KNOW THY ENEMY:
using drones to evaluate composition and size of nuisance blackbird flocks foraging in commercial sunflower.

The 46th Annual National Sunflower Association Research Forum
Fargo, ND

Jessica L. Duttenhefner
Dr. AbdElRahman (Ahmed) ElSaid
Dr. Timothy J. Greives
Dr. Page E. Klug

Presentation Outline

❀ **Background**

❀ **Study Area + Methods**

❀ **Results**

    Objective 1: Compare an automated count (i.e., ImageJ) to biologist counts.

    Objective 2: Apply a machine learning approach to detect and count blackbirds.

    Objective 3: Manually count and classify blackbirds by species, age, and sex to understand seasonal phenology.
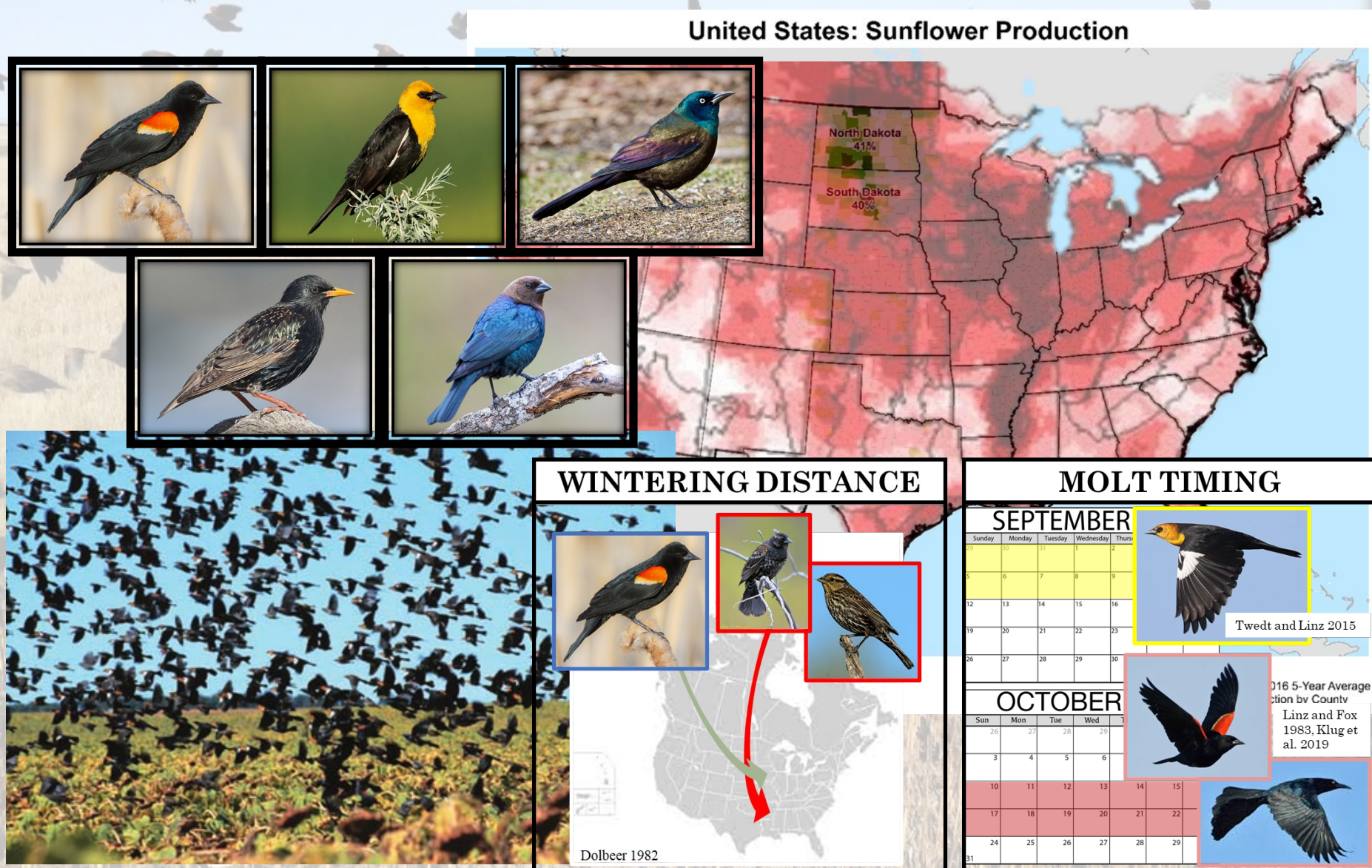
❀ **Summary**

❀ **Acknowledgements**

Presentation Outline

Flock composition is subject to change throughout the sunflower damage season

United States: Sunflower Production

North Dakota 41%

South Dakota 40%

WINTERING DISTANCE

Dolbeer 1982

MOLT TIMING

SEPTEMBER

Twedt and Linz 2015

OCTOBER

2016 5-Year Average ction by County

Linz and Fox 1983, Klug et al. 2019

Drones enter the wildlife research scene

Drones applied to wildlife ecology:
• monitor wildlife
• evaluate behavior
• estimate population sizes

Drones applied to human-wildlife conflict scenarios:
• estimate wildlife damage to crops
• haze nuisance species

Applying AI to facilitate:
• detection
• counting
• classification
of wildlife

Linchant et.al. 2015

Nieuki

Afan et al. 2018

Lhoest et.al. 2015

Weissenstei

Egan et.al. 2023

Lenzi et.al.

