



# DoD Environmental Planning and Conservation Webinar Series



**Motus Wildlife Tracking: An Introduction and Applications to the DoD Mission**

**Adam Smith and Michael Jungen**

April 30, 2024



*Please mute your phones*



Audio Dial-In: 410-874-6749

Participant Code: 576 532 190#

[www.denix.osd.mil/nr/](http://www.denix.osd.mil/nr/)

Twitter: @DoDNatRes

# Mobilizing



## Motus Wildlife Tracking: Introduction and Applications to the DoD Mission

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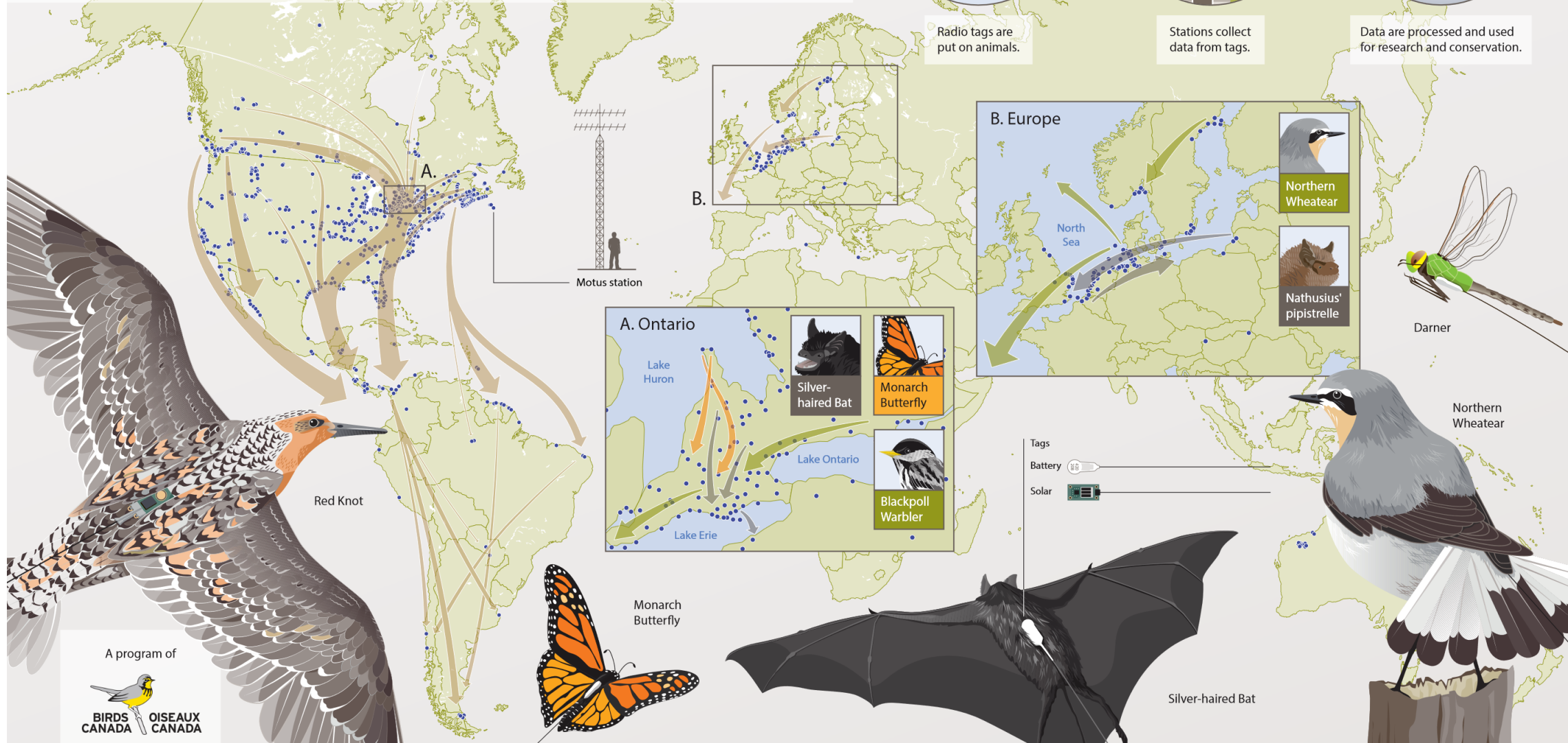
# A collaborative research network tracking wildlife movement for conservation



Radio tags are put on animals.

Stations collect data from tags.

Data are processed and used for research and conservation.



To learn more visit [motus.org](http://motus.org)

# The guts of Motus

## Digitally-coded radio transmitters (tags)



Small radio tags are safely deployed on birds, bats, and insects.

## Automated telemetry stations



Stations collect information from the tags.

## Centralized data repository



All data are processed centrally and returned to collaborators and made visible to the public.

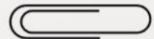
Tags: Battery



Solar



Paperclip (for scale)



# Digitally-coded radio transmitters (tags)

[motus.org/resources](https://motus.org/resources)

VHF: Nanotags (Lotek)

- 166.38 MHz in western hemisphere

UHF: LifeTags/PowerTags (Cellular Tracking Technology)

- 433/434 MHz worldwide

Size: 0.13 g – 3g

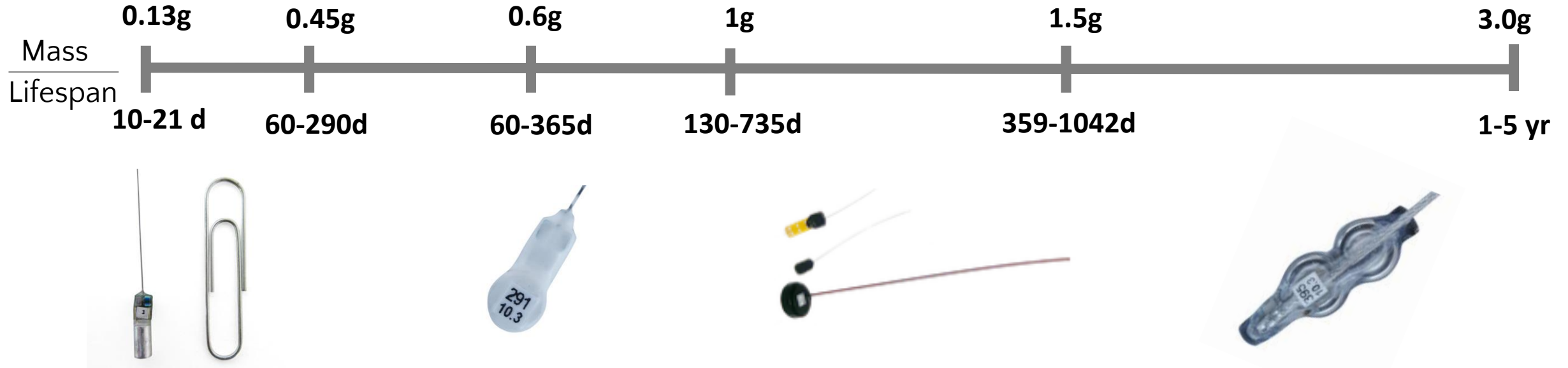
Life: 10d – years

Cost: ~ \$250/tag

Others on the horizon?

