

# Integrating camera traps, remote sensing and citizen science to improve ecological forecasting

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## Balancing Act of Wildlife Management

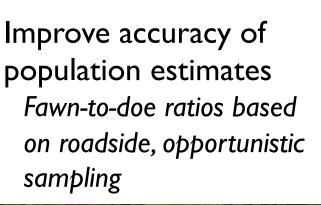
Monitor animal populations Deliver information to stakeholders Forecast changes in populations



Partnership to monitor wildlife year-round through a statewide network of trail cameras



# Potential of Snapshot Wisconsin





Increase coverage & reduce costs Aerial surveys limited by weather, cost, logistics Less need for invasive methods Baiting, trapping, harvest records



### Citizen Science



Volunteers set up cameras

Upload photos to database

Crowdsourcing photo id

Wildlife monitoring and modeling

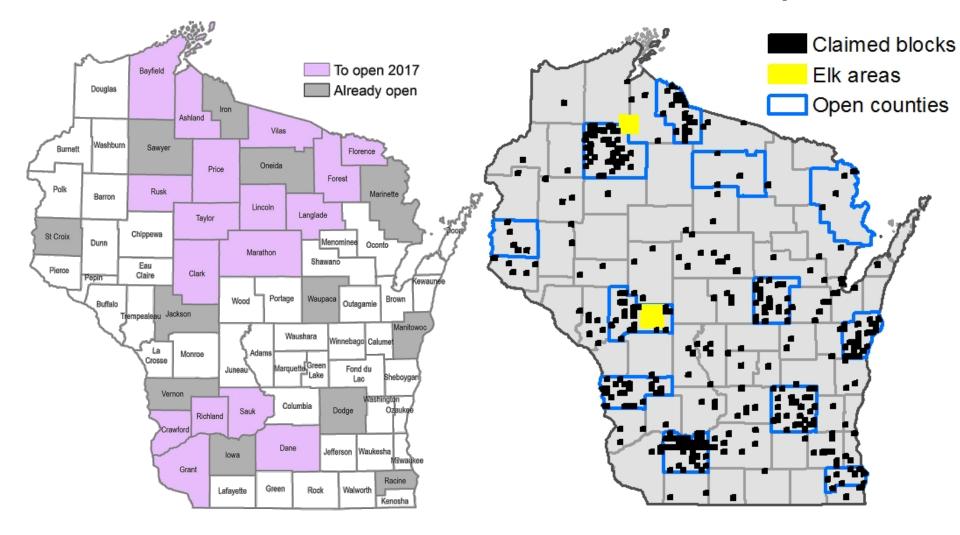
## Citizen Science





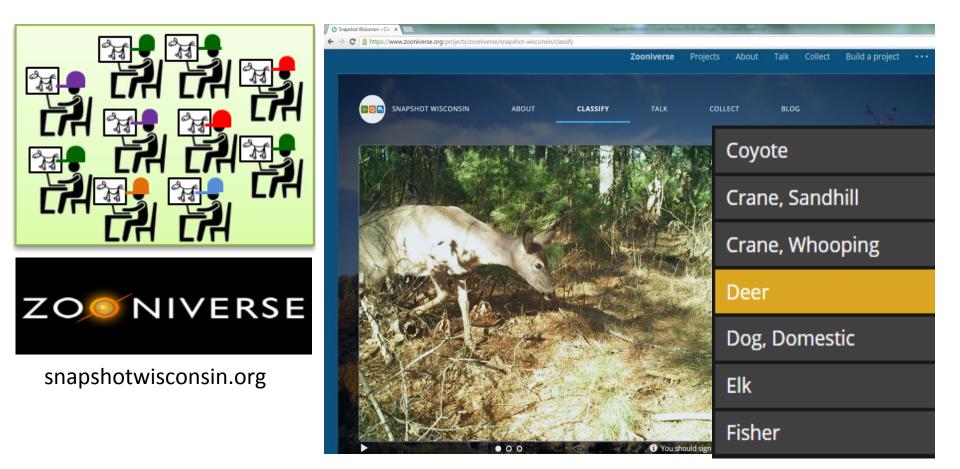
Volunteers receive training Free equipment DNR staff Motion-activated Photos of 3 with 15-second lag Encrypted, date/time programmable

