Post Construction Monitoring of Birds and Bats at Maple Ridge Wind Farm.

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North East Ecological Services

OLD BIRD

Presentation Outline

- Background
- Goals/Objectives
- Data collection methods
- Analyses and outputs

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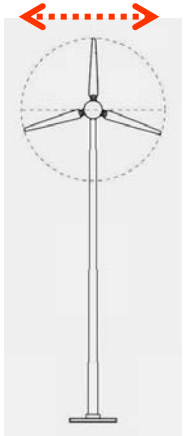
Blowin' in the Wind

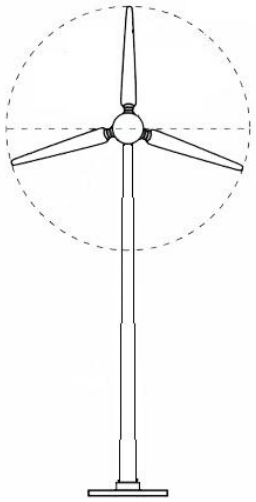
- Globally
  - Wind power generation is the fastest growing energy sector (~ 20% annually)
- USA
  - 2nd largest producer of wind energy globally
  - 11,600 MW installed as of 2006
- Higher capacity (MW)
  - Generate more power/unit operation time
- Lower cut-in speed
  - Wind speed needed to generate electricity