- Bluetooth (2.4 GHz)

# Battery Tags



# Solar and Hybrid Tags

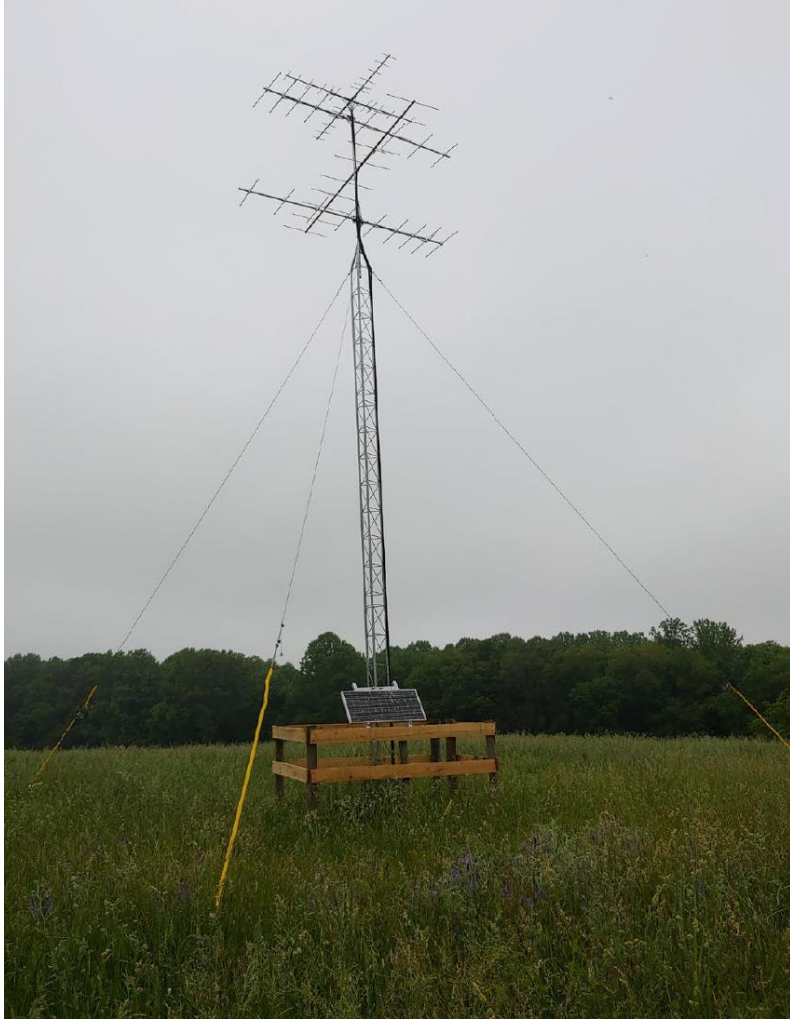


# Automated telemetry receiving stations

[motus.org/resources](https://motus.org/resources)

- Network of “ears”
- Receiver + Antennas + Power + Structure
- Relative high position in the environment
- Easiest installations:
  - existing infrastructure; grid power/internet available
  - 4 antennas: 2 long-range antennas per frequency (166 & 434 MHz)
- 20–30 km detection range (typical installation)
- Presence, direction
- Passive receiving (listen only; no transmission)
- Cost: varies with installation, “easiest” \$5000–7000 installed

# Communication/repeater towers





# Fire lookouts



# Utility poles



# Tall buildings

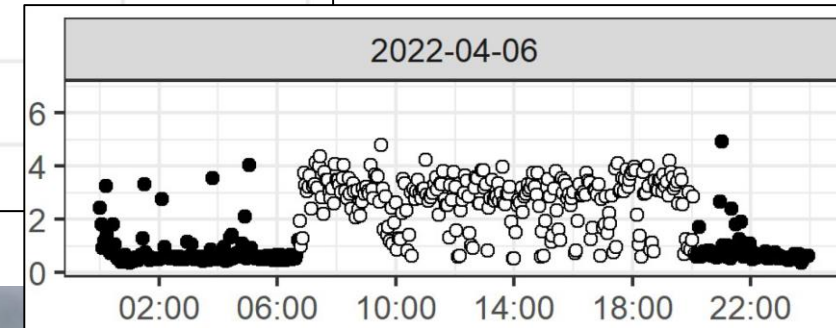
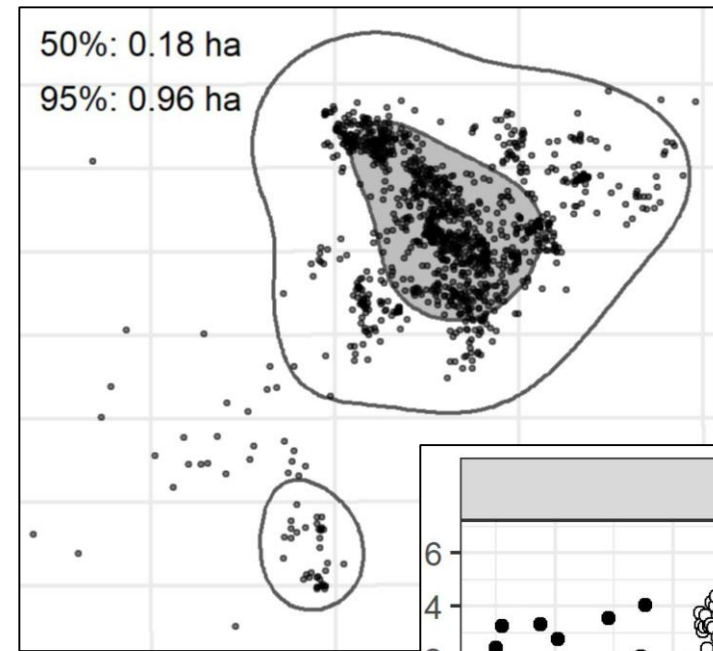


# Local scale inferences

## Node arrays

- UHF only
- Small standalone receivers
- Built-in solar; ~ 0.5 – 2 km range
- Data transfer to base station
- Cost: ~ \$300/node

## Framework for localization



# The guts of Motus

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All data are processed centrally and returned to collaborators and made visible to the public.

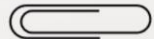
Tags: Battery



Solar



Paperclip (for scale)