White 202

Fischer et.al. 2019

Adult

Ghost

Rey et.al.

Hodgeson et.al. 2016

Hodgeson et.al. 2018

Witczuk et.al. 2017

Research Objectives

- How does an automated count method (i.e. ImageJ)
  compare to biologist counts?

- Can an A.I.-based detection model be developed to count
  blackbirds?

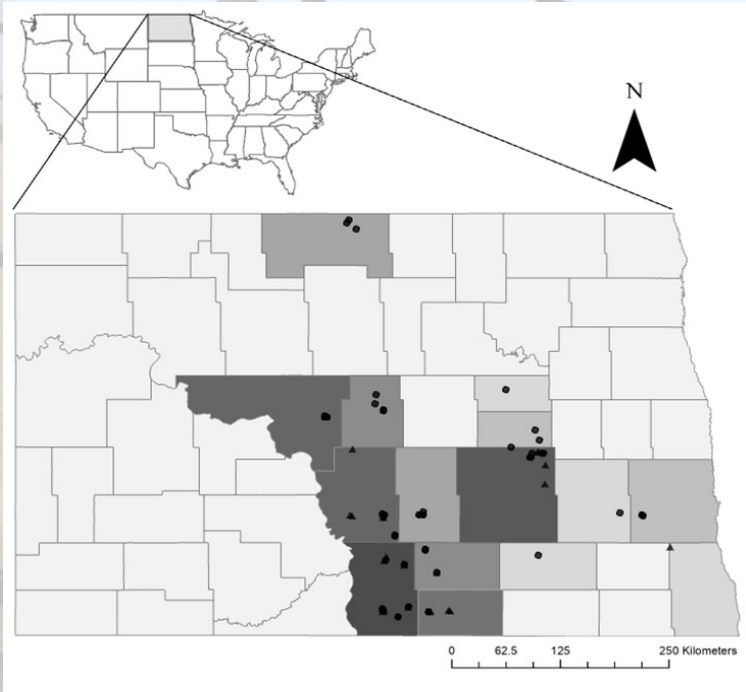- How does flock composition change throughout the sunflower damage season?

Presentation Outline

We operated two drones to capture blackbird footage in commercial sunflower and adjacent cattail throughout ND

DJI Mavic Air II:
- Aggressor drone
- Collects composition footage

DJI Mavic Pro:
- Stationary drone
- Collects flock size footage

Study Sites:
- Commercial sunflower fields and adjacent cattail in ND
- September – October
  - Following spray trial (n=57)
  - ▲ Standalone (n=27)

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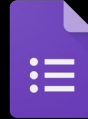❀ **Acknowledgements**

How does an automated count method (i.e. ImageJ) compare to biologist counts?

x60

MANUAL

Estimating blackbird flock sizes

jessica.duttenhefner@ndsu.edu (not shared) Switch account

* Required

How many years of experience do you have estimating bird flocks? *

- Self-reported experience ranged from 0–25 yrs.
- Instructed to:
  - Provide estimates for all 60 video frames in a single sitting
  - Make quick estimates (5-10 seconds/photo)
  - Limit their count to birds within the sky background
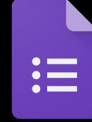 - Zoom in on photos when needed

AUTOMATED

Biologists are highly variable in estimating flock sizes

AUTOMATED

Ranged from
57-6,272 birds
(1,489 ± 1,374)
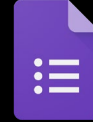
MANUAL

Ranged from
25-50,000 birds
(1,138 ± 2,303)

Spearman correlation
R = 0.94, p < 0.001

Avg. Biologist Estimation (y-axis: 0, 1000, 2000, 3000, 4000, 5000)