### 600 volunteers 800 cameras 10 million photos

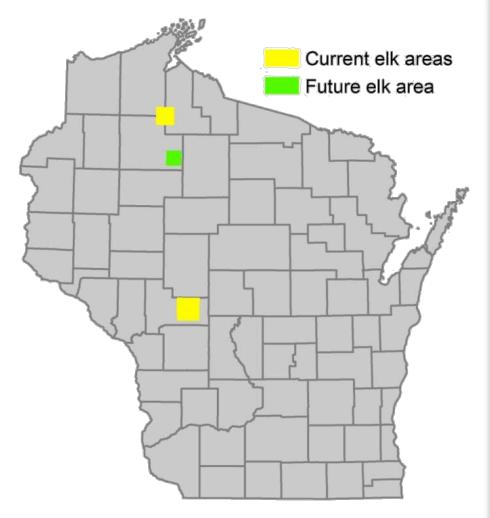


# Crowdsourcing with Zooniverse

### 5,000 volunteers I million classifications Online Global Community

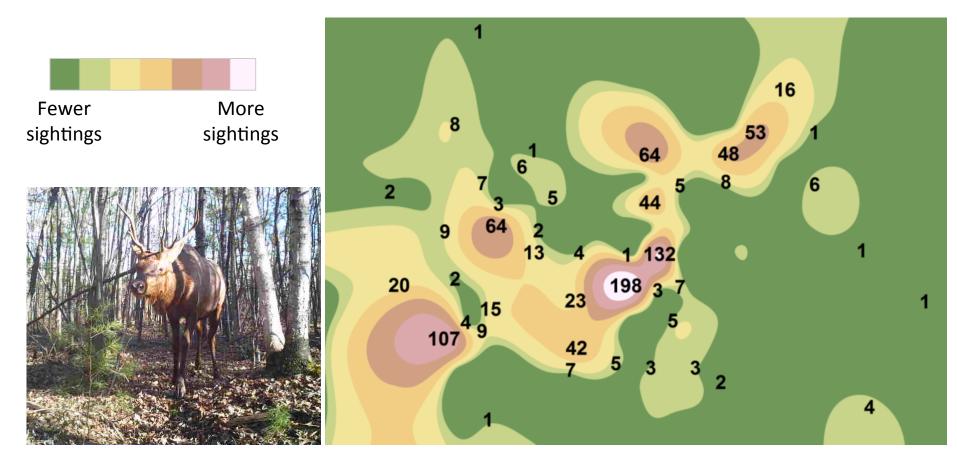


### Applications: Elk Reintroduction





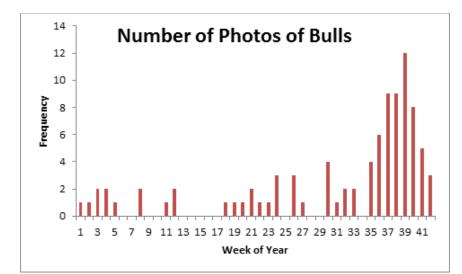
## Elk Sightings

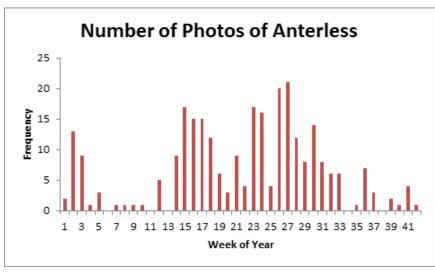


Susan Frett, Joe Dittrich, Christina Locke, Jennifer Stenglein, Dan Storm, Kevin Wallenfang (DNR)

For cameras active July 17 – Oct 5, 2015

### Patterns of Activity









Susan Frett, Joe Dittrich, Christina Locke, Jennifer Stenglein, Dan Storm, Kevin Wallenfang (DNR)

### Recruitment

Elk (Calf-to-Cow Ratios)

Deer (Fawn-to-Doe Ratios)

2015/16 = 0.47



Susan Frett, Joe Dittrich, Christina Locke, Jennifer Stenglein, Dan Storm, Kevin Wallenfang (DNR)

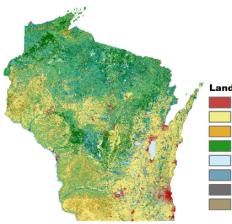
2015/16 = 0.7 to 1.0



Christina Locke, Susan Frett, Jen Stenglein (DNR)