Changes in Technology

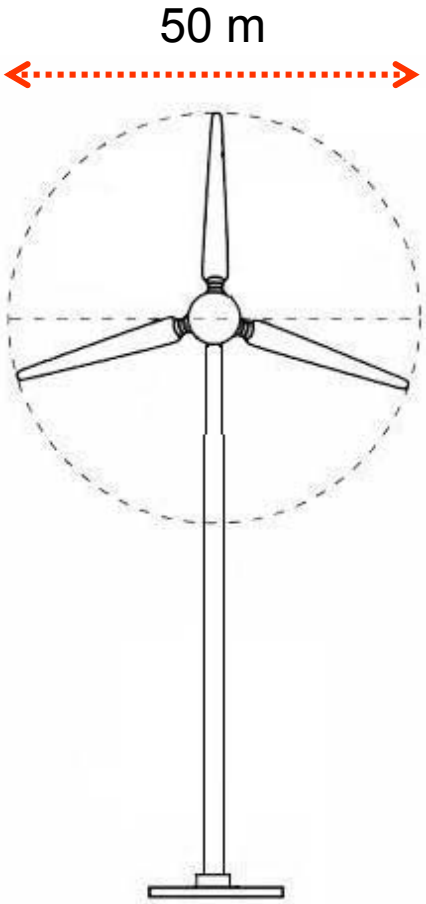
Modified from CWR, 2005



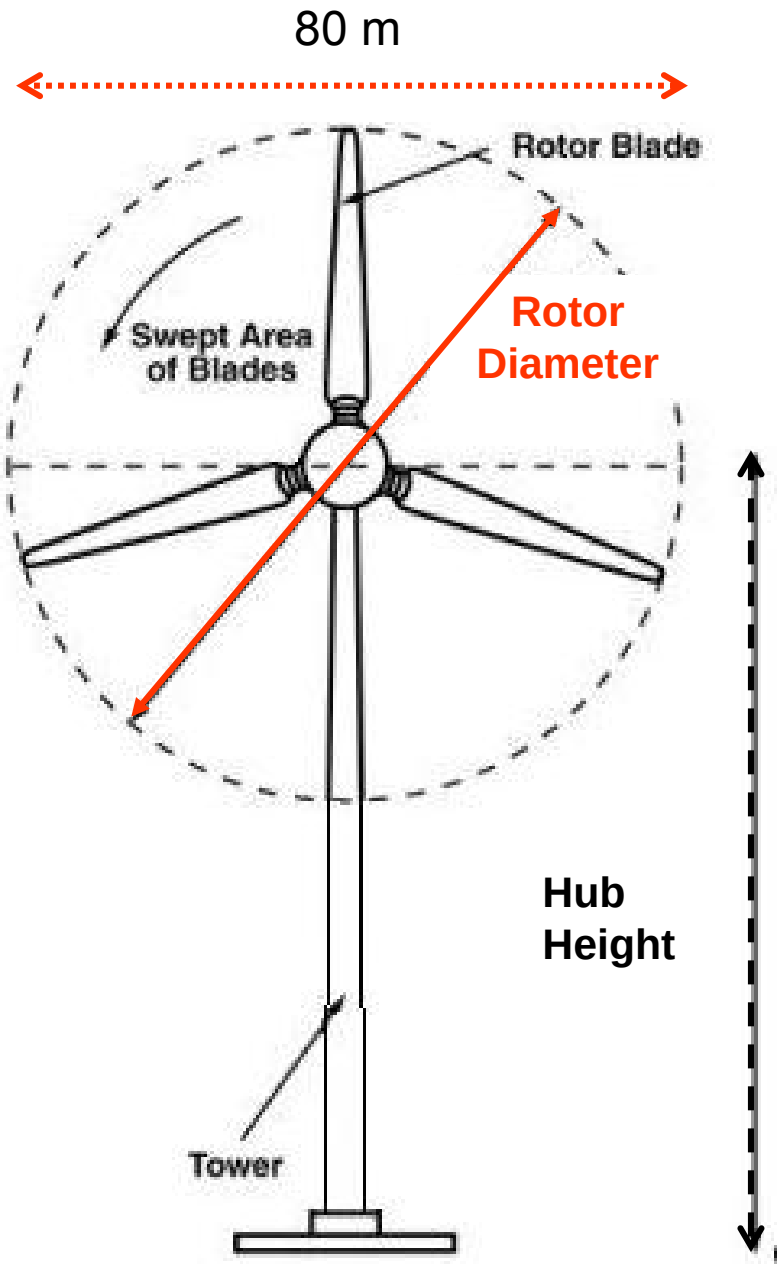
1981



2001



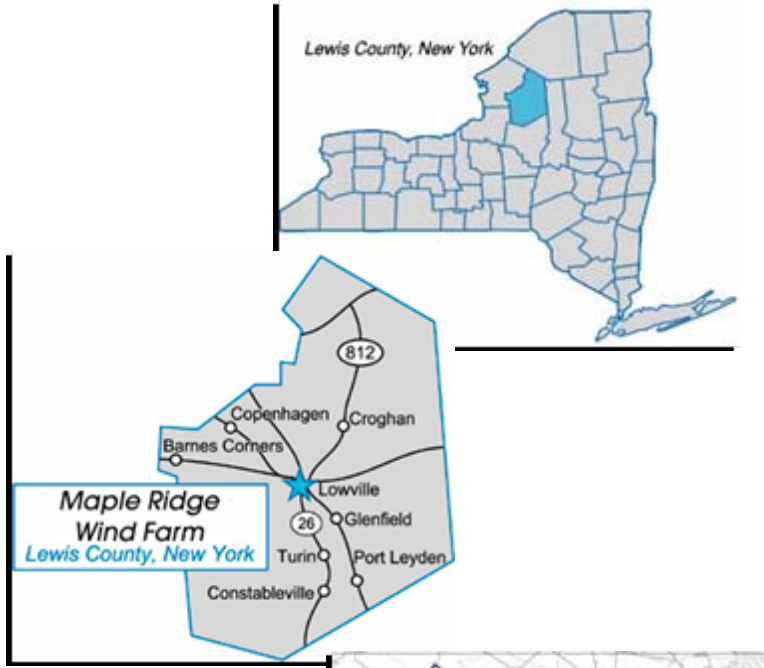
2004

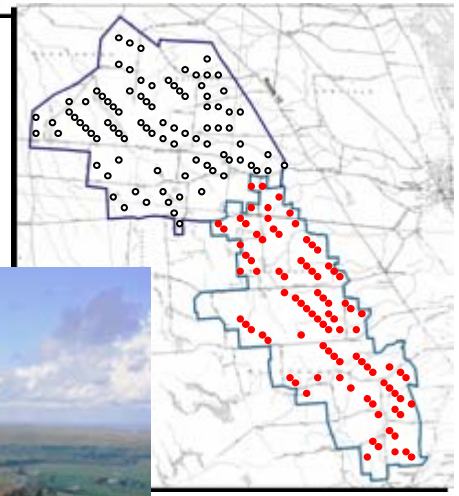


2007

Maple Ridge Wind Farm

- Tug Hill Plateau, Lewis County, NY
  - Elevation range ~400 - 600 m
  - Mosaic of habitat types
    - Open crop fields and pastures
    - Successional old field and shrubland
    - Woodlots, wooded wetlands, and riparian zones; contiguous forest in western region
- Largest wind power facility east of the Mississippi River
  - 196 wind turbine generators, 1.65 MW each
    - Hub height ~80 m, rotor diameter ~80 m
    - Turbine strings and individual turbine sites
    - ~19 km long, ~8,500 hectares





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Project Goals

- Provide data and analyses that assist in precise and cost-effective determination of impacts (e.g., mortality) to birds and bats at wind power generation sites in New York
- Relate those impacts to forecasted numbers based on pre and post construction monitoring (i.e., relationships between exposure and effect)
- Provide findings to resource managers and policy makers interested in assessing the effects of wind power development on wildlife

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Project Objectives

1. Use multiple methods to assess potential risk of birds and bats colliding with wind turbines
   - Quantify bird/bat movement patterns (rates, altitude and flight direction) during passage through the project area
   - Investigate how meteorological conditions modify patterns
2. Determine relationships between collision risk (pre and post construction assessments) and collision incidents
   - Investigate how meteorological conditions modify these relationships
3. Compare results of pre and post construction collision risk assessments
4. Evaluate the precision and efficacy of assessment methods

❖ Maple Ridge post construction wildlife monitoring project is unique – i.e., simultaneously evaluating relationships between risk and effect

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Why birds *and* bats?

- Exposure and effect relationships are different for birds and bats
  - Preliminary mortality study at Maple Ridge Wind Farm in 2006 suggests that bat collision incidents occur 3-6 times more frequently than in birds
- Design or operation modifications to resolve conflicts with bats may be different than with birds

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Data Collection Methods

- Estimate exposure (i.e., risk)
  - Dual marine radar system (passage rates, flight altitude, flight direction)
  - Bird/bat acoustic detection (passage rates, species identification)
  - Optically enhanced nocturnal surveys (passage rates, flight direction)
- Estimate effect
  - Collision incident searches
  - Acoustic strike detection

Multi methodological approach

- Each method, by itself, is incapable of providing a comprehensive account of exposure or effect (e.g., radar cannot distinguish between birds and bats)
- Improves confidence in data from specific monitoring methods and strengthen the overall conclusions of a study
  - Redundancy a priority recommendation from August 2006 NY Wind/Wildlife Technical Workshop

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Dual Marine Radar System

- Two 25 kW X-band (3 cm wavelength) radar units
  - 6.5 foot open array antennas
  - Beam 1.23☜(w) x 20☜(h)
- Operate simultaneously in vertical and horizontal planes

Vertical scanning mode

- Antenna rotates perpendicular to ground
  - Used to estimate (1) target altitude, (2) target passage

Horizontal scanning mode

- Antenna rotates parallel to ground
  - Used to estimate (1) target direction and velocity (2) target passage