Automated Estimation (x-axis: 0, 2000, 4000, 6000)
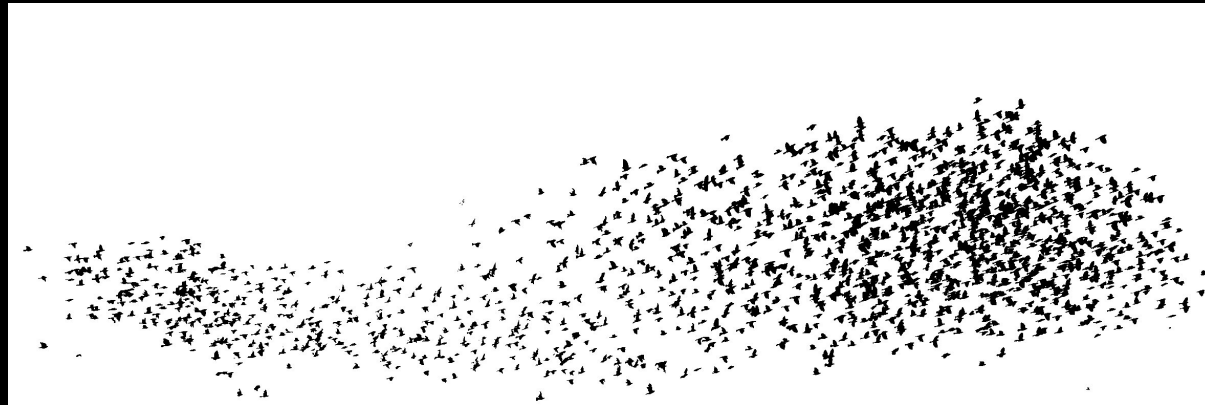
RESULTS: ◆ *AUTOMATED COUNT* ◆ *A.I. MODEL* ◆ *COMPOSITION*

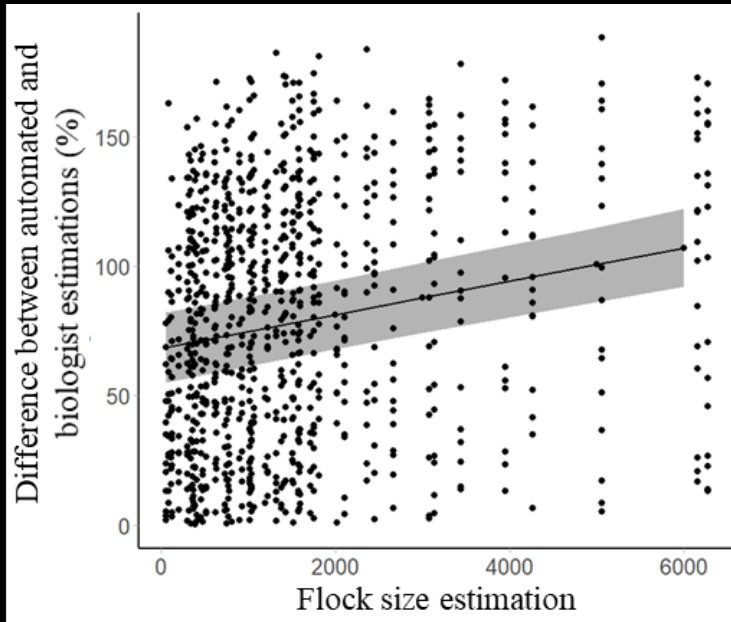# Biologists are highly variable in estimating flock sizes
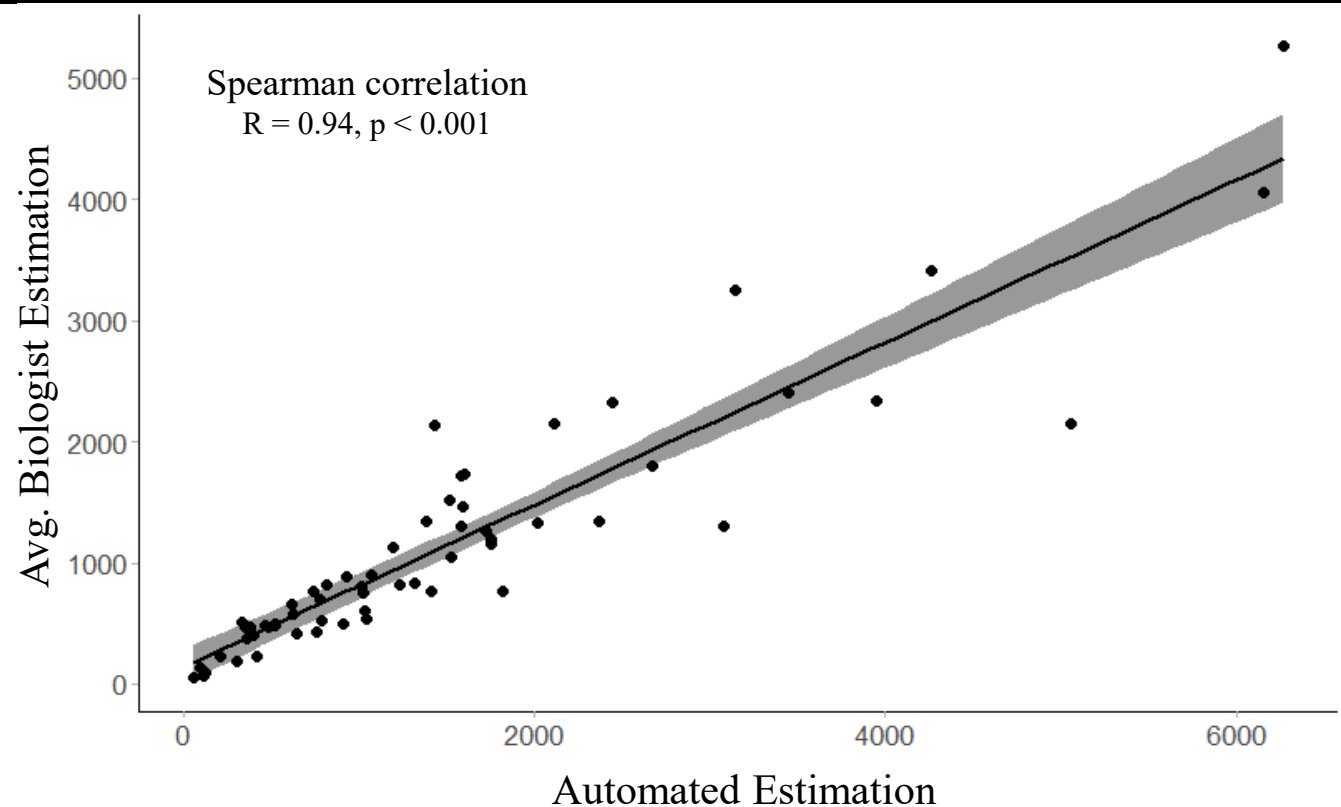
AUTOMATED

