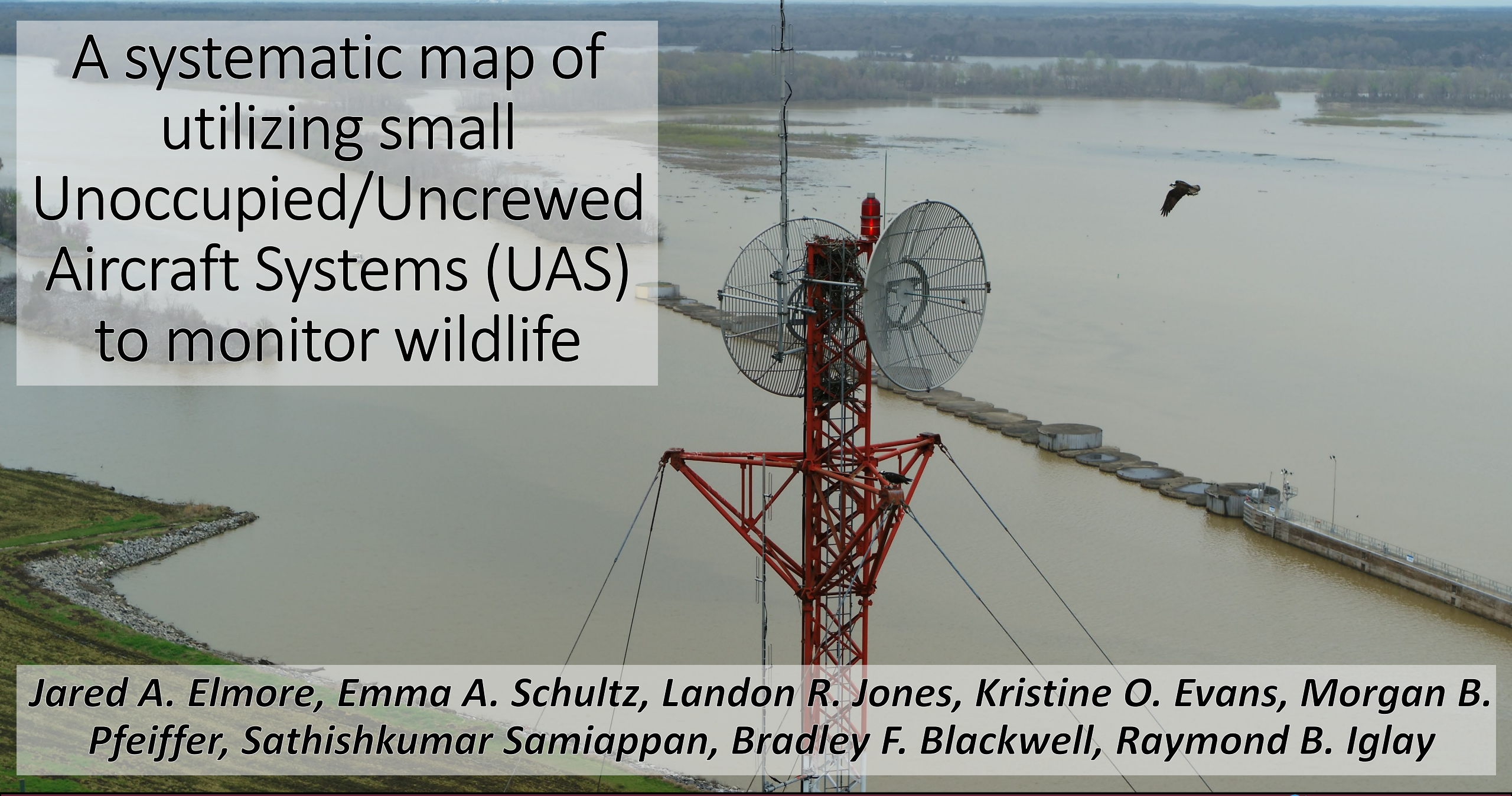
A systematic map of utilizing small Unoccupied/Uncrewed Aircraft Systems (UAS) to monitor wildlife



Jared A. Elmore, Emma A. Schultz, Landon R. Jones, Kristine O. Evans, Morgan B. Pfeiffer, Sathishkumar Samiappan, Bradley F. Blackwell, Raymond B. Iglay

MISSISSIPPI STATE UNIVERSITY
DEPARTMENT OF WILDLIFE, FISHERIES AND AQUACULTURE

MISSISSIPPI STATE UNIVERSITY
GEOSYSTEMS RESEARCH INSTITUTE

USDA

jae133@msstate.edu

@Elmore_Ecology

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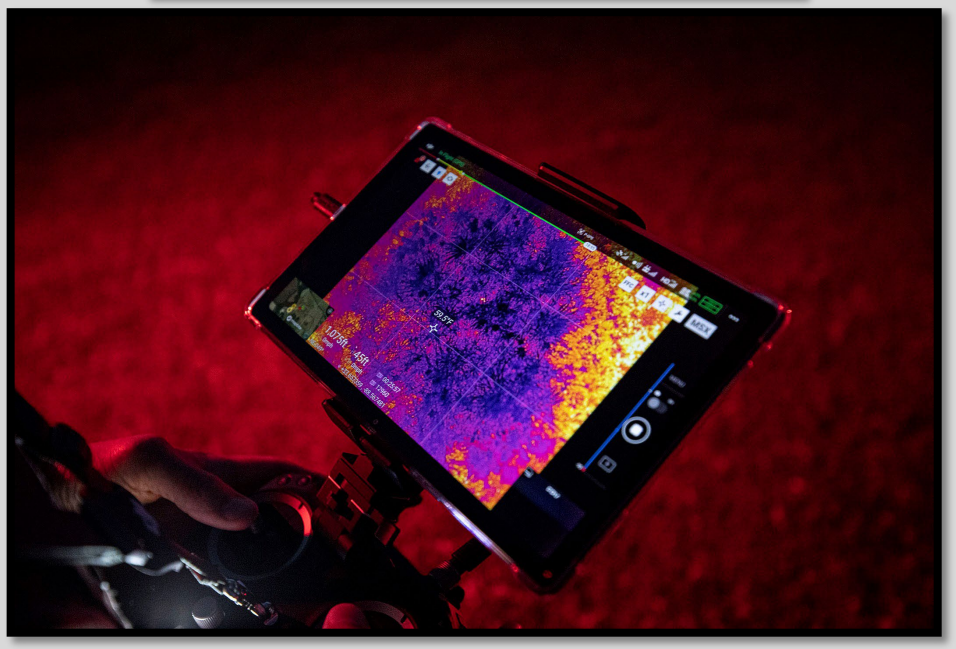
- Dr. Michael Curran & Mr. Meilun Zhou



