Use of Autonomous Aerial Acoustic Recording Systems to Inventory DoD Installation Impact Areas for T&E and at-Risk Bird Populations

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Project Team

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Why Does DoD Monitor Birds?

- **Support the training and testing mission!**
- **Compliance with legislation**
- **Obtain basic inventory data**
- **Identify problems and their causes**
- **Help design management programs**
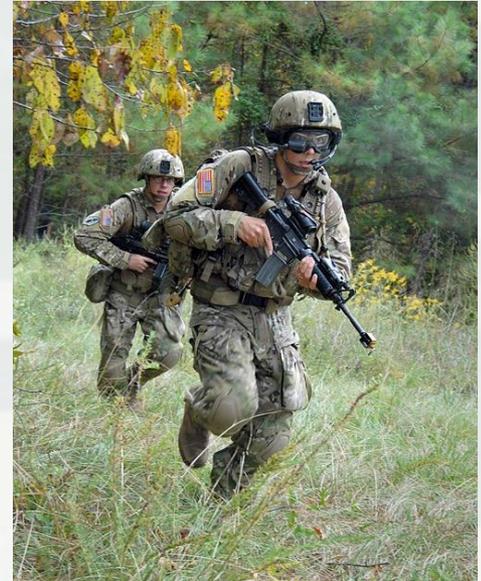- **Evaluate successes and failures of management**

Why Does DoD Monitor Birds?

Monitoring for Support of the Training and Testing Mission

- Support the military mission by ensuring sustained access to land, air and sea resources while:

  - Protecting important natural and cultural resources
  - Meeting all legal requirements
  - Promoting compatible multiple uses

Why Does DoD Monitor Birds?

Compliance with Legislation

- **Migratory Bird Treaty Act (1918)**

- **Endangered Species Act**

- **Executive Order 13186**
  - ❖ **2001 - "Responsibilities of Federal Agencies to Protect Migratory Birds"**

- **Sikes Act**
  - ❖ **Recognizes the importance of military lands for their natural resources and provides mechanism for their conservation while still meeting the military mission.**

- **Migratory Bird Rule**

Why Does DoD Monitor Birds?

Monitoring for Conservation

Shorebirds

Landbirds

Secretive Marsh Birds

Raptor and Upland Game Birds

Waterfowl

"The CBM Plan is intended to insure that DoD meets its conservation and regulatory responsibilities for monitoring birds, especially under the recently signed MOU for migratory birds and the Final Rule authorizing take of migratory birds promulgated by the US Fish and Wildlife Service"

A Coordinated Bird Monitoring Plan for DoD
What have we done so far?

- **Review of existing monitoring programs**
- **Provided guidelines for monitoring surveys**
- **Increased value of monitoring**
- **Identified DoD Mission-sensitive Bird Species of Concern for focused monitoring**
- **Integrated DoD's role into continental programs**
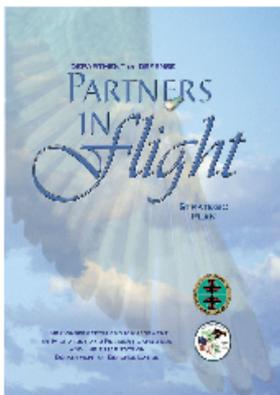- **Mining of archived data into the Avian Knowledge Network at Cornell Lab of Ornithology and USGS/Boise**

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DoD PIF Mission-Sensitive Priority Bird Species

Department of Defense Partners in Flight

Fact Sheet #11
August 2012

Department of Defense Partners in Flight Program

Mission

To conserve migratory and resident birds and their habitats on Department of Defense lands.

Minimizing Future Listings of Bird Species to Protect and Sustain the Military Mission

The DoD Partners in Flight Program has identified nearly 100 bird species that occur on DoD lands and are at risk of becoming listed as threatened or endangered under the federal Endangered Species Act if current populations trends continue. The purpose of this list is to help DoD resource managers better prioritize monitoring and management efforts on those species (and their habitats) having the highest potential to impact the military mission should they become Federally listed. A secondary focus was on those species with significant conservation concern on DoD lands.

To determine what migratory bird species are of highest "concern" to the Department of Defense, each DoD Partners in Flight Working Group member was tasked in 2008 with providing a list of their "Top 10" species of concern within their area of responsibility (exclusive of Federally-listed species). DoD representatives from all regions (Southeast, Northeast, Midwest, West, Alaska, and Hawaii), representing all military service branches, provided the initial input. Installation managers on Oah'u, Kaua'i and Hawai'i were queried for Hawaiian priority species. After two annual meetings of the DoD Partners in Flight Working Group and numerous reviewed iterations of the list, a final list was generated for use as a baseline for making better decisions about how to focus future DoD avian monitoring efforts. All bird species on the USFWS 2010 Candidate Notice of Review list known to occur on DoD lands are included.

In addition to helping prioritize monitoring programs and National Environmental Policy Act (NEPA) documents, the final list will be used as a basis to evaluate proposals for funding from the Legacy Resource Management Program and guide the development of conservation measures to support Executive Order 13186 (*Responsibilities of Federal Agencies To Protect Migratory Birds*), the associated Memorandum of Understanding, and the Final Migratory Bird ("Readiness") Rule. BirdLife Caribbean also reviewed the list and identified Important Bird Areas in the Caribbean where these species over-winter.

Red-headed Woodpecker is one of the species identified by DoD PIF as mission-sensitive for Department of Defense lands. (Photo: Chris Eberly)

To submit changes or comments on the species of concern list, contact:

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Hawaiian species:
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Common Name	DoD Installations			Winter Caribbean	FWS LPN[3]	Genus	Species	Subspecies
	Breed	Winter	Migration					
Northern Bobwhite	X	X				Colinus	virginianus	
[1,2]Greater Sage-Grouse	X	X			8	Centrocercus	urophasianus	
Greater Prairie-Chicken	X	X				Tympanuchus	cupido	
[1]Lesser Prairie-Chicken	X	X			2	Tympanuchus	pallidicinctus	
Ashy Storm-Petrel	X					Oceanodroma	homochroa	
Swallow-tailed Kite	X					Elanoides	forficatus	
Bald Eagle	X	X				Haliaeetus	leucocephalus	
Northern Goshawk	X	X				Accipiter	gentilis	
Golden Eagle	X	X				Aquila	chrysaetos	
Southeastern American Kestrel	X	X				Falco	sparverius	paulus
Prairie Falcon	X	X				Falco	mexicanus	
Yellow Rail	X	X				Coturnicops	noveboracensis	
Black Rail	X	X		X		Laterallus	jamaicensis	
King Rail	X			X		Rallus	elegans	
Snowy Plover (Gulf Coast)	X	X				Charadrius	alexandrinus	DPS
Wilson's Plover	X			X		Charadrius	wilsonia	
Mountain Plover	X	X				Charadrius	montanus	
American Oystercatcher	X	X				Haematopus	palliatus	
Black Oystercatcher	X					Haematopus	bachmani	
Upland Sandpiper	X		X			Bartramia	longicauda	
Long-billed Curlew	X	X				Numenius	americanus	
[1]Red Knot		X	X		3	Calidris	canutus	rufa
Buff-breasted Sandpiper			X			Tryngites	subruficollis	
Least Tern	X			X		Sternula	antillarum	
Gull-billed Tern	X			X		Gelochelidon	nilotica	
Elegant Tern	X	X				Thalasseus	elegans	
[1]Xantus's Murrelet	X				5	Synthliboramphus	hypoleucus	
[1]Western Yellow-billed Cuckoo	X				3	Coccyzus	americanus	
Burrowing Owl	X	X	X			Athene	cunicularia	
Common Nighthawk	X					Chordeiles	minor	
Chuck-will's-widow	X			X		Caprimulgus	carolinensis	
Eastern Whip-poor-will	X					Caprimulgus	vociferus	
Lewis's Woodpecker	X	X				Melanerpes	lewis	
Red-headed Woodpecker	X	X				Melanerpes	erythrocephalus	
Gilded Flicker	X	X				Colaptes	chrysoides	
Olive-sided Flycatcher	X			X		Contopus	cooperi	
Loggerhead Shrike	X	X				Lanius	ludovicianus	
Gray Vireo	X	X	X			Vireo	vicinior	
Pinyon Jay	X	X				Gymnorhinus	cyanocephalus	
[1,2]Streaked Horned Lark	X	X			3	Eremophila	alpestris	strigata
Brown-headed Nuthatch	X	X				Sitta	pusilla	
Coastal Cactus Wren	X	X				Campylorhynchus	brunneicapillus	sandiegensis
Bicknell's Thrush	X			X		Catharus	bicknelli	
Sage Thrasher	X	X				Oreoscoptes	montanus	
Bendire's Thrasher	X	X				Toxostoma	bendirei	
Crissal Thrasher	X	X				Toxostoma	crissale	
Le Conte's Thrasher	X	X				Toxostoma	lecontei	
[1]Sprague's Pipit	X	X			2	Anthus	spragueii	
Golden-winged Warbler	X			X		Vermivora	chrysoptera	
Blue-winged Warbler	X			X		Vermivora	cyanoptera	
Swainson's Warbler	X			X		Limnothlypis	swainsonii	
Lucy's Warbler	X					Oreothlypis	luciae	
Kentucky Warbler	X			X		Geothlypis	formosus	
Cerulean Warbler	X			X		Setophaga	cerulea	
Prairie Warbler	X			X		Setophaga	discolor	
Bachman's Sparrow	X	X				Peucaea	aestivalis	
Brewer's Sparrow	X	X				Spizella	breweri	
Black-chinned Sparrow	X					Spizella	atrogularis	
Sage Sparrow	X	X				Amphispiza	belli	
Grasshopper Sparrow	X			X		Ammodramus	savannarum	
Baird's Sparrow	X	X				Ammodramus	bairdii	
[2]Henslow's Sparrow	X	X				Ammodramus	henslowii	
Saltmarsh Sparrow	X	X				Ammodramus	caudacutus	
Seaside Sparrow	X	X				Ammodramus	maritimus	
Harris's Sparrow		X				Zonotrichia	querula	
Painted Bunting	X			X		Passerina	ciris	
Dickcissel	X					Spiza	americana	
Tricolored Blackbird	X	X				Agelaius	tricolor	
Eastern ("Lilian's") Meadowlark	X	X				Sturnella	magna	lilianae
[2]Rusty Blackbird	X	X				Euphagus	carolinus	

[1]FWS Candidate Notice of Review
[2]Army Species at Risk
[3]LPN: The USFWS assigns a Listing Priority Number to Candidate Species, based on an analysis of the immediacy and magnitude of threats, from 1 (highest) to 12 (lowest).

# Implementation of the DoD Coordinated Bird Monitoring Plan

Objectives:

(a) provide technical advice to DoD biologists on survey design and analysis of survey data,

(b) continue refining the Coordinated Bird Monitoring Database (CBMD) that provides long-term storage for DoD bird survey data, and

(c) to develop various decision support tools, especially one to calculate the fraction of DoD Mission-sensitive Priority Bird Populations that occur on DoD lands (relative to BCR or Global populations).

CBM Implementation Plan

(a) **to develop various decision support tools, especially one to calculate the fraction of DoD Mission-sensitive Priority Bird Populations that occur on DoD lands (relative to BCR or Global populations).**
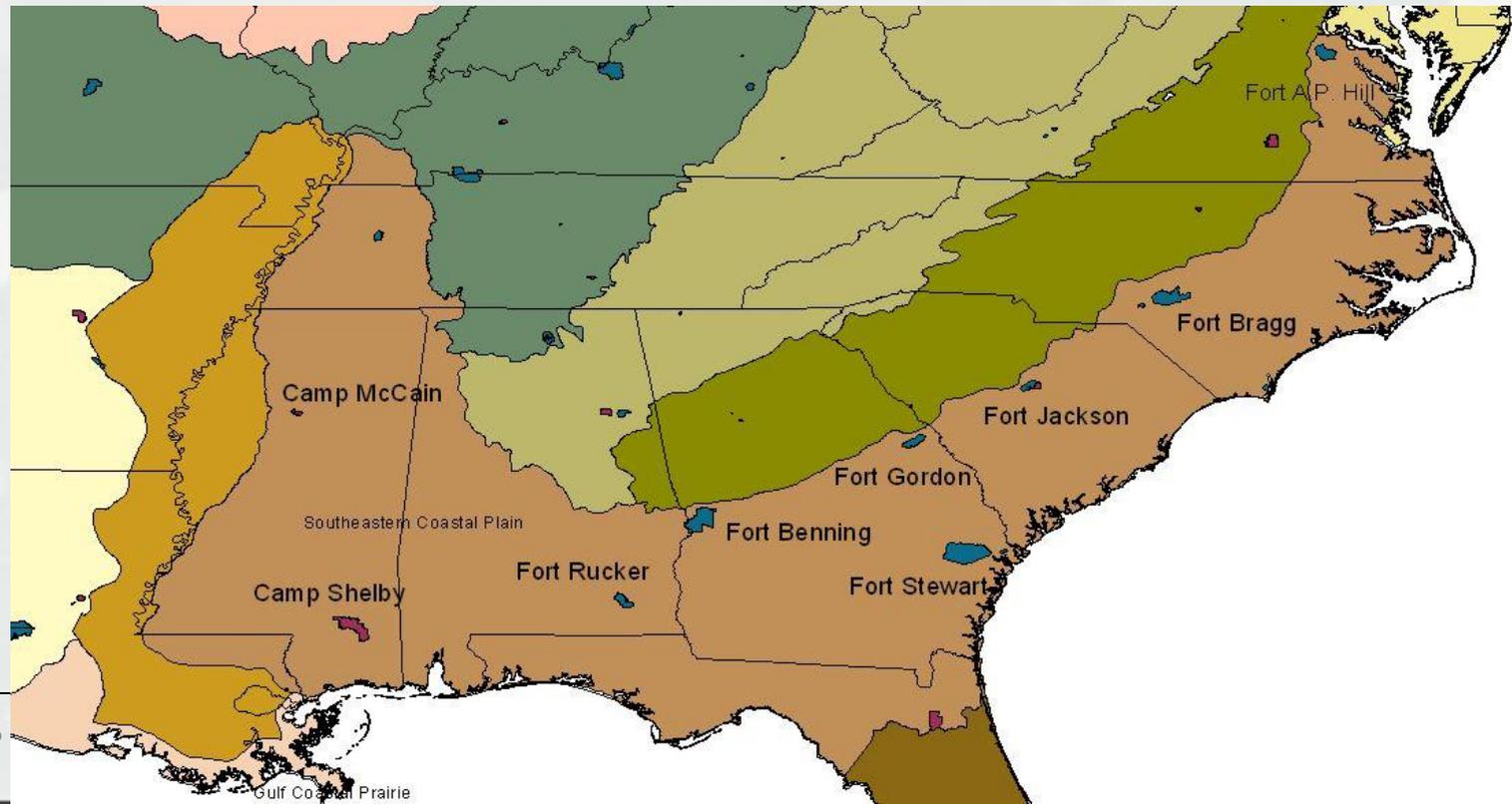
CBM Implementation

This will allow

- **Identification of installations that contribute significantly to SOC populations within BCR's,**

- **Recommendations for monitoring those SOC, and**

- **Assessment of DoD responsibilities relative to NEPA requirements.**

Background

- The DoD administers ~29 million acres of land on over 400 military installations in the United States

- ~425 federally-listed species and ~520 species at risk

- ~250 installations have at least one listed species

- Current best guess estimates suggest there are more than 1,000,000 acres of inaccessible "impact" areas with little to no monitoring data

- DoD needs monitoring data from these areas to contribute to the overall understanding of migratory bird populations inhabiting DoD installation habitats.

