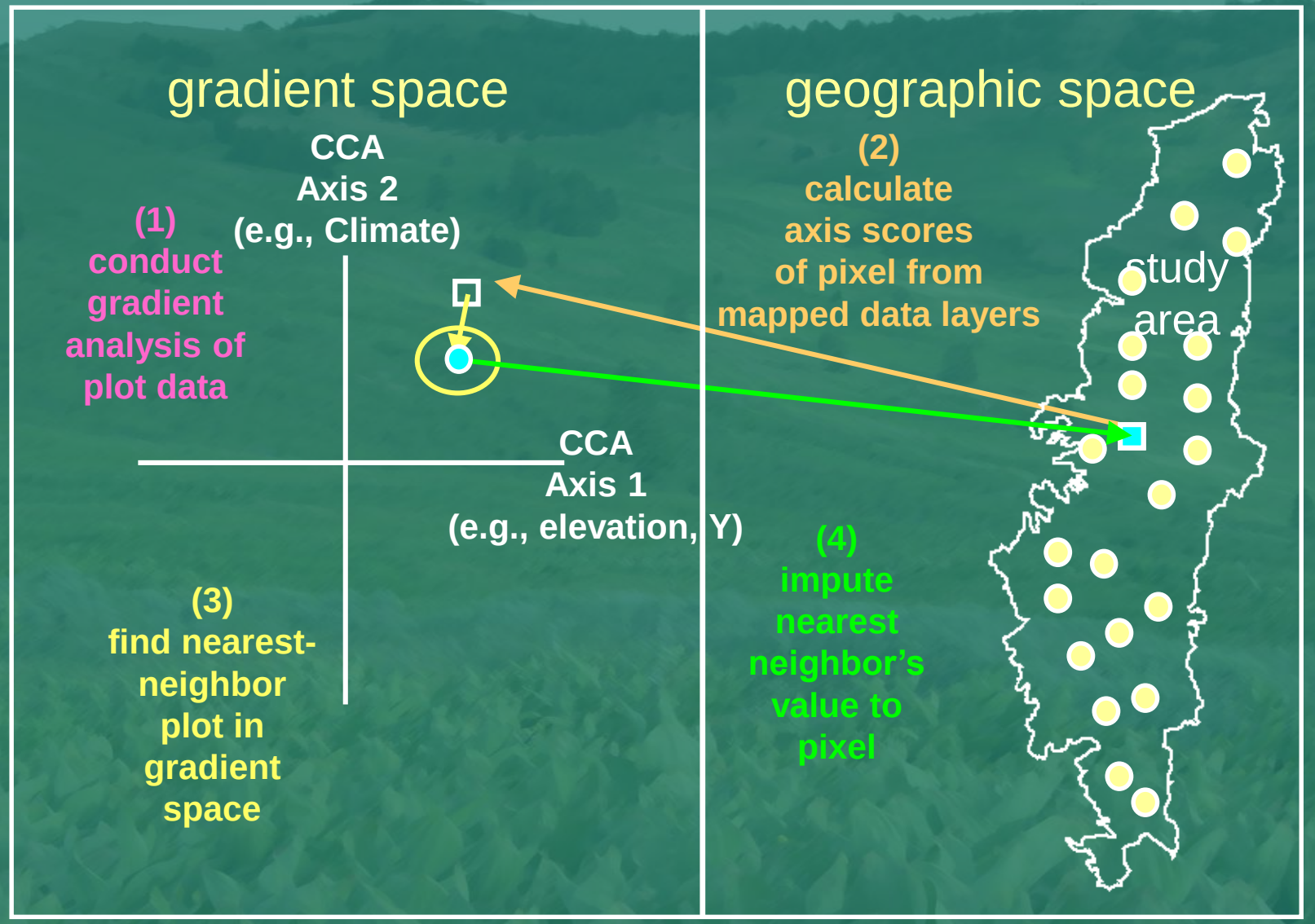
Gradient Nearest Neighbor Structure Maps

- Developed by LEMMA group @ Oregon State U
- Data available for CA, OR, and WA



http://lemma.forestry.oregonstate.edu/

Methods: GNN



Using nationally available FIA & AIM data to generate midscale data

CCA = Conoco Correspondence Analysis

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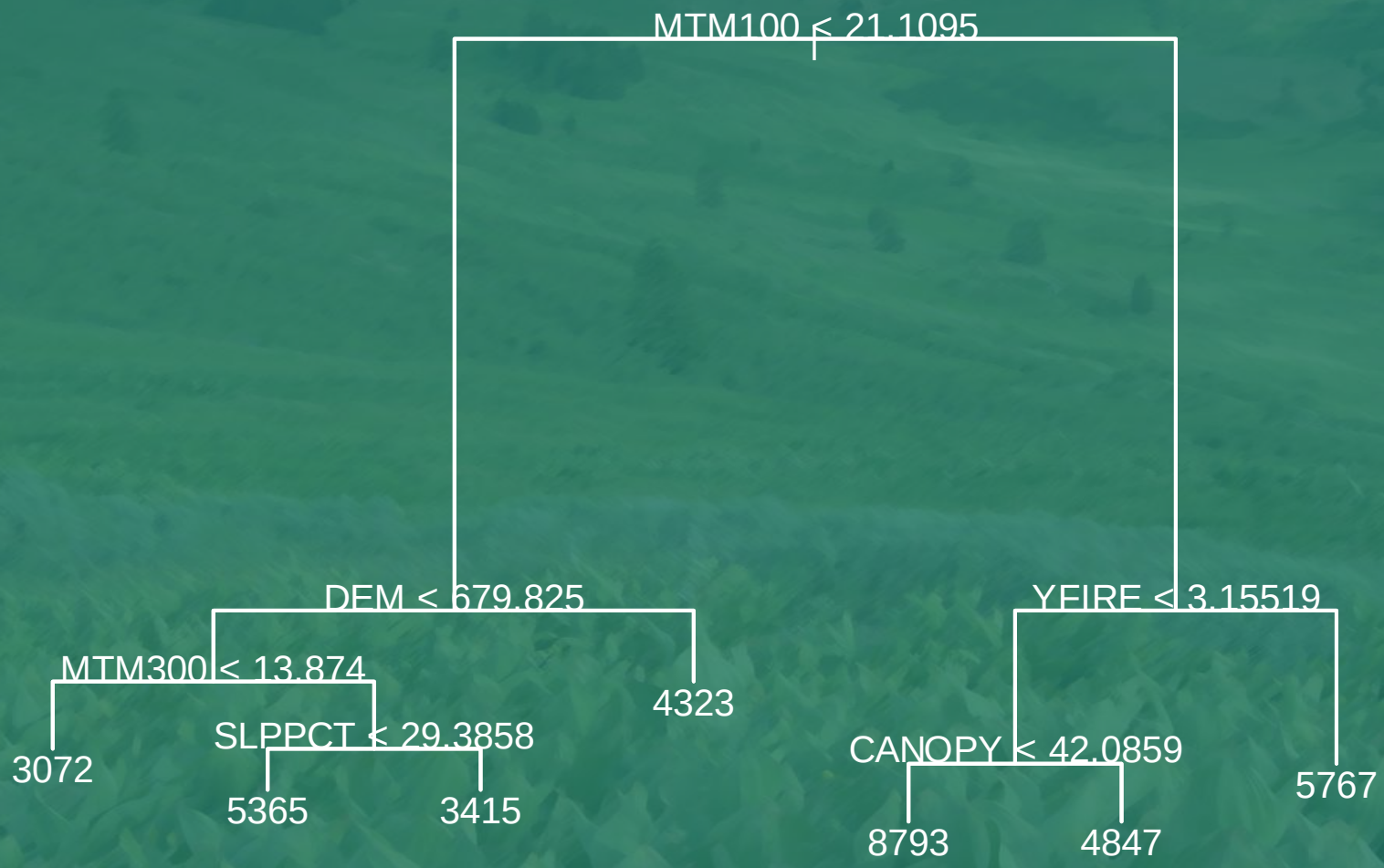
Methods: Random Forest (RFNN)