Ranged from
57-6,272 birds
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MANUAL

Ranged from
25-50,000 birds
(1,138 ± 2,303)

LMM = % difference ~ flock size + experience + photo order + (1|biologist)
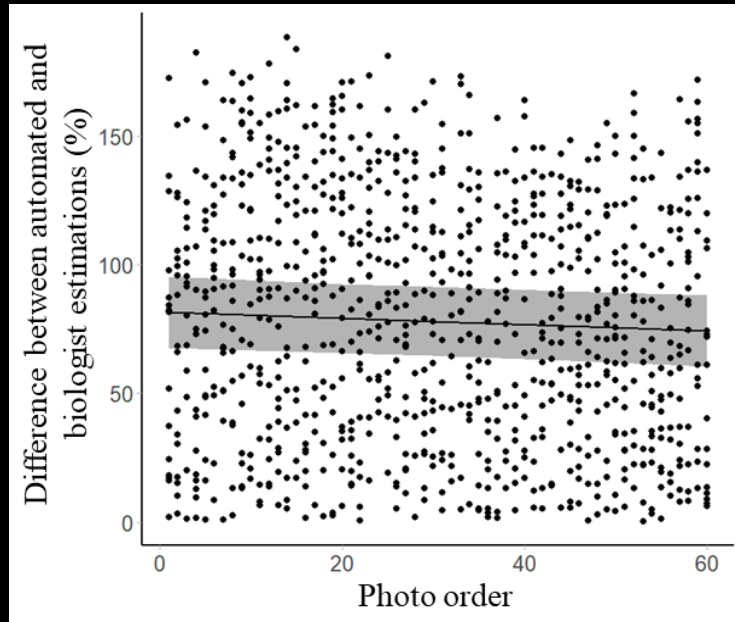
LINEAR MIXED MODEL			
Fixed Effects	Estimate	SE	t
Flock size	0.006	$7.66e^{-4}$	**8.445**
Photo order	-0.122	0.06	**-2.011**
Experience	-0.292	0.80	-0.365

Random Effects	Variance	SD
Biologist ID	906.6	30.11
Residual	1149.8	33.91

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Can an A.I.-based detection model be developed to count blackbirds?

Applying Machine Learning

STEP 1: IMAGE ACQUISITION

STEP 2: IMAGE LABELLING

LabelImg

Applying Machine Learning

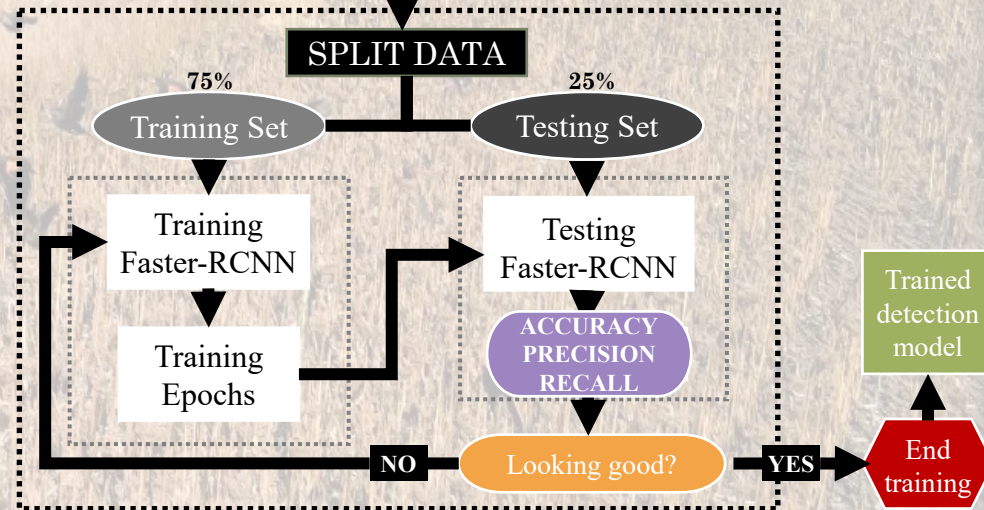9 video frames labelled per 10-day interval:

Sept 1 – October 30
54 video frames total

Applying Machine Learning

STEP 1: IMAGE ACQUISITION

STEP 2: IMAGE LABELLING

LabelImg

SPLIT DATA

75% — Training Set

25% — Testing Set

Training Faster-RCNN

Testing Faster-RCNN
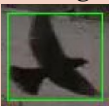
Training Epochs

ACCURACY PRECISION RECALL

Looking good?

NO · YES

End training
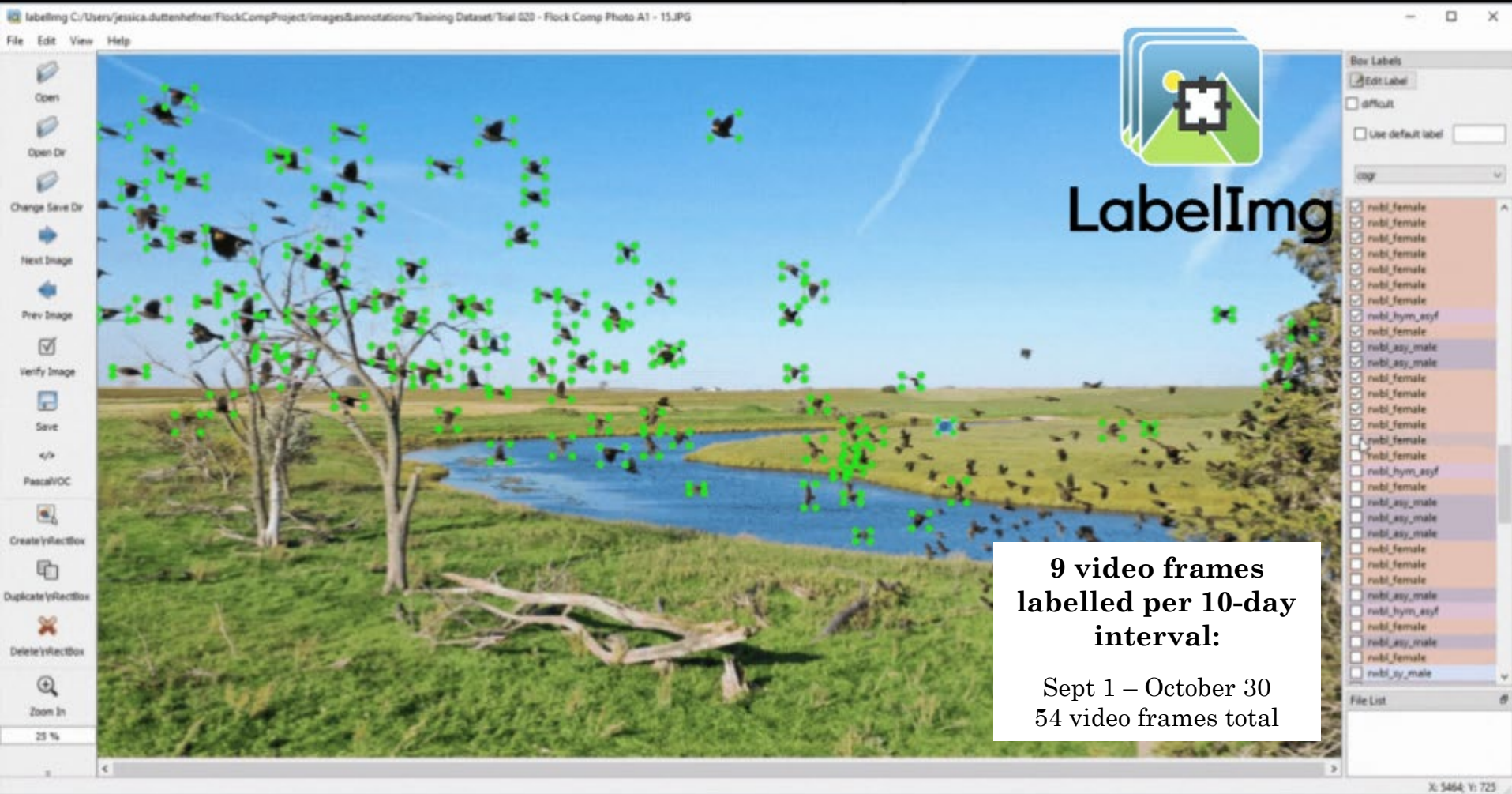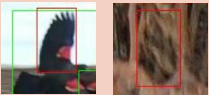
Trained detection model

The performance of a detection model is limited in this study system

	MANUAL (JLD)	
	BIRD	**NOT A BIRD**
BIRD	True Positive	False Positive
NOT A BIRD	False Negative	True Negative