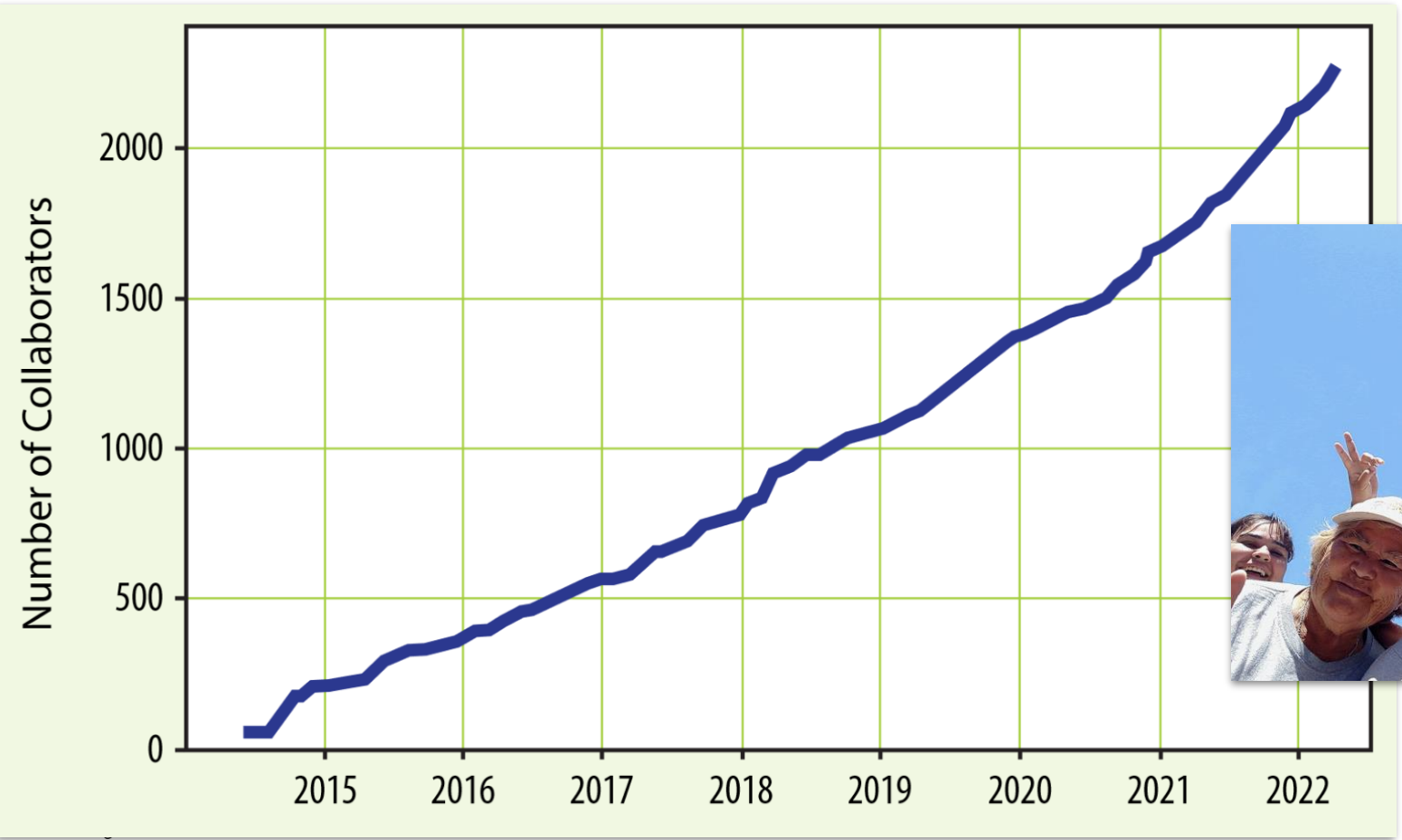
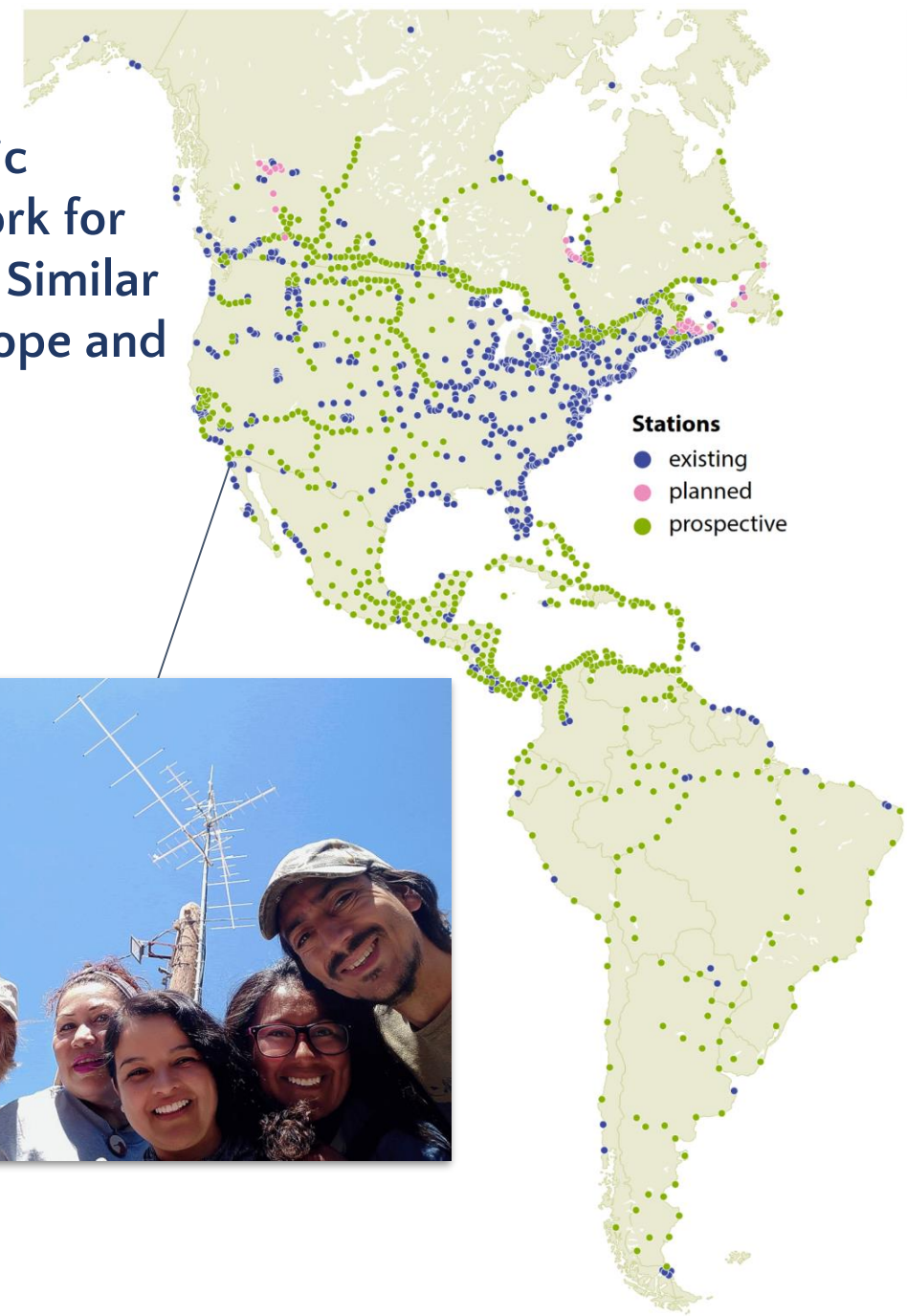






# Motus Community

Conceptual hemispheric infrastructure framework for the Americas by 2030. Similar ambition exists for Europe and other regions.





Red Knot, Yves Aubry

## Motus Strategy to 2030

- [motus.org/strategy](https://motus.org/strategy)

## Collaboration Policy

- [motus.org/policy2022](https://motus.org/policy2022)



# Strategy to 2030

Tracking wildlife, driving science and conservation

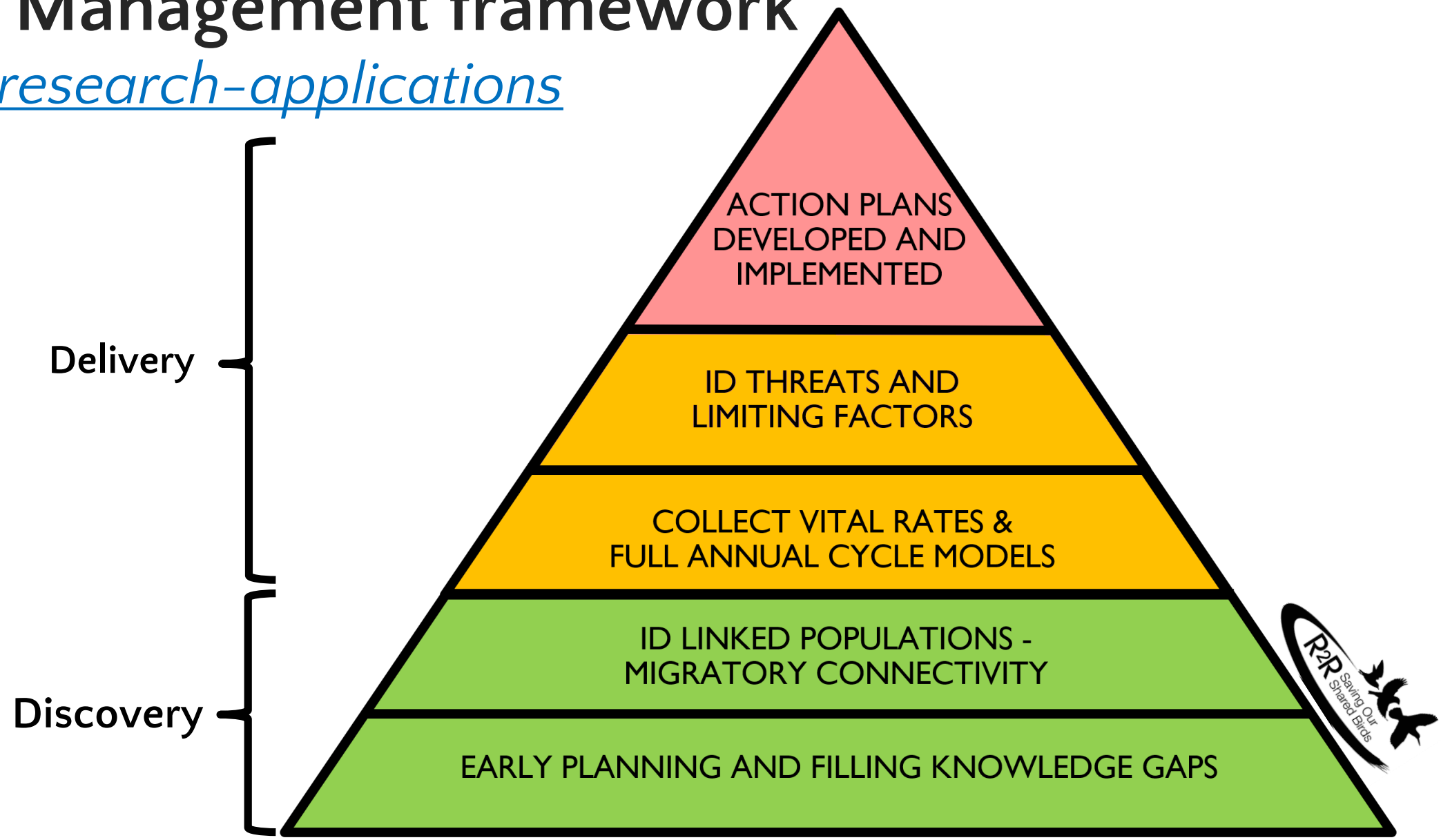
Version 2022





# Resource Management framework

[motus.org/research-applications](https://motus.org/research-applications)



