Spraying Drones:

Efficacy of applying an avian repellent to elicit blackbird flock dispersion in commercial sunflower fields.

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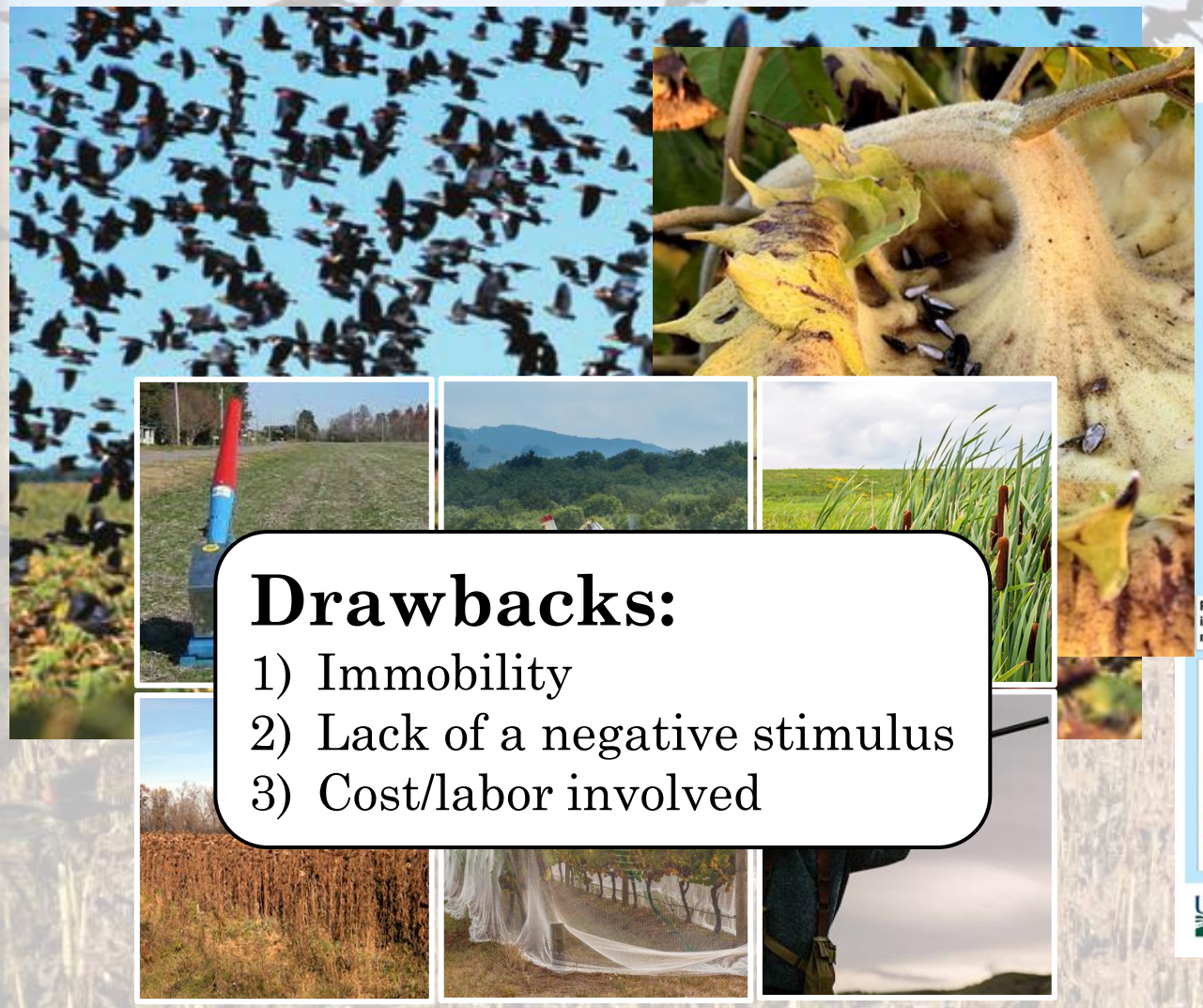
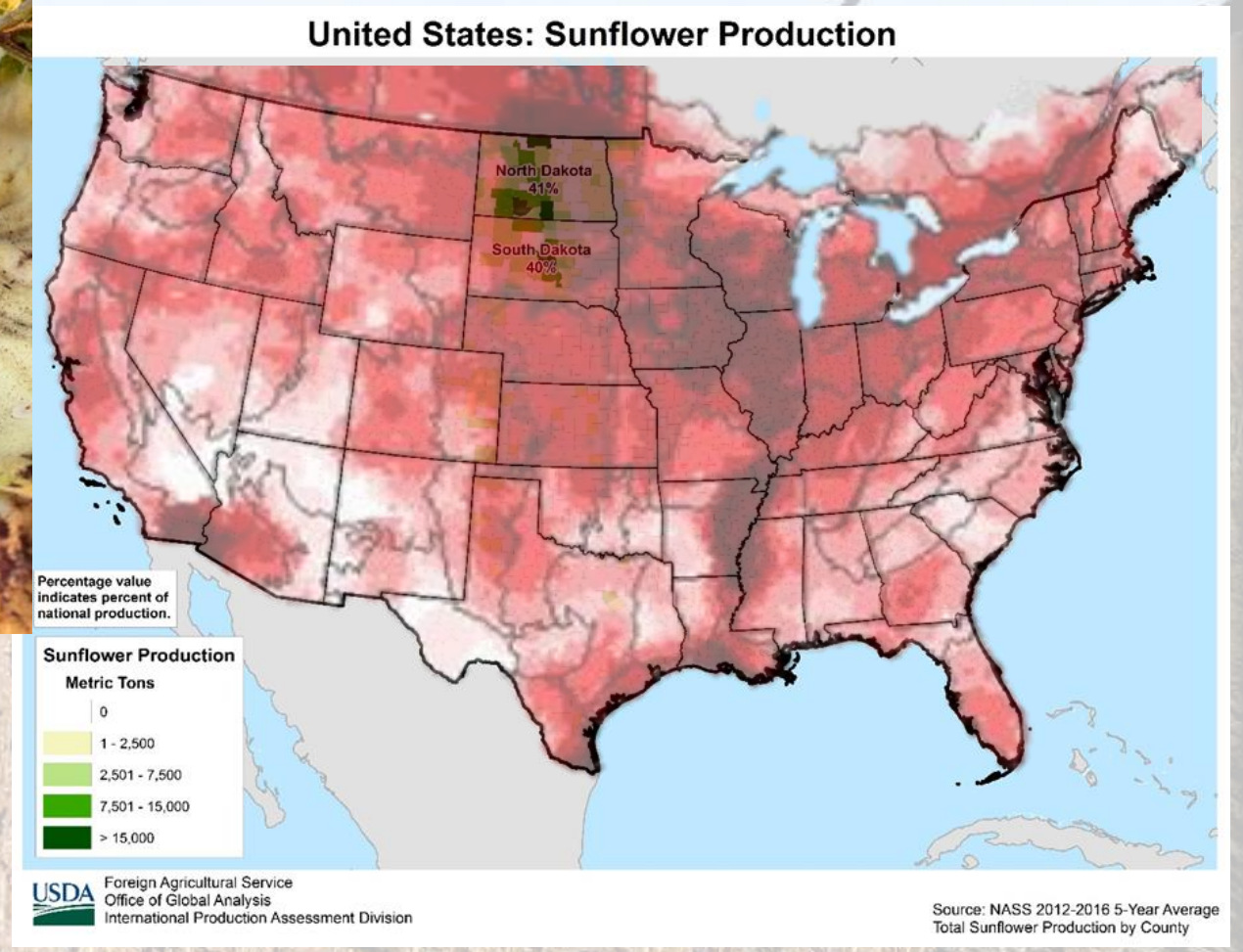
Blackbirds cause extensive damage to sunflower