FASTER RCNN

$$Accuracy = \frac{true\ positives}{true\ positives + false\ positives + false\ negatives}$$

$$Precision = \frac{true\ positives}{true\ positives + false\ positives}$$

$$Recall = \frac{true\ positives}{true\ positives + false\ negatives}$$

ACCURACY 25.4%

PRECISION 86.3%

RECALL 26.4%

LIMITATIONS

COLOR CONTRAST   BIRD SHAPE   IMAGE QUALITY   DEPTH PERCEPTION

LIMITATIONS
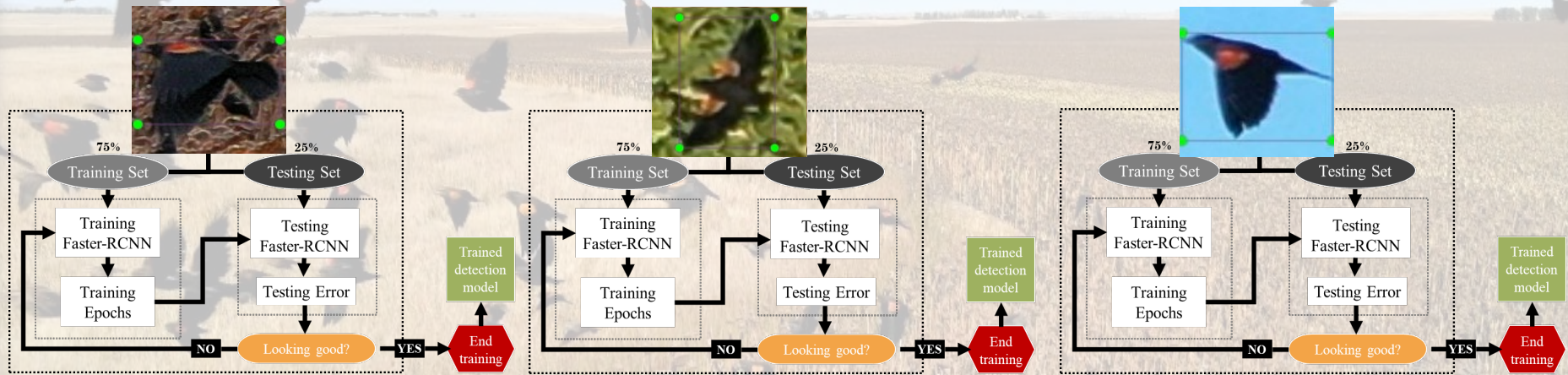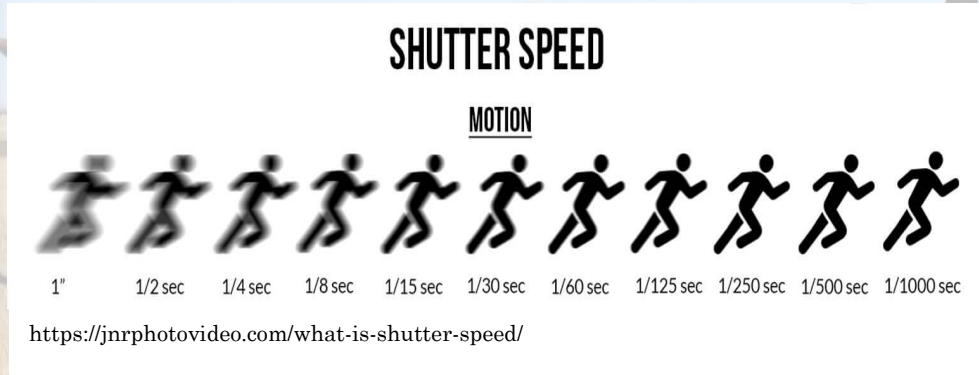
COLOR CONTRAST

BIRD SHAPE

IMAGE QUALITY

DEPTH PERCEPTION

RESULTS: ♦ *AUTOMATED COUNT* ♦ *A.I. MODEL* ♦ *COMPOSITION*

Not a lost cause: Future steps to improve the detection model

SHUTTER SPEED

MOTION

1"   1/2 sec   1/4 sec   1/8 sec   1/15 sec   1/30 sec   1/60 sec   1/125 sec   1/250 sec   1/500 sec   1/1000 sec

https://jnrphotovideo.com/what-is-shutter-speed/

LIMITATIONS

COLOR CONTRAST   BIRD SHAPE   IMAGE QUALITY   DEPTH PERCEPTION

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✿ **Summary**

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How does flock composition change throughout the sunflower damage season?