# Motus in the knowledge gaps

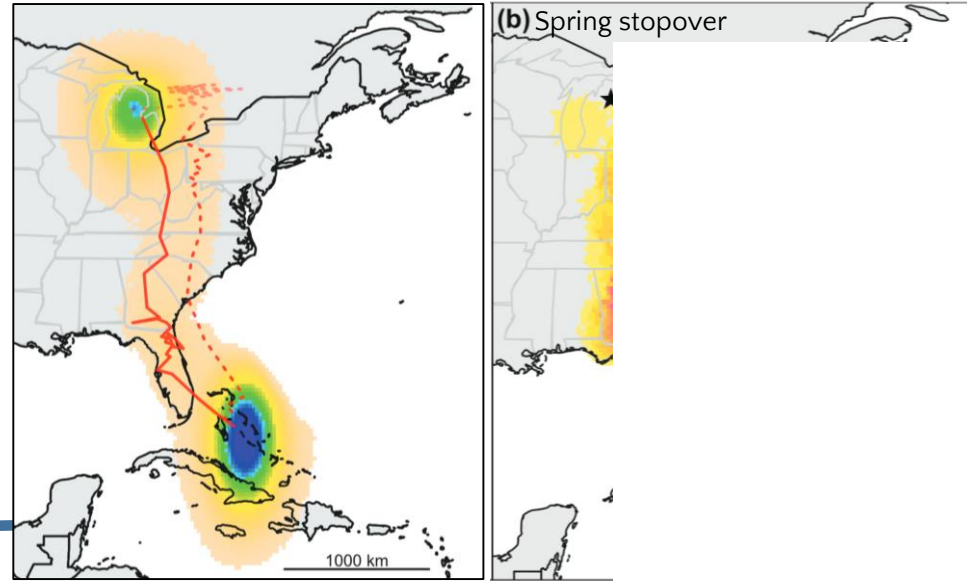
- Stopover duration
- Departure decisions: [Packmor et al. 2020](#)
- Daily activity: [Morales et al. 2022](#)
- Site fidelity: [Neima et al. 2020](#)
- Flight speeds and orientation: [Gomez et al. 2017](#)
- Colony attendance: [Roux and Nocera 2020](#)
- Connectivity; multi-scale movement: [Cooper and Marra 2020](#)

[motus.org/research-applications](https://motus.org/research-applications)

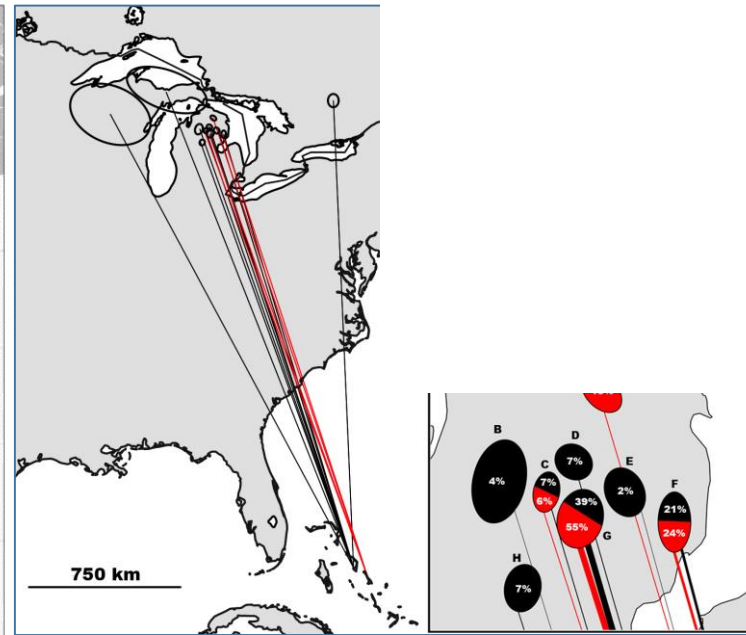
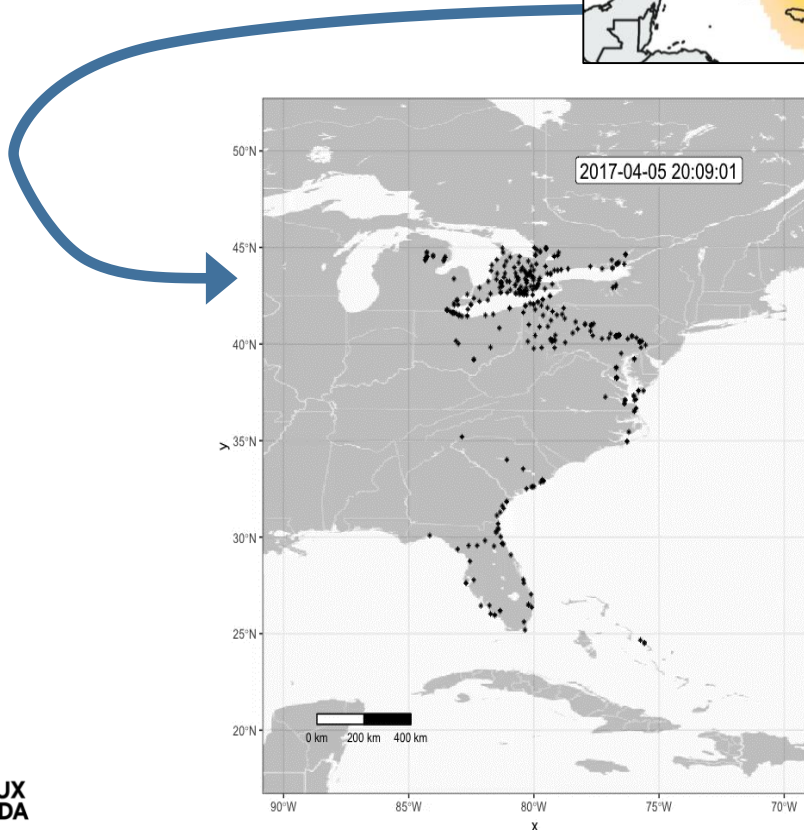
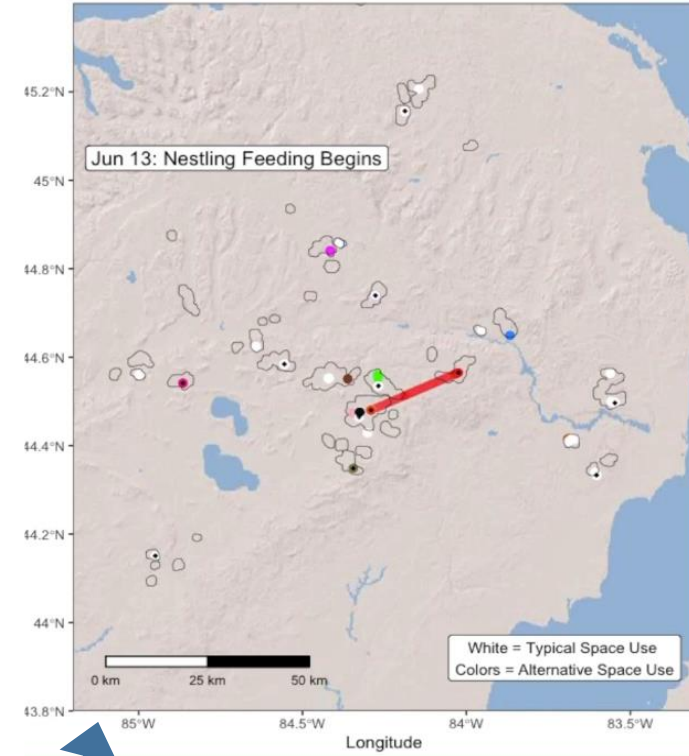