Drawbacks:

1) Immobility
2) Lack of a negative stimulus
3) Cost/labor involved



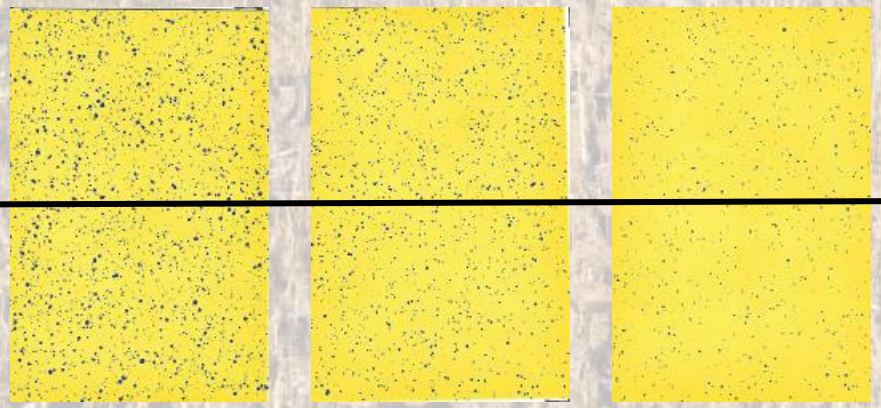
Adapting drone technology to combat bird damage

+

AVG. FLIGHT INITATION DISTANCE

39.9 M (± 14.3 M)

(White, 2021)



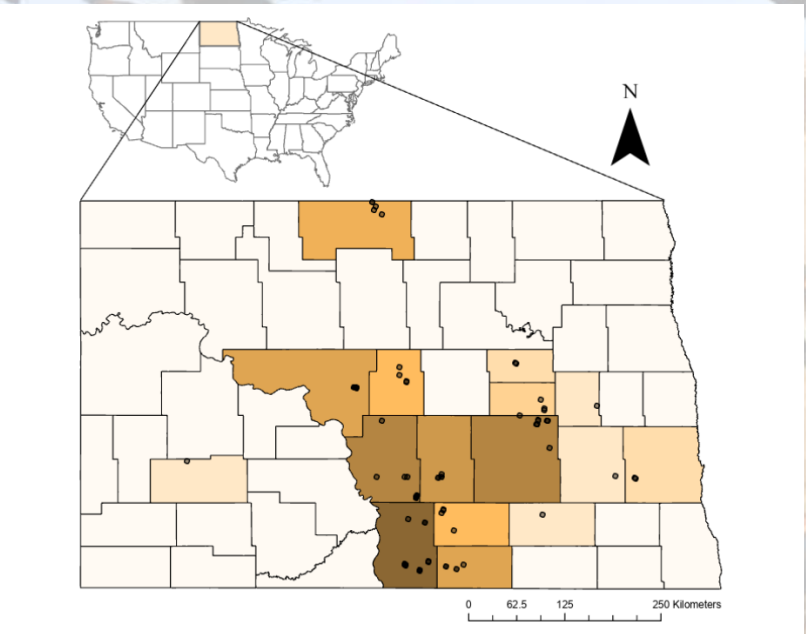
When operating the drone 15 M AGL, spray was detected as far as ~ 50 M downwind of the drone.

Study Objective

Main Objective:

Assess the effectiveness of this integrated method to elicit flock reductions or field abandonment by blackbirds foraging in commercial sunflower.

Study Site, UAS Platforms, & Behavioral Metrics



Study Sites:
- Commercial sunflower fields in ND
- September – October
- Presence of actively foraging blackbirds

UAS Platform:
DJI Agras MG-1P
- Spraying drone with a 10L spray tank
- ~10 min battery (full tank)

Flock Metrics:
- Pre-trial, During and Post-trial
- Flock size estimation
- Flock behavior
  - Number of flock lift-offs/min
  - Flock flight duration

Study Design

Trials length = 8 minutes

2 treatments:

- Avian repellent application
- Water application

Avian Control®:

- Only avian repellent currently registered for foliar application near harvest.
- Contains methyl anthranilate **(MA)**
- Primary chemical repellent
- Chemically noxious stimuli response

Avian Control™

Bird Repellent

Avian Control™ is formulated with food grade ingredients.

For Commercial and Agricultural Use:
To be used on Agricultural Commodities (Pome Fruit, Stone Fruit, Berry and Small Fruit, Cereal Grains) and Non-Agricultural Sites including Turf, Hydroseeding, Landfills, Non-fish bearing bodies of water, Buildings and Structures.

KEEP OUT OF REACH OF CHILDREN
CAUTION

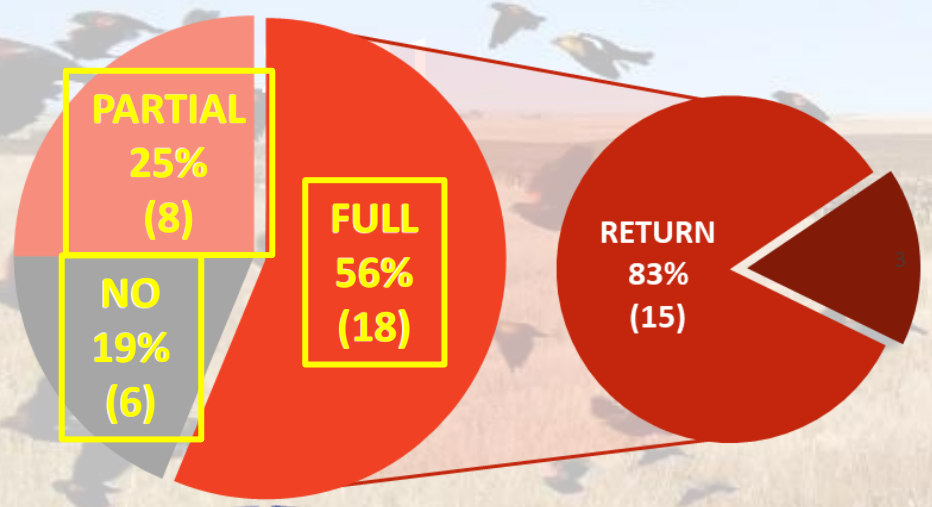
ACTIVE INGREDIENT	
Methyl Anthranilate (MA), methyl 2-aminobenzoate	20.0%
OTHER INGREDIENTS	80.0%
Total	100.0%

This product contains 1.65 pounds of Methyl Anthranilate per gallon of product.