Determining flock composition of mixed-species blackbird flocks

Determining flock composition of mixed-species blackbird flocks
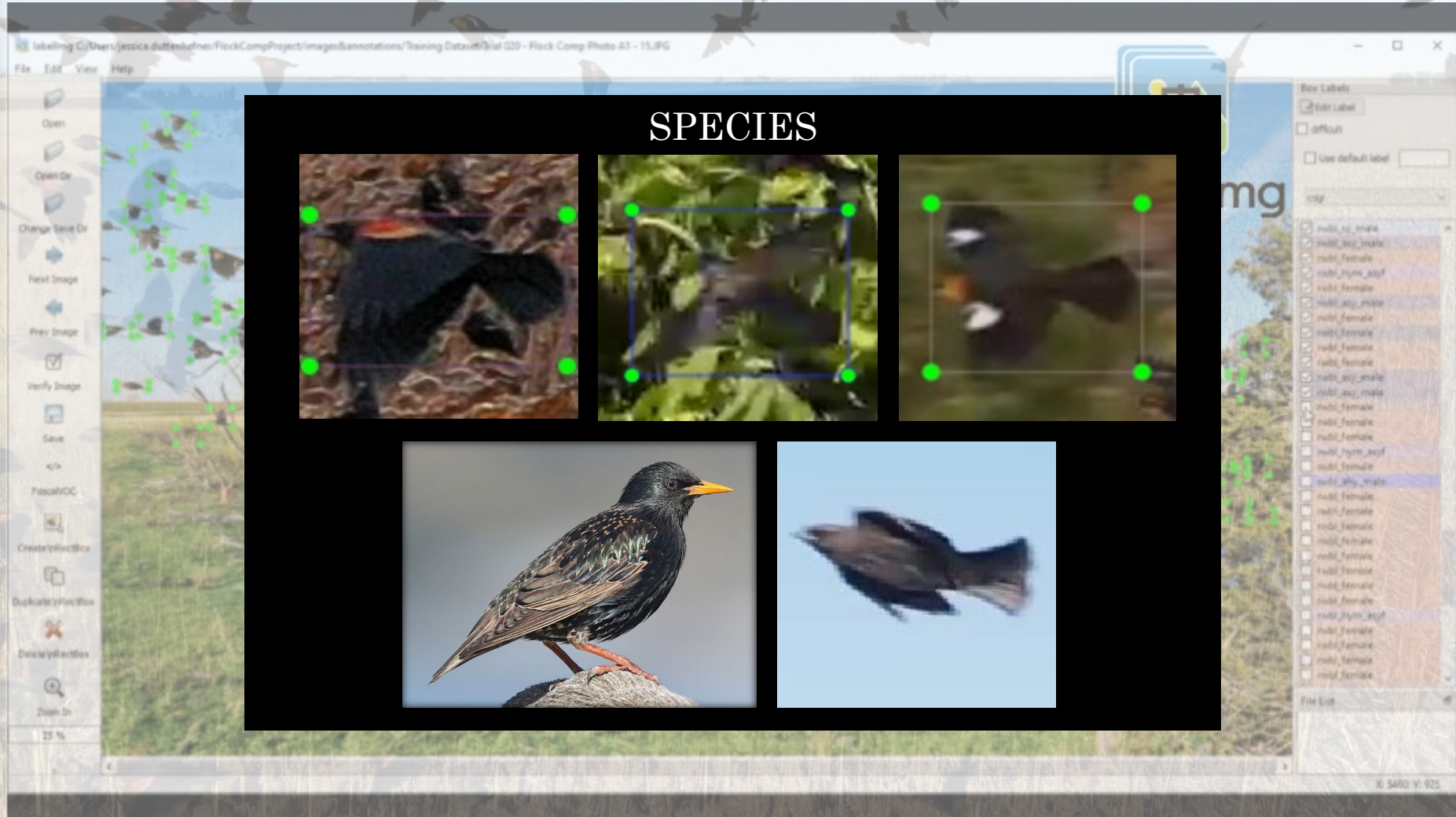
SEX & AGE