- One Classification Tree:



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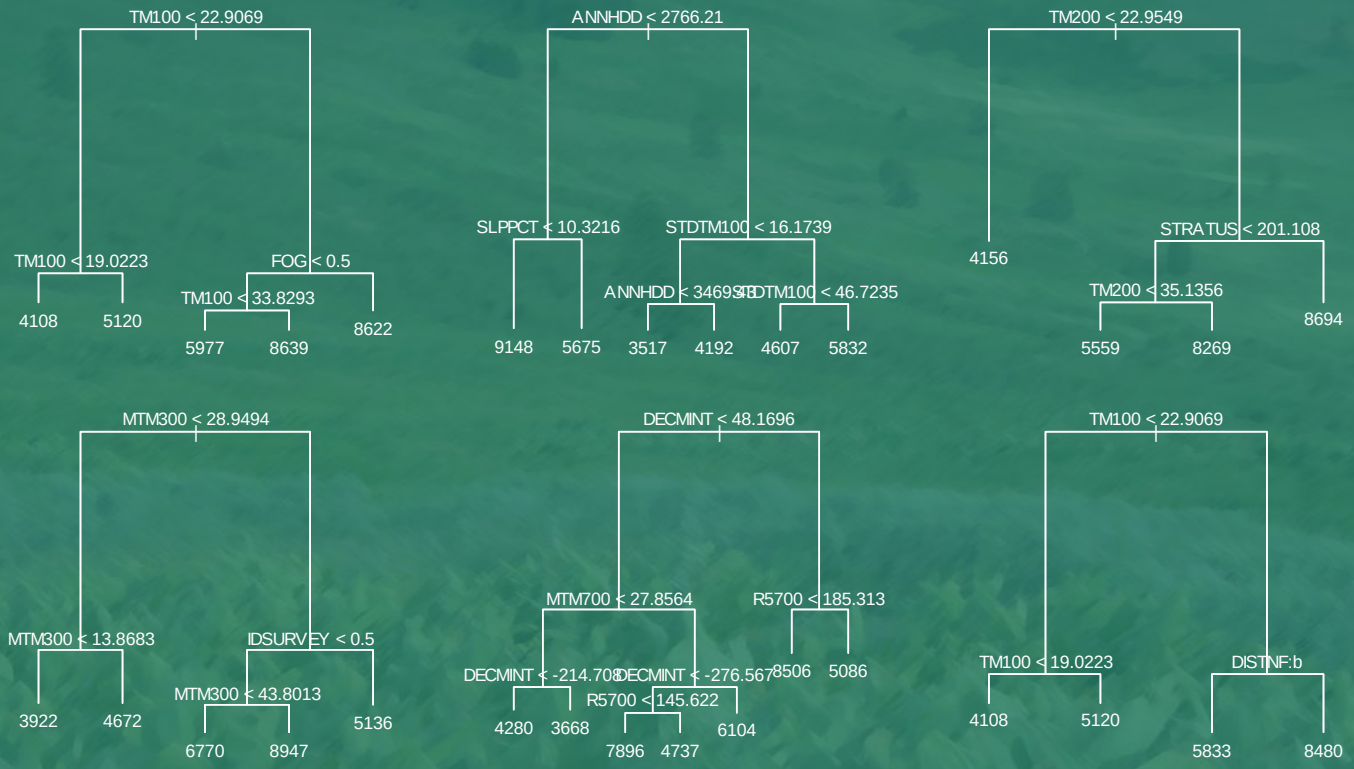
Methods: Random Forest (RFNN)

- A whole forest of classification trees!



- Each tree model is built from a random subset of explanatory variables and input data.
- When the model is applied to mapped data, each tree ‘votes’ on which Plot best represents a pixel should be.

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A map of plot identifiers

USFWS grouse image

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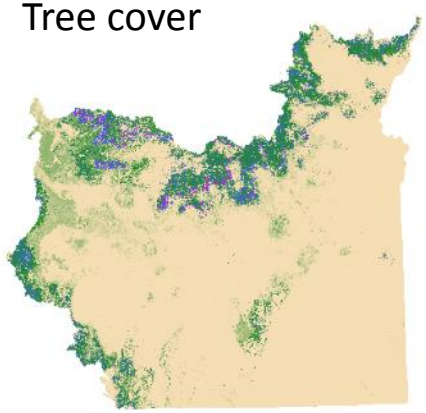
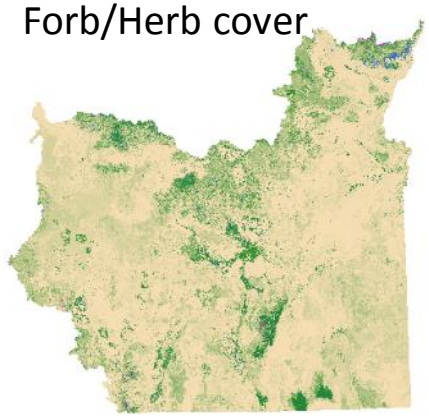
Tree cover