# **Species Distribution Modeling**

Length of Season High: 220 Low: 92

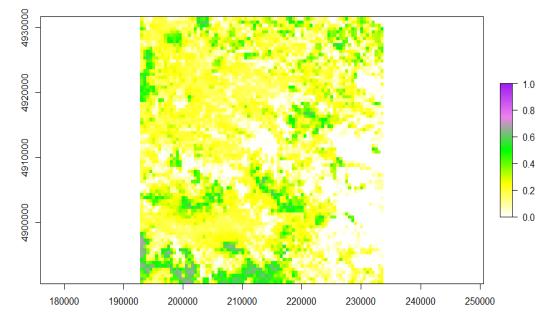








Gray Fox, Spring Occurrence



2.08.0 0.00



## See John Clare (NESSF student) Poster

More on the use of remote sensing to predict animal community patterns as a function of vegetation dynamics:

> Understanding Seasonal Variation in Community Structure by Linking Continuous Camera Sampling and Remote Sensing John Clare<sup>1</sup>, Nanderg Lu<sup>1</sup>, Jennier L. Stergein<sup>2</sup>, Timothy R. Van Deelen<sup>2</sup>, Bergarnin Zuckerber<sup>2</sup>, and Plain Clare<sup>1</sup>, Nanderg Lu<sup>1</sup>, Jennier L. Stergein<sup>2</sup>, Water State Charles and State Charles and

Motivation Species and organism distribution is spatially and intra-annually dynamic in temperate climates. Animal movement is linked to ephemeral pattems in resource amount and location and mediated by biotic interactions (e.g., competition) that limit resource availability or access. Landscape productivity and heterogeneity is strongly associated with species richness, and landscape contrast is believed to drive mechanisms underlying community assembly. These relationships have not been dynamicalle vealuated.



As the suitability of patches in a landscape are more strongly juxtaposed, species interactions and dispersal capability are stronger drivers of community assembly.

### Hypotheses

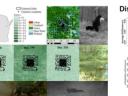
H1: Species richness will be greater in more productive (greener) patches across the year. H2: Changes in distribution will be most marked during periods of reduced landscape productivity (winter).

H3: Interspecific overlap should be greatest in winter because resources are most scare and least diverse.

### Methods

We explored seasonal variation in speciesdistribution/community characteristics using 350 camera locations active continuously between mid 2015 and 2016. Animal images were analyzed using dynamic multi-species occupancy models, with and cover and

vegetation indices extracted from MDDIs imagery used as predictors We defined occupanty seasons as plant phenology (green up, peak, decline, sensecnee).



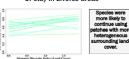
### Main Results

Positive associations between biodiversity and environmental productivity or heterogeneity are well-known, but identifying mechanisms for these associations has proven elusive. Our results suggest that heterogeneity may facilitate richness by increasing the duration of easy access to available resources, and that competition for shared and limited winter resources may limit species richness in temperate climates.

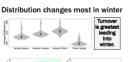
Animals move to green pastures

				Species were more likely to move into patches where EVI was relatively greater than the surrounding landscape.
-6.85	6,00	8.85	0.10	

