

# Wildlife@Home: Conservation Outreach using Nest Cameras, Citizen Science, and Computer Vision



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University of North Dakota



# Technology – a blessing and a curse!

- Historically, human observations, anecdotal evidence used to understand nesting behaviors.
- Cameras are everywhere in wildlife research & monitoring now!
  - Changed the questions we can ask!
  - Increase the amount of information we can obtain.
  - Reduce researcher presence.
  - Observations of processes logistically impossible to obtain.



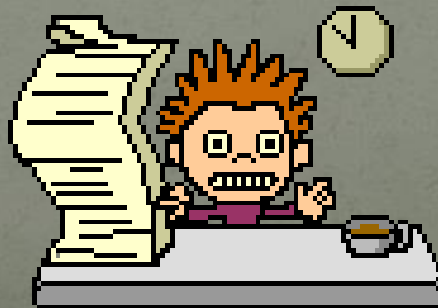
# Cameras in Avian Ecology

- **Predator Identification**
  - Pietz & Granfors 2000, Staller et al. 2005, Ellis-Felege et al. 2008...
- **Attendance Patterns**
  - Burnam et al. 2012, Davis & Holmes 2012, Powell et al. 2012...
- **Nest Defense**
  - Ellison & Ribic 2012, Ellis-Felege et al. 2013
- **Partial Clutch Loss**
  - Ellis-Felege et al. 2012a
- **Unusual behaviors**
  - Ellis-Felege et al. 2012a
- **Specific Management Questions**
  - Nest success implications with predator control (Ellis-Felege et al. 2012b)



# *Data Deluge Problem!*

- Ability to collect video is rapidly outpacing our ability to make use of the data in a timely fashion.
- Valuable information but often slow to review due to time to filter, analyze, & interpret!
- Not just a problem with nest videos...





# *Data Deluge: Problem 1*

- NDGF: Sharp-tailed Grouse & Oil Development
  - Estimate nest survival, cause-specific mortality, and behavioral implications (Paul, Becca, and Julia)
  - 105 nests monitored in 2012-2013
  - ~40,000 hours of video to review!
  - Undergrads are great but...
    - Reviewed > 6,700 hours (282 days) of video .
    - Need for timely answers...



# *Data Deluge: Problem 2*



- NPWRC/Army Corp/ USFWS – Least Terns & Piping Plovers
  - Refined monitoring methods?
  - Are the fates correct?
  - Researcher disturbance?
  - Predators/ humans/pets interactions?
  - General nesting behaviors?
  - 30 plover, 11 tern nests

Very timely data needs!





# Challenges

- Store/Back-up Data
  - Storage – solutions available, affordable
- Filter rapidly?
  - Motion-sensors inadequate (Ribic et al. 2012)
  - Data Deluge = processing limitation
  - Other image processing (e.g., UAS)
- Analyze and Disseminate
- What do you do?



# Solutions to Date Deluge?

- Step 1 – Recruit lots of undergrad and graduate students eager for “experience”!





# Solutions?

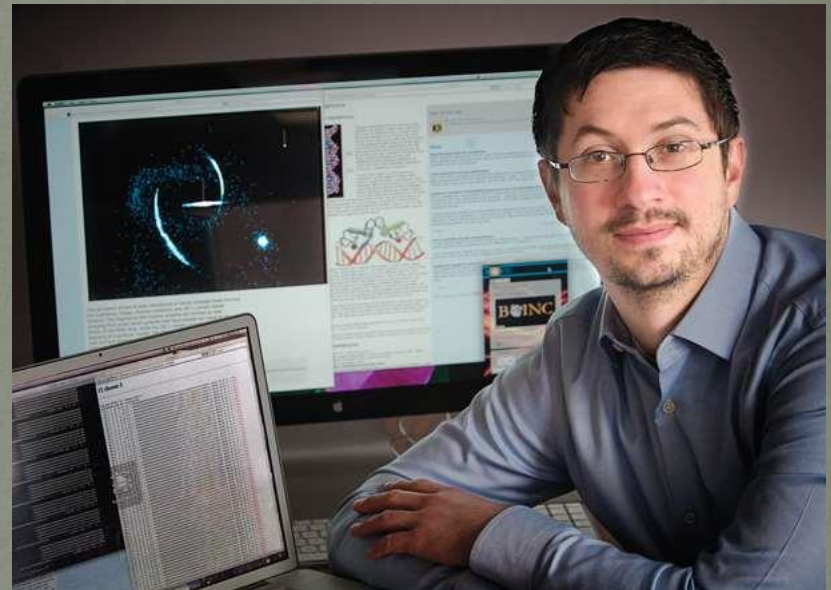
- Step 1 – Recruit LOTS of undergrad and graduate students eager for “experience”!
  - Limits to time (takes months - years to analyze videos)
  - Eye fatigue!
  - Sanity??