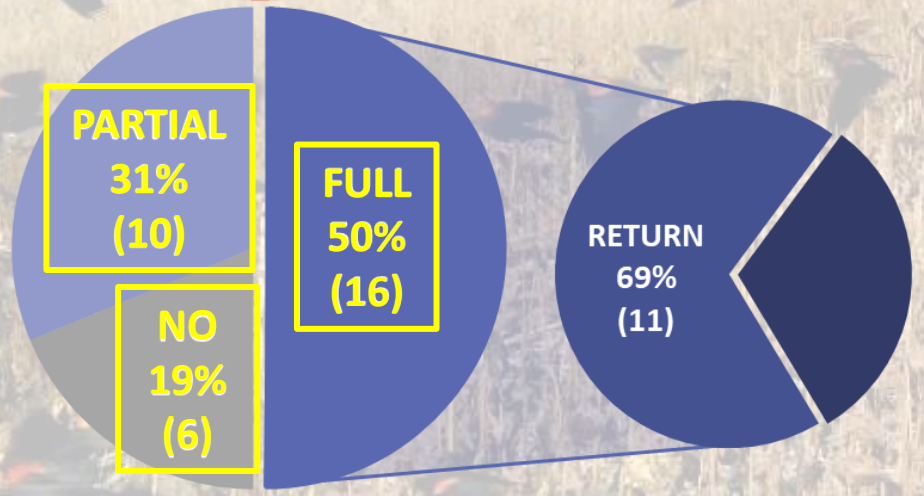
EPA REG. No. 88889-1
EPA EST. No. 33162-MI-01

Field Abandonment and Return Rates

Bird repellent (MA)

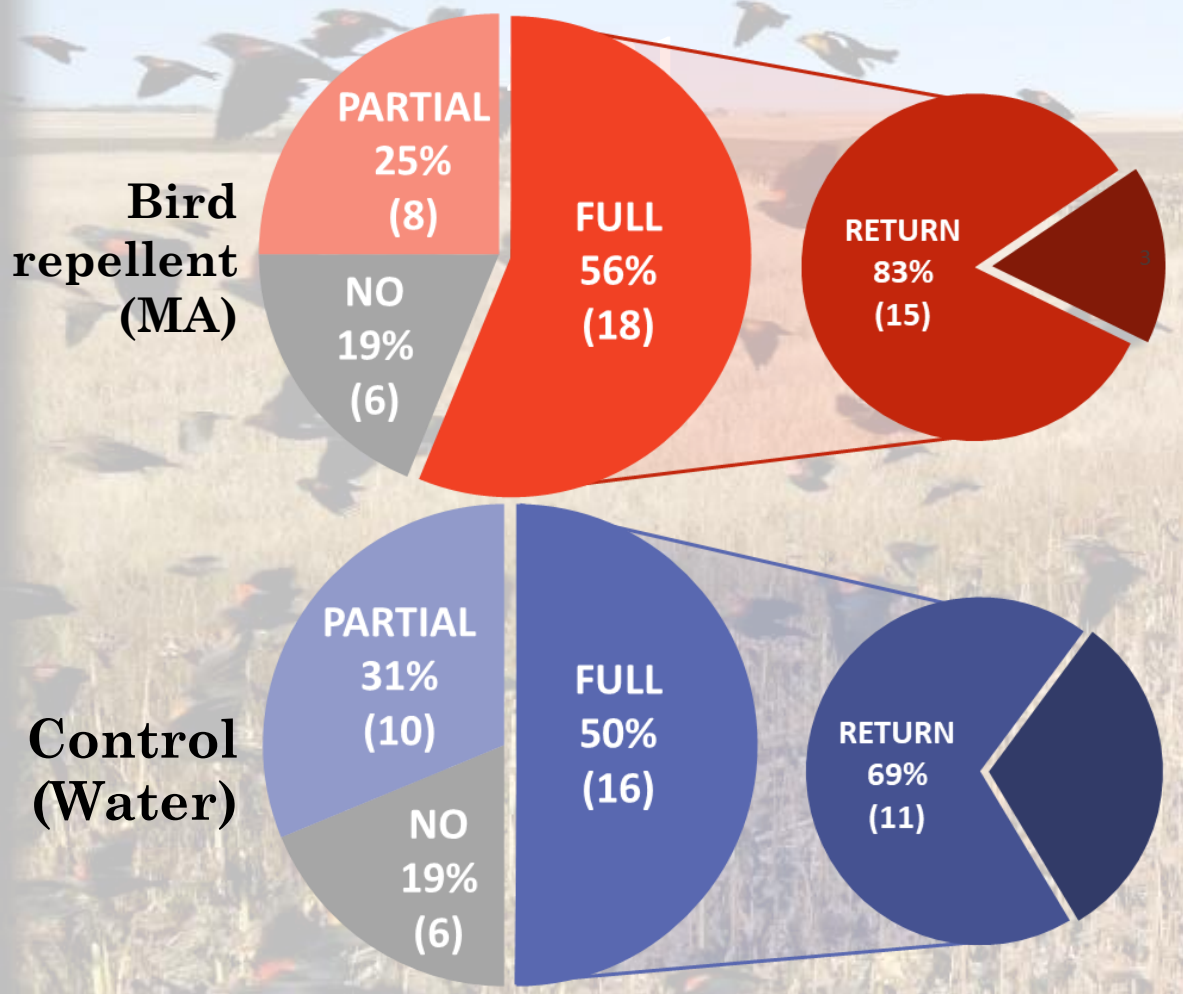


Control (Water)



Total trials = 64;
MA trials = 32 and water trials =32

Field Abandonment and Return Rates



Total trials = 64;
MA trials = 32 and water trials =32

OBJECTIVE 1: What factors influence field abandonment of blackbird flocks?

OBJECTIVE 2: Are there behavioral differences before, during & after the trial?

OBJECTIVE 3: What factors influence behavior during the 8 min trial?

OBJECTIVE 4: What influences reductions in flock size?

OBJECTIVE 5: What influences flock latency to return?

OBJECTIVE 1: Birds closer to the field edge are more likely to abandon.

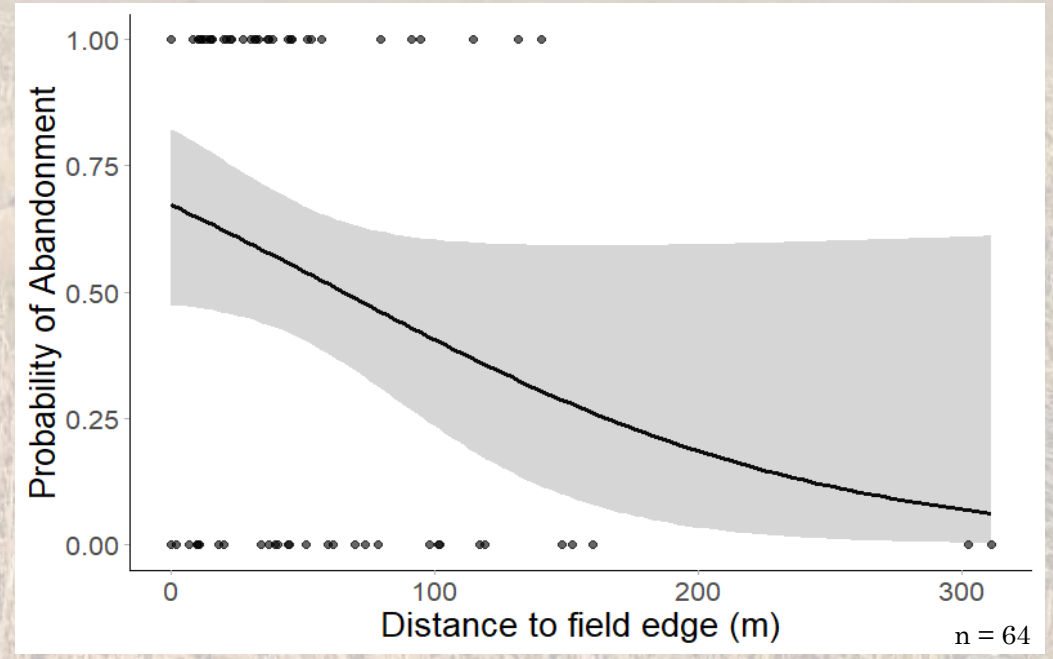
Covariates:
Environment Flock Metric UAS