Objectives

- Demonstrate the Autonomous Aerial Acoustic Recording Systems (AAARS) capability to collect vocalization data among a variety of species and habitats;

- Properly estimate density of TER-S birds with aerial transect data;

- Show relevance of data for making improved decisions (i.e., regulatory, legislative compliance, stewardship of TER-S birds);

- Train DoD natural resources staff to use AAARS and evaluate their ability to deploy the technology as well as analyze and use data collected; and

- Show cost-effectiveness across a range of DoD installations.

AAARS System

- Lifting system
- Microprocessor
- RF communications
- GPS system
- Altitude control
- Digital audio recorder
- Power supply
- PC-based ground tracking/control stations

Field Operation

- Balloon is released on downwind side of target area
- Vehicle flies with ambient wind direction and speed
- Onboard altitude control
- Recovery is on windward side of target area
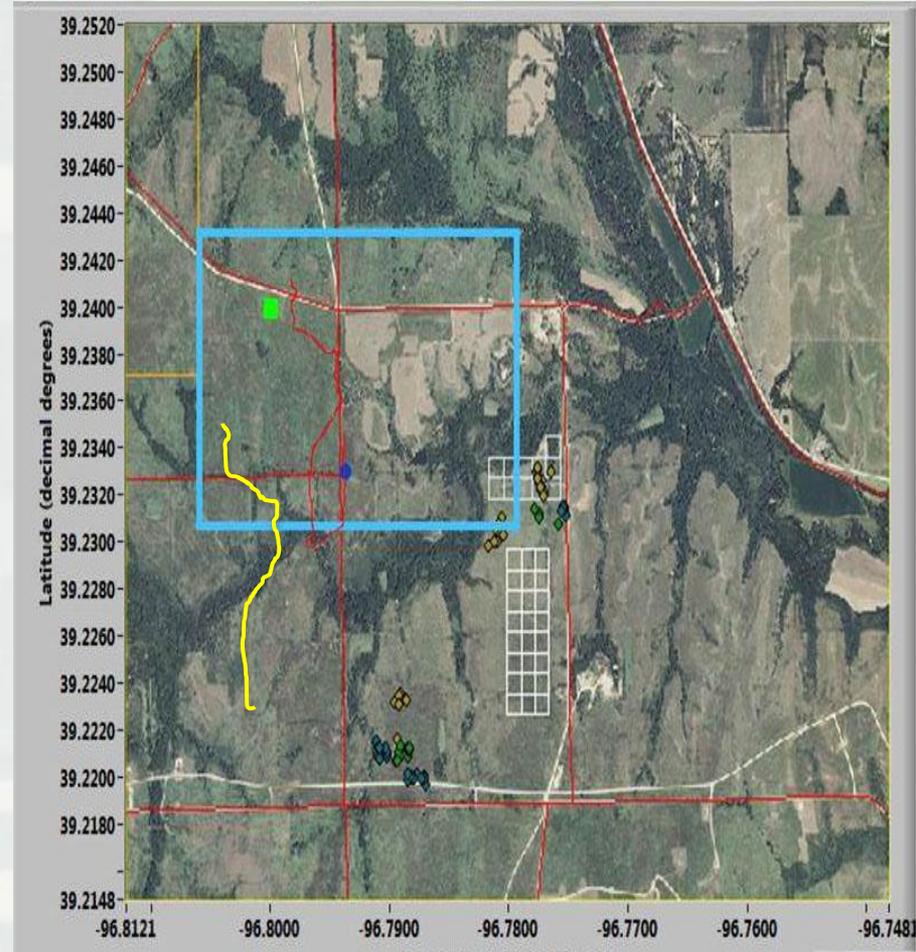
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Recovery

Demonstration Sites

Jefferson Proving Ground, IN

Fort Riley, KS

Fort Bragg, NC
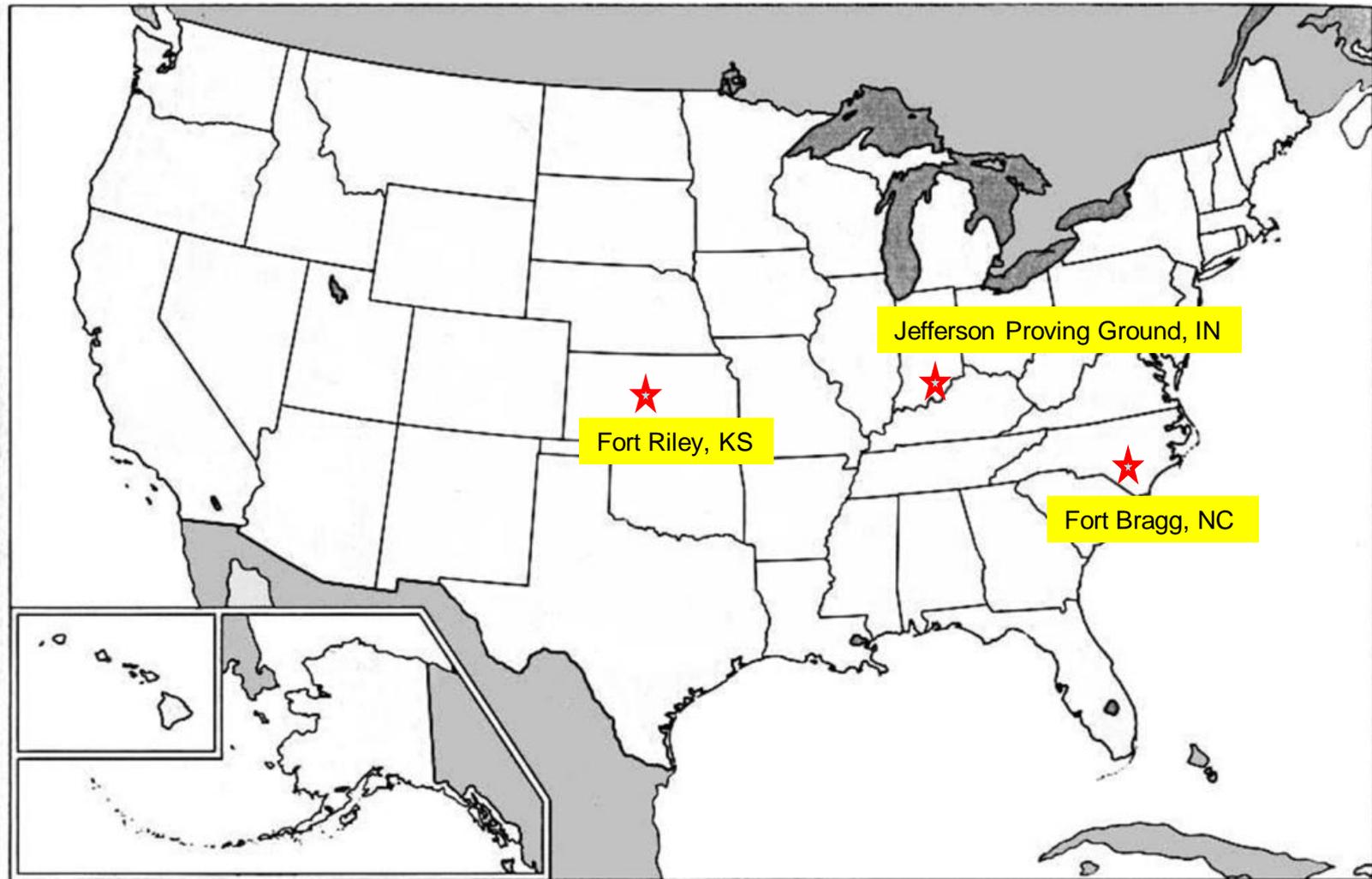
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Focal Species