- Note to Employers – if they stick with this, they can get through anything!

# Solutions?

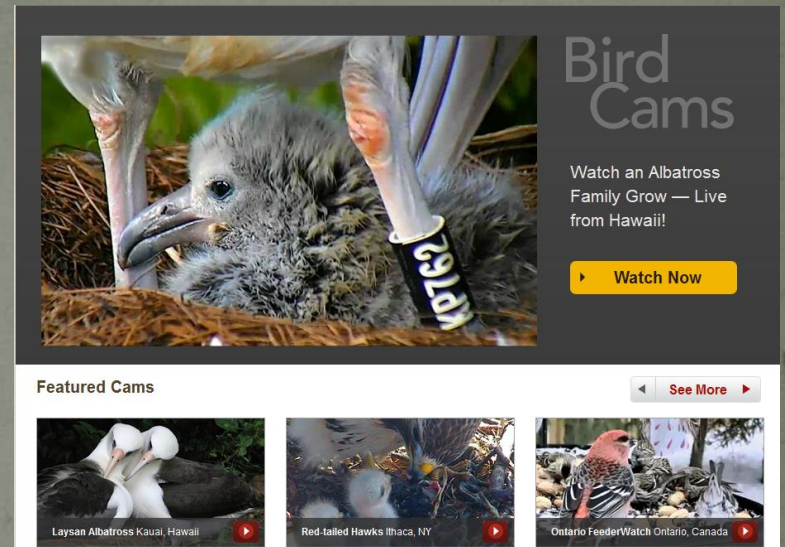
- **Step 2 – Partner with a computer scientist!**
  - Website
  - Storage/Back-up
  - Databases
  - Online Communities
  - Computer Vision
  - Computational Power





# Solutions?

- Step 3 – Engage the Public  
→ Citizen Science!
- Social Media & Web cameras
- Increase awareness & make public part of the conservation team!
- Allow citizens to help us learn and solve problems (part of the solution!)
- Archive for education



# Citizen Science – getting involvement

- Register for a free account
  - Data keeping on volunteers
  - Allows score to be kept (badges)
- Ways to Volunteer:
  - Crowd – sourcing: Volunteer brain power
  - Volunteer computing: Volunteer computer to run algorithms





# Solutions?

- **Step 4 – Recruit (VolunTELL) Education Specialist**
  - Integrate education with research
  - Allows us to target different audience than those already engaged in conservation
  - Explore K-12 Standards and use video archive to foster environmental/ecological education in classroom
  - Environmental responsible citizens (Bradley 1995, Van Velsor 2004).
  - Appeals to funding agencies (e.g., NSF)



# Putting Pieces Together

- Computer Scientist → Builds website, online community, and computer vision methods
- Undergraduate and Graduate students = project scientists
- Volunteers – watch and let us “borrow” computers
- Education Specialist – Outreach Opportunity





# Wildlife@Home Project

<http://volunteer.cs.und.edu/wildlife/>

Firefox

Wildlife@Home

+

volunteer.cs.und.edu/wildlife/

wildlife@home

Project Mangement (525) Susan Felege

Wildlife@Home

Watch Video

About the Wildlife

Message Boards

Project Information


## Welcome to Wildlife@Home

Wildlife@Home is citizen science project, developed in a joint effort by [University of North Dakota's Department of Computer Science](#) and [Department of Biology](#), aimed at analyzing video gathered from various cameras recording wildlife. Currently the project is looking at video of [sharp-tailed grouse](#), *Tympanuchus phasianellus*, performing their mating dances (lekking), and then examining their nesting habits and ecology. The nest cameras have been set up up both near western North Dakota's oil fields and also within protected state lands. We recently have also begun studying two federally protected species, interior least terns, *Sternula antillarum*, and piping plovers, *Charadrius melodus*.