Shrub cover

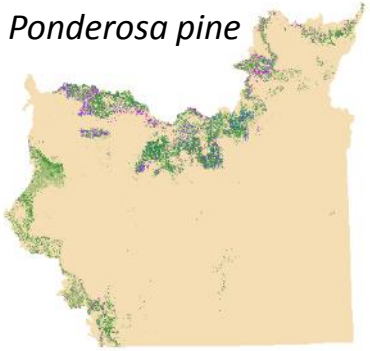
Grass cover

Forb/Herb cover

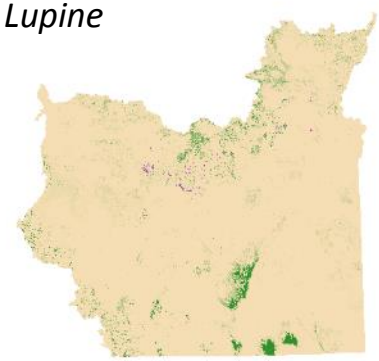


These Maps Are Not Perfect

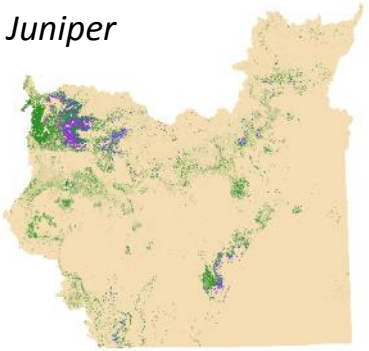
Ponderosa pine



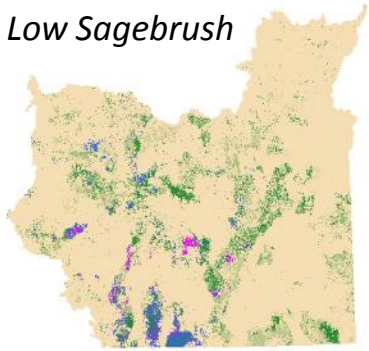
Lupine



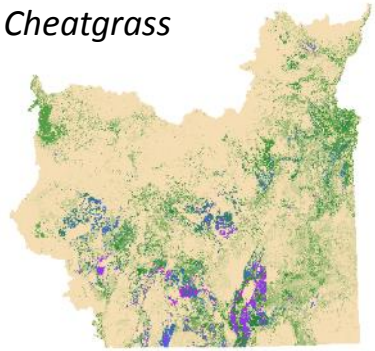
Juniper



Low Sagebrush



Cheatgrass



Food forbs for Greater Sage-grouse

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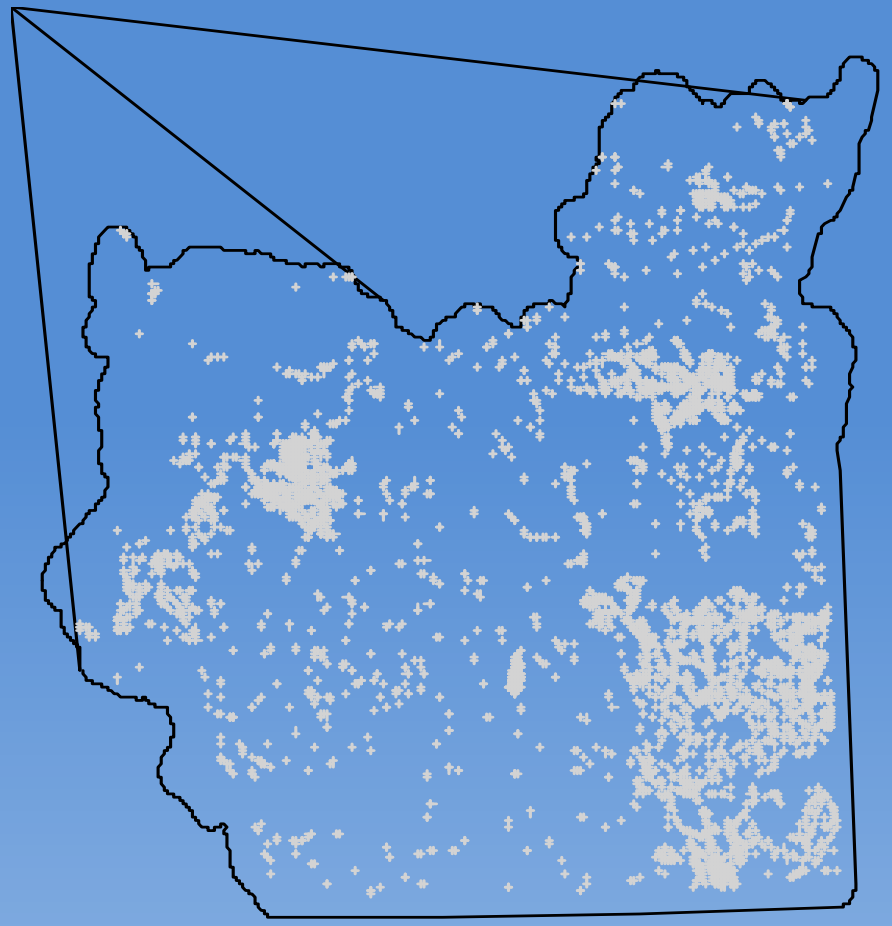
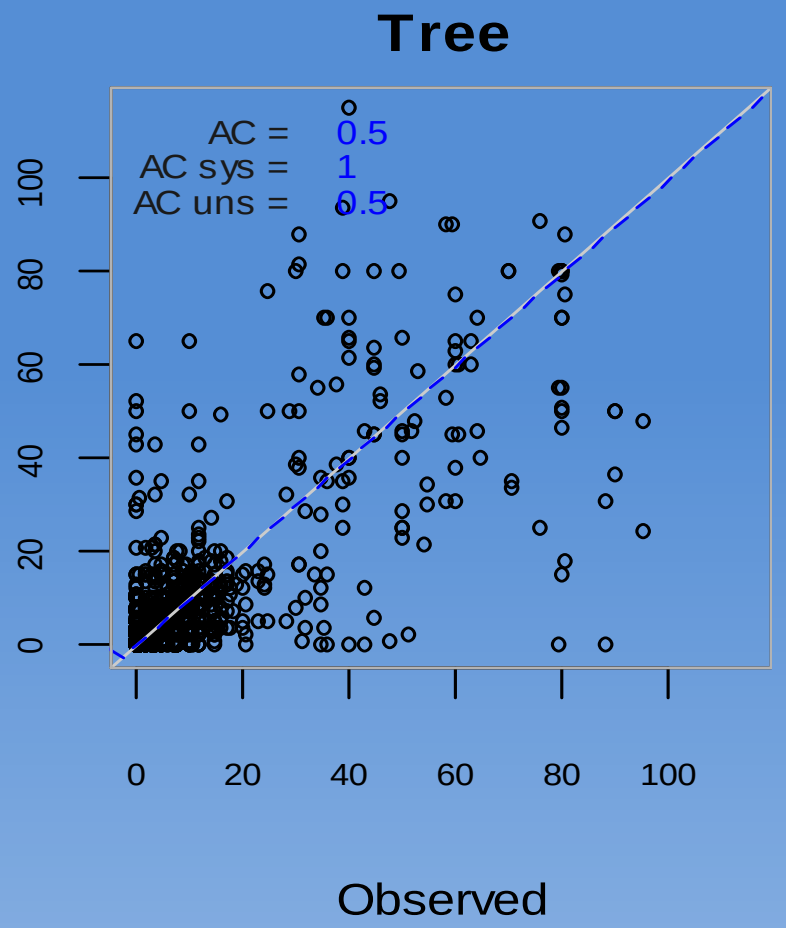
Plot scale accuracy