Henslow's Sparrow

Prairie Warbler

Greater Prairie Chicken

Grasshopper Sparrow

Bachman's Sparrow

Red-cockaded Woodpecker

Northern Bobwhite

Field Sparrow

Conceptual Test Design

Static validation tests under controlled environment at University of Tennessee

Audio simulation grid, AAARS

Static and dynamic validation tests under field conditions

Audio simulation grid

AAARS and human observers

Static and dynamic validation tests under field conditions

Real avian sources

AAARS and human observers

Analyses of audio files

Correct classification rates, density estimates for AAARS and human observers

UT Environmental Sensors Lab

Bird Song Simulators

- UT Biosystems Engineering developed computer remote-controlled mp3 players

- Play target species audio tracks of actual bird songs from Cornell library

- Programmable by species, timing, location

- Unique label on each track to allow for identification of target species and individuals

- Calibrated to field-measured amplitude for each species

- Produces absolute known place and time for target species

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Static Test Design

- 10-min point count
- AAARS vs. human observer
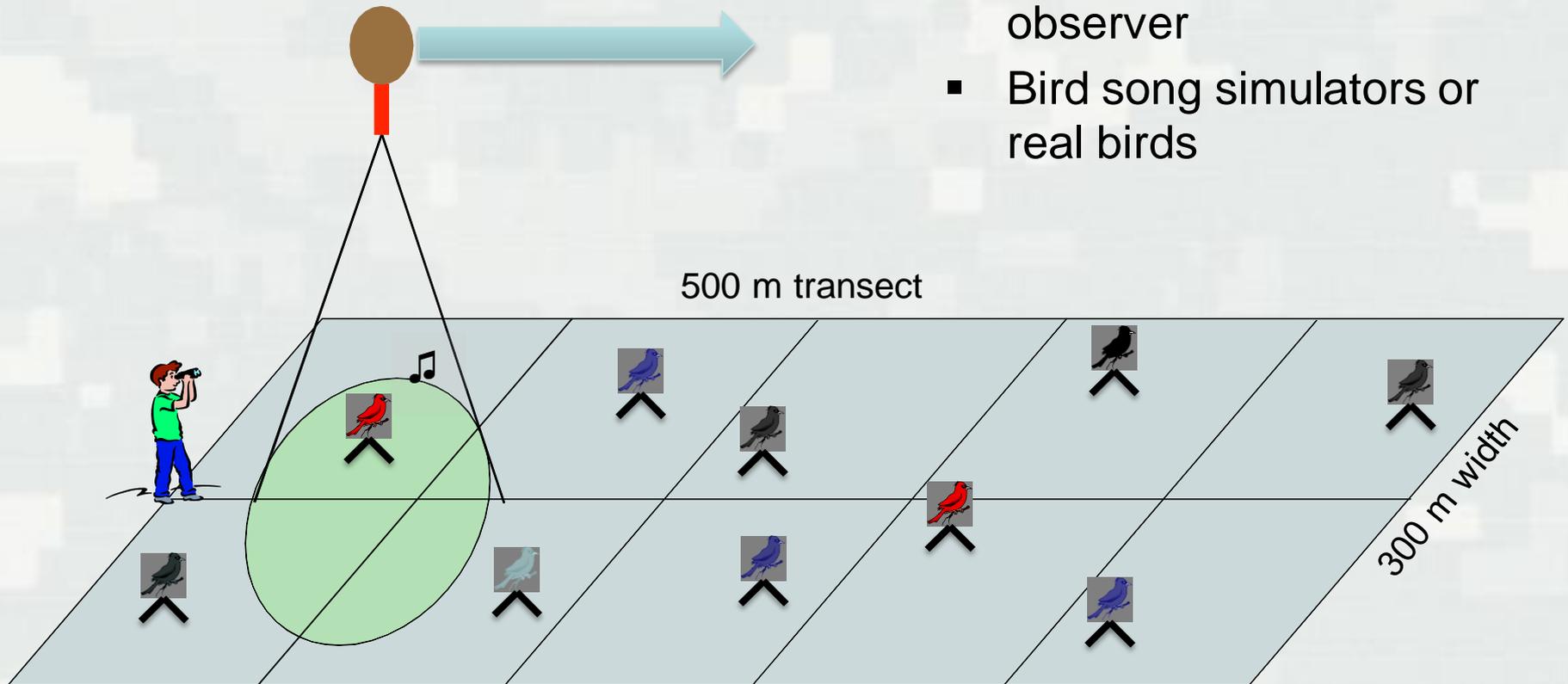- Bird song simulators or real birds
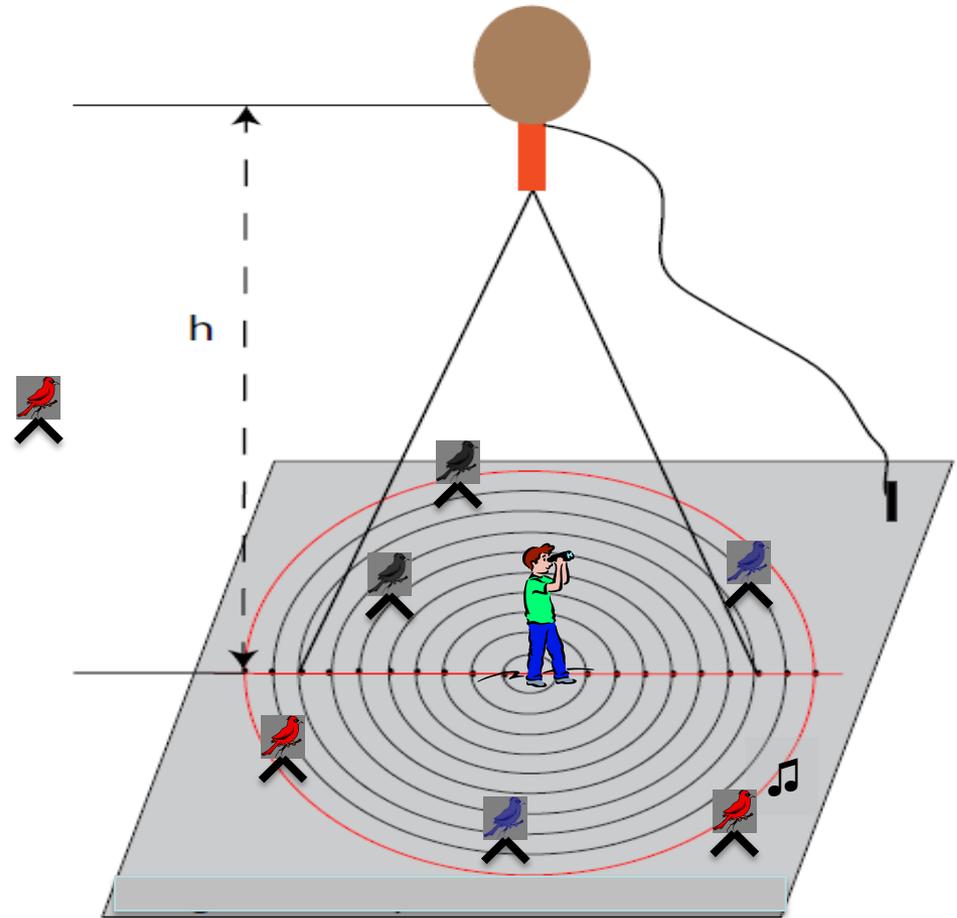
150 m radius