AHY+ males

HY males
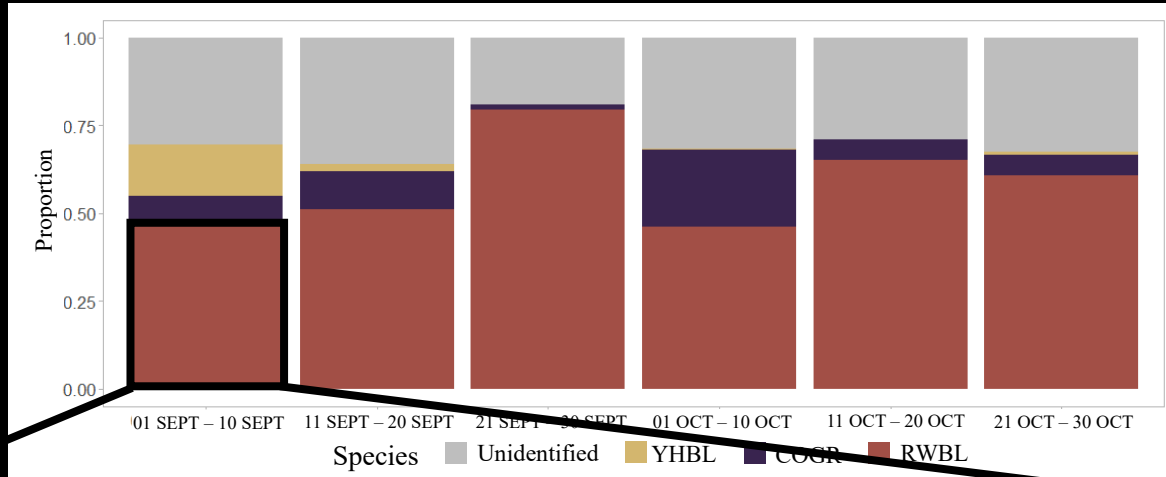
AHY+ and HY females

Our observations are consistent with the migration timing hypothesis, but not wintering distance
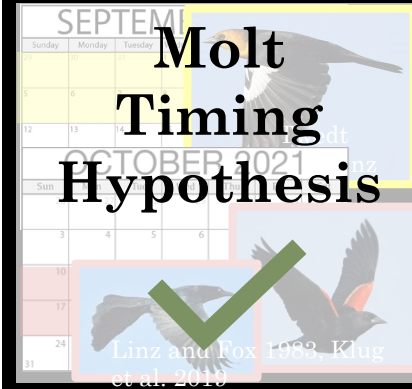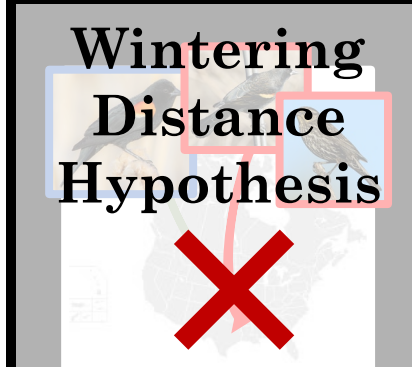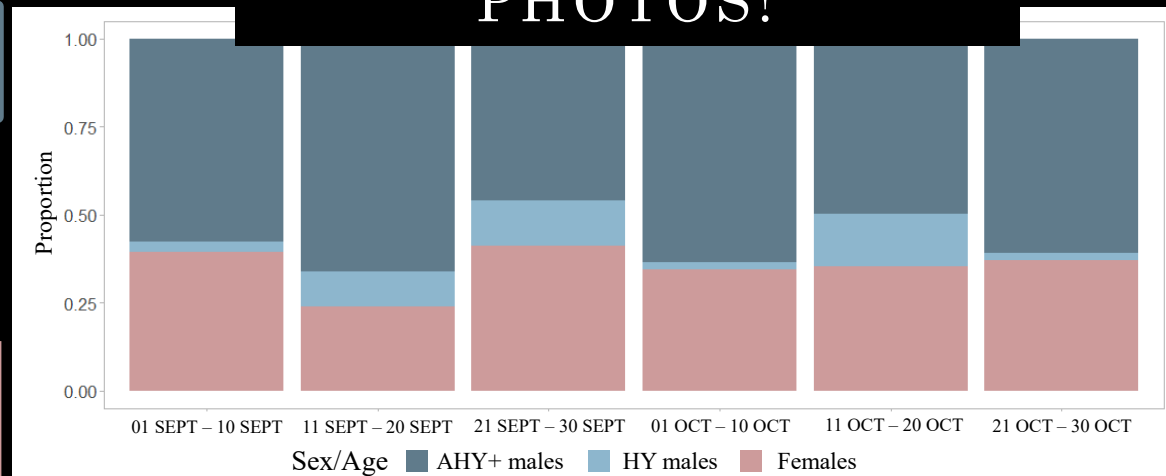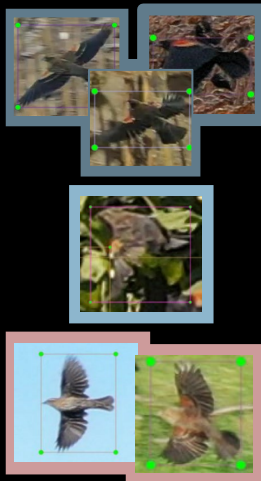
Molt Timing Hypothesis

Wintering Distance Hypothesis

ANALYZE MORE PHOTOS!

Presentation Outline

Technological advancements will continue to make drones more efficient

This research has taken important steps in:
- Identifying limitations
- Determining the feasibility of developing an AI detection model

<u>Future Implications:</u>

The development of fully autonomous bird control system to:

- Decrease the bird damage
- Decrease the cost and labor involved in protecting their livelihoods

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THANK YOU!

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- Dr. David Kramar

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- Michelle Stagl
- Jackie Harrison

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- Heidinger & Greives Lab

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Sunflower Producers

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- National Sunflower Association
- USDA-APHIS-WS-NWRC

NDSU NORTH DAKOTA STATE UNIVERSITY

National Sunflower ASSOCIATION

USDA Wildlife Services NWRC National Wildlife Research Center

Looking for some light reading? Check out my full thesis here!