Photo by Tim Romano/Smithsonian Conservation Biology Institute

### Light-level geolocators (Cooper et al. 2017)



### Motus (Cooper and Marra 2020)



### Motus (Cooper et al. 2018)



# Motus conservation delivery

- **Vital rate estimation**
  - [Evans et al. 2019](#) – post-fledgling survival of Barn Swallows
  - [Gomez et al. in prep](#) – apparent survival along migration route
  - [Rushing et al. in prep](#) – seasonal survival estimates and phenology

[motus.org/research-applications](https://motus.org/research-applications)

# Motus conservation delivery

- **Threat identification or risk mitigation**
  - [Bianchini and Morissey 2018](#) – oil spill residue
  - [Eng et al. 2019](#) – neonicotinoid insecticides
  - [Van Vliet et al. 2020](#) – agricultural intensification
  - [Howell et al. 2020](#) – wind energy development
  - [Loring et al. 2021](#) – wind energy development

[motus.org/research-applications](https://motus.org/research-applications)

## Tracking Movements of Migratory Shorebirds in the U.S. Atlantic Outer Continental Shelf Region

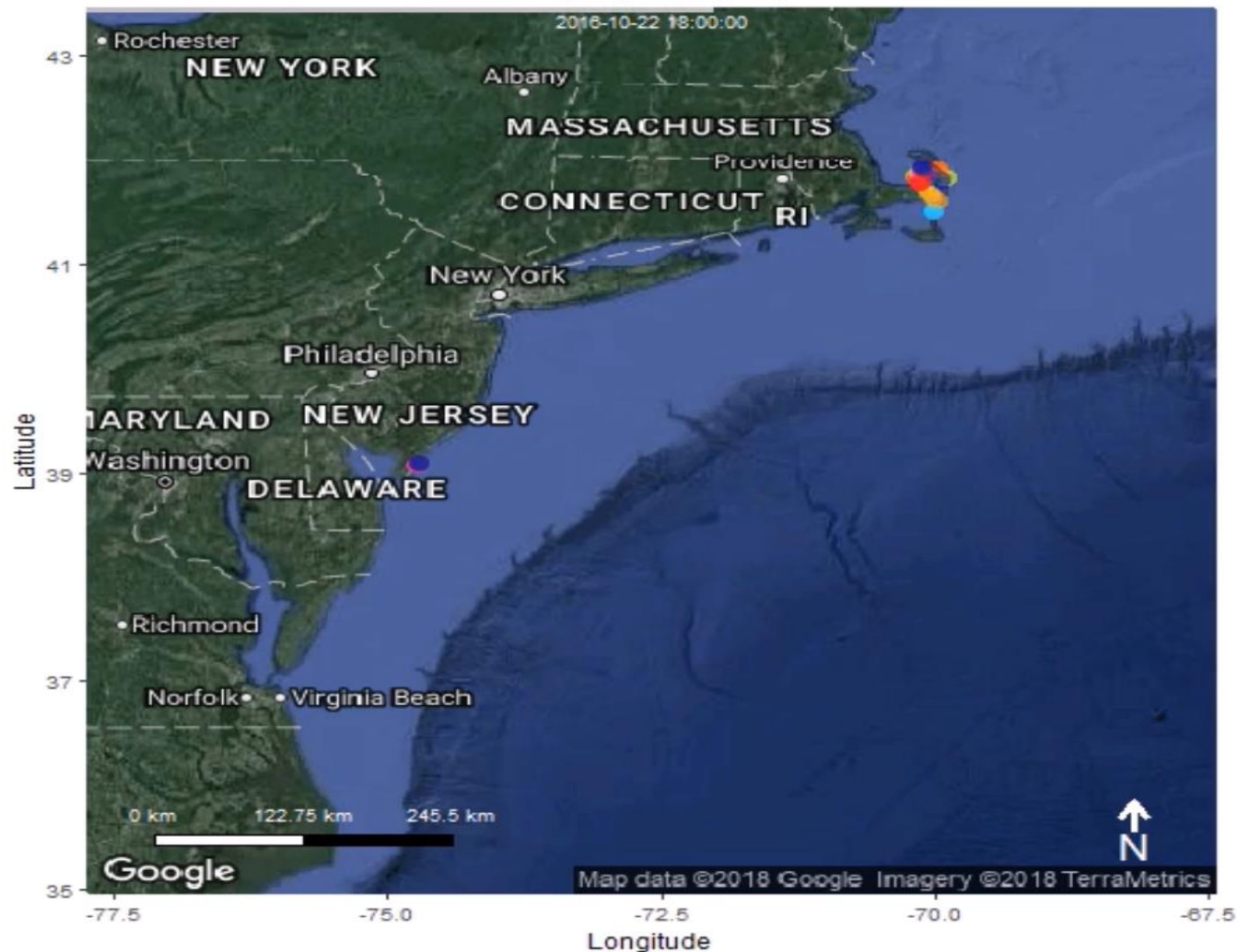


US Department of the Interior  
Bureau of Ocean Energy Management  
Office of Renewable Energy Programs



### Movements of Red Knots - Fall 2016

MA (n=88) and NJ (n=27)



Projection: Geographical, WGS84; Sources: Movebank 2013; Google Maps

# Motus conservation delivery

- **Spatially-explicit conservation/management implications**
  - [Begin-Marchand et al. 2022](#) – timing of forest harvest
  - [Herbert et al. 2022](#) – importance of limited high-quality wetland sites
  - [Gonzalez et al. 2022](#) – wintering habitat carry over effects
  - [Smith et al. 2023](#) – final migratory staging location and prey harvest

[motus.org/research-applications](https://motus.org/research-applications)

# Mobilizing Motus

## Motus Strategy to 2030

[motus.org/strategy](https://motus.org/strategy)

## Collaboration Policy

[motus.org/policy2022](https://motus.org/policy2022)

- Institutional partnerships
- Conservation delivery
- Open data
- International network of regional coordination