Dynamic Test Design

- 500-m line transect
- AAARS vs. human observer
- Bird song simulators or real birds

500 m transect

300 m width

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Supplemental Field Studies

- Territory size for focal species
  - ► Map territories of sample of males to document mean territory size
- Song frequency for focal species
  - ► Place automated recording units in center of territory of target species
  - ► Document song frequency by time of day and day of season
- Develop song library for focal species

Analysis of Acoustic Data

- MATLAB, XBAT, and RavenPro software
- Analyze acoustic files for detections of focal species songs based on spectrogram matching, Band Limited Energy Detection, amplitude detection, and neural networks
- Developed Neural network-based spectrogram analysis at UT
- Validate the correct classification rate of the AAARS data for comparison with human-collected data
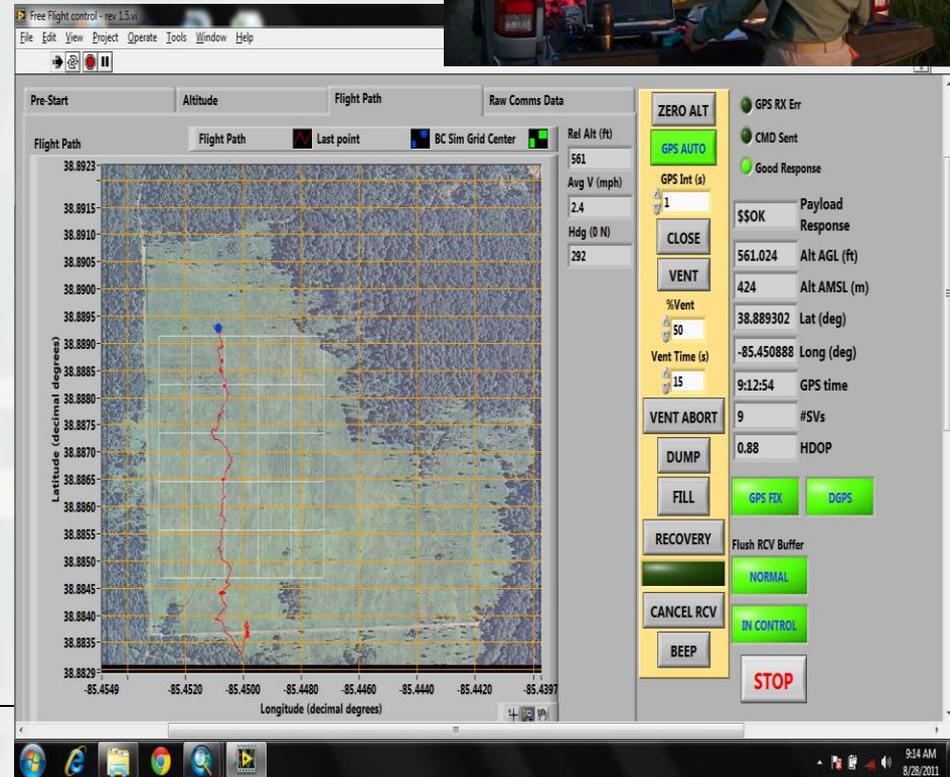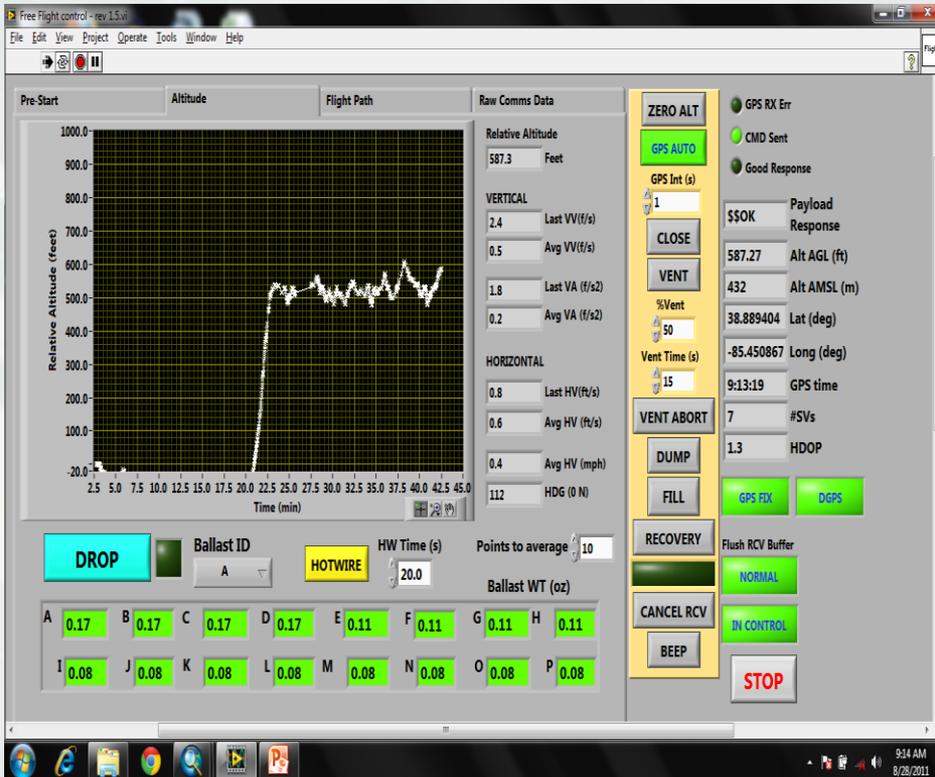
Technical Progress - Hardware

- Designed and built AAARS systems
  - ► n = 6 in 2011
  - ► n = 10 in 2012
  - ► n = 10 in 2013
- Designed and built base station communication modules
  - ► n = 6 in 2011
  - ► n = 6 in 2012
- Designed and built bird song simulators
  - ► n = 60 in 2011
  - ► n = 50 in 2012

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Technical Progress- Software