UAS

- Increasingly used for monitoring animals
  - Fine spatial and temporal coverage
  - Reduce surveyor bias and cost
  - Increase personnel safety
  - Minimize wildlife impacts

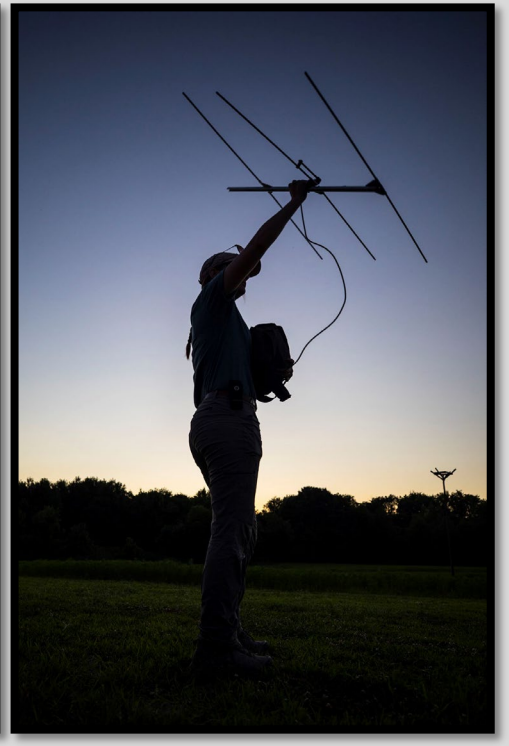
Christie et al. 2016, Hodgson et al. 2018, Sasse 2003

UAS technology

- Rapid development
- Lack of standardization
  - Selection, guidelines, methods

Animal monitoring on airports

- Can UAS supplement traditional methods?



Systematic maps

- Broad questions

Systematic Map Protocol | Open Access | Published: 30 June 2021

Evidence on the effectiveness of small unmanned aircraft systems (sUAS) as a survey tool for North American terrestrial, vertebrate animals: a systematic map protocol

Jared A. Elmore, Michael F. Curran, Kristine O. Evans, Sathishkumar Samiappan, Meilun Zhou, Morgan B. Pfeiffer, Bradley F. Blackwell & Raymond B. Iglay

Environmental Evidence **10**, Article number: 15 (2021) | Cite this article

Objective and question

- Consolidate evidence of UAS to monitor animals in terrestrial environments
- What evidence exists on the effectiveness of UAS as a survey tool for terrestrial, vertebrate animals?

Methods

- Literature search
- Article classification
- Data coding
- Mapping and presentation

Google Scholar

ProQuest Dissertations & Theses Global

Clarivate Web of Science™

Scopus

EBSCO

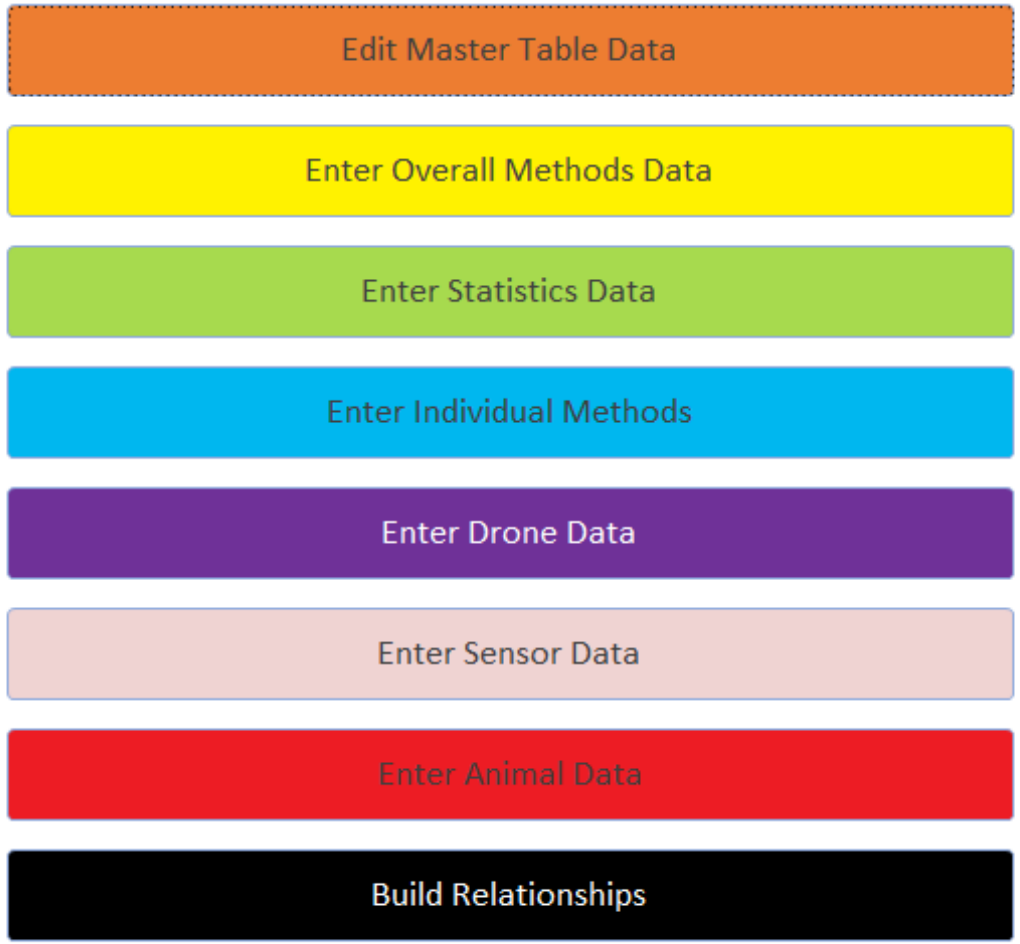
Wildlife & Ecology Studies Worldwide

Metadata specifics

StudyID	Years of study	Drone manufacturer
Authors	Country of study	Drone model
Title	State/province of study	Control type
Year of publication	Location latitude	Gimbal
Month of publication	Location longitude	Mission planning software
Day of publication	Multiple locations	Above Ground Level (AGL)
Publication type	Multiple methodologies	Flight Speed
Publication venue/journal	Land cover type	Flight pattern
Issue number	Subject family EN	Flight duration
Volume number	Subject species EN	Flight time of day
Pages	Subject species Latin	Ground control points
Peer-reviewed	Animal groups	Ground truth
URL with DOI	Purpose of the study	Sensor manufacturer
Assigned reviewer	Bias estimated	Sensor model
Language	Bias estimation methods	Field calibration
Bias consideration and factors	Comparison to other methods	Calibration type
Is raw data available	Description of other method used	Ground sample distance
Constraints	Statistical analysis	Image analysis
	Type of statistical analysis	Image preprocessing

