Assessing Bird Movements in the Gulf of Maine With Automated Telemetry: Implications for Offshore Wind Energy Development

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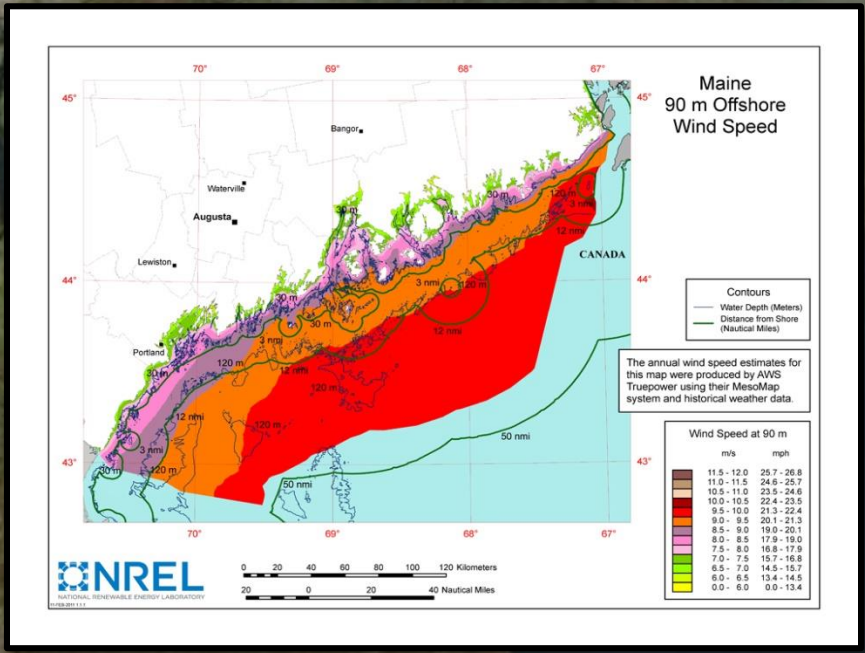
Background

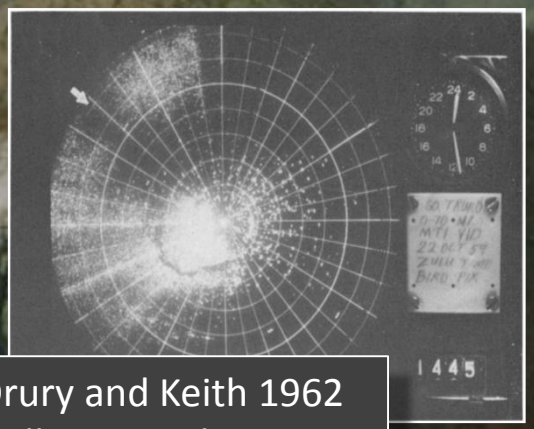
OFFSHORE WIND IN THE GULF OF MAINE:

- Excellent wind resources => Goal 5 GW by 2030



First grid connected offshore turbine US: Volturn floating prototype

Background



Drury and Keith 1962
Williams et al. 1981
Richardson 1978
McClintock et al. 1978

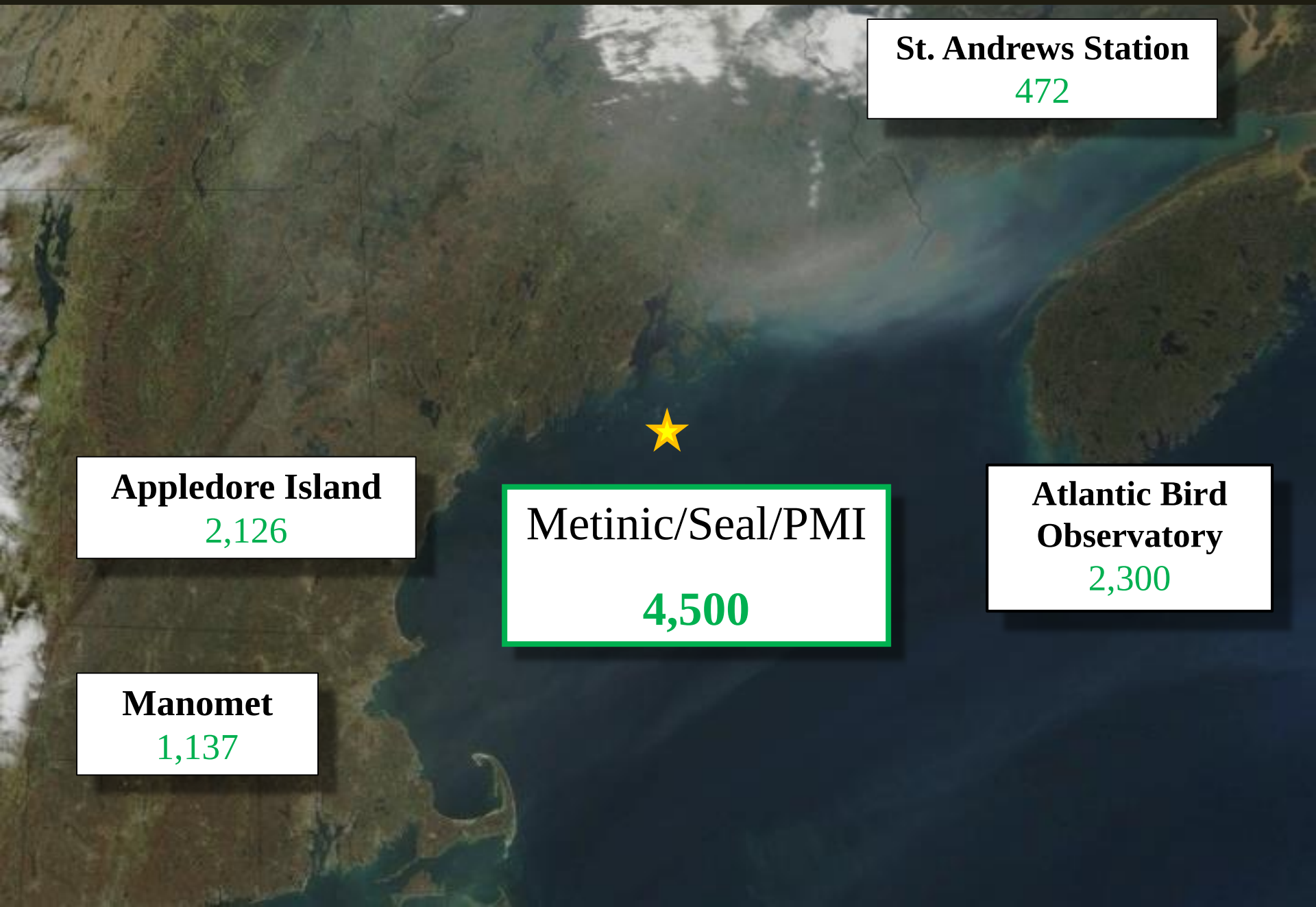
Canada Warbler

Blackpoll Warbler

Bicknell's Thrush

3000 + Offshore islands

Background


St. Andrews Station
472
Appledore Island
2,126
Metinic/Seal/PMI
4,500
Atlantic Bird Observatory
2,300
Manomet
1,137

Background

Collision Vulnerability:

- ~80% of mortality at terrestrial turbines
  - *0.01 –11.7 fatalities/MW/yr*
    (Kerlinger 1997, Nicholson 2003)

- Sporadic mass fatalities (lighthouses, oil platforms, coastal structures)
  - *Poor weather*
  - *Attraction to lights*
    - *Songbirds = 98% of collisions with offshore platforms (N=442)*
    - *50% of collisions on 2 nights (Hüppop et al. 2006)*

Timing matters!

Location matters!

Background

Collision Risk Models:

1. **Volume of activity**
   - *Not species specific*

2. **Amount of time spent at rotor height**
   - *Flight behavior*

3. **Altitude**
   - Fog, strong winds, time, season
     - *flight altitudes lower over water*

4. **Avoidance**
   - *Nysted => marked avoidance*
   - *Egmond aan Zee => mixed*
   - *Evasive action very close to turbines – 29% tailwinds (Winkelman 1992)*

