Preliminary effects of UAS angle of approach on escape responses of a large-bodied raptor

Morgan Drabik-Hamshare, WS National Wildlife Research Center, Ohio Field Station

Joshua L. Hoblet, WS National Wildlife Research Center, Ohio Field Station

Bradley F. Blackwell, WS National Wildlife Research Center, Ohio Field Station

Esteban Fernández-Juricic, Department of Biological Sciences, Purdue University

Approach

- Acknowledgements
- Some background
- The research topic
- Hypotheses & predictions
- Methods
- Findings
- Implications

Acknowledgements

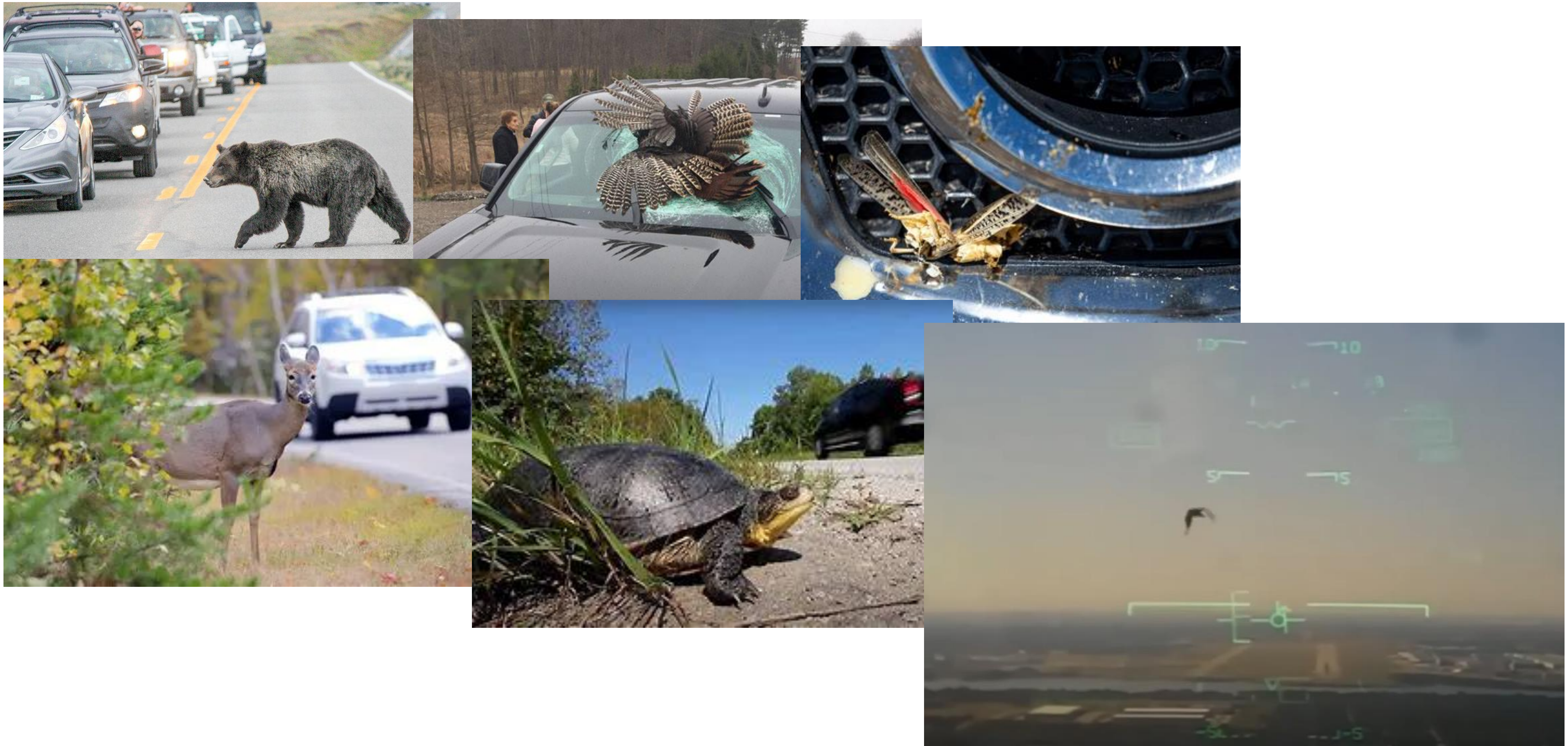
FEDERAL AVIATION ADMINISTRATION

USDA

PURDUE UNIVERSITY

Background

- Animal response to vehicle approach



Background

- Is it reasonable to expect that we can exploit animal behavior as related to vehicle approach?
- If so, how?
- Applications?

Background

BIOLOGICAL REVIEWS
Cambridge Philosophical Society

Original Article

Animal reactions to oncoming vehicles: a conceptual review

Steven L. Lima, Bradley F. Blackwell, Travis L. DeVault, Esteban Fernández-Juricic

First published: 25 March 2014 | https://doi.org/10.1111/brv.12093 | Citations: 101

PLOS ONE

PROCEEDINGS OF THE ROYAL SOCIETY B
BIOLOGICAL SCIENCES

Research articles

Speed kills: ineffective avian escape responses to oncoming vehicles

Travis L. DeVault, Bradley F. Blackwell, Thomas W. Seamans, Steven L. Lima and Esteban Fernández-Juricic

Published: 22 February 2015 https://doi.org/10.1098/rspb.2014.2188

RESEARCH ARTICLE

Can we use antipredator behavior theory to predict wildlife responses to high-speed vehicles?

Ryan B. Lunn[1]*, Bradley F. Blackwell[2], Travis L. DeVault[3], Esteban Fernández-Juricic[1]

1 Department of Biological Sciences, Purdue University, West Lafayette, IN, United States of America, 2 USDA, APHIS, Wildlife Services, National Wildlife Research Center, Sandusky, OH, United States of America, 3 Savannah River Ecology Laboratory, University of Georgia, Jackson, SC, United States of