Microsoft Access Database

Systematic Map Data Entry Navigation Pane



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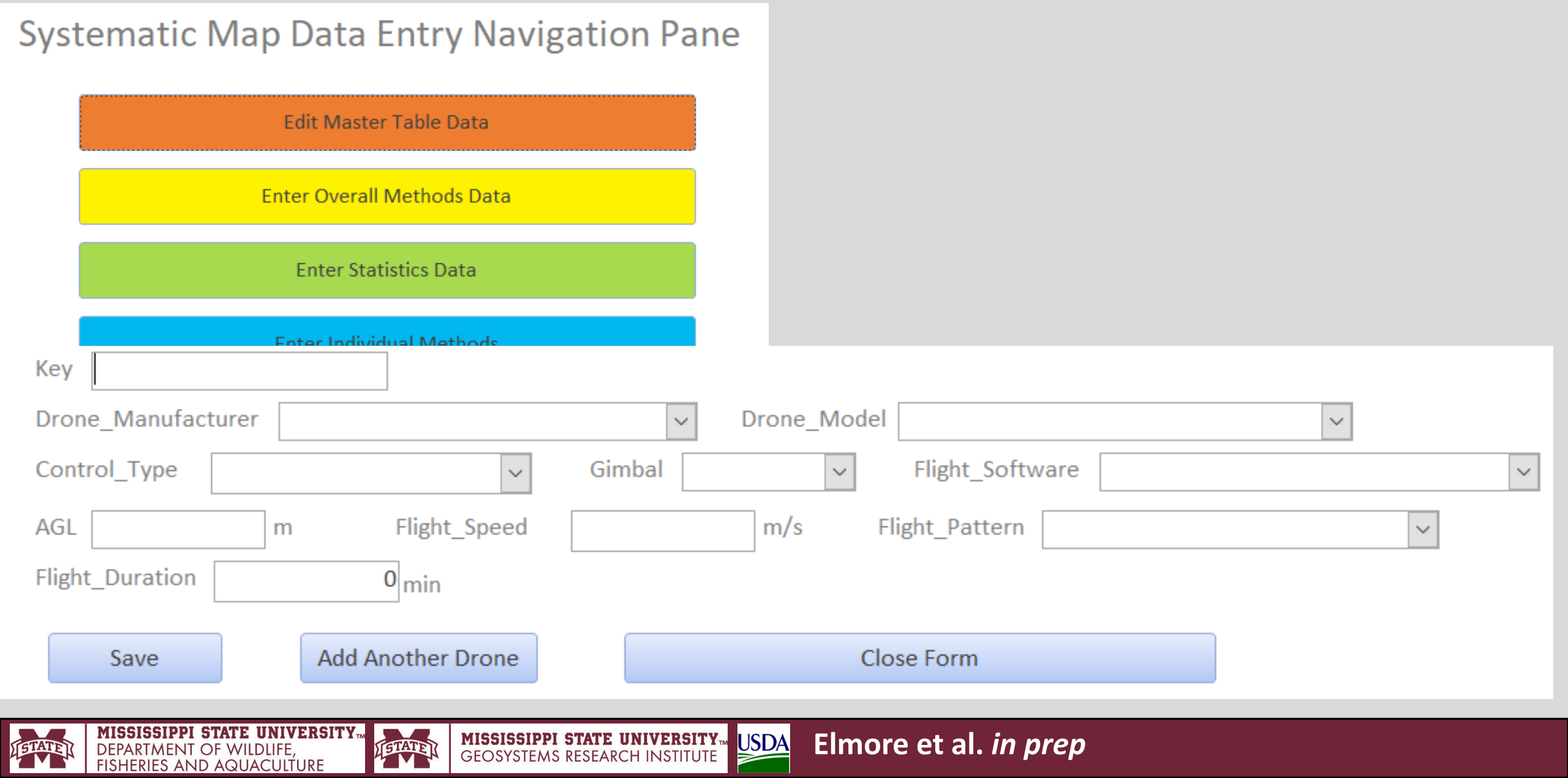

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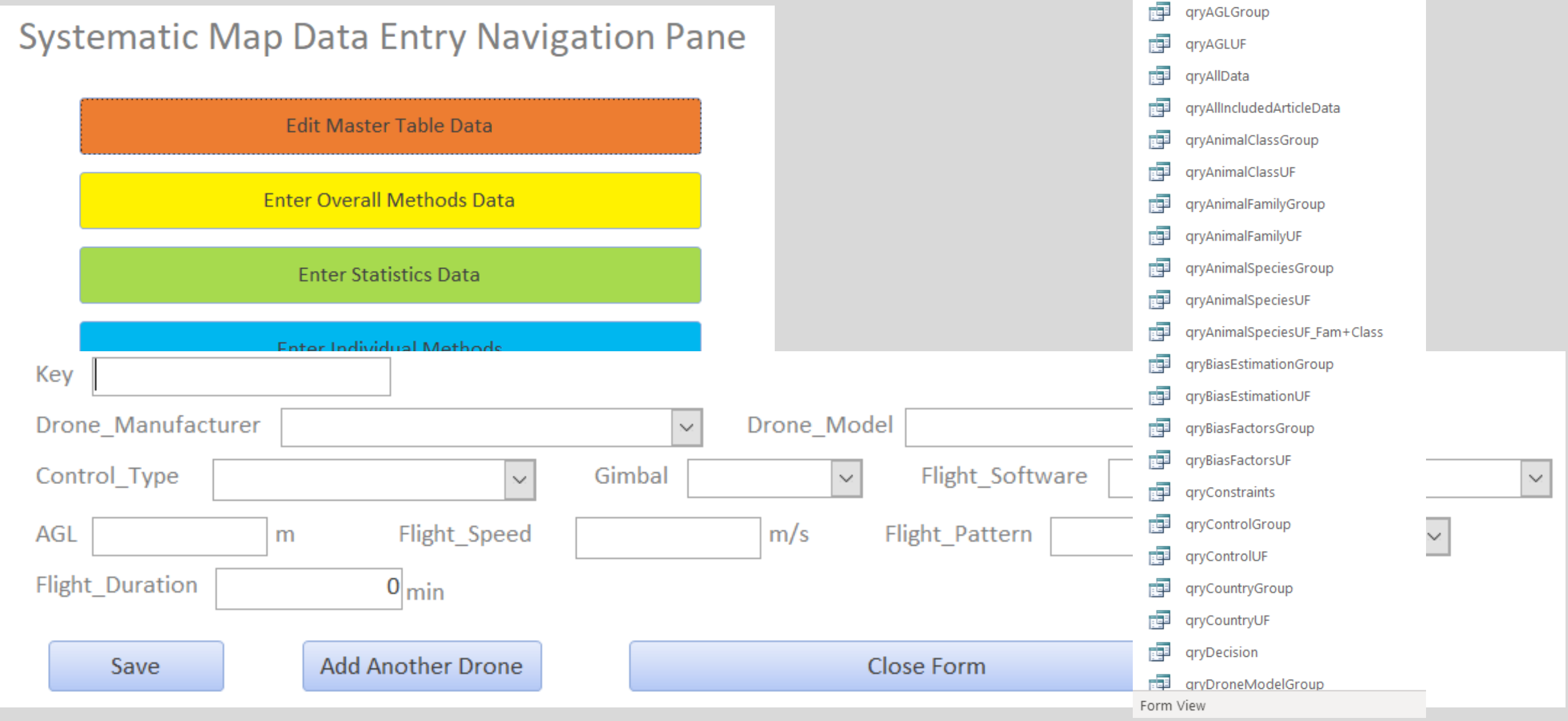