- Base station computer interface with Labview software

Altitude tracking and control
Location tracking and control

Technical Progress
Data Acquisition

As of July 2013…

- 2 field seasons completed at each research site

    - 405 successful flights total

    - 280 successful free flights

    - 325 Point counts

    - 321 Line transects

Technical Progress
Validation of Performance

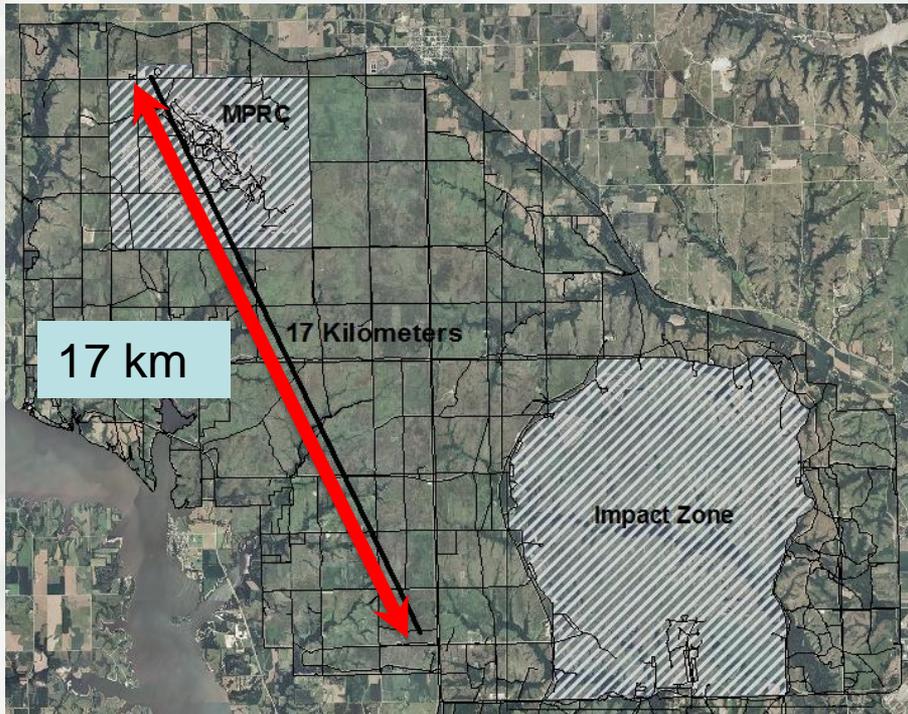Conducted 335 free flights at Fort Riley, Fort Bragg, and JPG in 2011-2013

- ♦ **95%** success on pre-flight
- ♦ **95%** hit target area
- ♦ **89%** maintained target altitude
- ♦ **83%** with good audio data
- ♦ **99%** were recovered
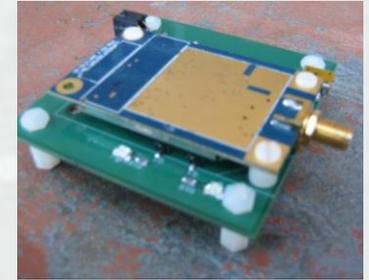- ♦ Total Free Flight Success (with audio) = 74%

Technical Progress
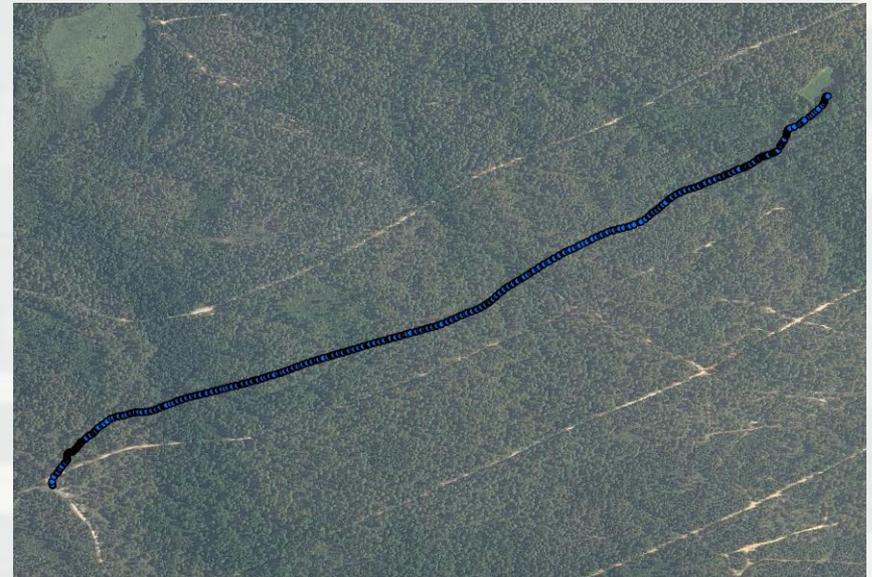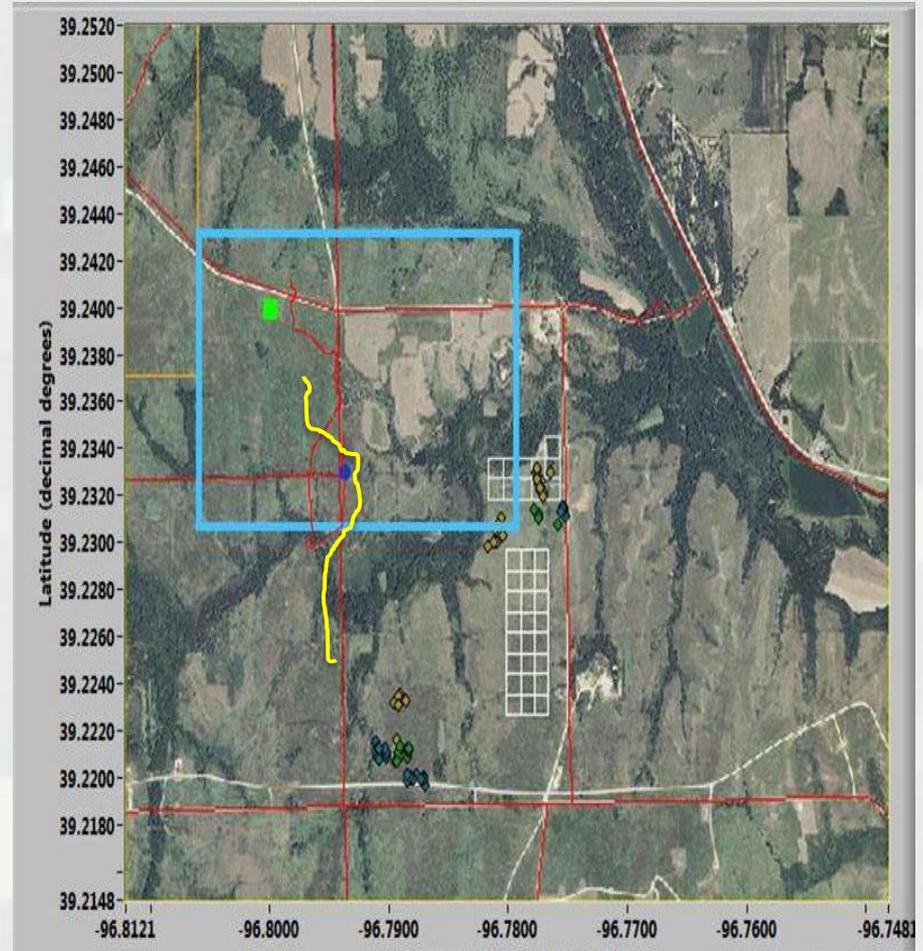# Validation of Performance

- Communications

Yagi antenna

1 W RF modem

17 km

MPRC

17 Kilometers

Impact Zone

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Validation of Performance

- Latitude/Longitude Control- "Fly the GPS box"

- Based on 31 flights at JPG with box:
  - 30 successful recovery
 - 1 box did not work (user error?)
  - ▶ 96% success
- Altitude limit?

