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Bird Nesting Behavior at a PV Site

Video Observations Aligned with Nest Survey Data

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Motivation | Objectives

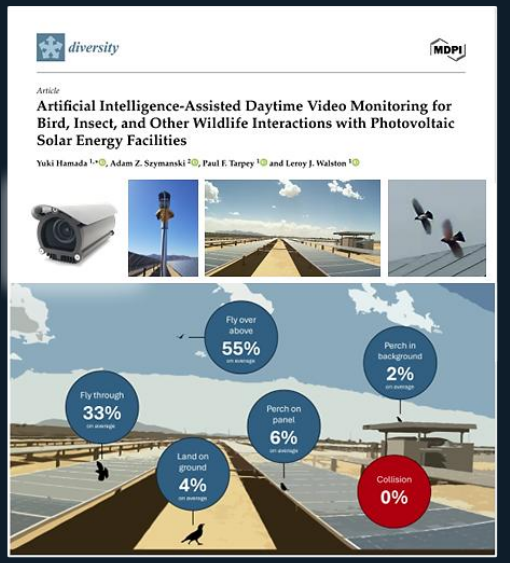
PV Solar Benefits for Birds

- Ecovoltaics
  - Ecologically informed PV facilities can provide birds with foraging, roosting, and nesting sites. These benefits could be effectively evaluated using traditional surveys and complementary methods.
- Objective
  - Examine AI-assisted video data for studying bird reproduction at a PV facility
    - Identify taxonomy and nesting behaviors|
    - Compare with nest survey

Acoustic Recording + AI

Walston et al. (2025) https://doi.org/10.1111/1365-2664.70208

Daytime Video + AI



Hamada et al. (2026) https://doi.org/10.3390/d18020095

ANL Avian-Solar Monitoring Software

Szymanski, Z., Tarpey, P., Hamada, Y. et al. (2023) Deep Learning-Computer Vision Framework for Monitoring Avian Interactions with PV Solar Facilities 2023 DOE SETO AI Workshop.

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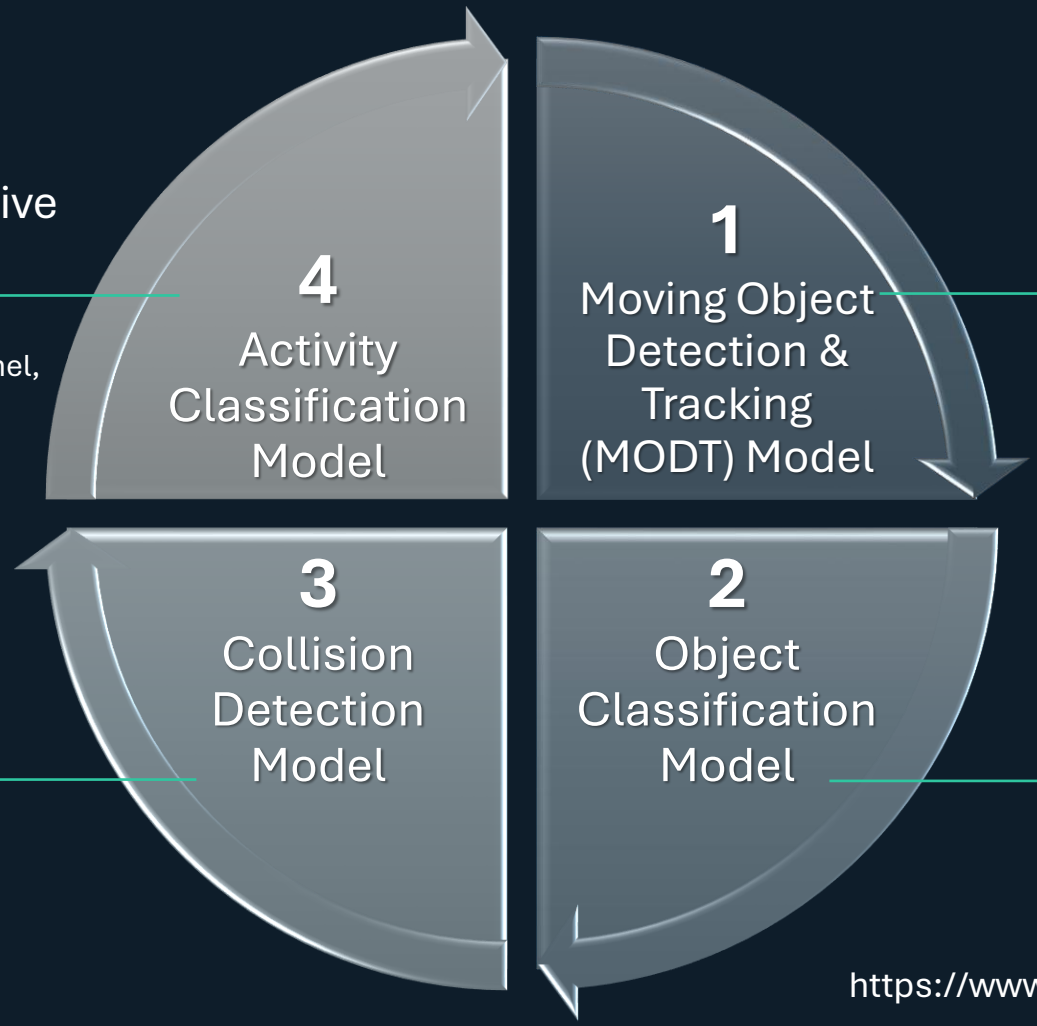