Factors affecting avoidance responses:

- Visual detection
  - Wavelength
  - Source intensity
  - Separation distance
  - Angle of approach
  - Closing speed
  - Dispersion/scattering
  - Intensity at receiver
  - Cue processing

- Group effects
  - Group size
  - Detectors
  - Initial responses
  - Collective responses

Research Topic

Drone Systems and Applications

OPEN ACCESS | Research Article

Preliminary effects of UAS angle of approach on escape responses of a large-bodied raptor

Morgan B. Pfeiffer[a], **Joshua L. Hoblet**[a], **Bradley F. Blackwell**[a], **and Esteban Fernández-Juricic**[b]

[a]U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870, USA; [b]Department of Biological Sciences, Purdue University, 915 West State Street, West Lafayette, IN 47907, USA

Corresponding authors: **Morgan B. Pfeiffer** (email: Morgan.B.Pfeiffer@usda.gov); **Bradley F. Blackwell** (bradley.f.blackwell@usda.gov)

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RESEARCH ART

Dispersal o
fields: effic
size but no

Conor C. Egan[1]
Esteban Fernánd

ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Research

Cite this article: Lunn RB, Blackwell B, Baumhardt P, Talbot A, Di Domenico I, Fernández-Juricic E. 2025 Light tuned to the avian eye elicits early detection and escape from an approaching aircraft. *R. Soc. Open Sci.* **12**: 250047. https://doi.org/10.1098/rsos.250047

Light tuned to the avian eye elicits early detection and escape from an approaching aircraft

Ryan Bradley Lunn[1], Bradley Blackwell[2], Patrice Baumhardt[1], Anne Talbot[1], Isaac Di Domenico[1] and Esteban Fernández-Juricic[1]

[1]Biological Sciences, Purdue University, West Lafayette, IN, USA
[2]USDA-APHIS/WS National Wildlife Research Center, Sandusky, OH, USA

RBL, 0000-0001-9998-3200

- A UAS characteristic that is not well understood

relative to bird escape response is angle of approach,

which is the angle from a horizontal plane that the UAS follows as it approaches.