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Technical Progress
Validation of Performance

- Microphone Footprint
  - ► Tethered AAARS at point-center
  - ► Walked song simulators down transect and stopped at 10-m intervals out to 300 m
  - ► Played 2, 5, and 8 kHz tones at each stop at target bird amplitudes
  - ► Conducted tests at 100 m, 200 m, and 300 m altitudes (h)
  - ► Analyzed the resultant audio files to determine effective detection distance horizontally and vertically

h

Song simulators placed at 10 m intervals
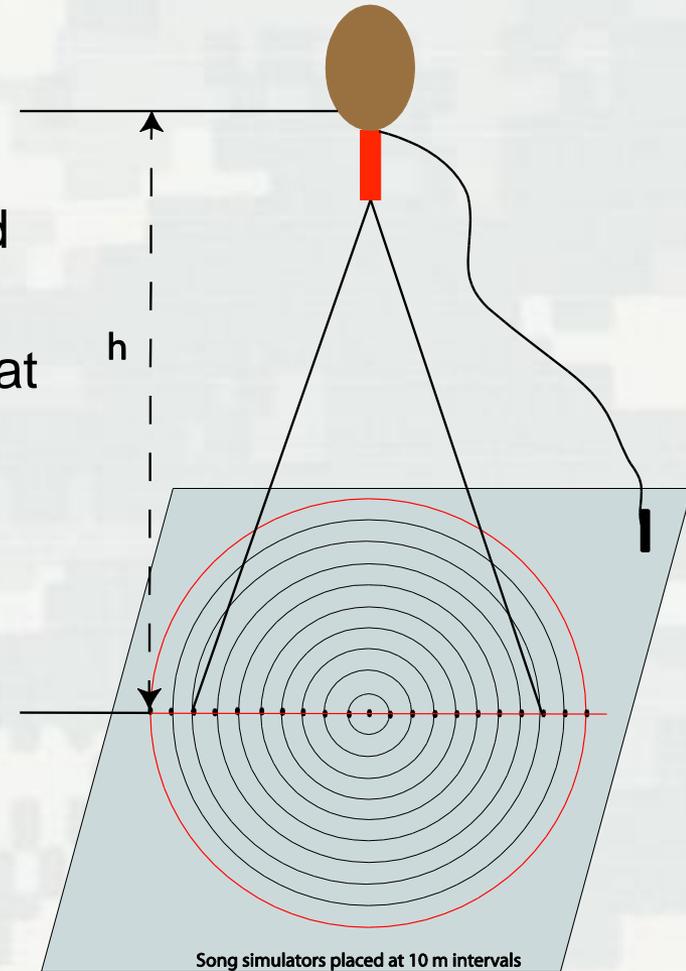
Technical Progress
Validation of Performance

- Detection Rates- Real and Simulated Birds
  - ► Target = 90% for simulated birds and 80% for real birds
  - ► Results from <u>simulated</u> bird point counts
    - 88% for HESP detection (8.5% False Positive)
    - 83% for PRAW detection (5.0% False Positive)
    - altitudes between 100-200 m
    - based on a 3-7 detector models in XBAT

Technical Progress
Validation of Performance

- AAARS accuracy and precision of detections compared to estimates from human observers
- AAARS classification rates- simulated birds and real birds compared to human observers
- Prairie Warbler analysis- AAARS vs. humans

|	Available	Human Detected	AAARS Detected
JPG	129	83 (64%)	117(91%)
FB	139	110 (79%)	135(97%)
TOTAL	268	193 (72%)	252(94%)

AAARS vs. Human Observers

- AAARS- 1 morning, 3 people
  - ► 5 flights @ 10 km per flight @ 300 m altitude and 10km/hr speed
  - ► 3000 ha surveyed
  - ► ~300 min of audio data
- Human Observers- 1 morning, 3 people
  - ► 10-min pt counts
  - ► 10 counts per observer/day x 3 observers = 30 pt counts
  - ► 300 min of audio data
  - ► 100-m radius pt count = 3.14 ha x 30 counts = 94 ha surveyed
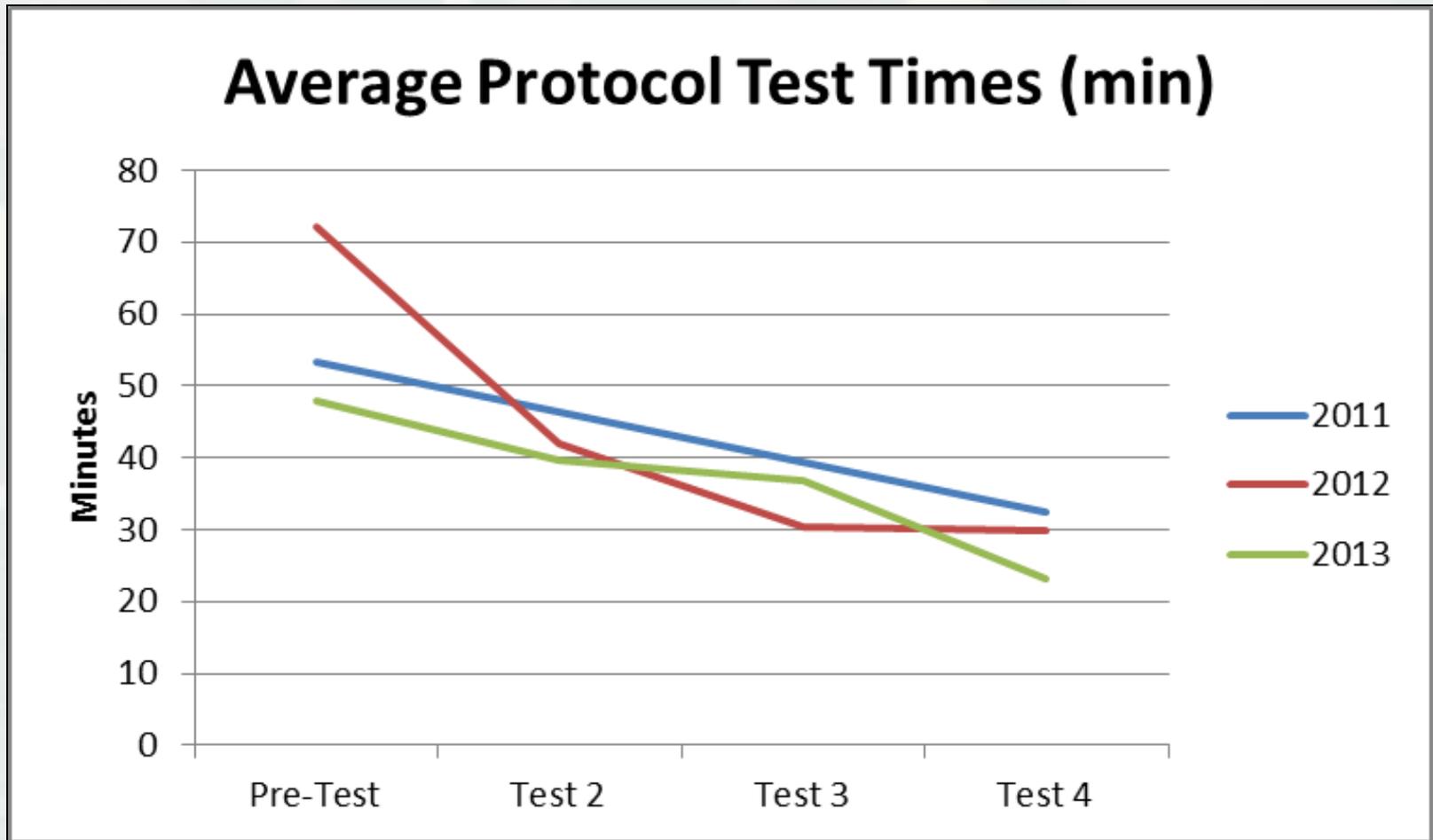- 33x the area covered, similar amount of audio data
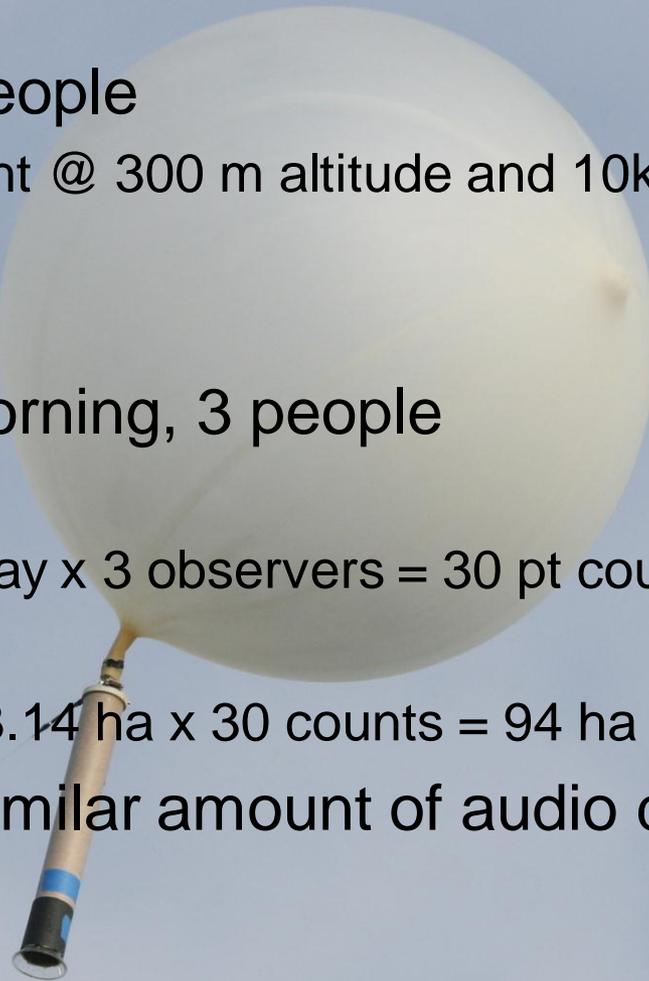
Cost