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Data Collection

- Radar processing unit sends raster image data direct to computer
- Frame grabber and scheduling software automate data collection
- Five successive radar sweeps (every 2.5 sec) captured as bitmap images every 10 min (i.e., 30 images/hr)
- Sunset to sunrise the following morning

- 24 Apr - 15 Jun 2007, 52 nights, ~624 hr, ~19,000 images/radar
- 01 Aug - 15 Oct 2007, 122 nights, ~1450 hr, ~45,000 images/radar

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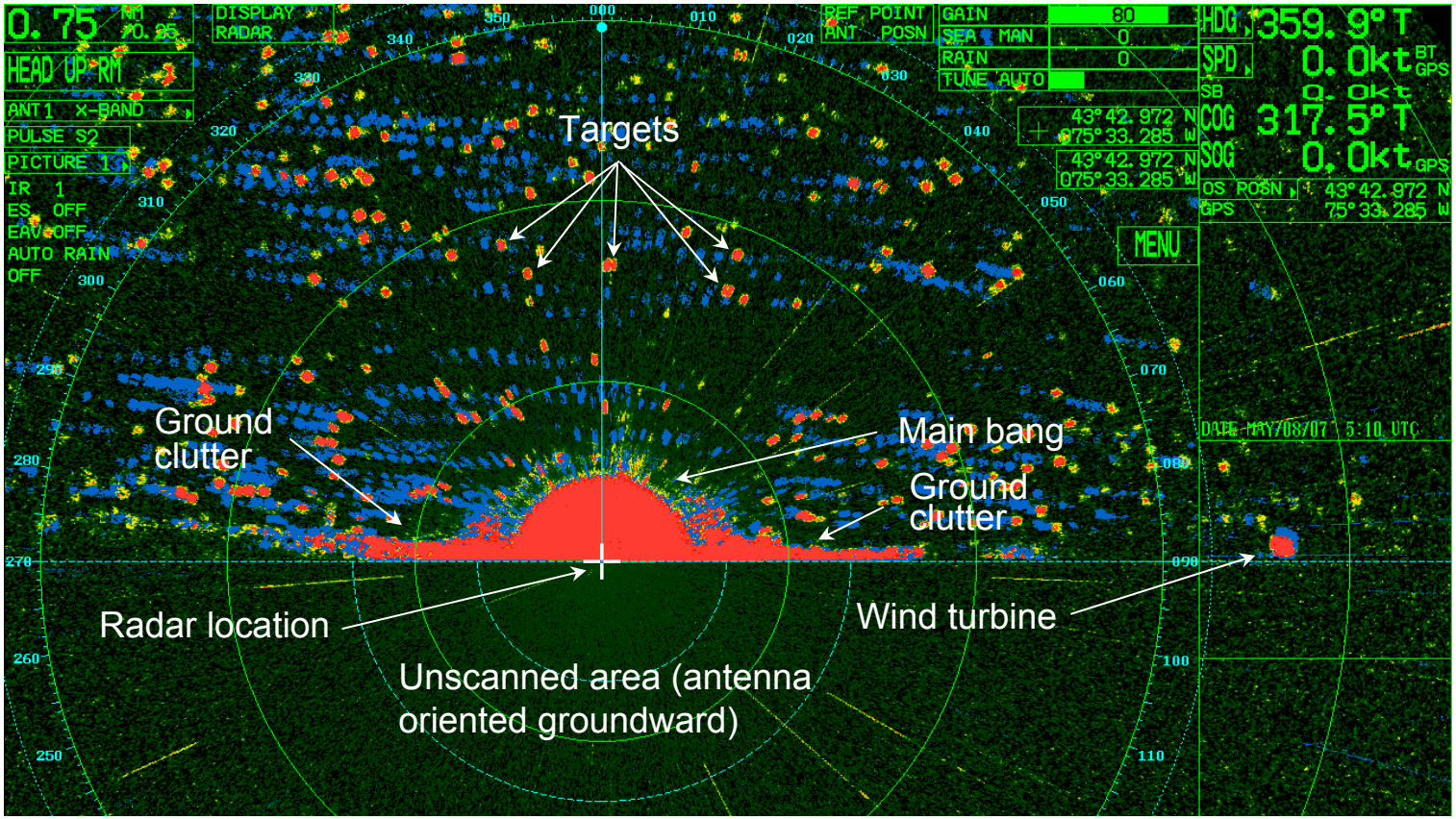
Radar data - vertically-oriented



- Radar displays targets using an RGB color scale to represent 29 reflectance levels (i.e., amount of energy reflected by target)
  - Greens → Yellows → Reds = low → moderate → high reflectance values
- Target tracking (shown in blue) for user-defined durations
  - Track data can be used to assess target velocity and movement direction