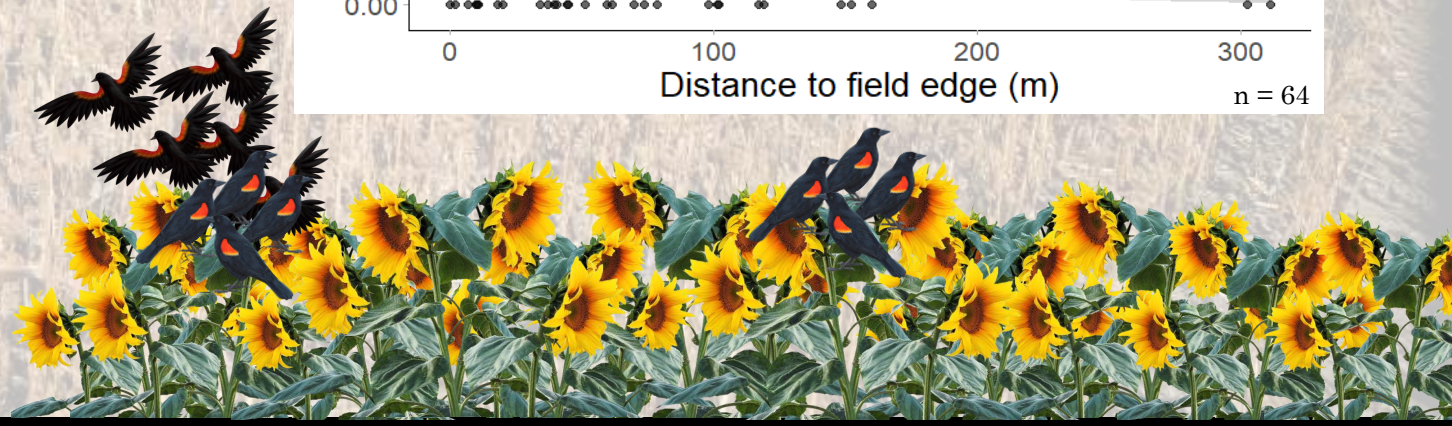
FULL MODEL	AIC (98.71)
Julian day	96.973
Avg. wind speed	97.113
Closest tree patch	97.195
Distance to launch site	97.255
Avg. drone speed	97.749
Treatment	97.839
Year	97.871
Temperature	97.995
Sunflower field size	98.077
Ambient light	**98.906**
Lift-offs per minute	99.590
Area of adjacent cattail	100.072
Est. flock size	**101.211**
Distance to field edge	**102.954**

Optimal model:
glm(Field abandonment ~ Est. flock size + Distance to field edge + Ambient light)

OPTIMAL MODEL	p = 0.012
Distance to field edge	**0.047**
Ambient light	0.137
Est. flock size	0.157

Success = Target flock abandons sunflower



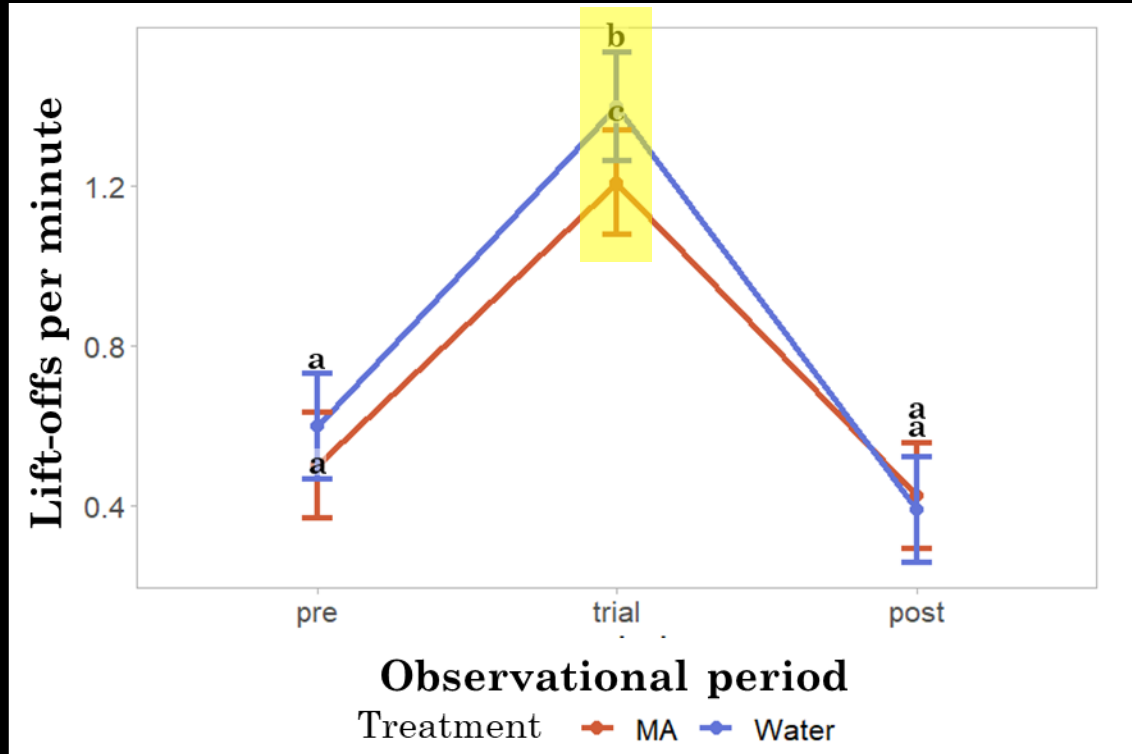


OBJECTIVE 2: Flock behavior changes when exposed to drone hazing.