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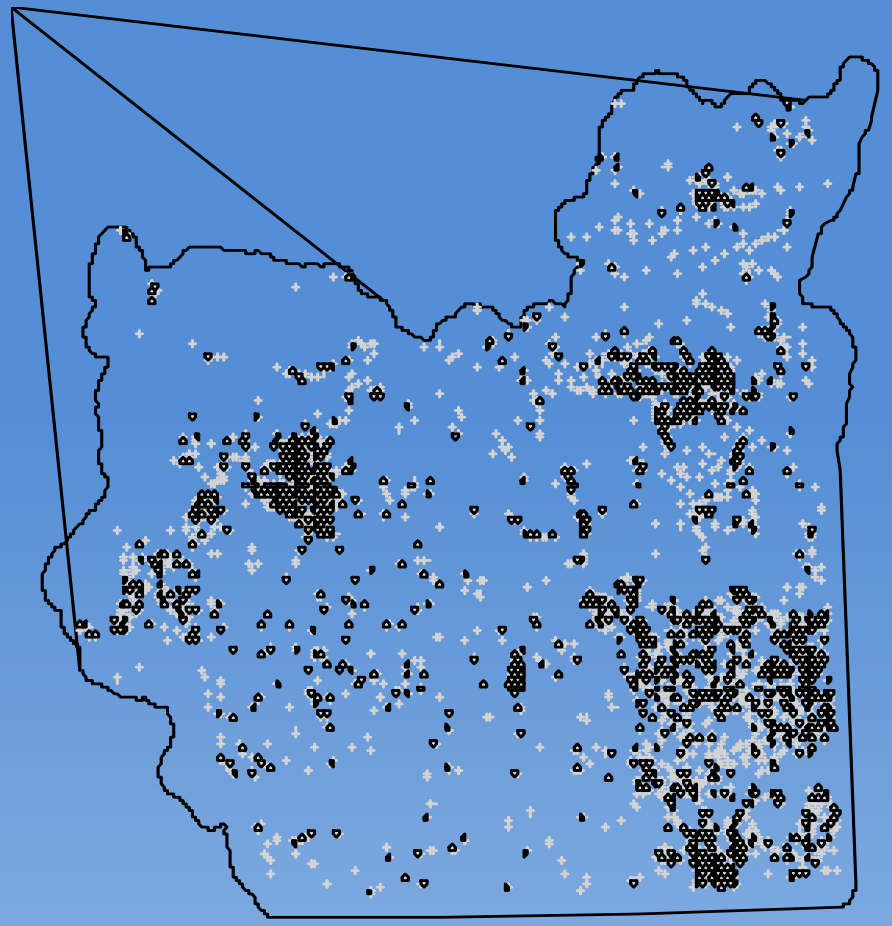
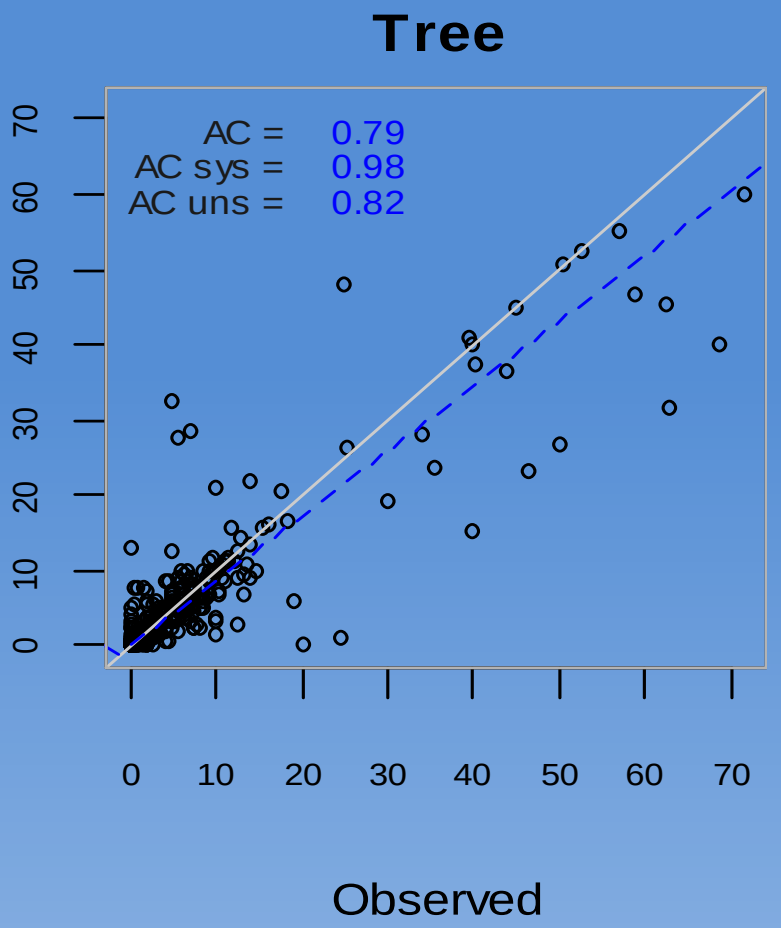