- AAARS fabrication = $1000 per unit
- Base stations (3/installation) = $1000 per base station
- Field operation
  - ▶ 3 trained personnel
  - ▶ 5 flights per morning
- Acoustic Analysis
  - ▶ costs still to be determined

AAARS vs. Human Observers
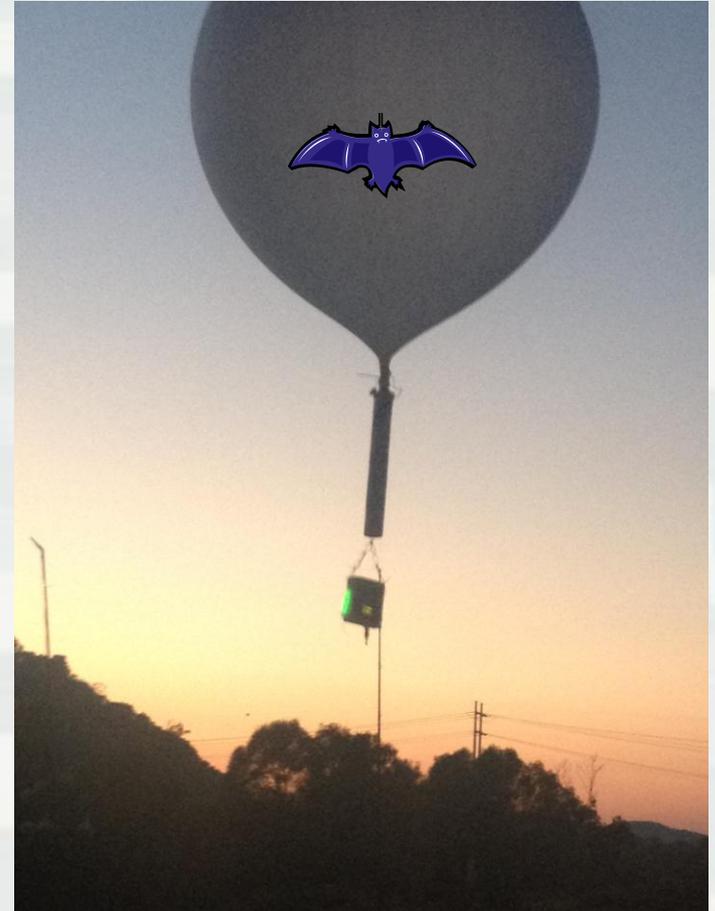

Average Protocol Test Times (min)
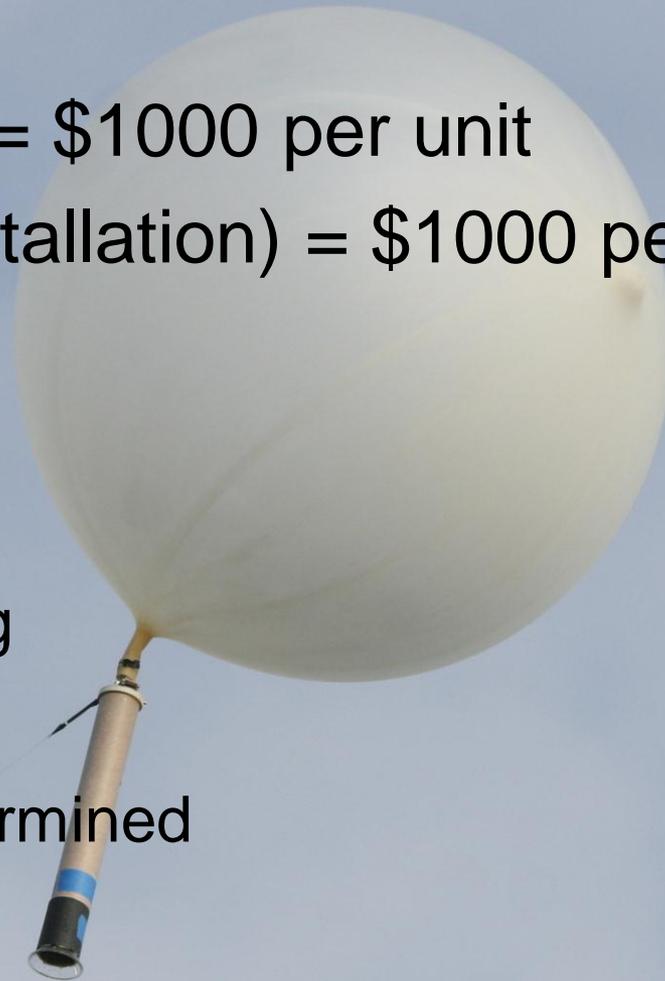
Other Applications?

- Initial feasibility assessment for adding bat detection technology to AAARS

Pettersson bat detector with balsa wood box, hanging attachments, and Li-Ion battery

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QUESTIONS?