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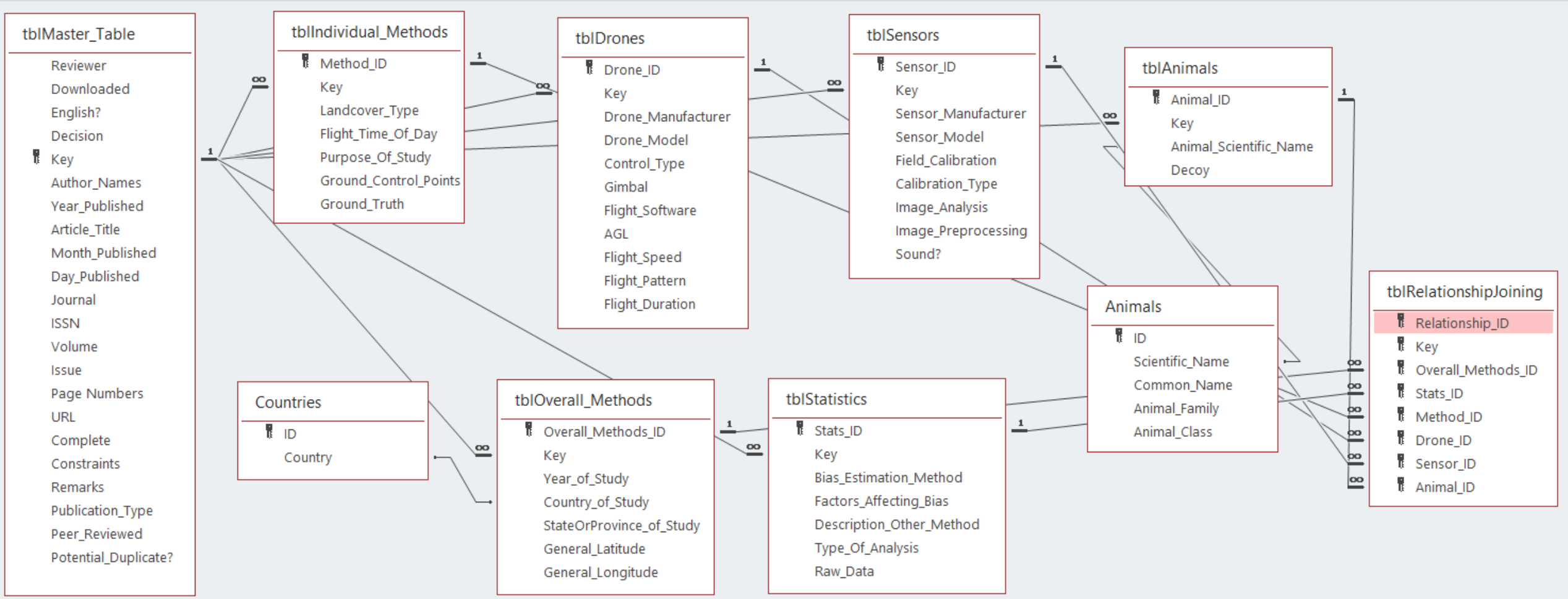