### Or stay in diverse areas









### And overlap increases





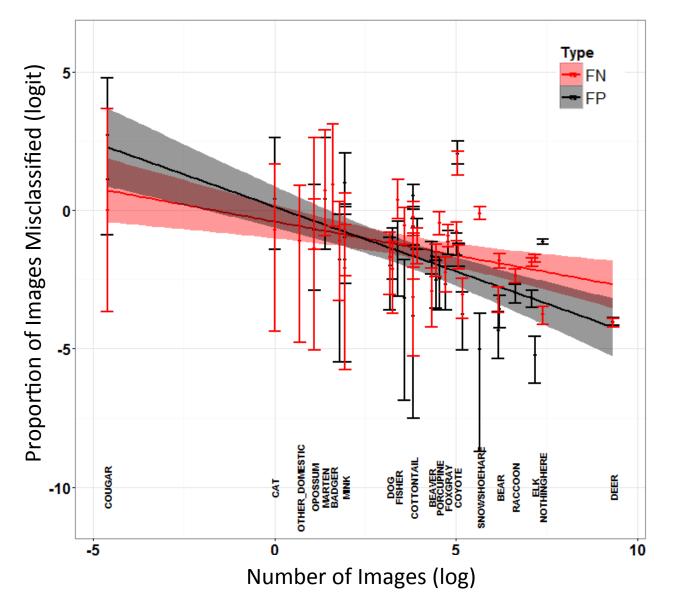
### Future Directions

1: More prolonged sampling and explicit consideration of dynamic distributions may elucidate whether inter-specific overlap in winter actually reflects increased competition for resources, and whether this shapes community structure. 2: Use of more detailed land cover metrics and incorporation of finer-grained remote sensing (e.g., LiDAR) may improve understanding/prediction of what exactly shared winter resources are 3: As the spatial extent of Snapshot Wisconsin continues to increase, the degree to which observed patterns in local space use reflect broader patterns in species distribution can be more strongly evaluated.

### Acknowledgments

Support provided by NASA via Ecological Forescasting # NNX14AC366 to P.A.T., B.Z., and T.R.V-D, and NESSF # NNX16A061H to J.C. Great thanks to additional UW and WDNR cooperators (Christine Anhalt-Depies, Christina Locke, Susan Frett, Aditya Singh, Young Lee).