Extract moving objects in video footage and generate tracks

https://www.sighthound.com/products/hardware

Differentiate birds from other objects

Birds vs. non-bird objects

Detect bird collision

Collisions vs. non-collision activities

Classify bird activities into five categories

Fly over above, fly through, perch on panel, perch in background, land on ground

https://www.anl.gov/evs/avian-solar

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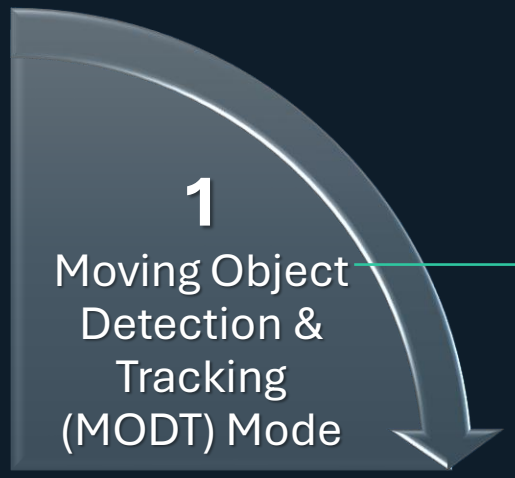
Methods for This Study



Extract moving objects in video footage and generate tracks

Interactively…

1. Differentiate birds from other objects
2. Identify taxonomy
3. Identify nesting behavior
4. Compare with nest survey

Study Site

- PV facility: Central MA | 4.7 MW_{ac} | ~7.8 acres | Fixed-tilt
- Ground cover: Natural vegetation with mowing
- Landscape context: Mixed forest (47%) | Urban (24%) | Cropland (18%)

Methods

Data

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	Video Collection	Nest Survey
Period	March 19, 2024~August 18, 2024	April 20, 2024~August 12, 2024
Coverage	~2.3 acres (viewing west) 	~7.8 acres (entire site)  
Frequency	Record from dawn to dusk each day	Revisit every nest every 4-6 days until fledged or failed
Type	Total 1,607 h of footage • Daytime only • True color • 4k resolution 	Information about nest contents • # of eggs/chicks • Developmental characteristics of chicks • Sound of chicks (e.g., begging food) • Brood parasitism  

Results

At a Glance

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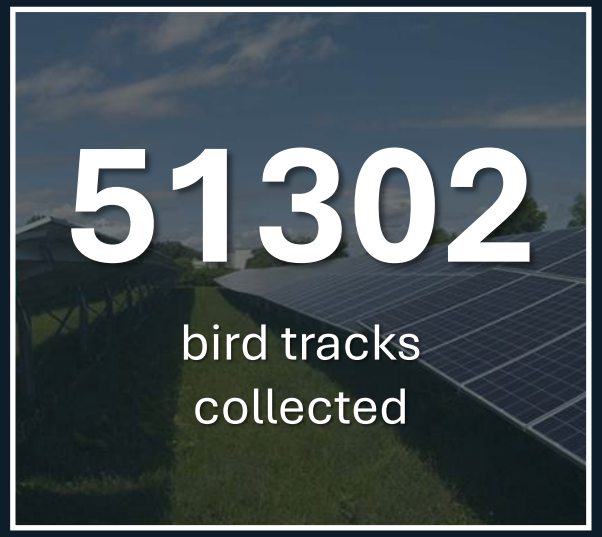