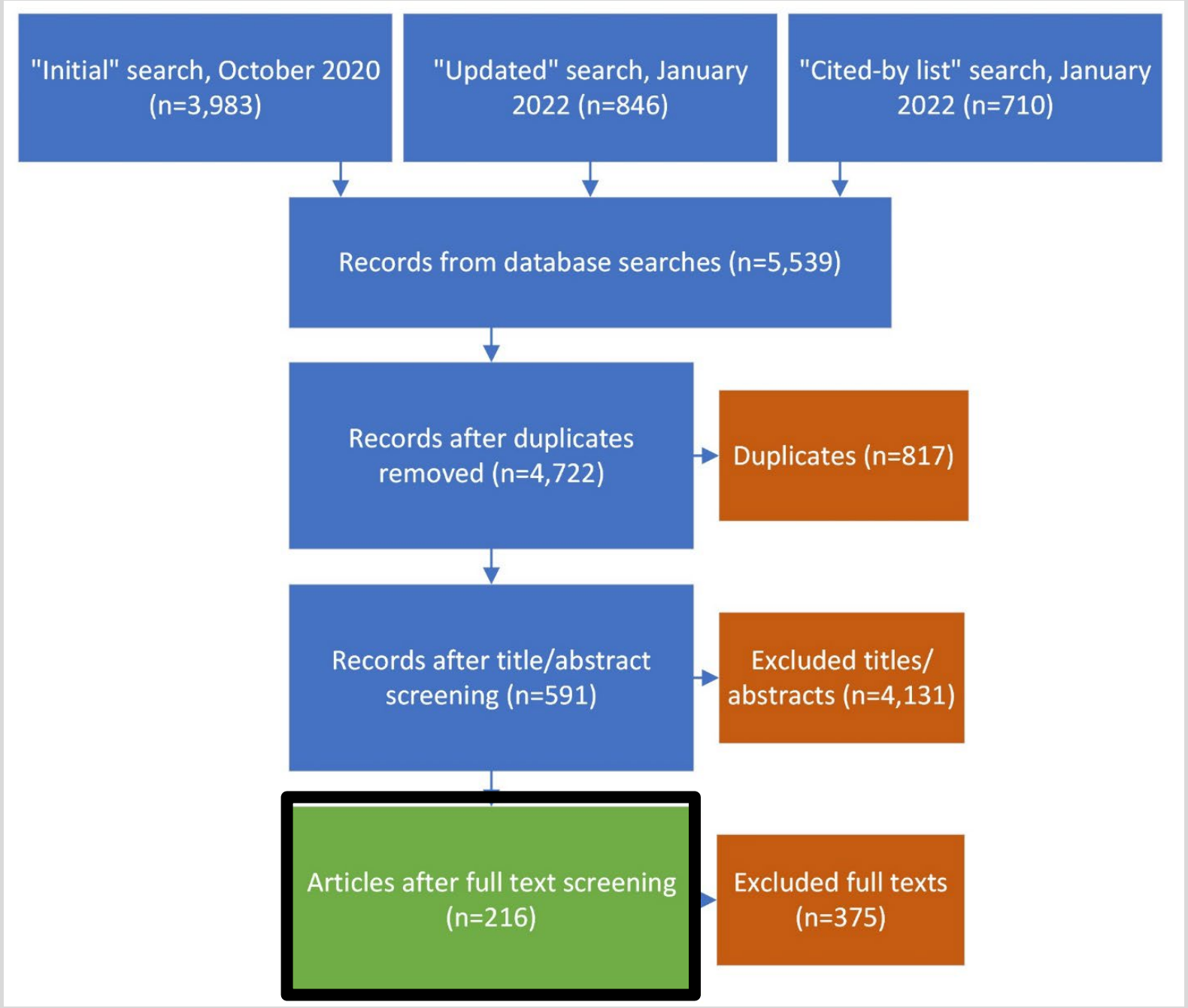
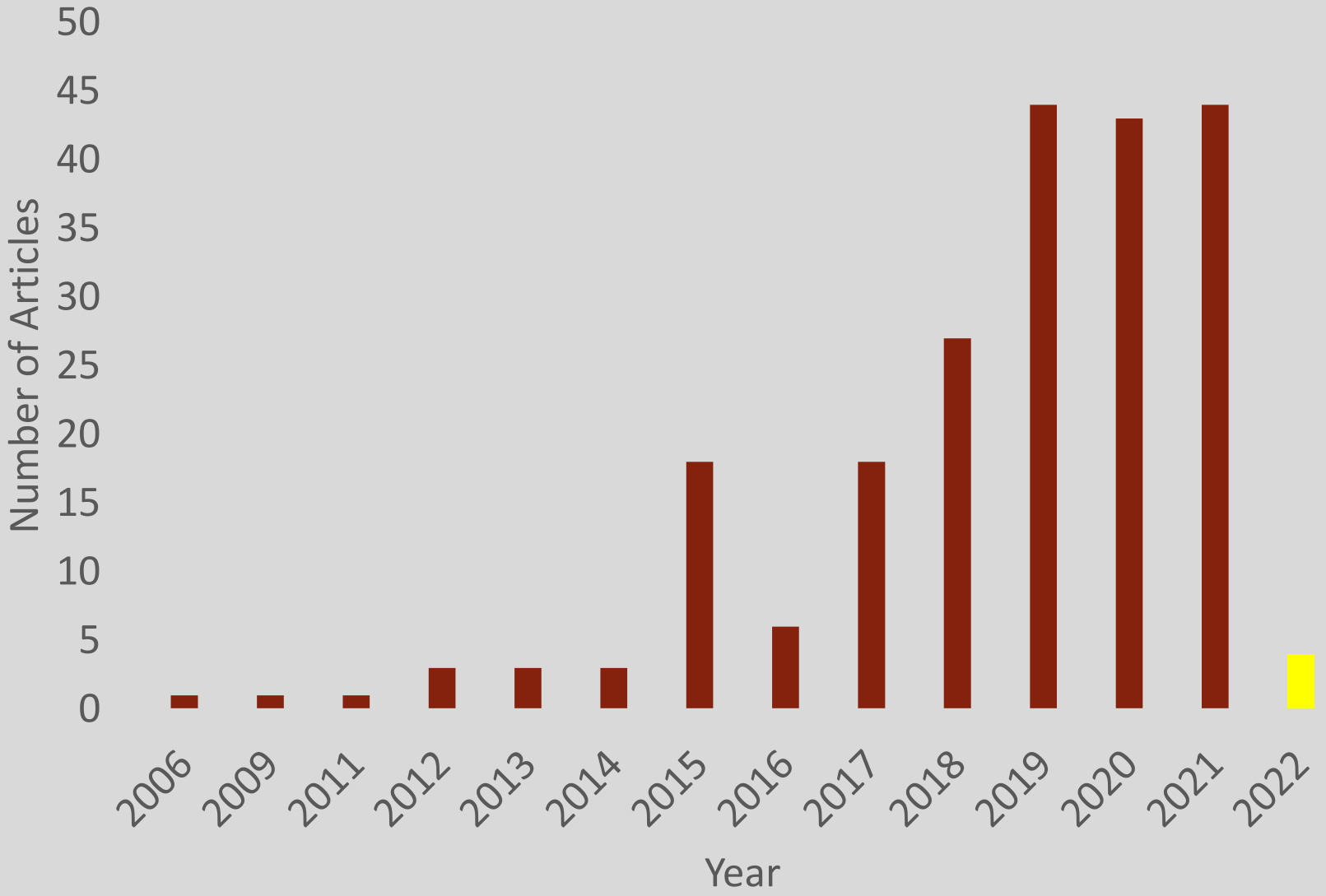