Hypotheses and predictions

- Same-level UAS approaches perceived as riskier than dive-bomb UAS approaches.
  - Alternatively, dive-bomb UAS approaches perceived as riskier because higher altitude is like aerial predator pursuit and the change in direction of approach perceived as a targeted pursuit with intent to “capture”.

- Predictions
  - Same-level UAS approaches would yield greater probability of dispersal on first pass and longer FIDs
  - Shorter escape times
  - Smaller vulture remaining index
  - Longer latency to return

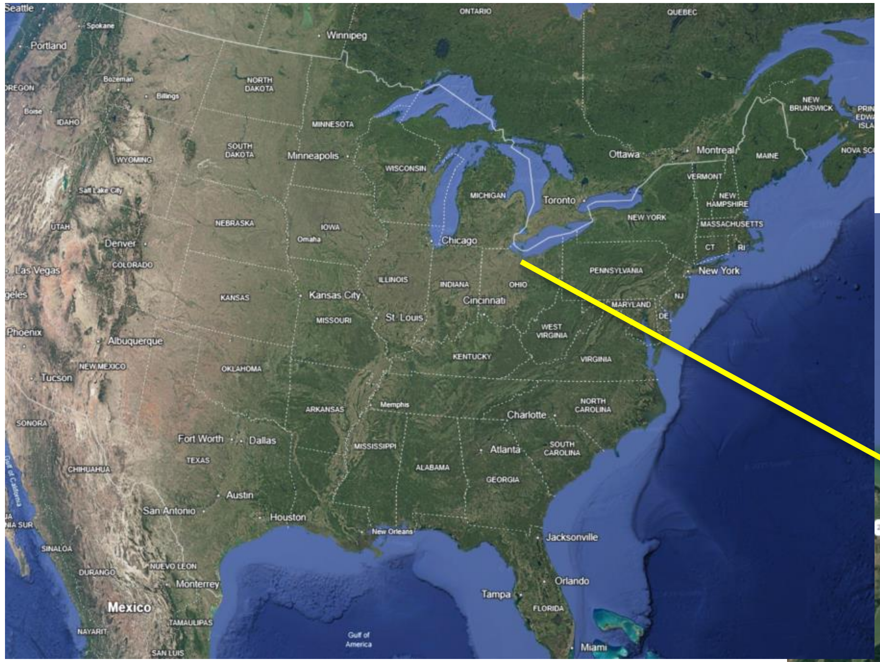
- Alternatively
  - Approach by UAS perceived as equally risky

Objective

- To manipulate UAS angle of approach against free-ranging Turkey Vultures using a reproducible approach speed greater than 30 kph.
  - Turkey Vultures are vulnerable to terrestrial and aerial predators and they can be deterred from an area by an aerial threat.
  - Previous research involving waterbirds and cranes showed that vertical (90∘) descent as the riskiest UAS approach based on lower percentages of approaches to reach within 4 m of birds and higher percentages of escape flights