We hope that your participation will help us determine the impact of the oil development on the sharp-tailed grouse, and better understand the behaviors of least terns and piping plovers to aid in their conservation, as well as provide some interesting video for everyone to watch and discuss. Feel free to scroll through our image gallery on the right to get a better idea of what's going on with the project and see the field biologists in action, or talk to us on the [message boards](#).

[Watch Videos](#)

[Volunteer Your Computer](#)



The leg bands used by wildlife biologists for bird identification are clearly visible on the flying adult piping plover.

## News

### Drive failure

One of the drives on the volunteer computing server had a failure. A new replacement is ordered and will be in tomorrow. The system is RAIDed (for redundancy), so there shouldn't be any issues; but if anyone sees any hiccups in the site let us know.

I've been testing the validator for the new interface and it looks like it might almost be ready to be rolled out for your input. Once that's done I'll get to making an interface so you can go over your watched videos and events from the new interface so we can

It's validating things correctly.

## Contact Information


Please email any questions or suggestions to [Travis Desell](#), or feel free to post a message in our [forums](#).


The Wildlife@Home team includes:

- [Travis Desell](#), Assistant Professor of Computer Science, University of North Dakota
- [Susan Ellis-Felege](#), Assistant Professor of Biology, University of North Dakota
- [Alicia Andes](#), Graduate Research Assistant in Biology, University of North Dakota

volunteer.cs.und.edu/wildlife/boinc\_instructions.php

It's validating things correctly.





12:38 PM  
2/2/2014

# What is Wildlife@Home?

- A *citizen science* project that combines both crowd sourcing and volunteer computing.
- Users volunteer their brain power by observing videos and reporting observations.
- Users volunteer their computer power by downloading videos analyzed by algorithms to filter through videos.
- A scientific web portal to robustly analyze and compare results from users, experts and the computer vision techniques.
- Allows interactions with the public and K-12 students.



# Early Development Accomplishments

- Website & Online Community
  - Users (>175 volunteers)
  - Select species



**Sharp-Tailed Grouse** *Tympanuchus phasianellus*

Sharp-tailed grouse are an important ground-nesting bird and a species that can serve as an indicator of grassland health. Cameras were placed in areas with different degrees of gas and oil development.

[Training Videos](#)

[Species Information](#)

**Belden, ND**

**2012-2013**

Cameras were placed at grouse nests in areas of intense gas and oil development.



[Watch Video](#)



**Interior Least Tern** *Sternula antillarum*

Interior least terns are federally listed as an endangered species. They nest on sandbars and islands along the Missouri River in western North Dakota.

[Training Videos](#)

[Species Information](#)

**Missouri River, ND**

**2012-2013**

Cameras were placed at least tern nests along the Missouri River in western North Dakota.



[Watch Video](#)



**Piping Plover** *Charadrius melodus*

Northern great plains piping plovers are federally listed as threatened species. They nest on sandbars and islands along the Missouri River and Alkali lakes in North Dakota.

[Training Videos](#)

[Species Information](#)

**Missouri River, ND**

**2012-2013**

Cameras were placed at piping plover nests along the Missouri River in western North Dakota.



[Watch Video](#)

# Accomplishments

- Video Classification
- Training Videos



**Sharp-Tailed Grouse** *Tympanuchus phasianellus*

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Wildlife@Home

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[Project Information ▾](#)

[Project Mangement \(](#)

Cameras have become common and powerful tools in the field of avian ecology, as they can be used to capture events that would be otherwise difficult to impossible to observe in any other way. Cameras allow us to evaluate a variety of questions ranging from behaviors to interactions with other species.

We need your help so we can answer the following questions:

1. Which predators are responsible for destroying nests?
2. Female grouse must allocate their time between incubating the eggs and foraging; how often do they leave to forage? How long are they away from the nest on foraging bouts?
3. How often do grouse defend against predators?