LIFT-OFFS PER MINUTE

2-WAY ANCOVA

Significant effect of period: F = 57.65, df= 2,184 , p <0.001

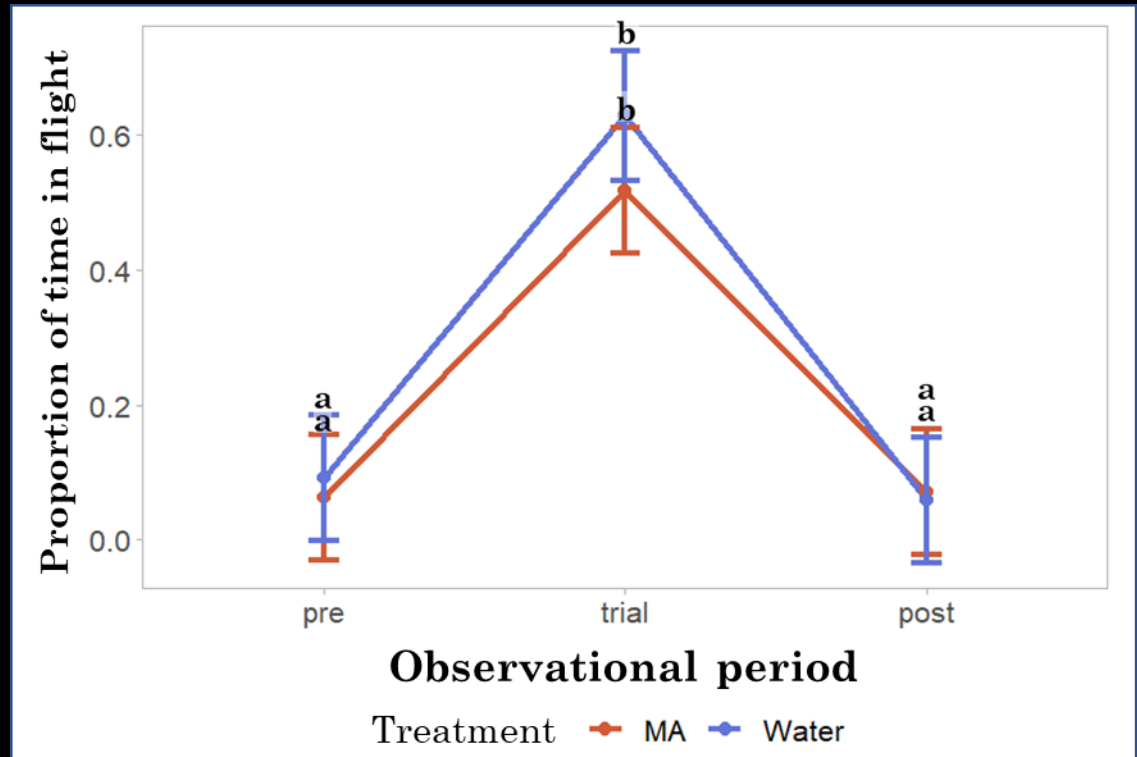


Pwc: emmeans, p.adjust -= bonferroni

PROPORTION OF TIME IN FLIGHT

2-WAY ANCOVA

Significant effect of period: F = 74.212, df= 2,183 , p <0.001



Pwc: emmeans, p.adjust -= bonferroni

OBJECTIVE 3: Flock lift-offs is best predicted by year and julian day

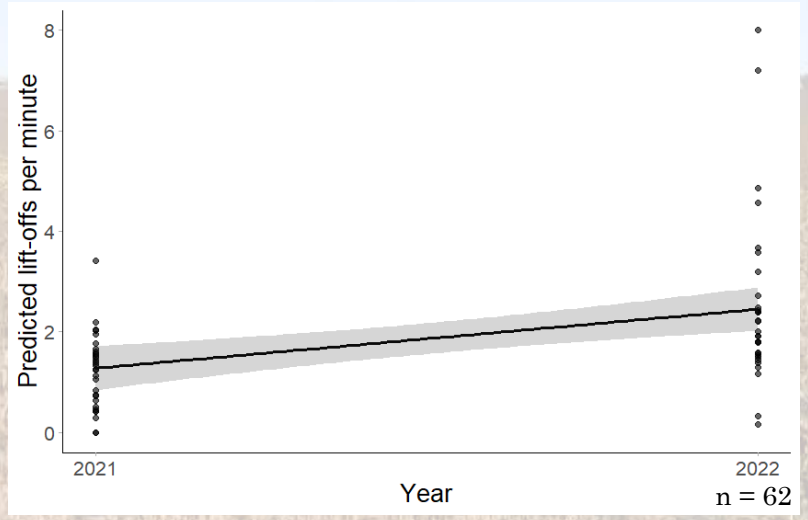
Covariates:
Environment | Flock Metric | UAS

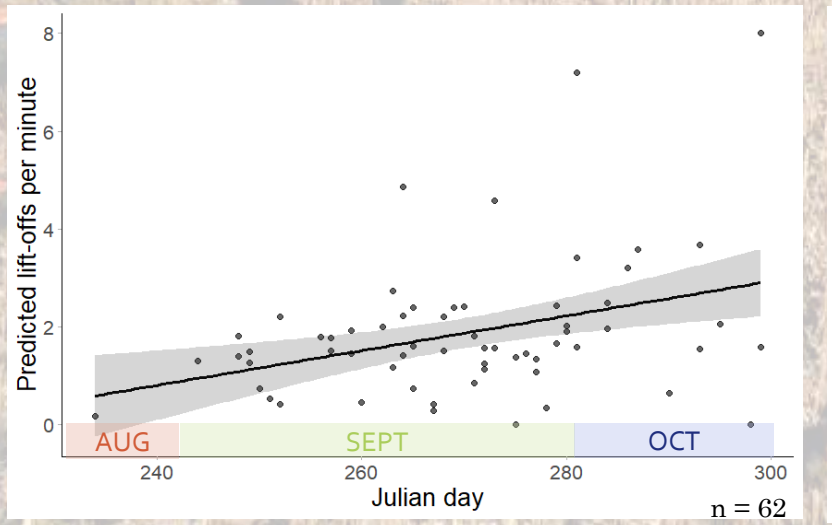
FULL MODEL	AIC (44.18)
Julian day	**49.543**
Avg. wind speed	42.205
Closest tree patch	43.267
Distance to launch site	**49.543**
Avg. drone speed	42.225
Treatment	42.203
Year	**50.061**
Temperature	42.272
Sunflower field size	43.459
Ambient light	42.369
Lift-offs per minute	43.998
Area of adjacent cattail	42.513
Est. flock size	42.190
Distance to field edge	42.185

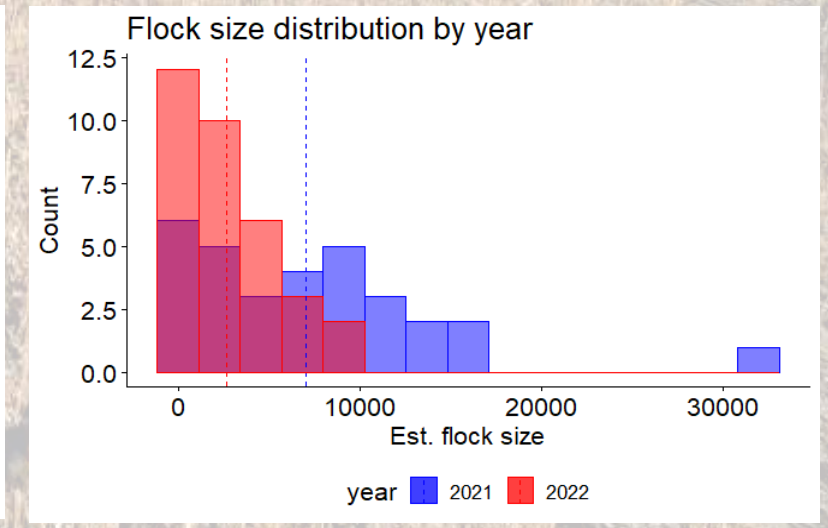
Optimal model:
lm(Trial lift-offs per minute ~ Year + Julian day + Distance to launch site)

OPTIMAL MODEL	p <0.001
Year	**<0.001**
Julian day	**0.001**
Distance to launch site	0.055