Methods

- Study site: Erie County Landfill, Milan, Ohio

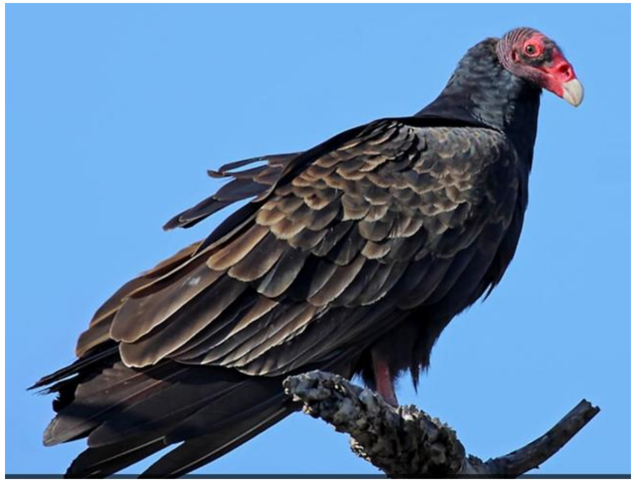


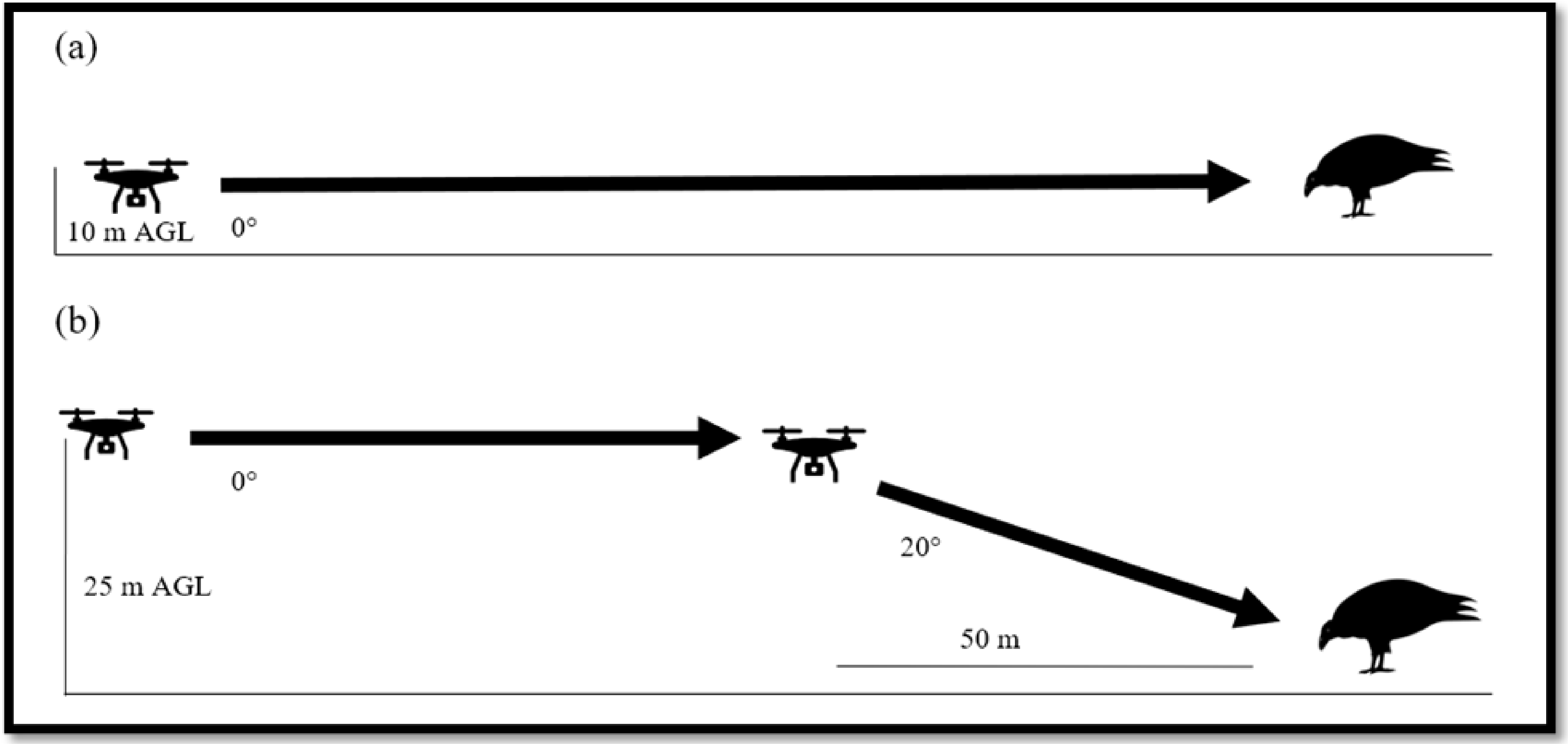
Methods

- UAS (quadcopter Autel Evo II Dual v2, Autel Robotics Company, Shenzhen, China

- Launched from at least 199 m south of focal birds

Methods





Methods

- Approached vulture(s) with the UAS until (1) it escaped with flight; or (2) 2 min passed;
- Attempted to follow focal vultures in flight following escape;
- Measured escape times, flight-initiation distance horizontally and diagonally, vulture remaining index (index of the number of vultures remaining after treatment by the number present before), and the latency to return to the target area.
- We estimated means and 95% confidence intervals of each variable (and their effect sizes) for same-level and stoop approaches.

Methods

- At least 20 min between UAS treatments
- Recorded sound emitted by the stoop and same-level UAS treatments
- Accessed UAS flight data using the HD 360 Pro subscription to AirData UAV (AirData UAV, Inc., California, USA). Used these data to identify when the UAS started to move forward.
- Identified UAS position at the time of escape.

Methods-*analyses*

- Calculated vulture escape time since forward motion.
- Using UAS flight data, summarized
  - angle of approach
  - approach altitude
  - distance from target when stoop component began
- Calculated horizontal FID.
- Calculated diagonal FID.

Methods-*analyses*

- Used estimation statistics to analyze our data.

- Estimated effect sizes

- Focused interpretation of results on the magnitude of the effect size and its precision, given by the confidence interval.