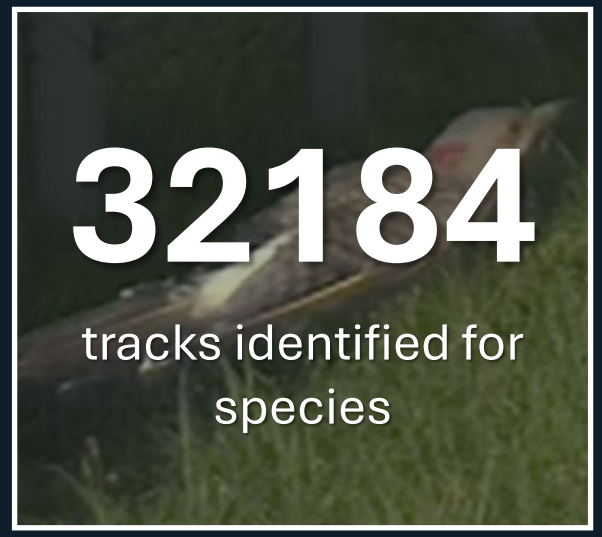

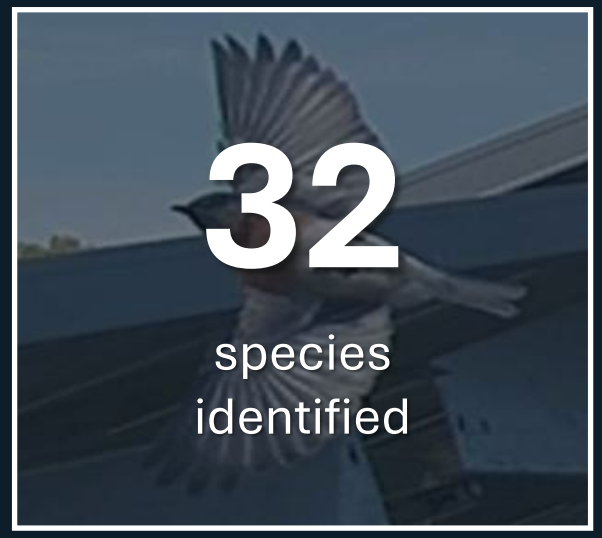

Results

From Video to Data by Numbers

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1,607
hours of daytime videos

171,399
tracks of moving objects extracted using MODT

51,302
bird tracks

32,184
id-ed by species

2,628
with nesting behavior

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Results

32 Species were Identified in Videos

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17
passerines

7
raptors

3
woodpeckers

1	1	1	1	1
dove /pigeon	humming bird	night-hawk	wading bird	water-fowl

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Results

32 Species were Identified in Videos

Passerines (17)	Song sparrow	**Waterfowl (1)**
American goldfinch	Tree swallow	Canada goose
American crow		
American robin	**Raptors (7)**	**Wadding bird (1)**
Barn swallow	American kestrel	Greater blue heron
Bluejay	Bald eagle	
Common grackle	Cooper's hawk	**Dove/pigeon (1)**
Common raven	Osprey	Mourning dove
Dark-eyed junco	Peregrine falcon	
Eastern bluebird	Red-tailed hawk	**Nightjar (1)**
Eastern phoebe	Turkey vulture	Common Nighthawk
European starling		
House finch	**Woodpeckers (3)**	**Swift/hummingbird (1)**
House sparrow	Northern flickers	Ruby-throated hummingbird
Northern cardinal	Pileated woodpecker	
Northern mockingbird	Red-bellied woodpecker	

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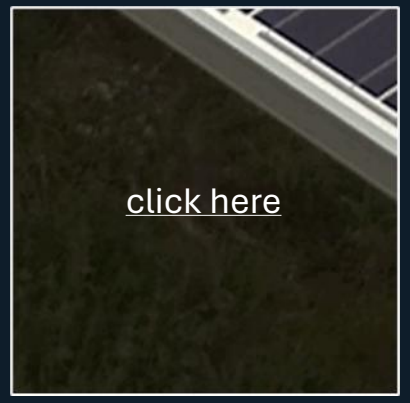
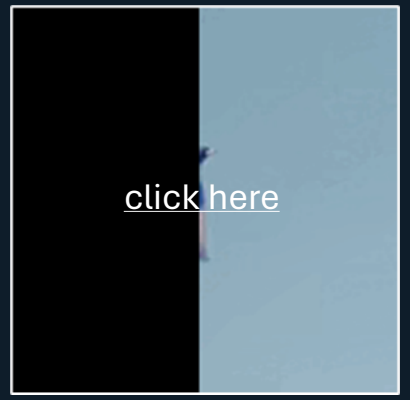
Results

6 Nesting Behaviors were Observed

Courtship or Copulation (n=1)	Carrying Nest Material (n=204)	Carrying Food (n=1913)	Carrying Fecal Sac (n=161)	Visiting Nest Site (n=221)	Pair in Suitable Habitat (n=128)
 click here	 click here	 click here	 click here	 click here	 click here
C	CN	CF	CS	N	P

- These behaviors can correspond to standardized breeding codes.