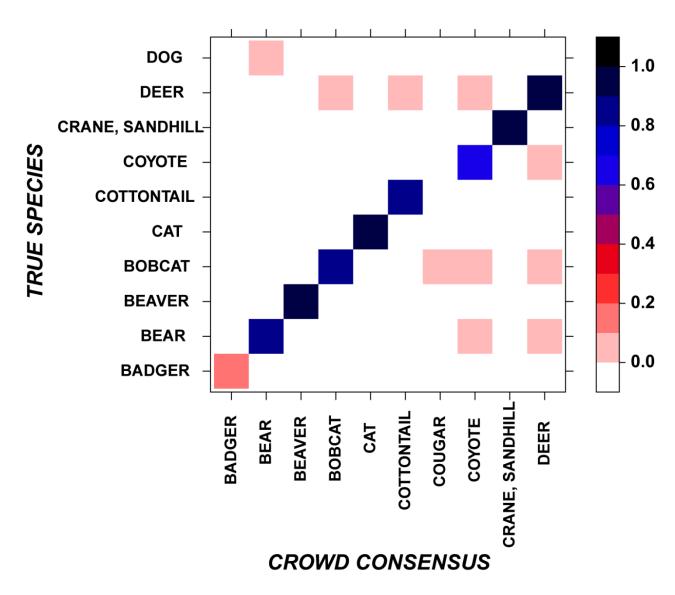
## **Classification Accuracy**



Comparison of expert vs. crowdsourced classification

Less common species have higher classification error

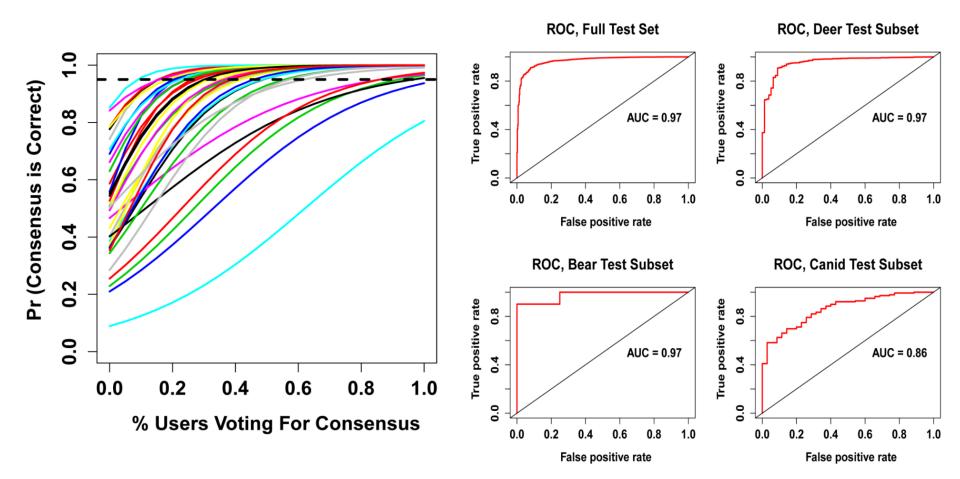
## **Classification Accuracy**



Comparison of expert vs. crowdsourced classification

Error is not equally distributed across species

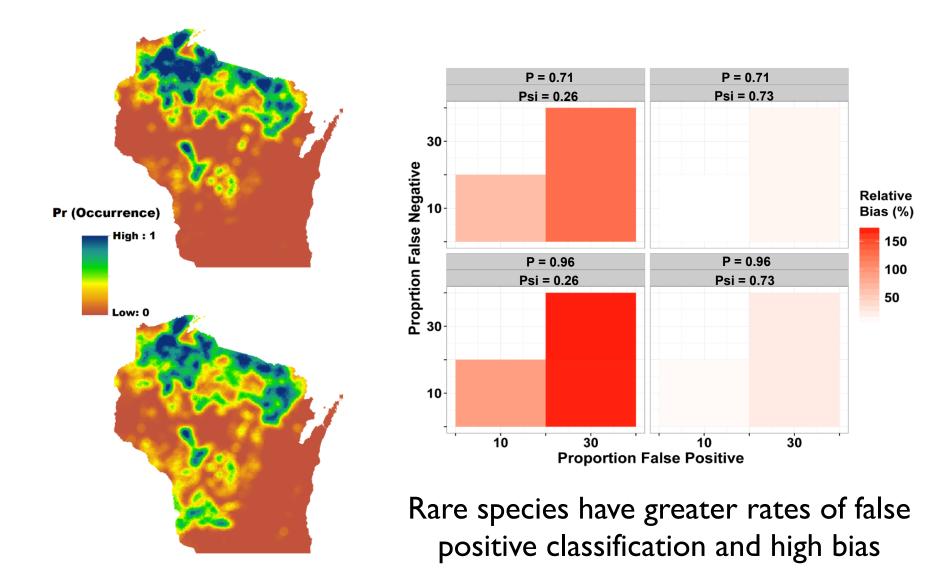
### **Classification Accuracy**



More people agree, the more likely it is that the consensus is correct

Strong predictability of whether a given image is correctly classified

## **Distribution Modeling**



## **Volunteer Motivation**

94%

Of volunteers are property owners (n = 52)

73%

Of volunteers are male (n = 54) with an average age of 61 (range 25-75, n = 52)

60%

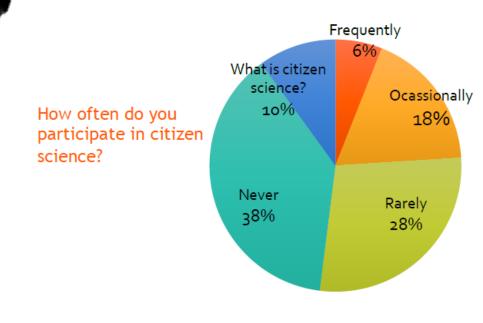
Of volunteers identify as a hunter (n = 55)

40%

Of volunteers have a graduate degree or more (n = 52)

To hopefully aid the DNR & public in understanding wildlife populations more accurately.

I want to know what is on my land. Have always wanted a trail cam—curiosity.



# Agency Partner: Wisconsin DNR

Fully bought-in This is their show already!

3 fulltime staff

>\$1,000,000 spent (staff, IT infrastructure, cameras)

Project will be sustained after NASA funding

(full deployment of cameras 2019 – received state pressure to speed up the process – project is viewed as a success)



### Lessons Learned

### Successes

Hybrid citizen science Inclusion of interest groups IT development Remote sensing



### Challenges

Computer skills of volunteers Data management \*long-term, high volume\* Dealing with "nothing there"



# Acknowledgements



Susan Frett Scott Hull Christina Locke Joe Dittrich Dan Storm Mike Kvitrud Sarath Manne Dougal Walker Mitch Liddicoat Dan Storm John Dadisman Joe Dittrich



Volunteers Laura Trouille Ali Swanson Sarah Allen



**Becky Sapper** 



Clayton Kingdon Young Lee Prabu Ravindran

Trail camera monitoring volunteers Ho Chunk Nation DNR Jackson County Forest and Parks US Forest Service WDNR staff helping with camera hosting and photo classification























# **Questions?**