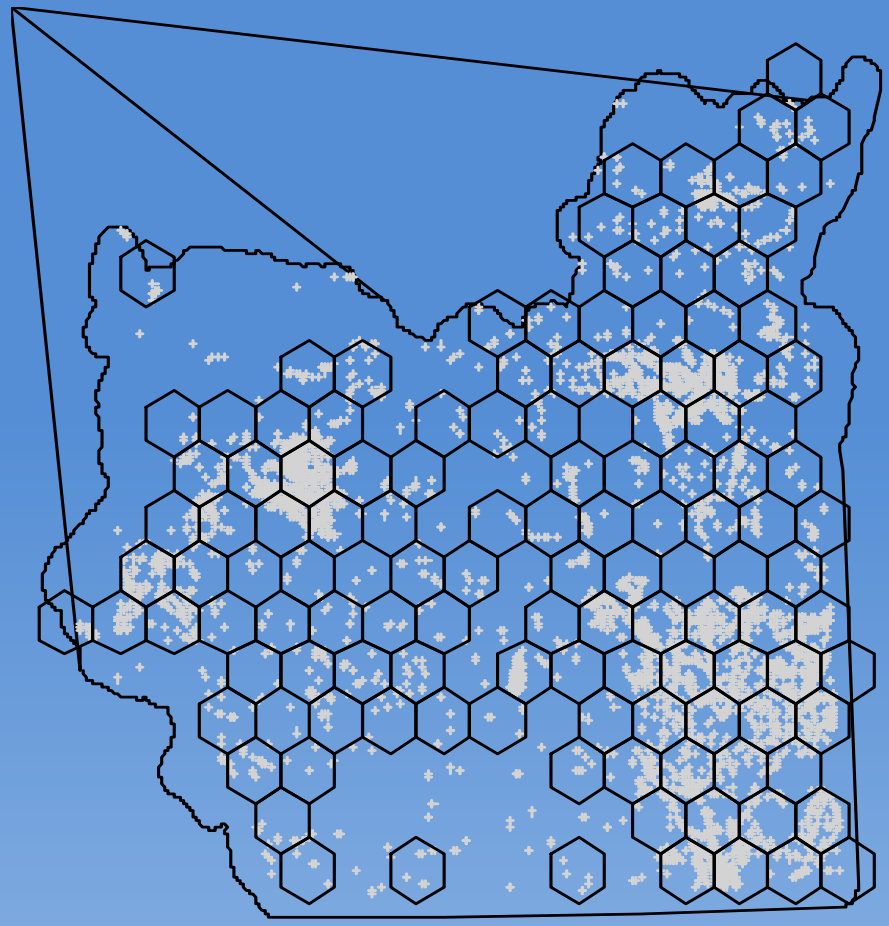
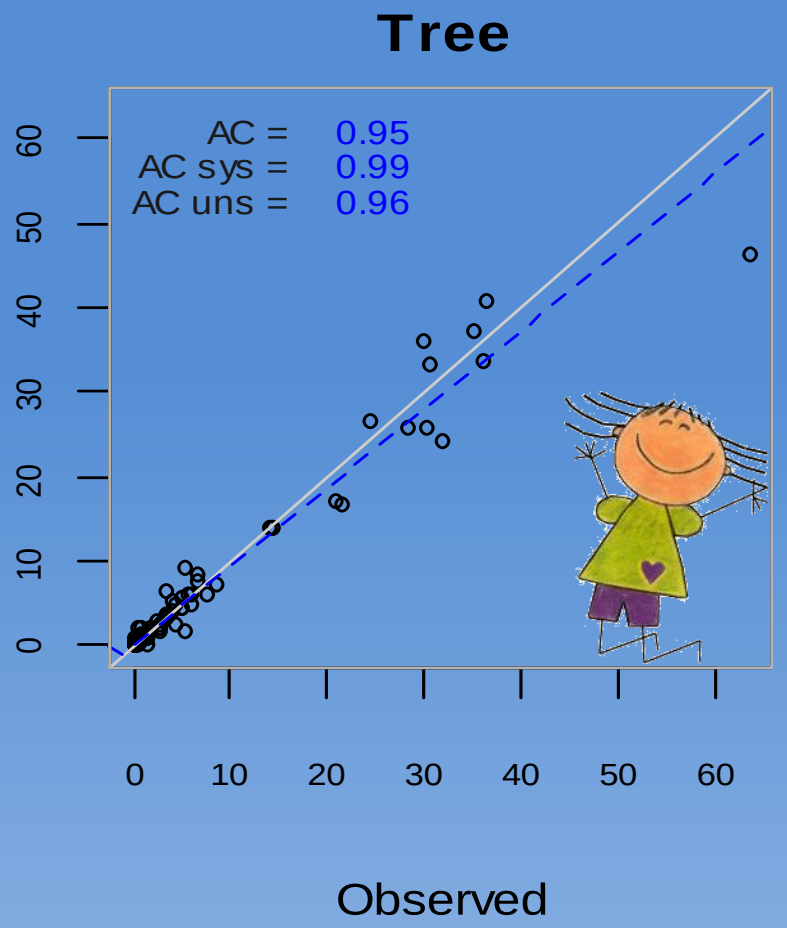
500 ha scale accuracy