Results

- 216 articles

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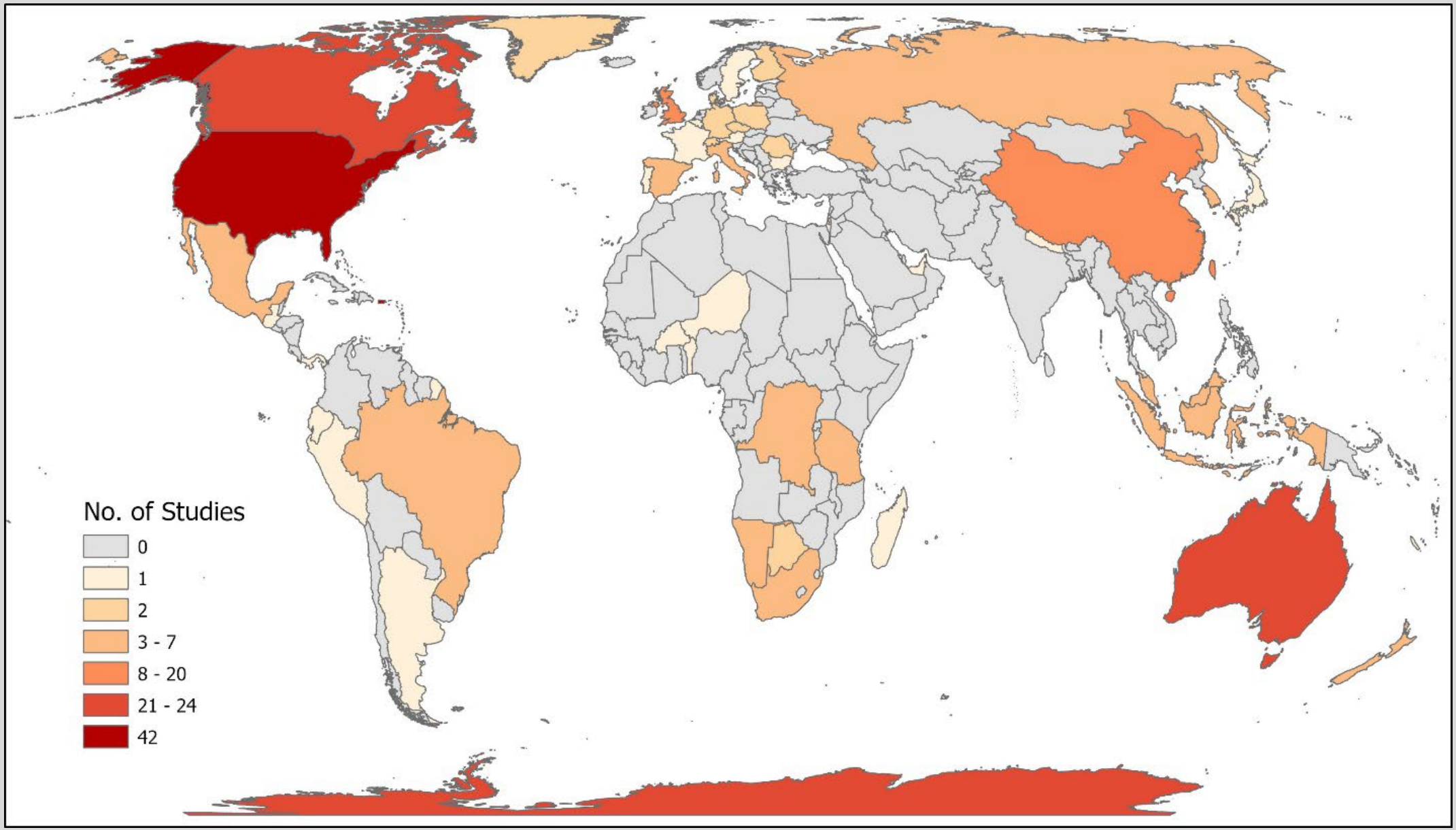
2022
Year


No. of Studies
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2
3 - 7
8 - 20
21 - 24
42

UAS Manufacturer
DragonFlyer
Ritewing
feima
Falcon UAV
Ascending Tech
Microdrones
Easy Fly
CropCam
Bormatec
ING Robotic Aviation
Trimble
Aerial Imaging Solutions
Skywalker
SenseFly
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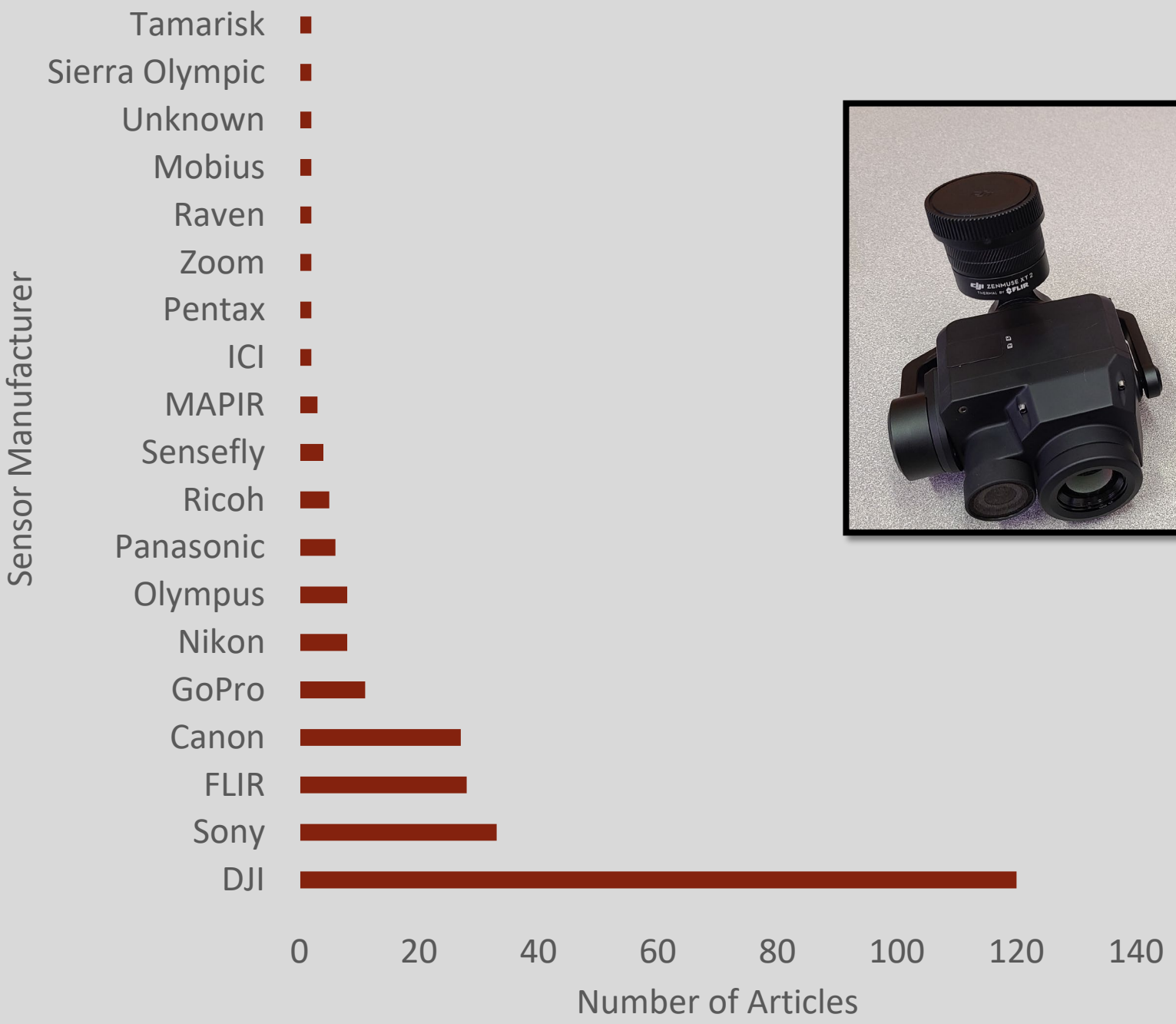
Number of Articles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GoPro
Canon
FLIR
Sony
DJI
Sensor Manufacturer
0
20
40
60
80
100
120
140
Number of Articles