To do this, we will need to you to watch 3 minutes clips of video to identify when the grouse is on the nest, leaving the nest, off the nest, and returning the nest.



As you will notice, it can be challenging to determine if the bird is on the nest. Her coloration helps her to blend in with her surroundings, and she prefers to nest in areas with plenty of grass to conceal her and the nest. Use this video where the bird is leaving the nest to see how difficult is to locate her until she moves, and how exposed the eggs become when she leaves the nest.



# Accomplishments

- Video Classification
- Project Background

## Nest Cameras and Citizen Science: Implications for evaluating Sharp-tailed Grouse Nesting Ecology

Rebecca Eckroad – M.S. Student in Biology

We are evaluating the behaviors of female sharp-tailed grouse (*Tympanuchus phasianellus*) exhibit during incubation for hens nesting in areas of high and low natural gas and oil development. *Nest recesses* are when the hen leaves the nest for her own self-maintenance such as feeding. We look at when the hens leave, how long they are gone, and how many times they leave per day. Information about these events can provide researchers with information about basic incubation patterns, and determine if disturbances related to gas and oil production are correlated with the way hens allocate their time.



Hen leaving the nest for morning recess. Notice that both the radio collar and leg band are visible. The band gives the bird a unique identifying number, and the collar sends out a signal allowing researchers to locate her using radio telemetry.



*Nest defense* events are any time the hen exhibits behaviors that puts her in danger in the attempt to save her eggs. For these events we are interested in what the hen is defending against, what defense behaviors she is displaying (posturing, pecking, attacking the predator, etc.), time of day, and duration of the event. Results from this data will help researchers determine under what circumstances hens will be more willing to risk their lives



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[Training Videos](#)

[Species Information](#)

Belden, ND

2012-2013

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[Watch Video](#)

# Accomplishments

- Video Classification
  - Watch Videos & Classify Events



**Sharp-Tailed Grouse** *Tympanuchus phasianellus*  
Sharp-tailed grouse are an important ground-nesting


Wildlife@Home: Watching Video

volunteer.cs.und.edu/wildlife/watch.php?site=2&species=1

Wildlife@Home Message boards Project preferences for lengths of videos to... Glory to Kyle Wildlife@Home: Watching Video

Wildlife@Home Watch Video About the Wildlife Message Boards Project Information Project Mangement (264) Travis Desell

149.704 - CH00\_20120607\_072707MN\_CHILD16 83,187s watched - 97.25% accuracy



fast backward speed: 1 fast forward

|     |    |        |   |   |
|-----|----|--------|---|---|
| yes | no | unsure | Parent leaves the nest.                   | ? |
| yes | no | unsure | Parent returns to the nest.               | ? |
| yes | no | unsure | Parent present at the nest.               | ? |
| yes | no | unsure | Parent absent from the nest.              | ? |
| yes | no | unsure | Predator at the nest.                     | ? |
| yes | no | unsure | Nest defense.                             | ? |
| yes | no | unsure | Nest success (eggs hatching).             | ? |
| yes | no | unsure | Chicks present at the nest.               | ? |
| yes | no |        | Was the video interesting or educational? | ? |

Any other comments (predator identifications, etc)?

video problem ? submit

Designed by [Travis Desell](#) and the Wildlife@Home Team with much help from [Twitter's Bootstrap](#).

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# Accomplishments

- Video Classification
- Discussion Boards & Badges

Wildlife@Home Watch Video ▾ About the Wildlife ▾ Message Boards Project Information ▾ Project Mangem


Author



JumpinJohnny

Send message


Joined: 24 Sep 13  
Posts: 29  
Credit: 0  
RAC: 0  
Watched: 2,725,405s  
99% accurate



Message

Message 2495 - Posted: 1 Feb 2014, 2:37:08 UTC [Hide](#) [Move](#) [Banish author](#)

I would like to discuss this video: "Belden/149.732\_PREDATION/5-14-12\_149732/CH00\_20120515\_063344MN\_CHILD1"



05/15/2012  
06:50:29 10:00

The bird has clearly attacked the camera because it moves several times.  
She then comes partly into view with wing tip down?? (06:50:29)  
This is typical defense behavior, I marked it as "Nest Defense". Probably should not have.  
It cannot be seen that the hen is ever incubating before or after entering view therefore, I did not mark it as Present or Absent. Was that wrong as well??  
I'm really a bit confused on what I should have done with this or what is seen here.  
I would also like to know, if this incident was part of what caused this nest to be deemed "Predation" or did that all happen after this date?