50,000 ha scale accuracy





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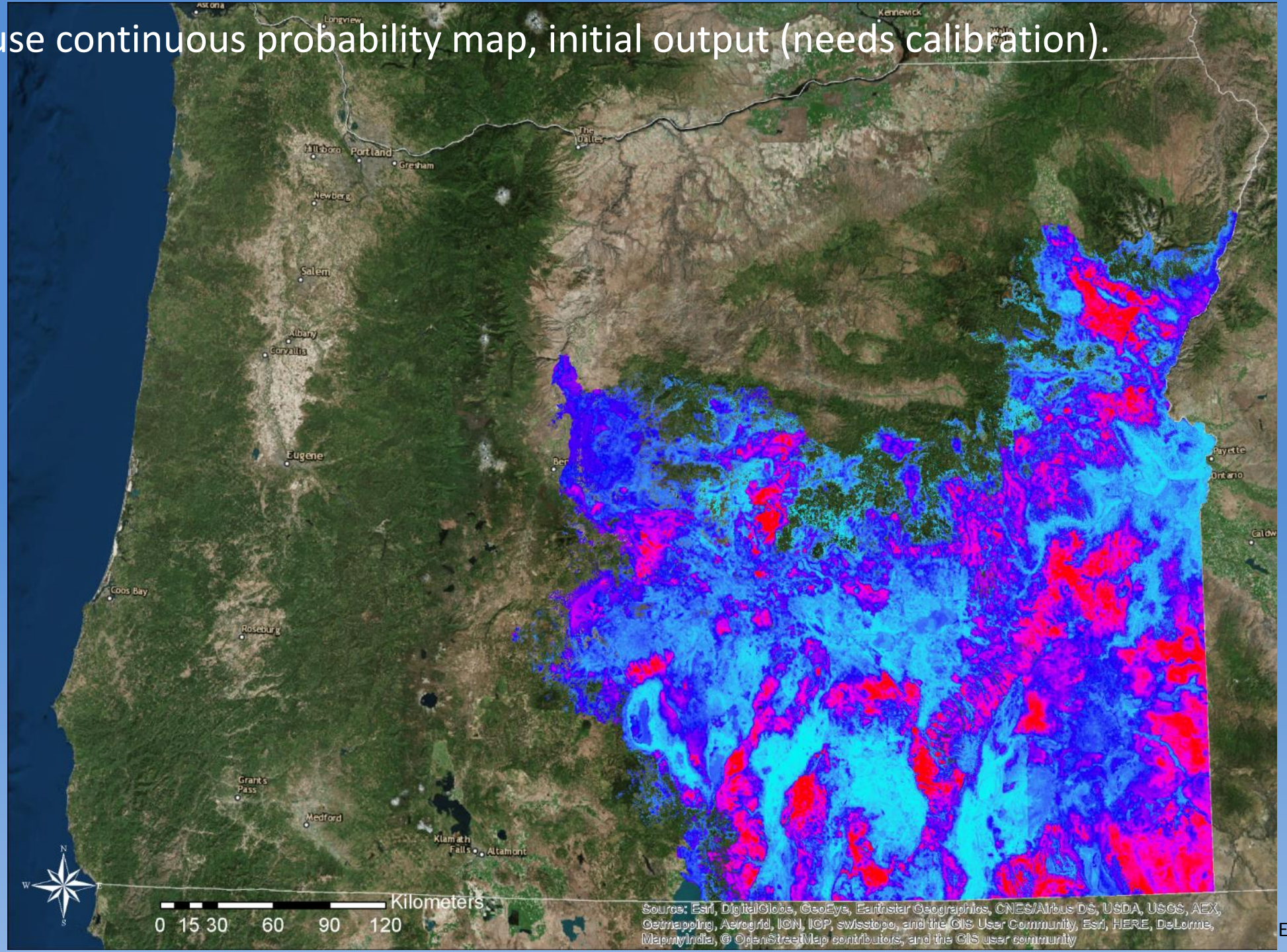
Sage-Grouse continuous probability map, initial output (needs calibration).



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Gorse (*Ulex europaeus*) Modeling on OR Coast

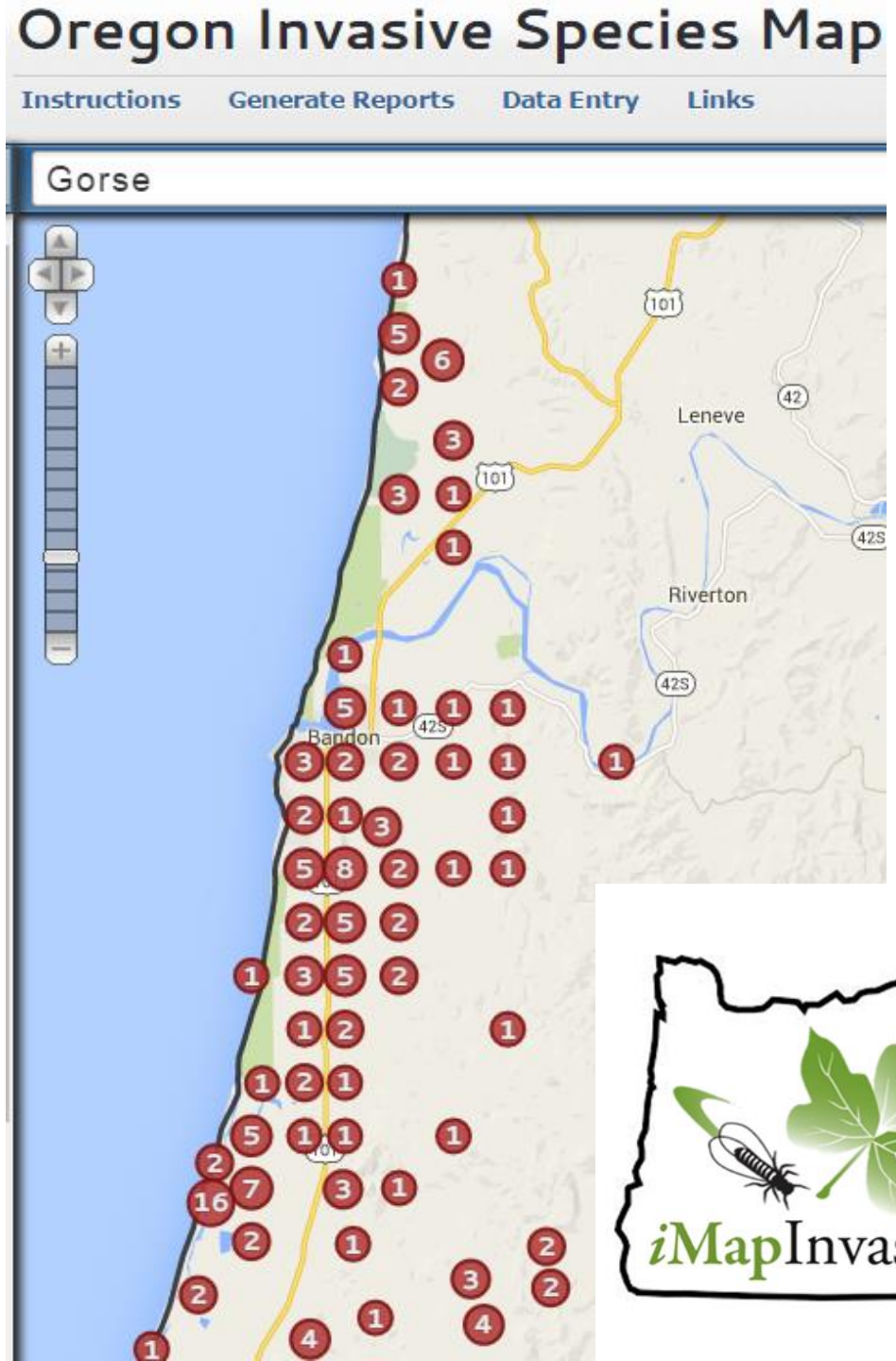
- Gorse is an invasive shrub that dramatically changes dune ecology and poses a fire risk
- Gorse fires twice destroyed the town of Bandon, OR in1914 and 1936
- Invades dunes – and golf courses
- Interest in learning where seed sources are