ZENMUSE XT 2
THERMAL BY FLIR
ZENMUSE X7

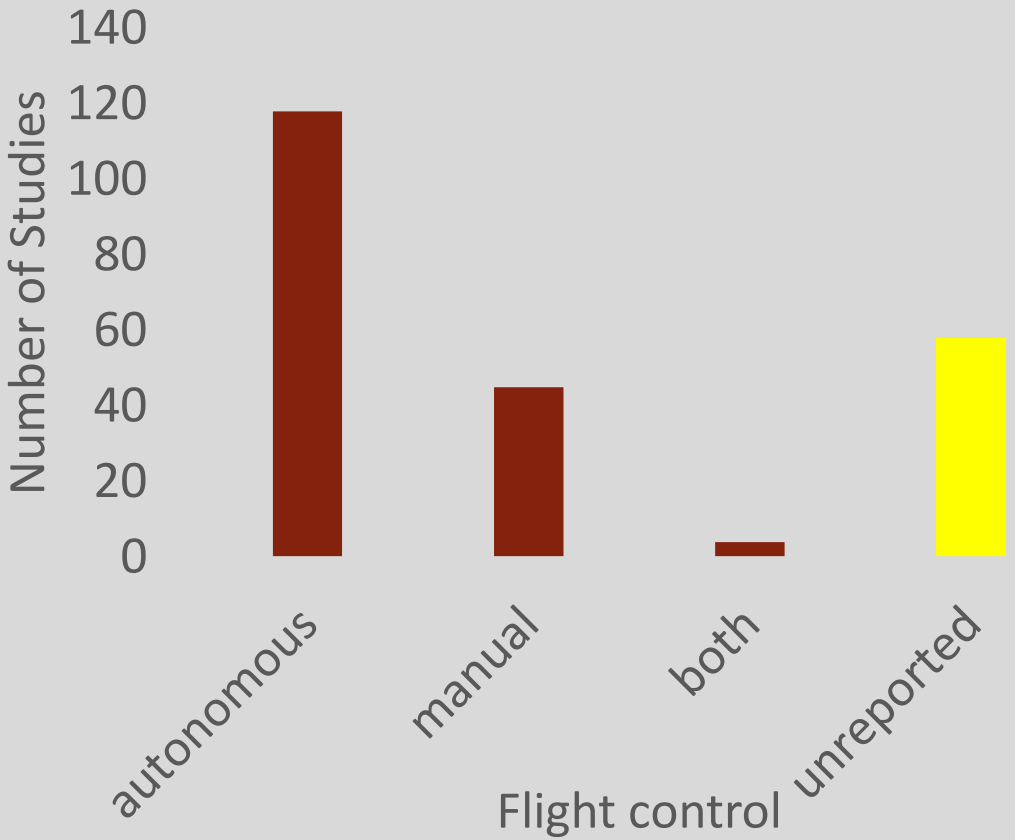
Species

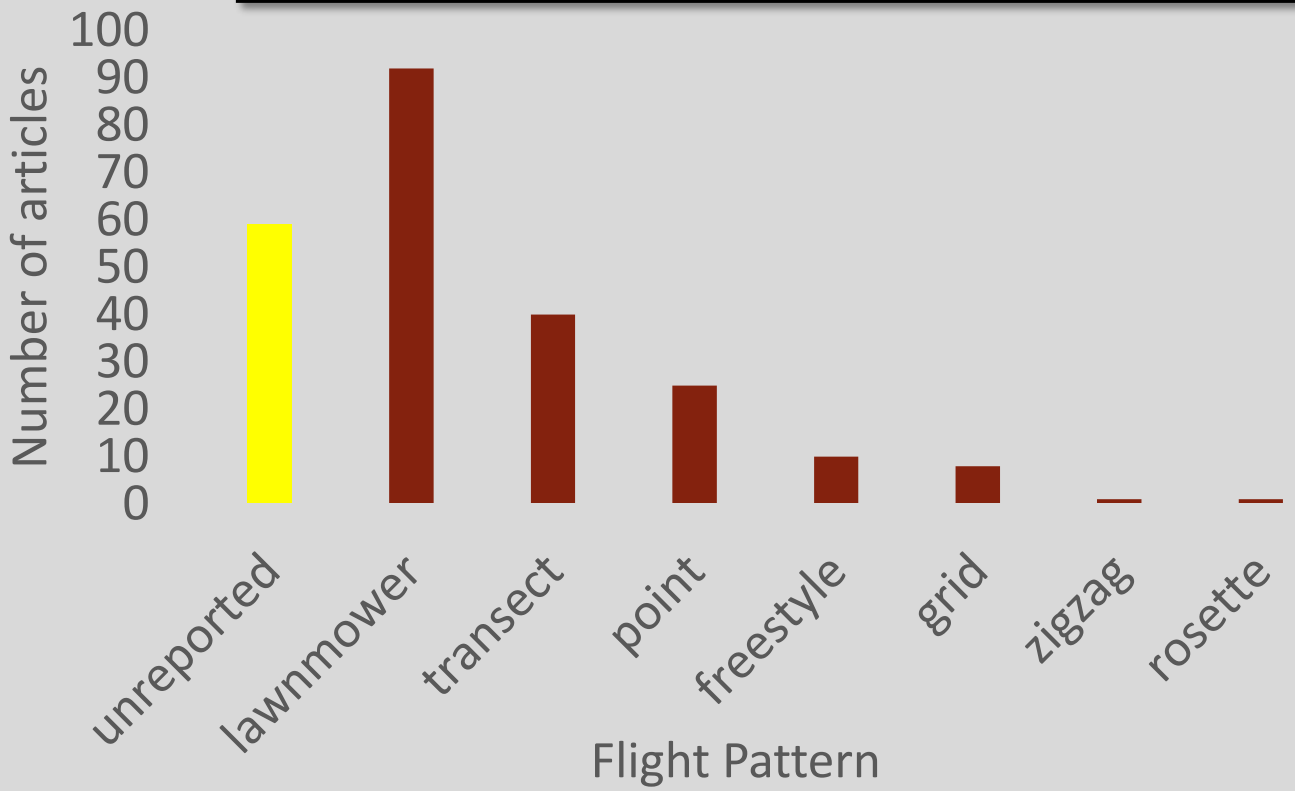
- 187 bird species in 98 studies
- 103 mammal species in 113 studies
- 13 reptile species in 11 studies
- 1 amphibian species in 1 study