New York Breeding Bird Atlas III

https://ebird.org/atlasny/about/breeding-codes#confirmed

eBird

Results: Corresponding Pattern #1

EUST* was Dominant in Video & Survey

* EUST is a non-native species, not protected by the law. It is mentioned in this presentation as an example for a technology demonstration purpose.

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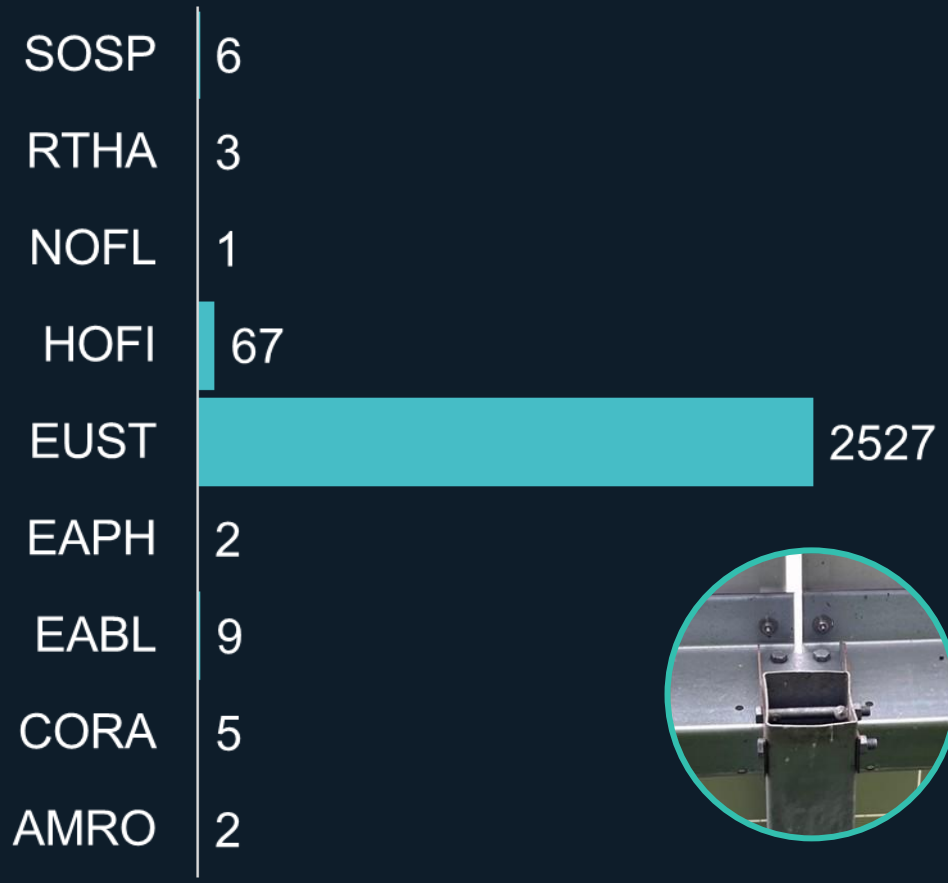
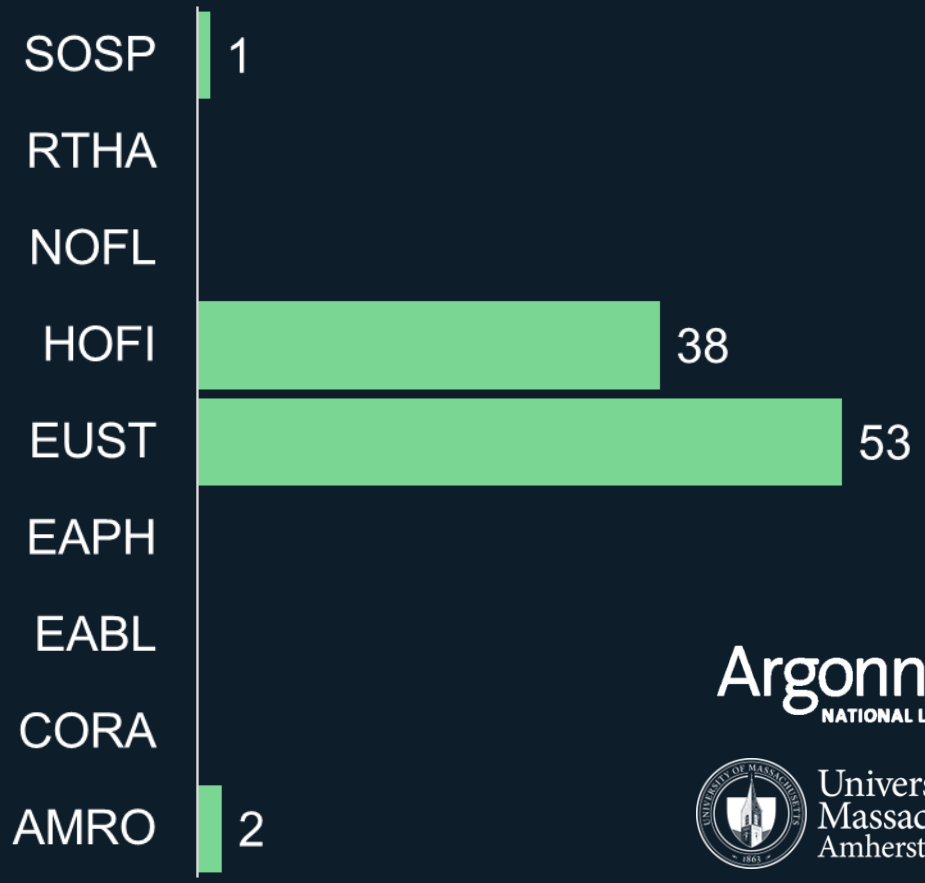
Nesting Behavior in Video (n=2628)