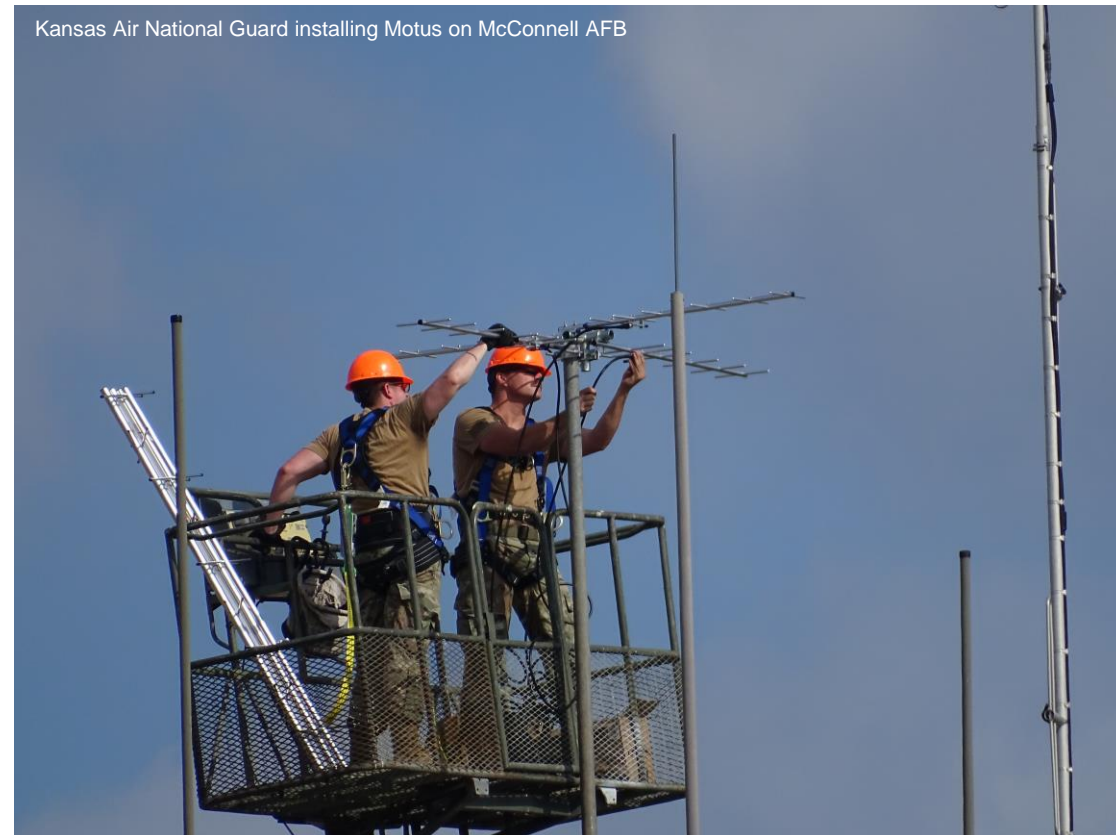
# Key U.S. institutional partnerships

- Department of the Interior
  - USFWS, NPS, USGS, BLM, BOEM
- USDA Forest Service (National Wildlife Program)
- Department of Defense (Nat Res Program, DoD PIF)



# How is Motus Relevant?

- Motus is relevant to DoD in three primary ways:
  - Sampling Tool for INRMP
  - Data informing Flight Safety
  - Opportunities for Collaboration



# Reframing the System

- Conservation infrastructure
- Another tool for surveys
  - Point Counts
  - Line Transects
  - Mist Netting
  - Motus
- Fixed Point Telemetry
  - Opportunities otherwise unavailable
  - Act of passive sampling – at the very least



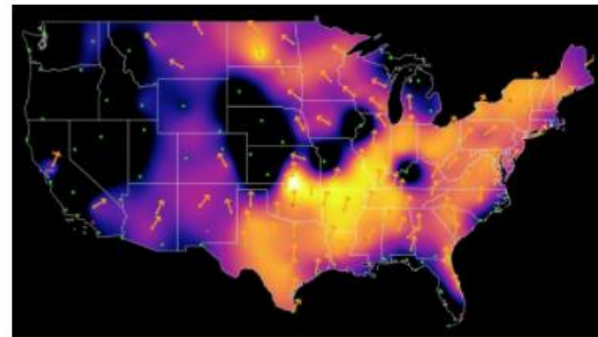
# Relevance to DoD: Sampling Tool

- Sikes Act – INRMP Projects Tool
  - Bats
  - Birds
  - Terrestrial Invertebrates
  - Terrestrial Vertebrates?
- Presence
- Investigate species of interest
- Habitat Use
- Long-term Data Sets and Trends



# Relevance to DoD: Flight Safety

- New kind of data for flight safety
- Deconstruct migration assumptions
- Investigate species of safety concern
- Investigate airfield use
- Use for measuring mitigation actions
- Data can inform flight schedules



Live bird migration maps

# Example Data

## Tag deployment detections

Tag deployment: **American Kestrel (ID# 33721)**

Tag: **AMKE MN#2D190761:5 M.51348**

List of receiver deployments and dates having detections of this tag deployment.

Show detections in: [a table](#) | [a timeline](#) | [a map](#)

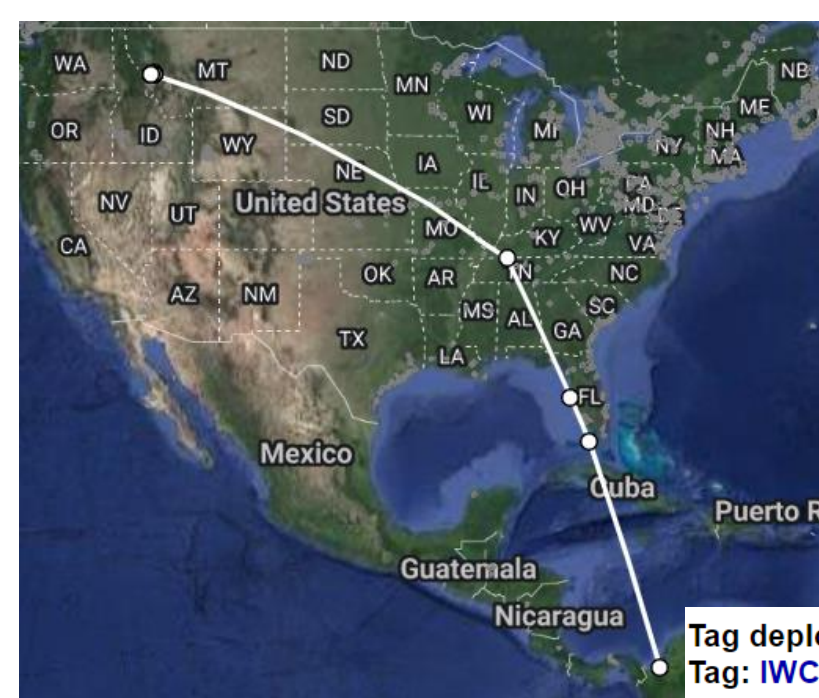
Filter:

100

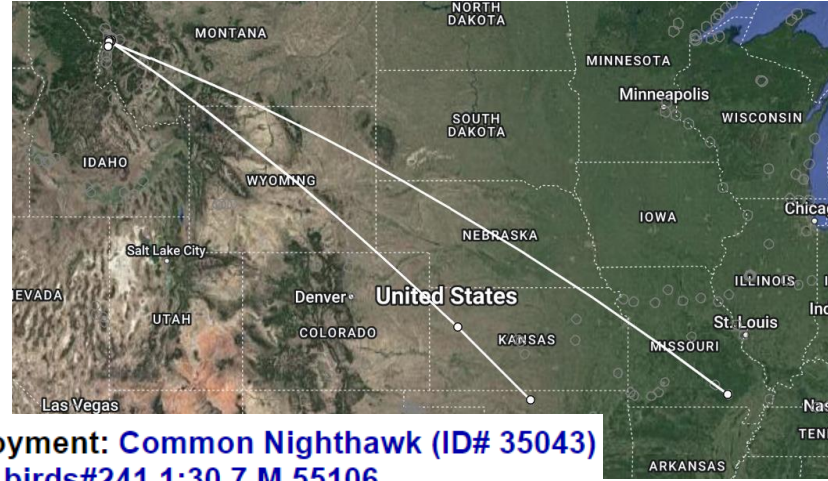
Detection date	Receiver deployment	Latitude	Longitude
2021-06-05	AHATS	45.09°	-93.17°
2021-06-08	AHATS	45.09°	-93.17°
2021-06-09	AHATS	45.09°	-93.17°

2021-07-09	AHATS	45.09°	-93.17°
2021-07-10	AHATS	45.09°	-93.17°
2021-07-11	AHATS	45.09°	-93.17°
2021-07-12	AHATS	45.09°	-93.17°
2021-07-13	AHATS	45.09°	-93.17°
2021-07-14	AHATS	45.09°	-93.17°
2021-07-15	AHATS	45.09°	-93.17°
2021-07-16	AHATS	45.09°	-93.17°
2021-07-17	AHATS	45.09°	-93.17°
2021-07-18	AHATS	45.09°	-93.17°
2021-07-19	AHATS	45.09°	-93.17°
2021-07-20	AHATS	45.09°	-93.17°
2021-07-21	AHATS	45.09°	-93.17°
2021-07-22	AHATS	45.09°	-93.17°
2021-07-23	AHATS	45.09°	-93.17°
2021-07-24	AHATS	45.09°	-93.17°
2021-10-03	MDC PURDIN	39.94°	-93.11°
2021-10-04	MDC COLLEGEMOUND	39.62°	-92.56°
2021-10-04	MDC JENKINS	36.82°	-93.73°
2022-06-20	Longwood Gardens	39.87°	-75.69°

Detection date	Receiver deployment	Latitude	Longitude
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Tag deployment: **Common Nighthawk (ID# 35043)**  
Tag: **IWC birds#241.1:30.7 M.55106**



Tag deployment: **Turkey Vulture (ID# 23093)**  
Tag: **IWC birds#7:11.3 M.34333**

List of receiver deployments and dates having detections of this tag deployment.