Results

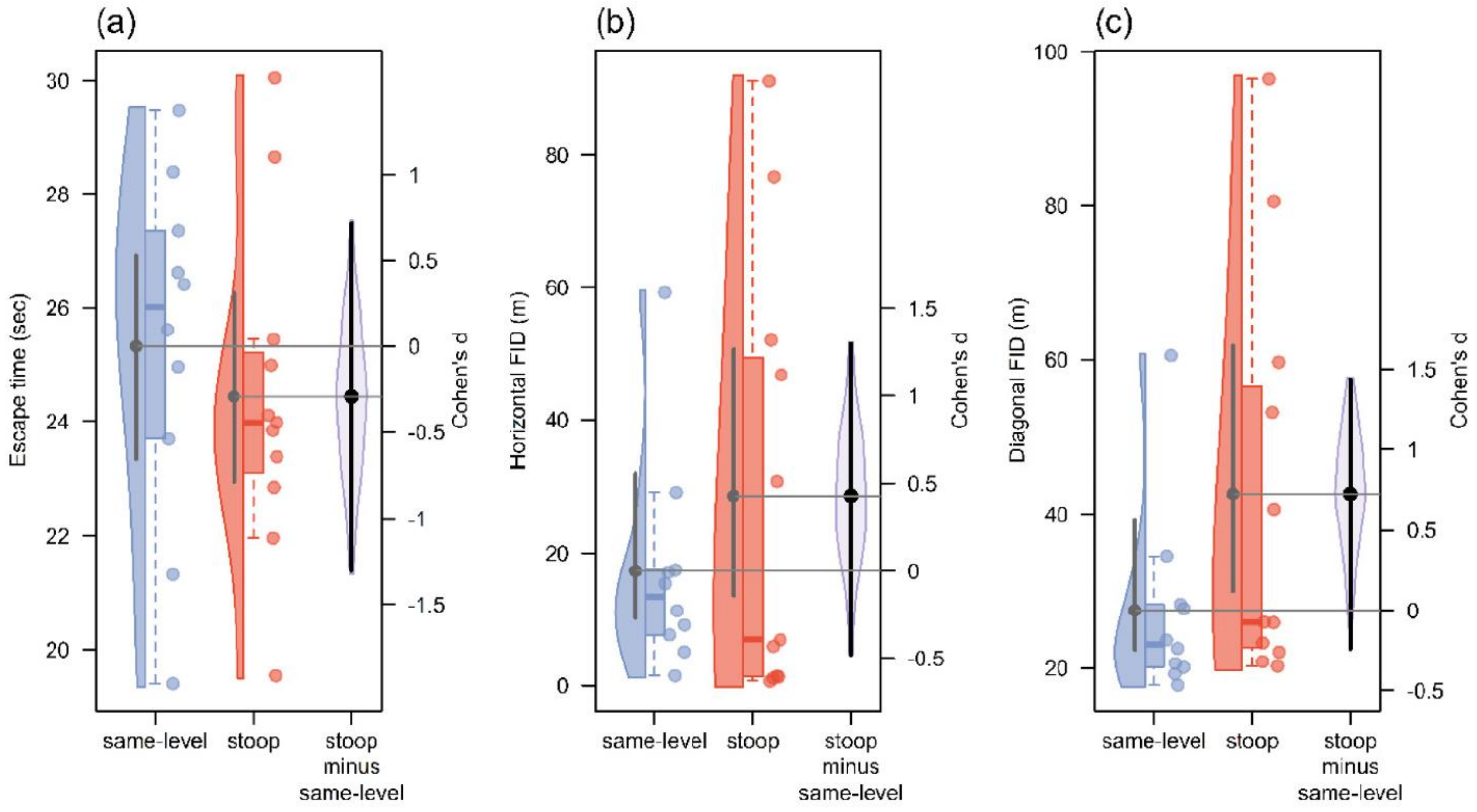
- Between 5 July and 26 July 2022: 35 UAS treatments (same-level = 16 and stoop = 19) over 11 days at the landfill.
- Removed nine approaches because
  - vultures reacted to something other than the stimuli
  - UAS did not achieve a direct approach
- Mean altitude of stoop approaches was 18.74m (16.92, 20.83) higher
- Angle of approach was 21.26∘ (−28.87, −19.12) lower than same-level approaches.

Results

- Altitude at vulture escape was 6.28 m (3.71, 9.05) lower, and its speed was 13.05 kph (1.92, 20.93) slower in the same-level approach.
- Average sound emitted by the UAS 0.49 dB (–0.78, 1.59) louder in stoop approach.
- UAS altitude at escape effect size estimate showed highest precision.
- 4 of 15 (27%) stoop treatments failed to elicit an escape response.
- All same-level treatments ($n = 11$) resulted in target vulture escaping.