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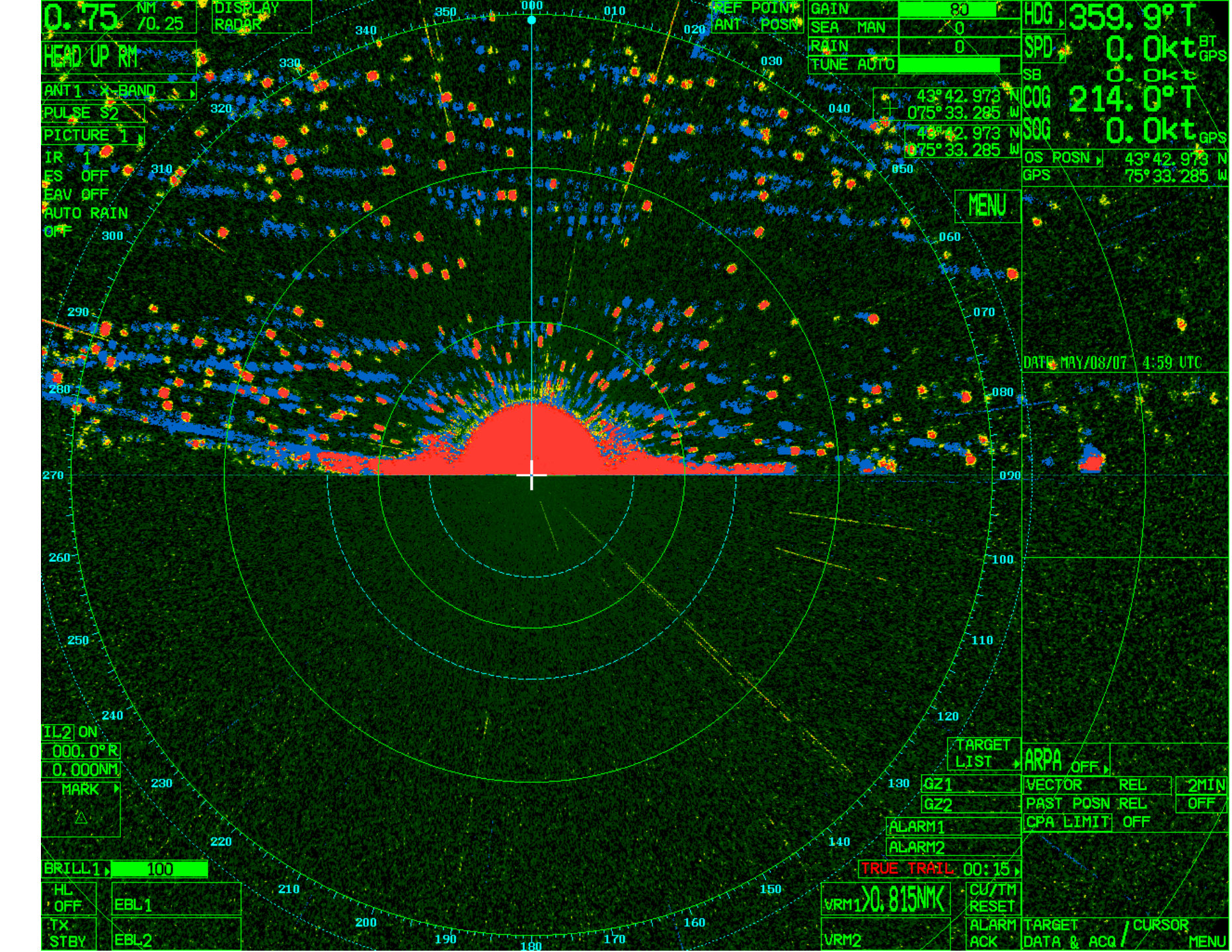
0.75 NM
/0.25
DISPLAY
RADAR
REF POINT
ANT POSN
GAIN 80
SEA MAN 0
RAIN 0
TUNE AUTO
HDG 359.9°T
SPD 0.0kt BT GPS
SB 0.0kt
COG 214.0°T
SOG 0.0kt GPS
OS POSN 43°42.973 N
GPS 75°33.285 W
43°42.973 N
075°33.285 W
43°42.973 N
075°33.285 W
HEAD UP RM
ANT 1 X-BAND
PULSE S2
PICTURE 1
IR 1
ES OFF
EAV OFF
AUTO RAIN
OFF
MENU
DATE MAY/08/07 4:59 UTC
IL2 ON
000.0°R
0.000NM
MARK
BRILL 1 100
HL OFF
TX STBY
EBL1
EBL2
TARGET LIST
GZ1
GZ2
ALARM1
ALARM2
TRUE TRAIL 00:15
VRM1 0.815NM
VRM2
CU/TM RESET
ALARM ACK
ARPA OFF
VECTOR REL
2MIN
PAST POSN REL
OFF
CPA LIMIT OFF
TARGET DATA & ACQ
CURSOR MENU

Data Processing

- Data images reviewed to identify precipitation, fog, insect contamination
  - Images excluded from analyses
- Automated data processing (NJAS developed software)
  1. Identifies sample area
  2. Removes stationary targets (ground clutter)
  3. Identifies and enumerates targets
  4. Locates target's position or altitude depending on which scanning mode is considered (i.e., horizontal, vertical respectively)
  5. Outputs text file with information on each identified target
- Text file outputs used to summarize flight characteristics (NJAS developed software)
  - Mean target count, mean flight altitude, % targets ≤ designated altitude,
  - Temporal patterns: 10 min, hourly and nightly