Show detections in: [a table](#) | [a timeline](#) | [a map](#)

Filter:

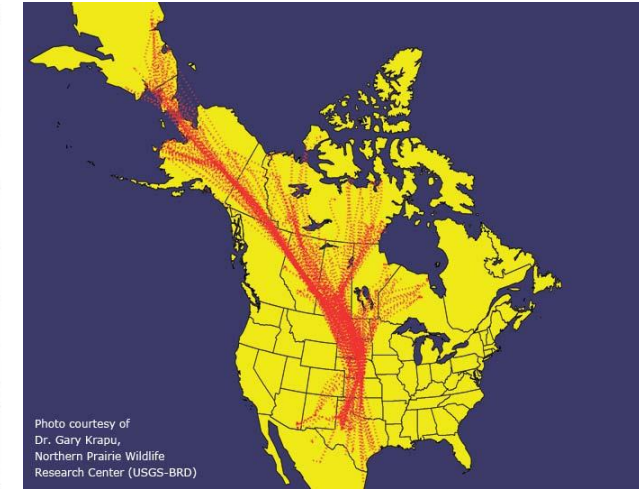
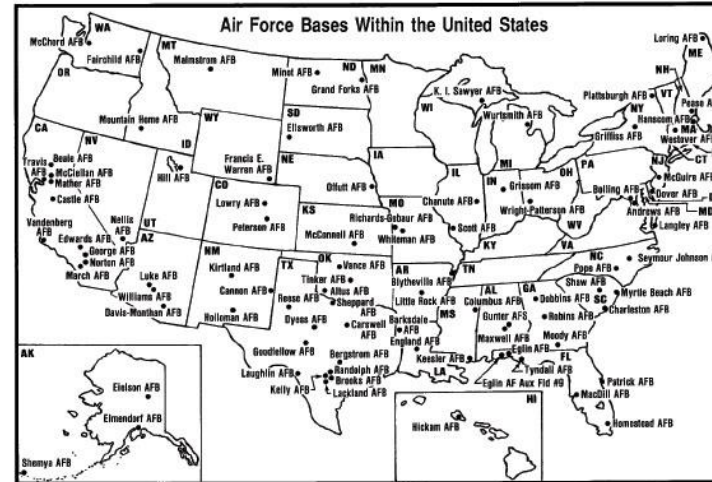
100

Detection date	Receiver deployment	Latitude	Longitude
2019-06-09	Miller Ridge2-MPG-MT	46.76°	-113.97°
2019-07-19	Lee Metcalf National Wildlife Refuge-MT	46.56°	-114.07°
2019-07-20	Lee Metcalf National Wildlife Refuge-MT	46.56°	-114.07°
2019-07-21	Lee Metcalf National Wildlife Refuge-MT	46.56°	-114.07°
2019-07-24	Lee Metcalf National Wildlife Refuge-MT	46.56°	-114.07°
2019-07-26	Lee Metcalf National Wildlife Refuge-MT	46.56°	-114.07°
2020-09-30	Mackay Island NWR, NC	36.53°	-75.99°
2021-10-24	Mackay Island NWR, NC	36.53°	-75.99°



# Relevance to DoD: Collaboration

- Across DoD
  - Species w/wide distribution
  - MSS
  - Bats
- Flyways
- States
- Universities
- NGOs



VOLUME 12, ISSUE 1, ARTICLE 8

Taylor, P. D., T. L. Crewe, S. A. Mackenzie, D. Lepage, Y. Aubry, Z. Cryslar, G. Finney, C. M. Francis, C. G. Guglielmo, D. J. Hamilton, R. L. Holberton, P. H. Loring, G. W. Mitchell, D. Norris, J. Paquet, R. A. Ronconi, J. Smetzer, P. A. Smith, L. J. Welch, and B. K. Woodworth. 2017. The Motus Wildlife Tracking System: a collaborative research network to enhance the understanding of wildlife movement. *Avian Conservation and Ecology* 12(1):8. <https://doi.org/10.5751/ACE-00953-120108>  
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Methodology

## The Motus Wildlife Tracking System: a collaborative research network to enhance the understanding of wildlife movement

Philip D. Taylor<sup>1,2</sup>, Tara L. Crewe<sup>2,3</sup>, Stuart A. Mackenzie<sup>2</sup>, Denis Lepage<sup>2</sup>, Yves Aubry<sup>4</sup>, Zoe Cryslar<sup>1,2</sup>, George Finney<sup>2</sup>, Charles M. Francis<sup>5</sup>, Christopher G. Guglielmo<sup>6</sup>, Diana J. Hamilton<sup>7</sup>, Rebecca L. Holberton<sup>8</sup>, Pamela H. Loring<sup>9,10</sup>, Greg W. Mitchell<sup>11</sup>, D. Ryan Norris<sup>12</sup>, Julie Paquet<sup>13</sup>, Robert A. Ronconi<sup>1,14</sup>, Jennifer R. Smetzer<sup>9</sup>, Paul A. Smith<sup>11</sup>, Linda J. Welch<sup>15</sup> and Bradley K. Woodworth<sup>1,12</sup>

# Examples on DoD

- **Langley AFB**
  - Nodes – Bald Eagle airfield use
- **Grand Forks AFB**
  - Nodes – Airfield bird movement + BASH
- **McConnell AFB**
  - Wichita resident Canada Goose study
- **Fort Indiantown Gap**
  - Bat studies
- **Letterkenny Army Depot**
  - Nodes – Northern Bobwhite translocation
- **Fort Drum**
  - Golden-wing Warbler study

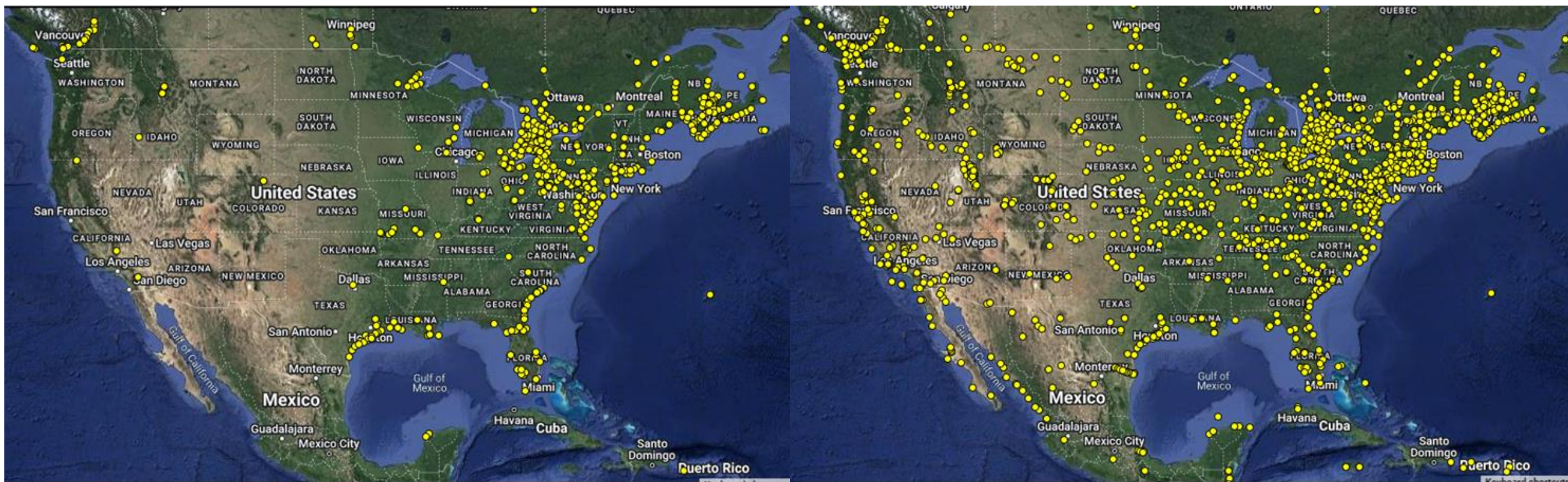




# History of Motus on DoD

- 2020: 3
- 2024: 12 + 22 planned

# Motus Expansion!



2020

2024

# DoD Motus Project – Proof of Concept

- Show efficacy of Motus as a tool for DoD
- ESTCP call for Proposals FY26
- Funding for staff/labor, receivers, and tags
  - DoD PIF MSS
  - BASH
  - Bat