Connected to signature.statseb.fr...



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**Belden, ND**

**2012-2013**

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[Watch Video](#)

# Early Development Accomplishments

- Volunteers: 14,000 hrs watched; >6,000 hrs verified
- Computer Vision & Volunteer Computing
  - Early success with shape recognition

E-Science – October 2013

## Wildlife@Home: Combining Crowd Sourcing and Volunteer Computing to Analyze Avian Nesting Video

Travis Desell\*, Robert Bergman\*, Kyle Goehner\*, Ronald Marsh\*, Rebecca VanderClute\*, and Susan Ellis-Felege†

\*Department of Computer Science

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University of North Dakota

**Abstract**—New camera technology is allowing avian ecologists to perform detailed studies of avian behavior, nesting strategies and predation in areas where it was previously impossible to gather data. Unfortunately, studies have shown mechanical triggers and a variety of sensors to be inadequate in capturing footage of small predators (*e.g.*, snakes, rodents) or events in dense vegetation. Because of this, continuous camera recording

tern (*Sternula antillarum*), federally listed as an endangered species, and 682 for the piping plover (*Charadrius melodus*), federally listed as a threatened species. There are further plans to monitor these birds in future nesting seasons, which should result in a total of over 100,000 hours of video. The sharp-tailed grouse is considered an *indicator species*, meaning that



# Computer Vision



**There are many challenges but also interesting questions:**

1. Dramatically changing weather conditions
2. Dawn/Day/Dusk/Night lighting conditions
3. Model species (sharp tailed grouse and piping plover) and some predators have cryptic coloration (camouflage).
4. Moving vegetation and insects can cause false negatives.

# What Next?

- Expand community – Increase ecologists/wildlife volunteers
  - Help answer questions, join discussion forums
- Reformatting volunteers responses for plover and tern behaviors
- Education Modules → 1<sup>st</sup> available expected in Fall 2014
- Evaluate our user proficiency & learn about volunteer backgrounds (Becca Eckroad – M.S. Student)
- Use archive to learn about behaviors & answer research questions
  - Paul Burr – M.S. Student
  - Becca Eckroad – M.S. Student
  - Julia Johnson – Undergraduate
  - Alicia Andes – Ph.D. Student
  - Leila Mohsenian – Undergraduate



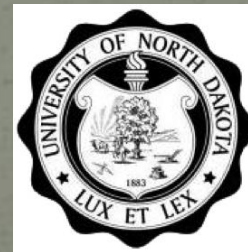
# What next?

- Infrastructure for processing images and videos.
- Nest cameras, trail cameras, & UAS images/video...
  - Scientists use Wildlife@Home to host data project
- Opportunity to communicate conservation issues and impacts of the changing landscape!



# Acknowledgements

- Project Scientists/Volunteers/Lab
  - Paul Burr
  - Rebecca Eckroad
  - Alicia Andes
  - Leila Mohsenian
  - Julia Johnson
  - Amanda Saul
  - Matt Rash
  - Drew MacDonald
  - Anna Mattson
  - Adam Pachl
  - Beth Walters
  - RJ Gross
- Field Crews
- Wildlife@Home project team
  - Kyle Goehner (M.S. Student)
  - Rebecca VanderCluter (Undergraduate)
- Agency Collaborators
  - Aaron Robinson – NDGF
  - Mark Sherfy – NPWRC
  - Terry Shaffer – NPWRC
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  - UND SEED grant
  - National Science Foundation
  - UND Biology Department
  - ND Game and Fish
  - USGS





# Questions?

Wildlife@Home

<http://volunteer.cs.und.edu/wildlife/>