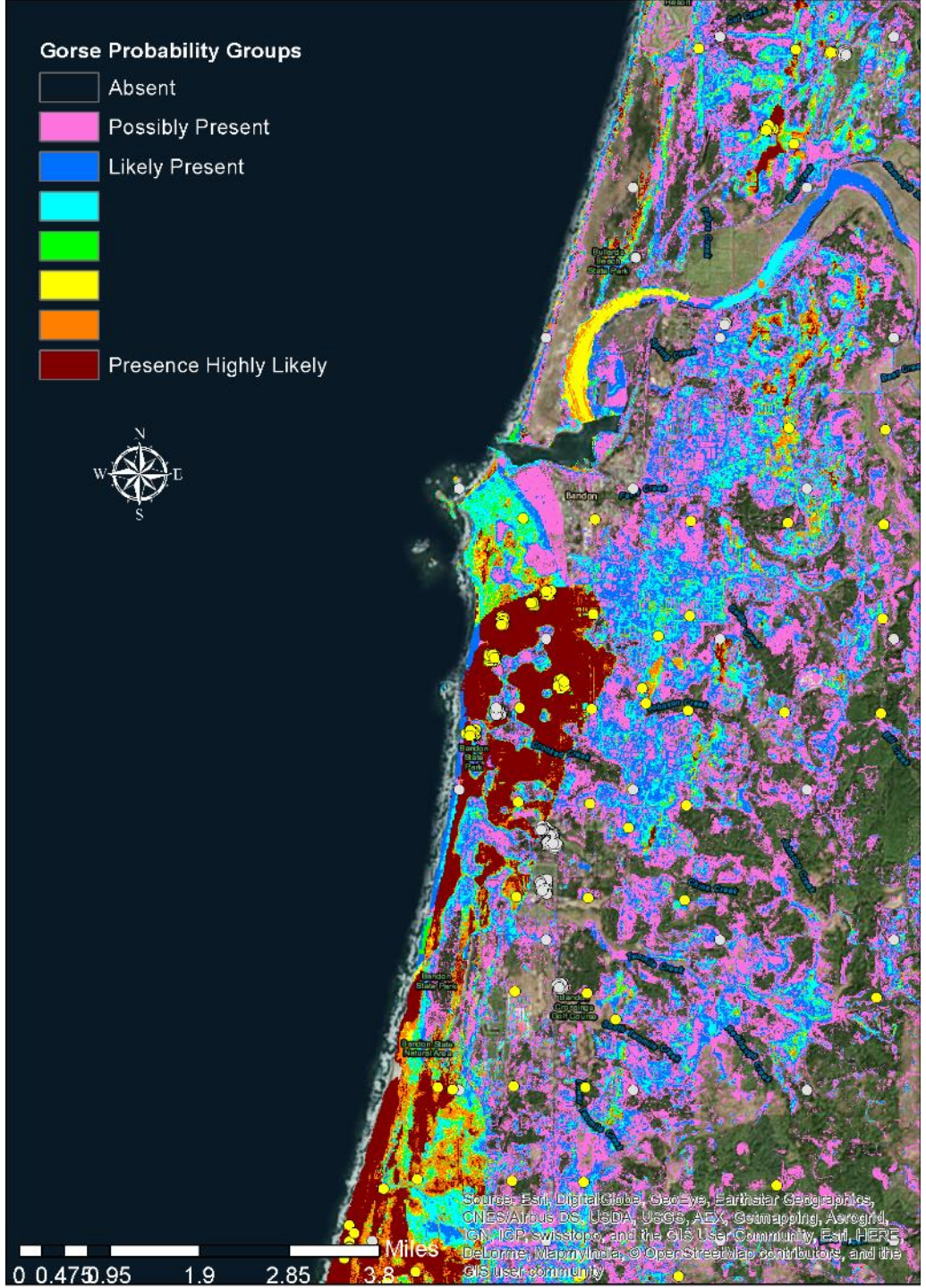
Gorse (*Ulex europaeus*) Modeling on OR Coast

- Developed a Gorse probability map for OR coast
- Based partly on observation data from iMapInvasives, which includes:
  - Agency data (local, state, federal)
  - Non-profit and land trust data
  - Citizen-sourced observations