Common Name	Scientific Name	Status
Northern long-eared Bat	<i>Myotis septentrionalis</i>	Endangered
Tricolored Bat	<i>Perimyotis subflavus</i>	Proposed Endangered
Little Brown Bat	<i>Myotis lucifugus</i>	FY24 Determination
Indiana Bat	<i>Myotis sodalis</i>	Endangered
Gray Bat	<i>Myotis crisciens</i>	Endangered
Hawaiian Hoary Bat	<i>Lasiurus cinereus semotus</i>	Endangered
Hoary Bat	<i>Lasiurus cinereus cinereus</i>	FY27 Determination

Table 1. DoD PIF Mission-Sensitive Species

Northern Bobwhite	Bendire's Thrasher
<sup>1</sup> Greater Sage-Grouse	Bachman's Sparrow
Greater Prairie-Chicken	<sup>1</sup> Henslow's Sparrow
Mountain Plover	Tricolored Blackbird
Least Tern (Atlantic Coast Pop)	<sup>1</sup> Rusty Blackbird
Burrowing Owl	<sup>2</sup> Golden-winged Warbler
Southeastern American Kestrel	Cerulean Warbler
Pinyon Jay	

<sup>1</sup>Army Species at Risk  
<sup>2</sup>Undergoing 12-month status review to determine if listing is warranted - no ESA status

Table 2. DoD PIF Tier 2 Species

Scripps's Murrelet	Prothonotary Warbler
Ashy Storm-Petrel	Allen's Hummingbird
Long-billed Curlew	Canada Warbler
Snowy Plover (Gulf Coast)	Virginia's Warbler
King Rail	Loggerhead Shrike
Elegant Tern	Gilded Flicker
Eastern Whip-poor-will	Red-headed Woodpecker
Black-billed Cuckoo	Lewis's Woodpecker
Flammulated Owl	Wood Thrush
Swallow-tailed Kite	Gray Vireo
Le Conte's Thrasher	Chestnut-collared Longspur
Golden Eagle	Yellow-billed Magpie
Greater Yellowlegs	Brown-capped Rosy-Finch
Grasshopper Sparrow	Prairie Warbler
Black-chinned Sparrow	Bell's Sparrow
Kentucky Warbler	Baird's Sparrow
Olive-sided Flycatcher	Lawrence's Goldfinch
Sprague's Pipit	

Tier 2 species are not listed as Army Species at Risk, undergoing 12-month status reviews, or proposed for ESA protection.

**WESTERN U.S.**

- Turkey Vulture
- Canada Goose
- American White Pelican
- Black Vulture
- Red-Tailed Hawk
- Mourning Dove
- Swainson's Hawk
- Snow Goose
- Mallard
- Rock Dove/Pigeon

**U.S. AIR FORCE**

**MOST COSTLY SPECIES**

The ten species on this poster are those that caused the most damage in this region due to aircraft wildlife strikes over the past 15 years. Multiple factors are known to increase the risk and severity of wildlife strikes, including flight at low altitudes, at high speeds, along natural features such as ridges and coastlines, and within 1 hour of sunrise or sunset. Aircrews are required to consider wildlife strike risk during mission planning and may reduce their strike risk by staying informed, being aware, and reporting all wildlife strikes to their local safety office.

Vultures prefer open habitats and feed primarily on dead animals, located by sight and smell. Turkey Vultures are often seen soaring or feeding alone or in small groups and roost communally year-round. Black vultures tend to form larger flocks and roosts of up to 400 birds in the winter months.

Canada Geese and Snow Geese both appear in small to large flocks, and often fly in a V formation. They are attracted to water bodies and open fields or grassy areas to feed on aquatic vegetation, grain, and grass shoots. Geese prefer well manicured lawns for security as this environment allows them to quickly recognize potential threats.

The American White Pelicans are large, white aquatic birds with black wingtips that can be seen in flight. They are attracted to shallow water bodies and feed primarily on fish, often in small groups.

Red-tailed and Swainson's Hawks hunt primarily small mammals from a perch or by kiting over open areas. They can also prey on birds or snakes. Swainson's Hawks consume insects heavily during the non-breeding season. The Red-Tailed Hawk is significantly larger and much more common than the Swainson's Hawk. While the Red-Tailed Hawk is generally solitary or in a mating pair, Swainson's Hawks have been known to migrate in flocks of thousands.

Doves feed on seeds and fruit on open ground. The Mourning Dove is the most abundant dove in the US and prefers brushy, open habitat. The Rock Dove/Pigeon is most common in cities and will also feed on litter and bread crumbs.

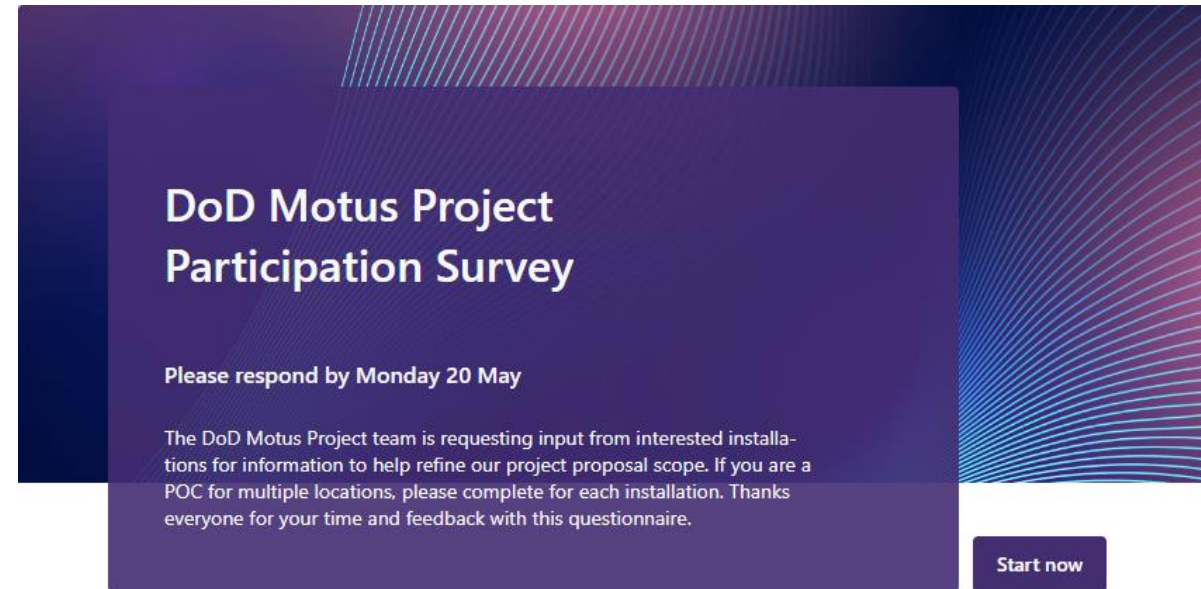
Mallards prefer water with vegetation such as cattails, reeds, and grass. They feed on various seeds and shoots, acorns, and invertebrates. Male mallards have green/blue heads during breeding season and both sexes have a purple/blue and white speculum (visible from the back or side) year round.

**WWW.SAFETY.AF.MIL**



# Where we are now?

- Meeting since early 2023
- Call for Participation
- NMFWA 2024
- 60 installations interested!
- Open to hearing from more!
- Sent our survey to collect data →
- Looking to identify species to tag
- Working through logistics of implementation and management
- Write pre-proposal for FY26 call for ESTCP



# DoD Motus Project Installations



# Is Your Installation Interested?

- **USFWS** – Mike Jungen – michael\_jungen@fws.gov
- **USDA WS** – Jason Kougher – jason.d.kougher@usda.gov
- **American Bird Conservancy** – Adam Smith – asmith@abcbirds.org
- **UNC-Chapel Hill** – Susan Cohen
- **Bird Conservancy of the Rockies** – Matt Webb
- **NAVFAC SW** – Dave McNaughton
- **ERDC** – Doug Raybuck

# Questions?