Nest in Field (n=96)



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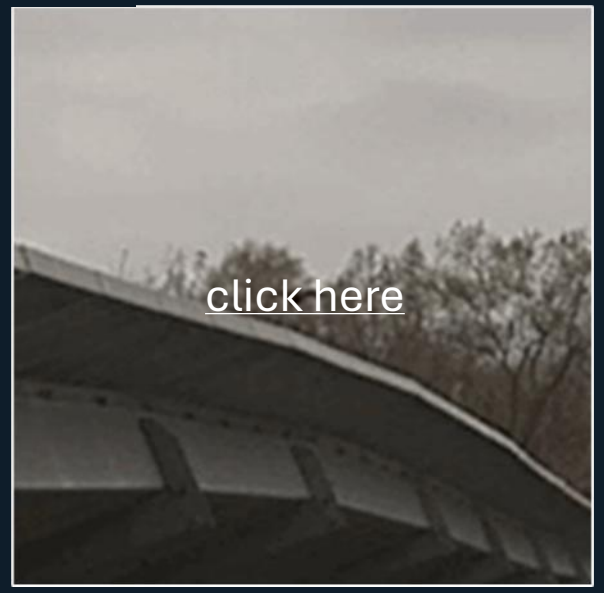
Results: Corresponding Patterns #2–#5

More Video-Survey Correlations

EUST

Carrying nest material peaked 1-2 weeks earlier than increase of carrying food and fecal sac.



Carrying food and fecal sac observed during nestlings audibly begging food in the field.

HOFI

Carrying nest material and observed pair spiked a week before observing nests with eggs.

Flying under panel frequently when chicks were seen in the nearest nest.

Takeaways

Potential for Ecovoltaic Evaluation

- Ability to observe ‘behavior by taxa’ (not all) would complement ‘state of nest’ observed by nest surveys.
- Nesting behavior in AI-assisted video observation could align with traditional nest survey data.
- Site characteristics and bird nesting patterns influence proper study design (e.g., site selection, camera placement)
- The method introduces minimal human disturbance.

Thank You

Contact: Yuki Hamada, yhamada@anl.gov

Funding

- U.S. Department of Energy, Solar Energy Technologies Office (DOE SETO) Award Number DE-EE0010382

Contribution

- Site access & Coordination – Steve Roof, Hampshire College
- Video (partial) – DOE SETO #41250 (Multi-regional avian-solar study)
- Software – DOE SETO #36473 (Avian-solar monitoring system R&D)
- Computational resource – Argonne Laboratory Computing Resource Center (LCRC), Argonne Leadership Computing Facility (ALCF)

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