Number of flock
LIFT OFFS/MIN
during the 8-min trial







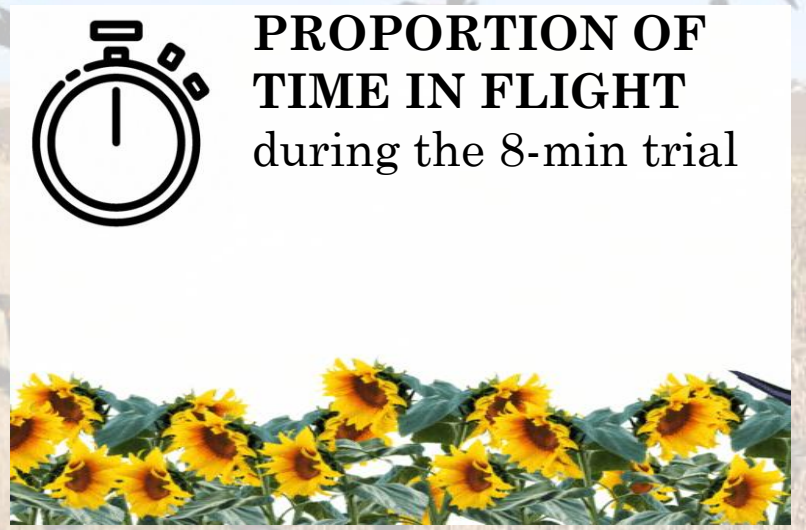
OBJECTIVE 3: Flock time in flight is best predicted by julian day.

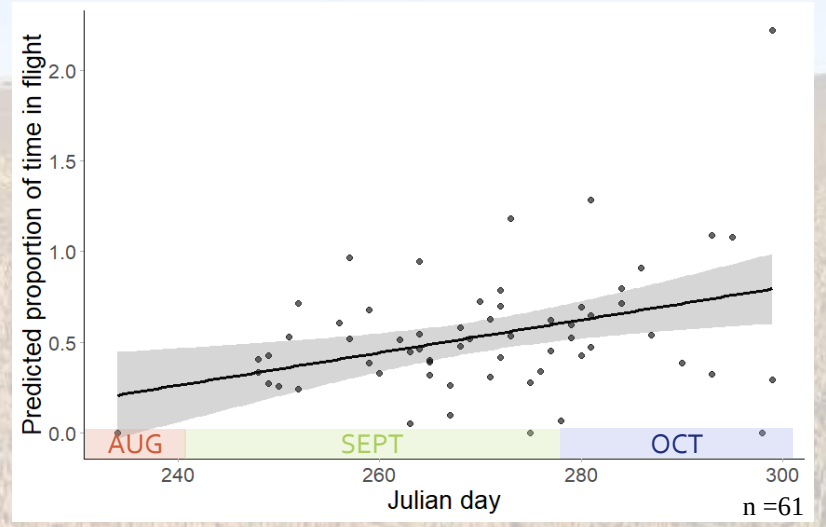
Covariates:
Environment | Flock Metric | UAS

FULL MODEL	AIC (-114.61)
Julian day	-111.40
Avg. wind speed	-116.21
Closest tree patch	-114.78
Distance to launch site	113.11
Avg. drone speed	115.98
Treatment	-116.37
Year	-114.23
Temperature	-116.45
Sunflower field size	-116.42
Ambient light	-116.33
Lift-offs per minute	-115.76
Area of adjacent cattail	-116.35
Est. flock size	115.35
Distance to field edge	-116.52

Optimal model:
lm(trial proportion of time in flight ~ Julian day + Distance to launch site)

OPTIMAL MODEL	p = 0.006
Julian day	**0.004**
Distance to launch site	0.156





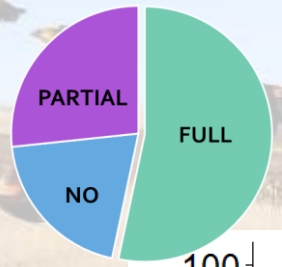
OBJECTIVE 4: Flock size reductions are best predicted by the distance to edge, wind speed, year and cattail area

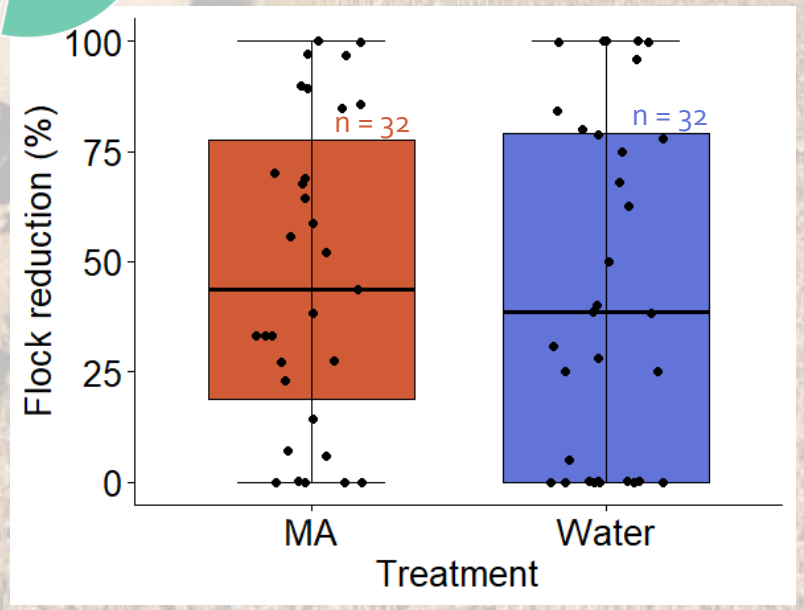
Covariates:
Environment | Flock Metric | UAS

FULL MODEL	AIC (452.15)
Julian day	450.65
Avg. wind speed	**459.10**
Closest tree patch	450.49
Distance to launch site	**451.19**
Avg. drone speed	450.20
Treatment	450.47
Year	**453.66**
Temperature	450.37
Sunflower field size	450.64
Ambient light	**452.82**
Pre-trial lift-offs per minute	452.10
Area of adjacent cattail	**455.99**
Est. flock size	450.48
Distance to field edge	**460.82**

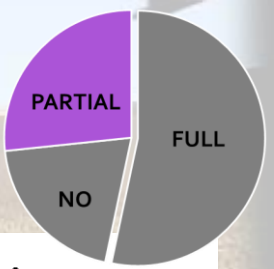
Optimal model:
lm(Flock reduction ~ Distance to launch site + Ambient light + Area of adjacent cattail + Year + Avg. wind speed + Distance to field edge)