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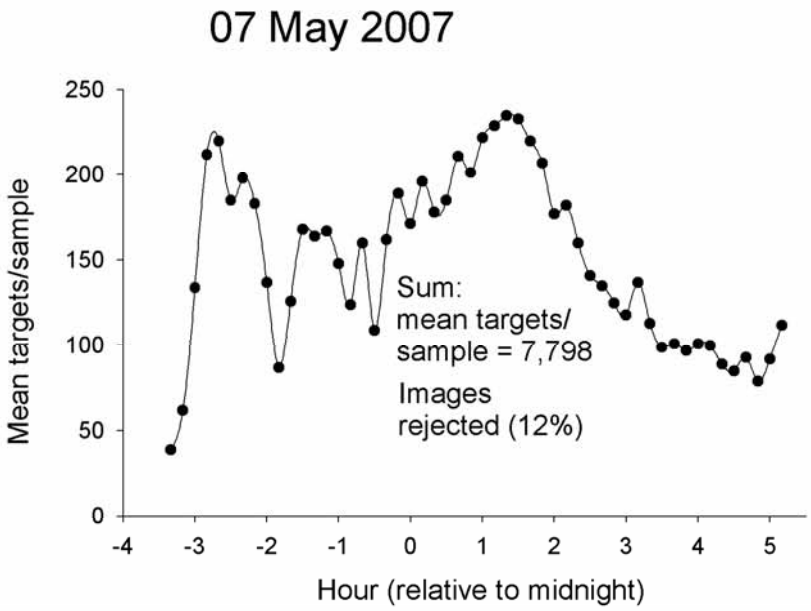
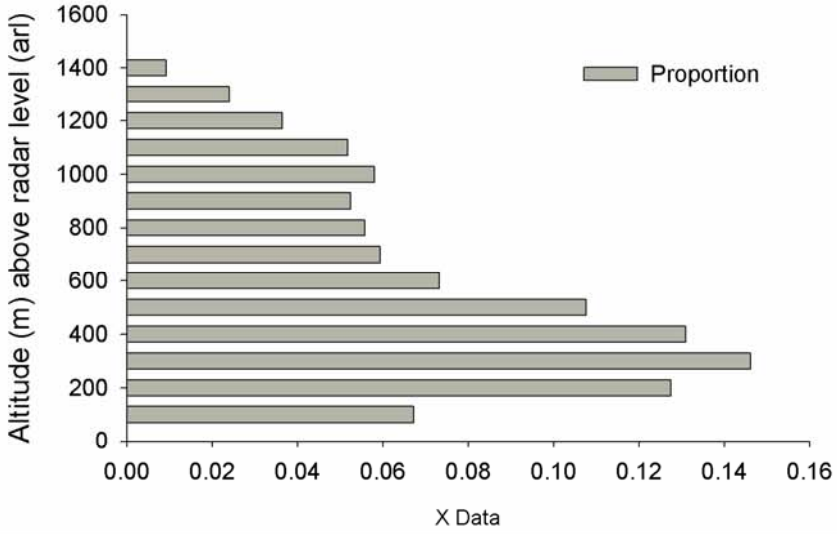
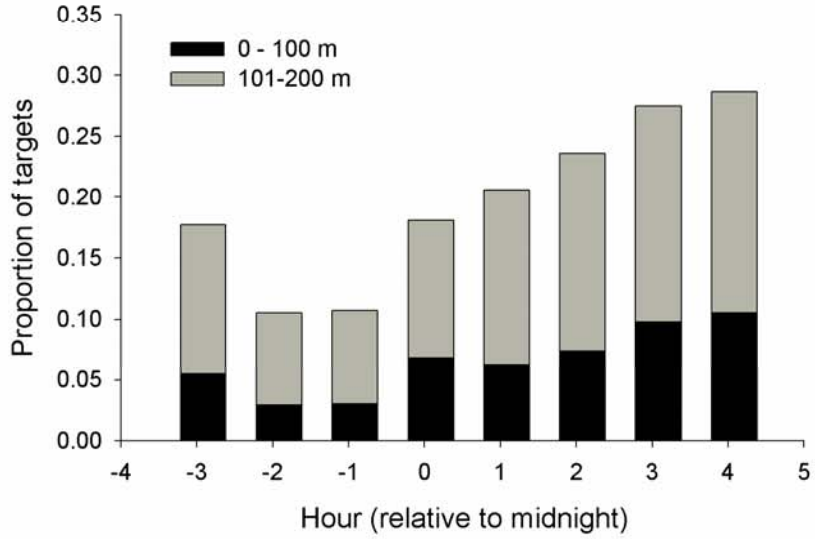
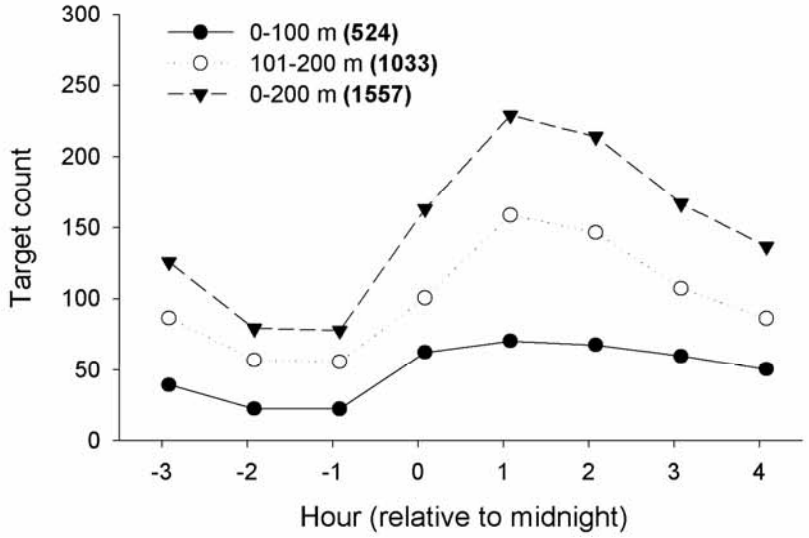

07 May 2007
Mean targets/sample
250
200
150
100
50
0
-4
-3
-2
-1
0
1
2
3
4
5
Hour (relative to midnight)
Sum:
mean targets/
sample = 7,798
Images
rejected (12%)

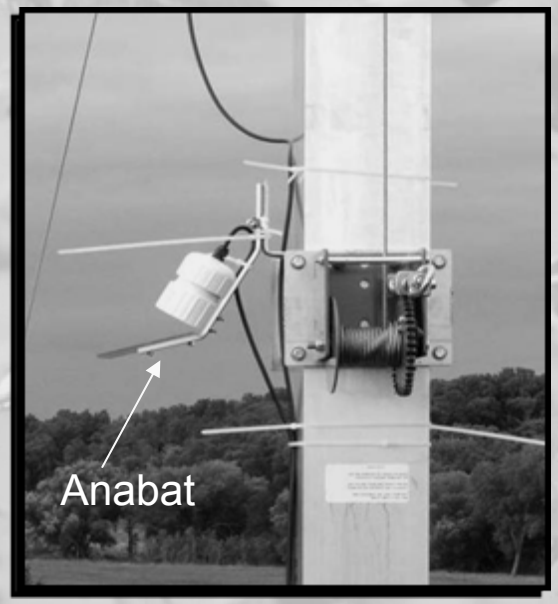

Altitude (m) above radar level (arl)
1600
1400
1200
1000
800
600
400
200
0
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
X Data
Proportion