iMapInvasives

Sharing information for strategic management

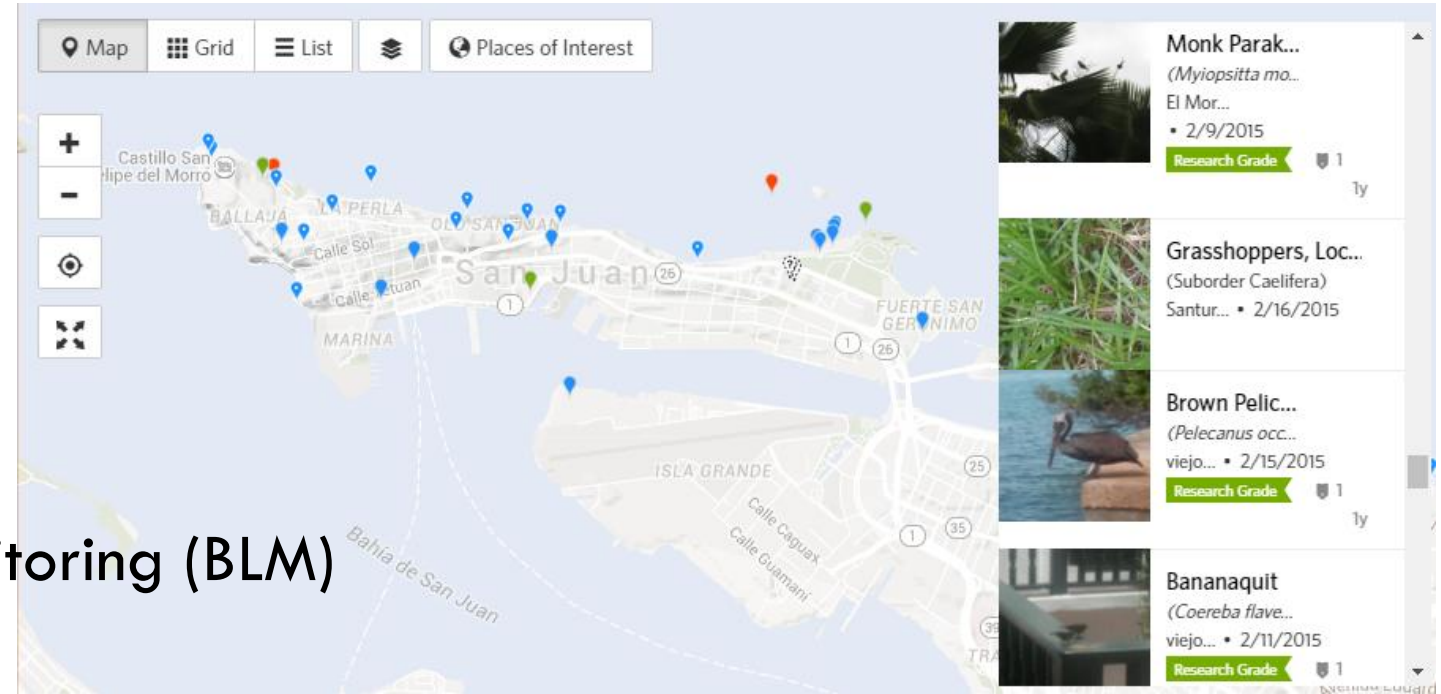




iMapInvasives

Integration of Observations

- Citizen-Sourced
  - Global Biodiversity Information Facility (GBIF)
  - National Ecological Observation Network (NEON)
  - iNaturalist (Happy Hour Tues 5:30pm Ficus Café)
  - DataONE
  - eBird
- Agency-Sourced
  - Forest Inventory Analysis (USFS)
  - Inventory and Monitoring (NPS)
  - Assessment, Inventory, and Monitoring (BLM)



Integration of Observations

- Citizen Science data
  - Time consuming to find, evaluate, mine datasets
  - Develop list of datasets in use by Network partners, scripts to help process
- Agency Observation data can be messy too
  - Tools like OpenRefine (Data Manager Workshop Friday 10:30-noon)
  - Share scripts to cross-walk data (e.g., scientific names to ESTs)
- Revisit Observation Data Standard (2006)
- Kestrel and Biotics?
- Other observation data management systems?

Application to Monitoring

Ecoinformatics: supporting ecology as a data-intensive science, William K. Michener, Matthew B. Jones, 2012

- Ecology moving into the realm of "big science", massive datasets and analysis
- "scientists and institutions share observation platforms, accumulate and analyze massive amounts of data, and collaborate across institutions to address environmental grand challenge questions"
- Needs: Standard protocols; Promoting data sharing; Transparency; Reproducibility

Application to Monitoring

Ecological monitoring with citizen science: the design and implementation of schemes for recording plants in Britain and Ireland, Pescott et al. 2015

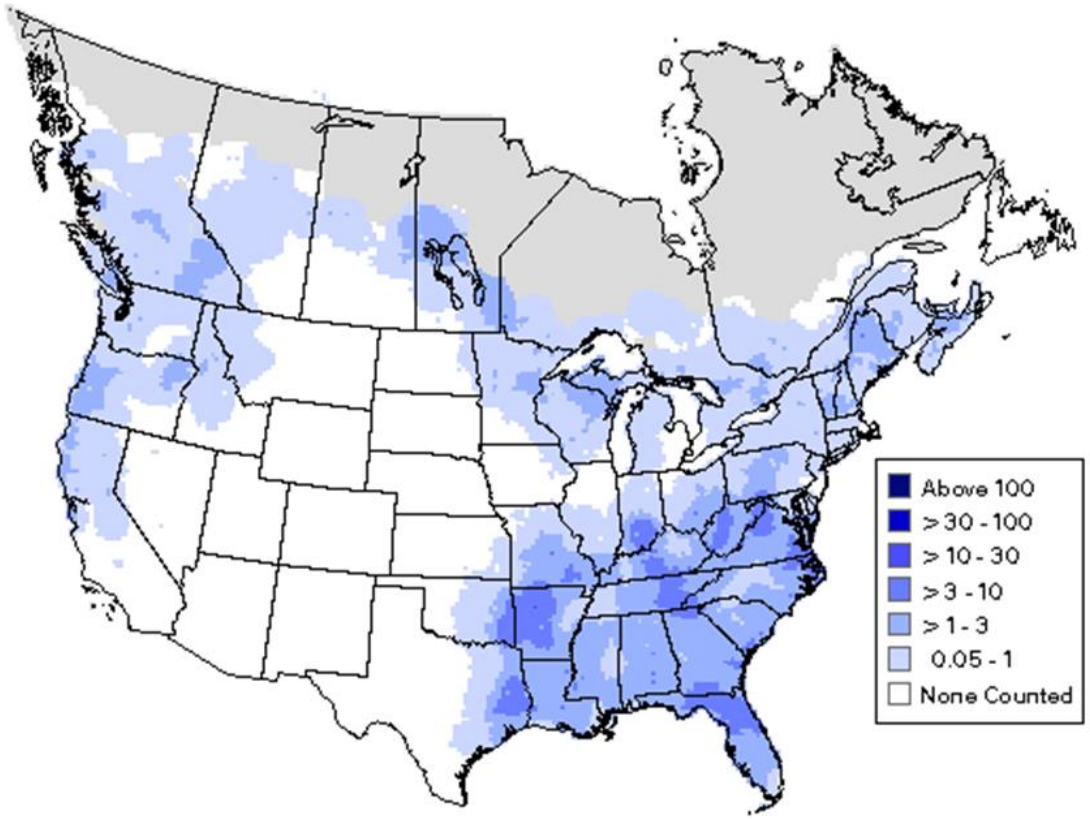
- "Knowledge of species' abundances at finer-scales often provides a more powerful means of detecting and interpreting change"
- Botanical Society of Britain and Ireland (BSBI) volunteer surveys in 1960s led to documentation of widespread decline of many native plants: "widely considered as one of the most significant applications of the data collected"
- Contributed (and continues to add) greatly to *Atlas of British Flora*

Application to Monitoring

Ecological monitoring with citizen science: the design and implementation of schemes for recording plants in Britain and Ireland, Pescott et al. 2015

- BSBI surveys repeated in 2003-2004 for comparison to historical data, used same methodology and grid squares as before
- Highly successful in detecting signals of ecological change
- BSBI will re-run the survey in the early 2020s
- New abundance-based "National Plant Monitoring Scheme" can be applied to continue this work by volunteers for other projects

Discussion



Pileated Woodpecker *Dryocopus pileatus*
Breeding Bird Survey Summer Distribution Map, 1994 - 2003
(http://www.mbr-pwrc.usgs.gov/bbs/htm03/ra2003_blue/ra04050.htm)