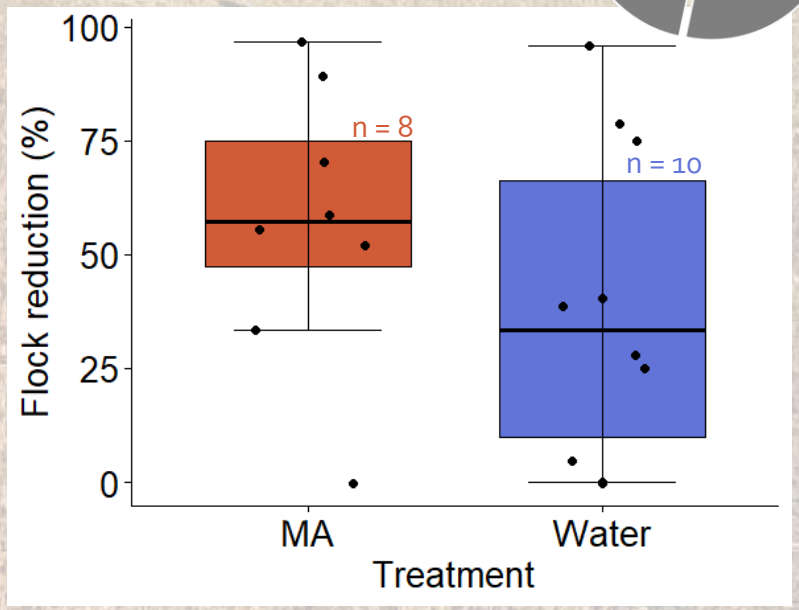
OPTIMAL MODEL	p = 0.001
Distance to field edge	**0.002**
Avg. wind speed	**0.009**
Year	**0.026**
Area of adjacent cattail	**0.028**
Ambient light	0.051
Distance to launch site	0.114





Average decline was **47±6%** for MA and **43±7%** for water.





Average decline was **56±10%** for MA and **38±10%** for water.

OBJECTIVE 4: Flock size reductions are best predicted by the distance to edge, wind speed, year and cattail area

Covariates:

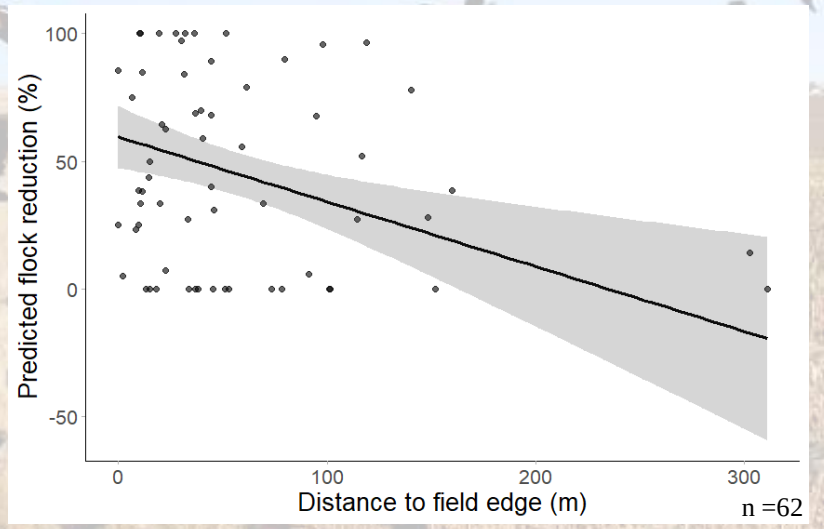
Environment | Flock Metric | UAS

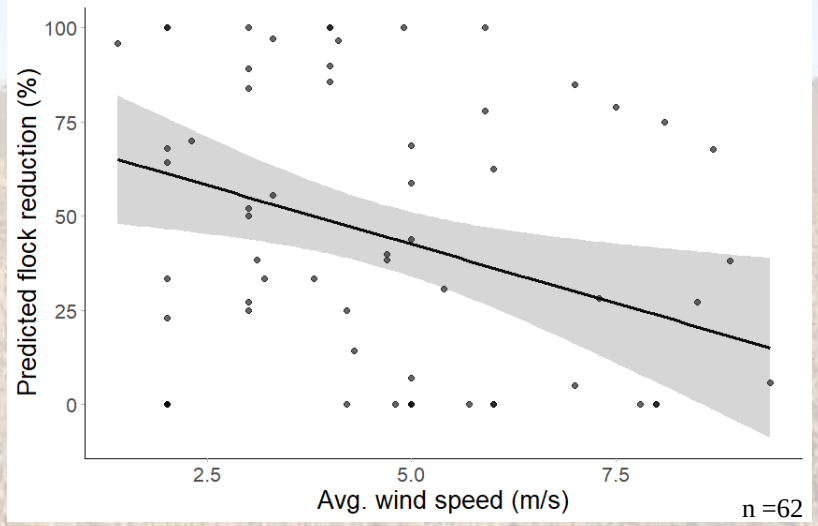
FULL MODEL	AIC (452.15)
Julian day	450.65
Avg. wind speed	**459.10**
Closest tree patch	450.49
Distance to launch site	**451.19**
Avg. drone speed	450.20
Treatment	450.47
Year	**453.66**
Temperature	450.37
Sunflower field size	450.64
Ambient light	**452.82**
Pre-trial lift-offs per minute	452.10
Area of adjacent cattail	**455.99**
Est. flock size	450.48
Distance to field edge	**460.82**

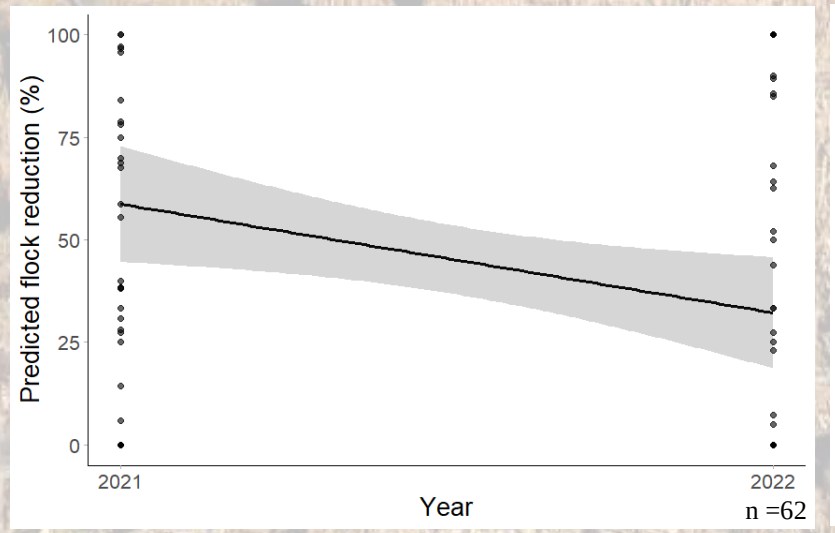
Optimal model:

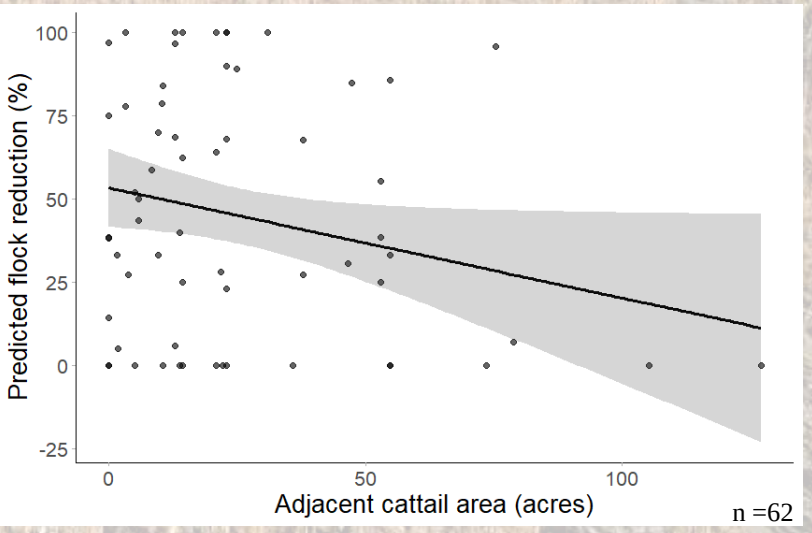
lm(Flock reduction ~ Distance to launch site + Ambient light + Area of adjacent cattail + Year + Avg. wind speed + Distance to field edge)