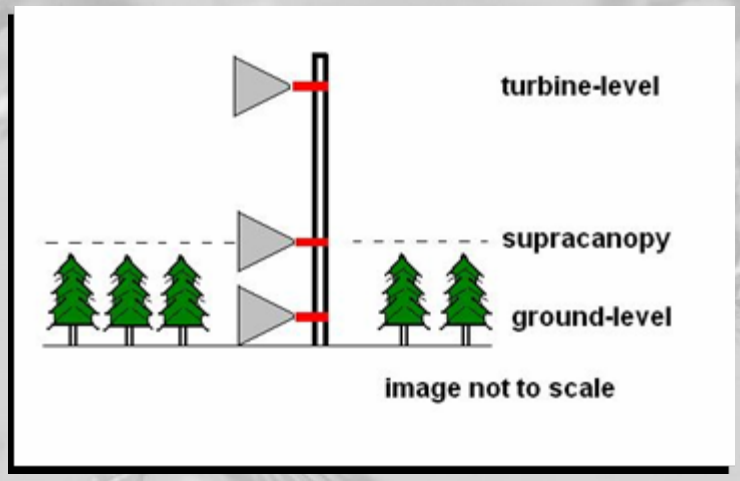

Proportion of targets
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-4
-3
-2
-1
0
1
2
3
4
5
Hour (relative to midnight)
0 - 100 m
101-200 m


Target count
300
250
200
150
100
50
0
-3
-2
-1
0
1
2
3
4
Hour (relative to midnight)
0-100 m (524)
101-200 m (1033)
0-200 m (1557)

Acoustic Detection - Bats

- Anabat II ultrasonic acoustic systems to record bat echolocations
- Three units installed on each of four meteorological towers on project site
  - ~10 (ground-level), 20 (supracanopy) and 50 m (turbine-level) above ground
- Capable of detecting echolocation calls of approaching bats up to 20-25 m away
  - 254 m^3 potential sampling volume
- 2007 data collection from 10 May - 30 November
  - 1900 – 0700 hours each night
  - > 1800 hours of recordings





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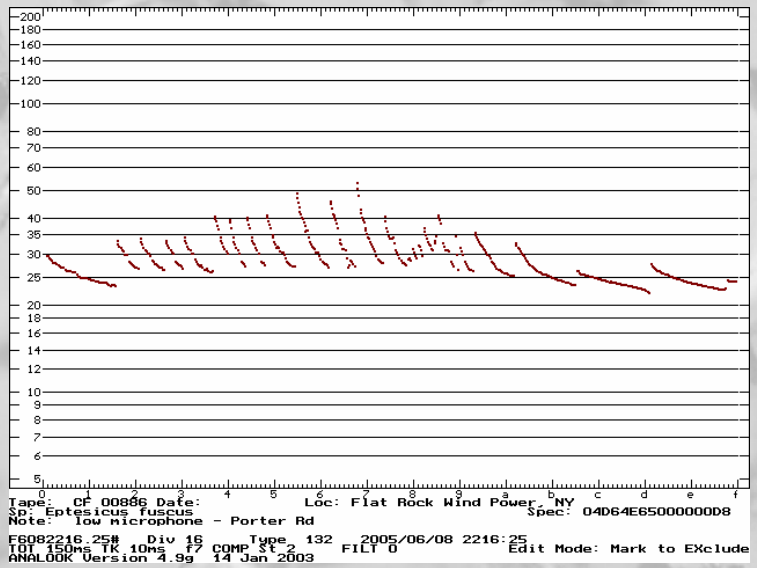
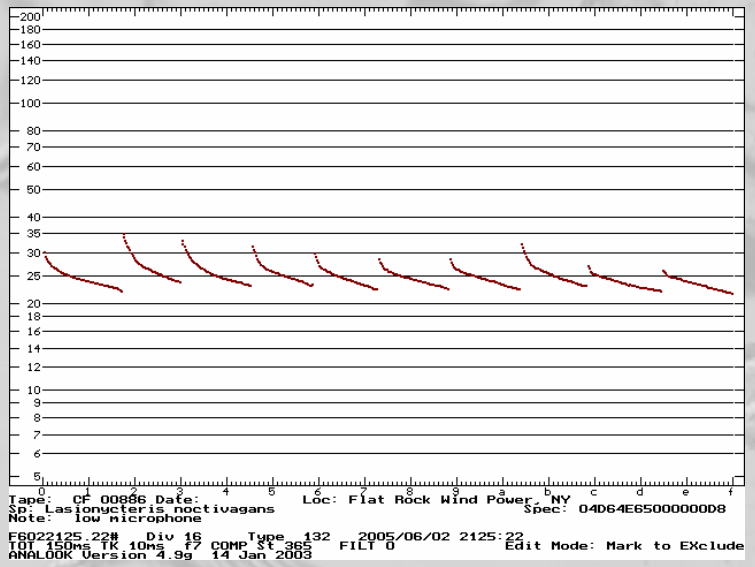
Acoustic Detection - Bats

- Each detector connected to a data processing and storage unit (Titley Electronics)
  - Stores ~7,000 individual bat echolocation incidents
- Calls identified to species or species-group
  - ID of tree-roosting (e.g., *Myotis* spp.) and *Pipistrellus* spp. possible, but difficult to differentiate most others
- Develop models that describe relationships between bat activity and meteorological conditions, time of night, date, and season.