Results

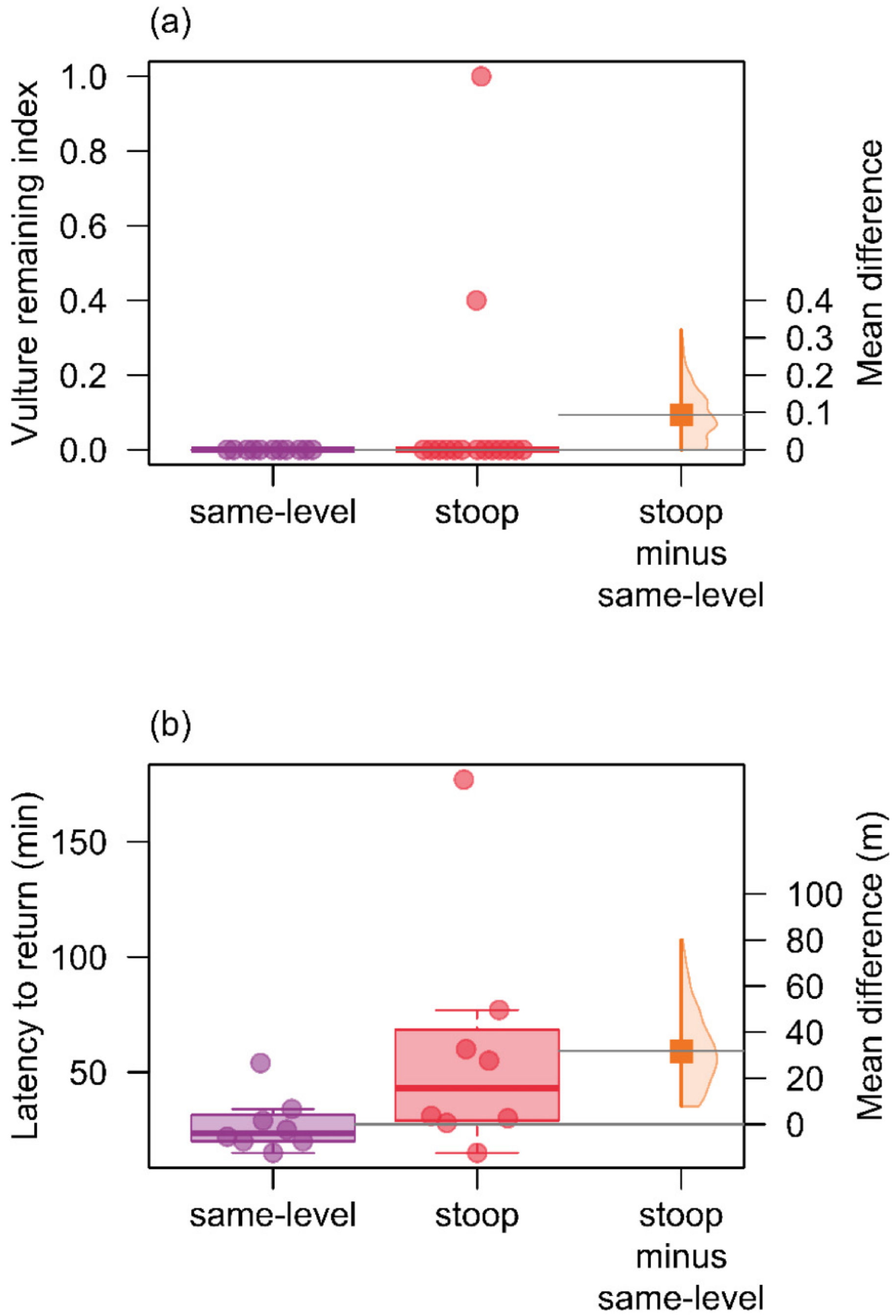
- Mean escape time was 1.69 (−4.63, 1.09) s slower for same-level treatments.
- Horizontal FID was 11.33 (−7.05, 38.27) m longer for stoop
- Diagonal FID was 15.11 (−0.26, 31.34) m longer for stoop



Results

- Vulture remaining index was 0.09 (0, 0.28) higher for stoop (*n* = 15)

- Latency to return was 31.75 (6.90, 87.13) min longer for the stoop



Summary

- All vultures exposed to same-level approaches escaped on the first approach, whereas escape occurred in 73% of stoop approaches.
- When vultures escaped, they did so 1.69 s faster and at over 11 and 15 m greater horizontal and diagonal escape distances when exposed to stoop approaches.
- More (on average, 0.09) vultures remained after stoop approaches
- Vultures exposed to stoop approaches showed over 31min longer latencies.
- Our results, though limited by sample size, indicate that stoop approaches might pose greater perceived risk to vultures.

Management Implications

- Managers should be prepared to apply more than one application, given that not all vultures reacted with escape on the first approach.

- UAS hazing should be integrated with other nonlethal techniques, such as animal carcass removal and pyrotechnics to reduce the probability of vultures habituating to UAS approach.

Questions?