OPTIMAL MODEL	p = 0.001
Distance to field edge	**0.002**
Avg. wind speed	**0.009**
Year	**0.026**
Area of adjacent cattail	**0.028**
Ambient light	0.051
Distance to launch site	0.114









OBJECTIVE 5: Latency to return to the field is best predicted by the drone speed, temperature, and initial flock size

Covariates:

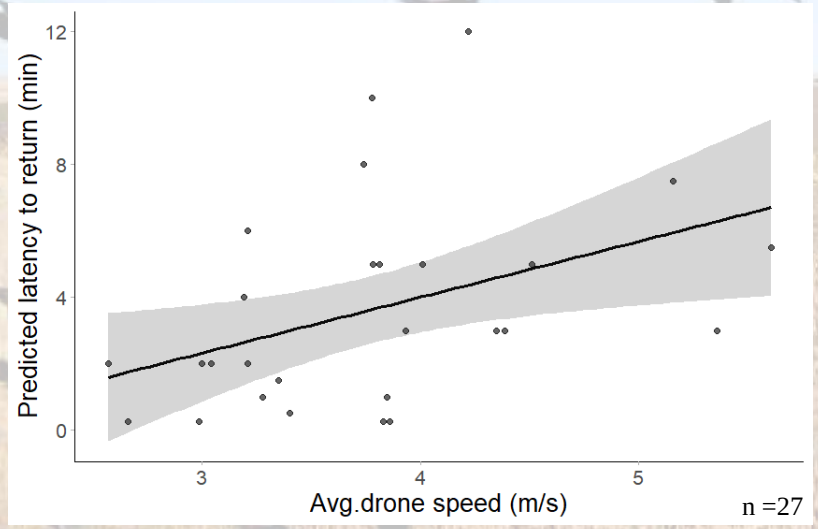
Environment | Flock Metric | UAS

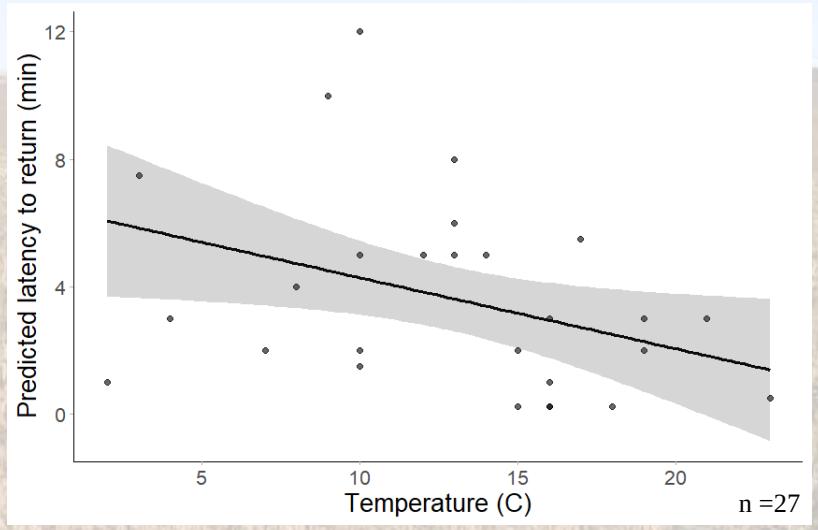
FULL MODEL	AIC (62.46)
Closest tree patch	62.519
Distance to launch site	60.669
Avg. drone speed	**67.852**
Treatment	60.528
Year	63.214
Temperature	**63.181**
Sunflower field size	60.852
Area of adjacent cattail	61.514
Est. flock size	**65.272**
Distance to field edge	61.729

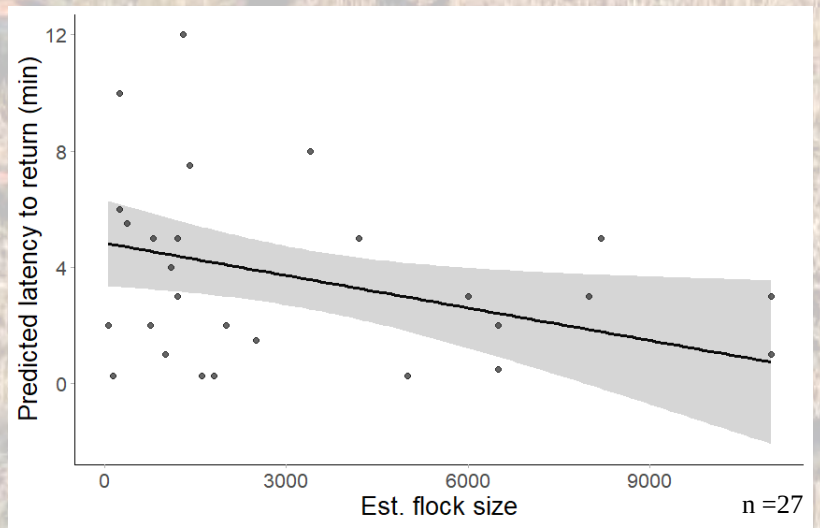
Optimal model:

lm(Latency to return ~ Avg. drone speed + Temperature + Est. flock size + Year)

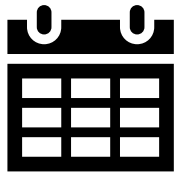
OPTIMAL MODEL	p = 0.003
Avg. drone speed	**0.017**
Temperature	**0.028**
Est. flock size	**0.032**
Year	0.095







So, what does all of this mean?

MANAGEMENT IMPLICATIONS:	
	• Smaller fields = More edge ≠ more success!
	• Use early in the season on smaller flocks to prevent establishment of feeding areas.
	• Extended periods of hazing (>8 min) or multiple drones for larger flocks (>10,000 birds).

Future Directions:

- Extended periods of hazing
- Drone speed + size

THANK YOU!

Graduate Advisor
- Dr. Page Klug

Committee members
- Dr. Ned Dochtermann
- Dr. Timothy Greives
- Dr. David Kramar

Lab Mates
- Mallory White
- Morgan Donaldson

Bird Lab
- Heidinger Lab
- Greives Lab

UAS Technicians
- Melissa Baldino, Avalon Cook, & Shayly Van Ert

Sunflower Producers

Funding Sources
- National Sunflower Association
- USDA

Questions? Email me! Jessica.duttenhefner@ndsu.edu

NDSU NORTH DAKOTA STATE UNIVERSITY

National Sunflower ASSOCIATION

USDA

Certifications/Permits:
- FAA Part 107 – Small Unmanned Aircraft System Pilot
- FAA Part 137 – Agricultural Pesticide Applicator
- NDGF Scientific Collection Permit – #OLN05908426
- NDSU IACUC Approval
- US EPA – Experimental Use Permit
- ND Aeronautics Commission – Aerial Applicator License/Temp. Exemption
- State of North Dakota Department of Agriculture Air and Ground Core Commercial Vertebrate Pesticide Certificate