Big brown bat



Silver-haired bat

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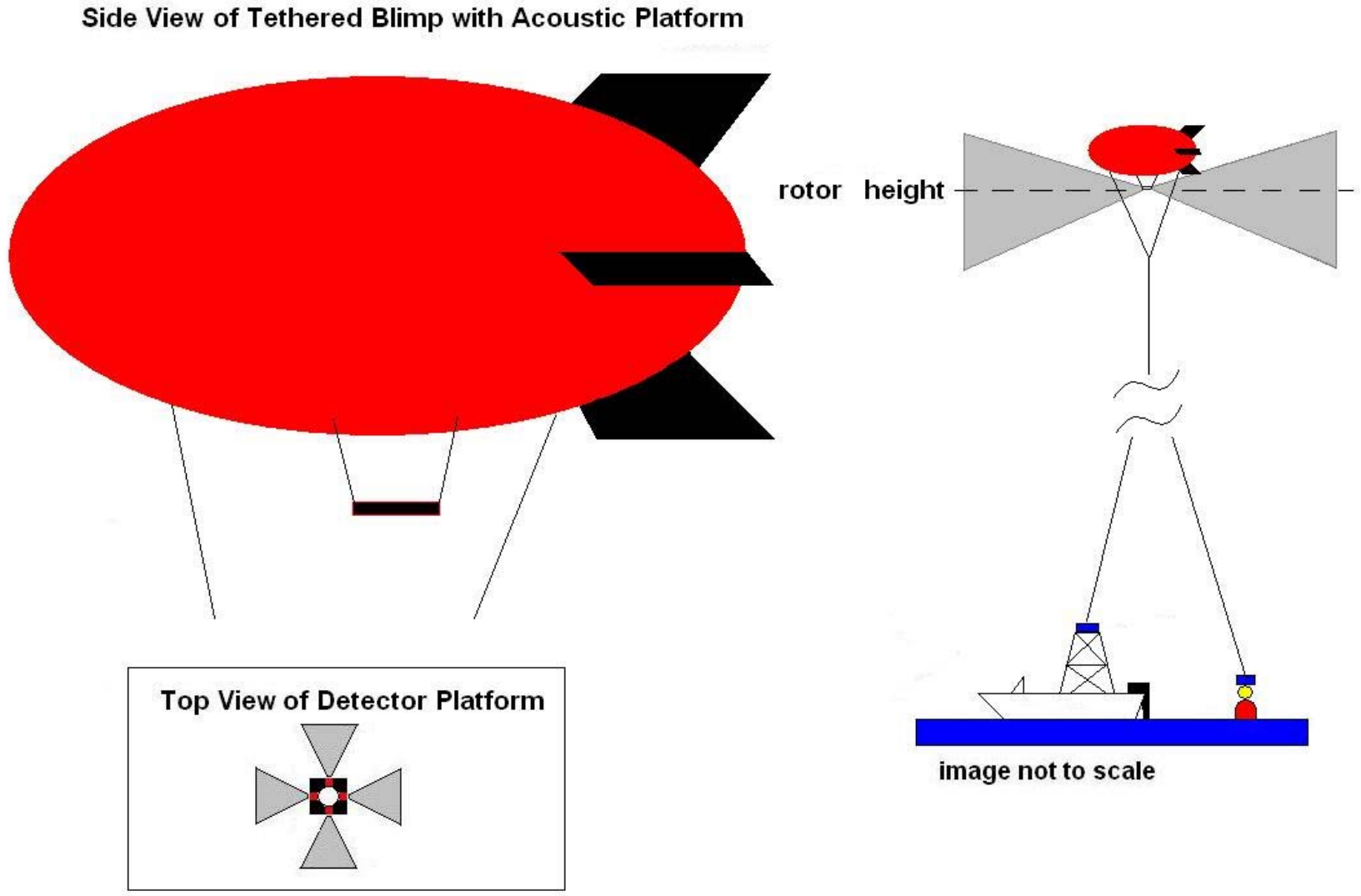
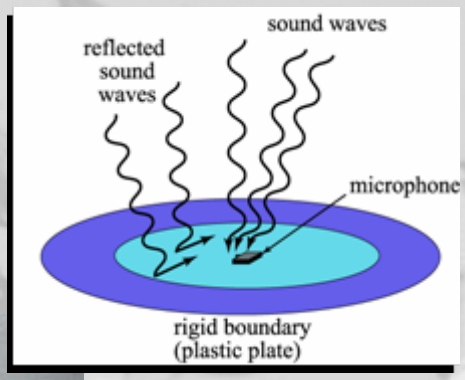
Acoustic Monitoring for On- and Off-Shore Wind Development



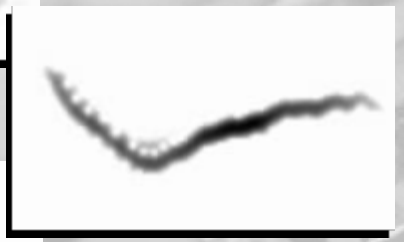
North
East
Ecological
Services

Acoustic Detection - Birds

- Two pressure zone microphone systems
  - Spatially associated with dual marine radar system
  - 10-12 hours of sounds recorded nightly to computer as a single “wav” file
- Calls 3-5 kHz detected up to ~700 m; calls > 6 kHz detected to ~300 m
- Spectrogram analysis using software developed by W. Evans
  - Enumerate calls/unit time
  - Identify species/species group flight calls
- Not all species call; species-specific call rates unknown