Class	Family	Scientific Name	Common Name	# Studies
Birds	Spheniscidae	*Pygoscelis antarcticus*	Chinstrap Penguin	10
Mammals	Cervidae	*Odocoileus virginianus*	White-tailed Deer	9
Mammals	Phascolarctidae	*Phascolarctos cinereus*	Koala	8
Mammals	Bovidae	*Bos taurus*	Domestic Cattle	8
Birds	Anatidae	*Anas platyrhynchos*	Mallard	8
Birds	Ardeidae	*Ardea alba*	Great White Egret	7
Birds	Spheniscidae	*Pygoscelis adeliae*	Adelie Penguin	7
Mammals	Phocidae	*Halichoerus grypus*	Grey Seal	7
Mammals	Phocidae	*Mirounga leonina*	Southern Elephant Seal	6
Birds	Anatidae	*Anas acuta*	Northern Pintail	5
Birds	Anatidae	*Anas crecca*	Common Teal	5
Birds	Ardeidae	*Ardea cinerea*	Grey Heron	5
Birds	Spheniscidae	*Pygoscelis papua*	Gentoo Penguin	5
Birds	Phalacrocoracidae	*Leucocarbo atriceps*	Imperial Shag	5
Mammals	Hippopotamidae	*Hippopotamus amphibius*	Hippopotamus	5

Statistics and study methods

- 36 different analyses
- 61% descriptive





Common constraints

- animal characteristics, size, coloration, position, disturbance
- heat and shadows from sun, sun angle, sun glare/contrast
- time/effort to process and analyze images
- government regulations/approvals
- weather: rain, fog, wind, heat
- animal movement causes detection/counting issues
- vegetation density/canopy cover
- limited flight coverage and time
- software/hardware reliability and errors
- control signal strength and connectivity
- ground verification not available or different
- hardware bulky, fragile, and not water resistant
- false positive/negatives by computers and humans
- radiometric thermal capabilities, camera resolution, 2D images
- equipment costly and quickly becomes obsolete
- visual obstruction from vegetation and water
- pilot experience
- payload capacity/multiple sensor attachment
- misidentification of animals by humans and computers
- imprecise mapping/flight plans

Conclusion

- Effective for monitoring wildlife
- Standardize selection, guidelines, and methods
- Identify future gaps to fill

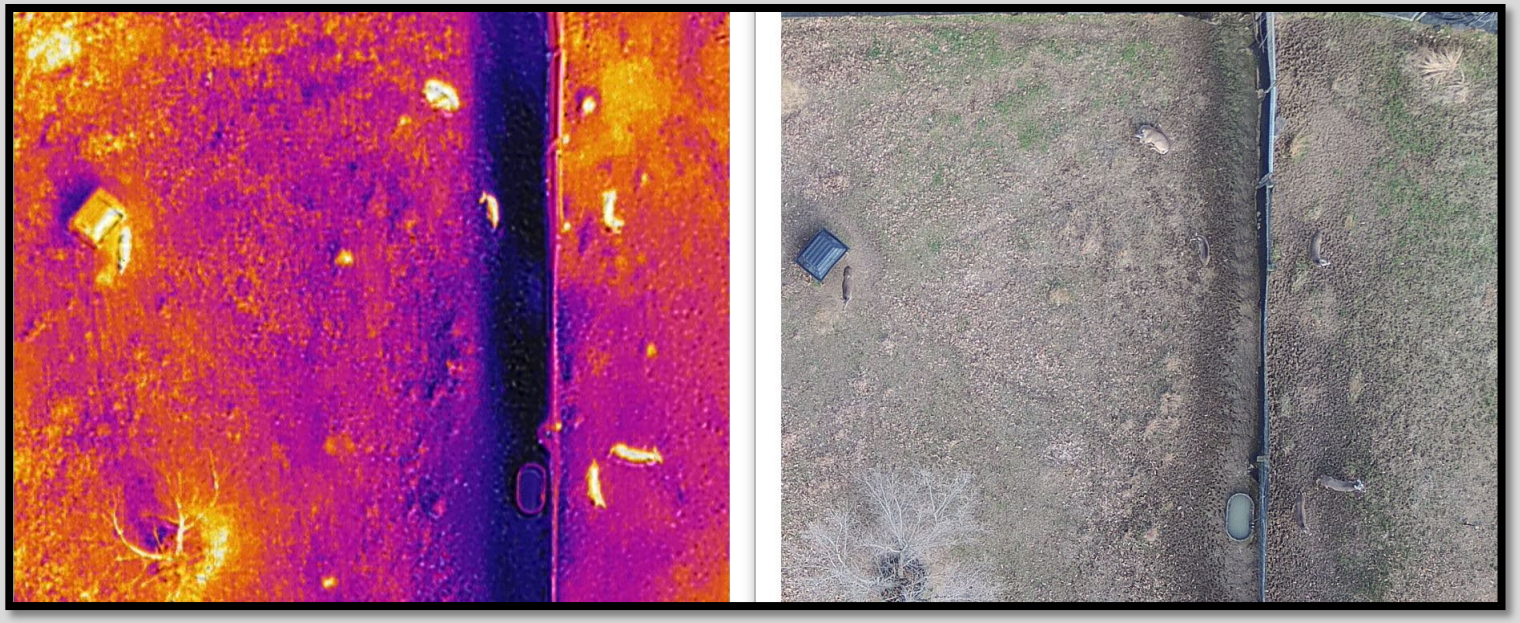


Photo: The Confluence Group