Indigo Bunting



American Redstart

Northern Parula

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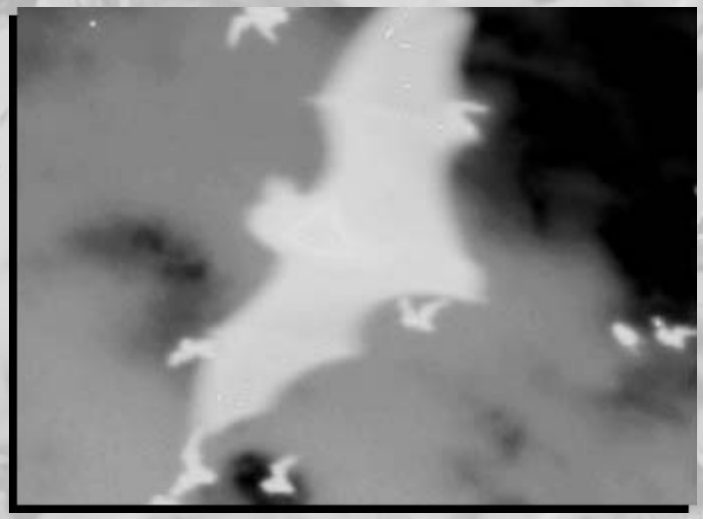
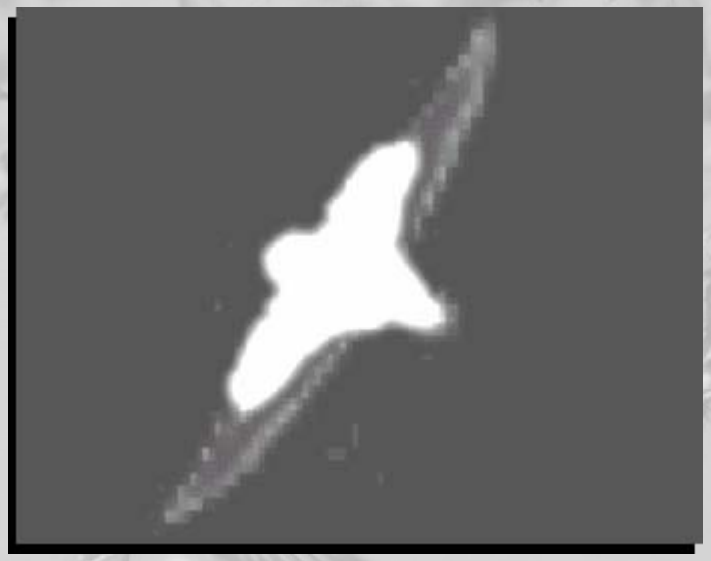
Optically enhanced nocturnal surveys

- Night vision goggles (3rd generation, military specifications) and infrared spotlight
  - Monitoring range is limited to ~120 m
- 1 May -15 Jun, 1 Aug - 30 Sep
  - Periods when both birds and bats are present
  - Nightly surveys begin at sunset, last four hrs
- Discriminate between bird and bats
  - Quantify passage density
  - Proportion of birds and bats
  - Estimate flight direction





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Assessing Collision Incidents

- Systematic searches conducted by Curry and Kerlinger, LLC staff at ~60 turbines
  - Search area = 15,600 m^2 (120 x 130 m) centered on turbine
  - Searching conducted along transects ~5 m apart
  - Each turbine searched once every seven days
- Mortality estimates corrected for observer efficiency and carcass removal (i.e., scavenging) rates

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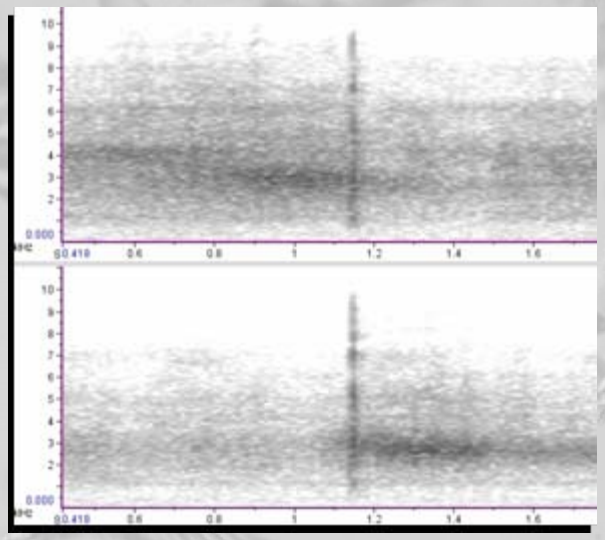
Acoustic Strike Detection

- Record distinctive sounds flying vertebrates make when striking turbine
- Two discrete two-week periods
  - Mid-Aug.: peak bat movements
  - Late Sept.: peak bird movements
- Two upward-facing microphones mounted at the base of 6-8 study turbines
- Stereo recordings distinguish strike sounds from turbine noise
- Verification of strike incidents
  - Forward looking infrared recorder (FLIR)
  - Searches for grounded individuals



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Lots of data and . . .
. . . lots of analyses!!

- Model relationships between meteorological conditions, time of night, date, season and year
  - Radar measures of bird/bat movement (i.e., passage, altitude, direction, velocity)
  - Other bird/bat passage measures (i.e., bat acoustic, bird acoustic, optically enhanced nocturnal surveys)
- Investigate how indices of passage correlate among different data collection methods
- Investigate correlations between pre and post construction measures of bird/bat movement
  - Radar, bat acoustic detection
- Model relationships between proportion of birds/bats detected at ca. rotor sweep height (i.e.,potential for collision) and number birds/bats found during mortality searches (i.e.,incidence of collision)

Data analyses are just beginning . . . so stay tuned

Acknowlegdments

- NYSERDA
- Maple Ridge Wind Farm
- Curry and Kerlinger, LLC