Background

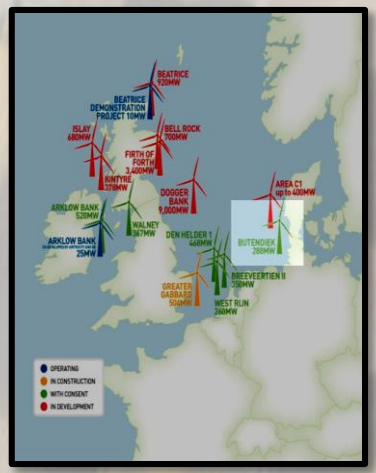
POPULATION-LEVEL EFFECTS

Minimal compared to other taxa

- Large reference populations
  - ➢ *Mortality spread throughout*
- Short lived, fast to reproduce

Differential migration

- Systematic differences in migration
- Systematic differences in exposure
  - ➢ *99% juveniles in coastal areas*

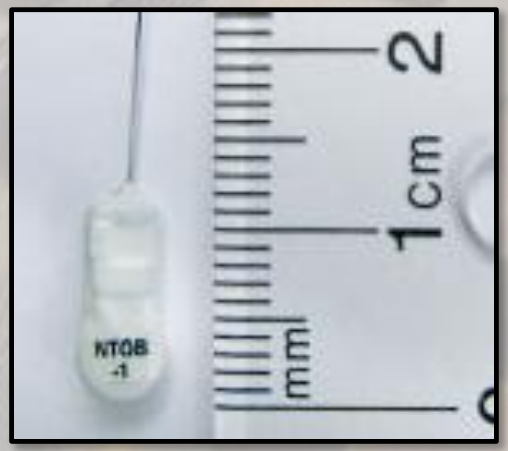


$$\begin{pmatrix} n_0^{(t+1)} \\ n_1^{(t+1)} \\ n_2^{(t+1)} \\ \vdots \\ n_T^{(t+1)} \end{pmatrix} = \begin{pmatrix} f_0 & f_1 & f_2 & \cdots & f_T \\ p_0 & 0 & 0 & \cdots & 0 \\ 0 & p_1 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & p_{T-1} & 0 \end{pmatrix} \begin{pmatrix} n_0^{(t)} \\ n_1^{(t)} \\ n_2^{(t)} \\ \vdots \\ n_T^{(t)} \end{pmatrix}$$

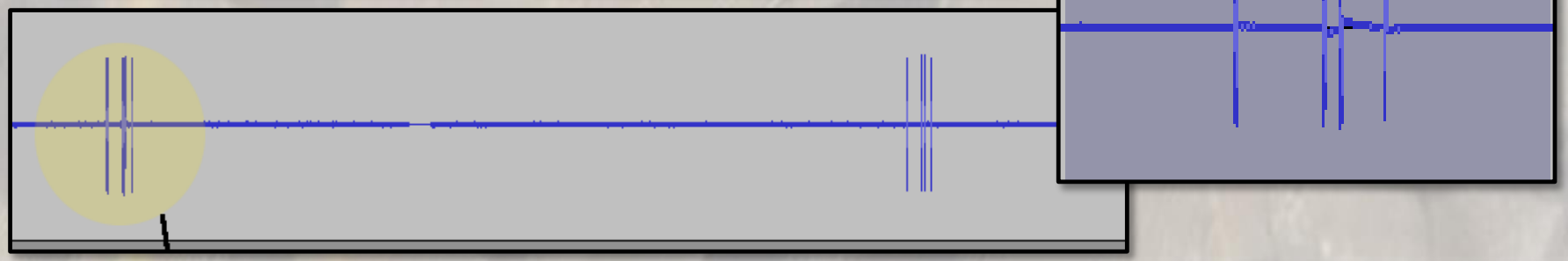
Background

Avian Nano Tags (0.25g)

- Coded
- > 500 birds on same frequency



LOTEK
WIRELESS
FISH & WILDLIFE MONITORING



Goals & Objectives

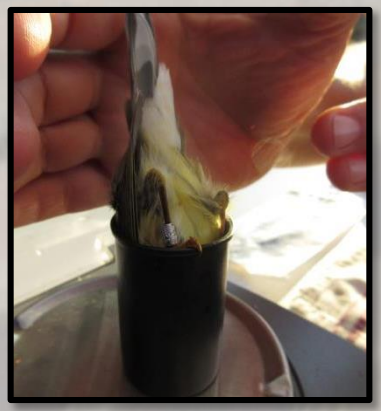
1. **Test new tool for tracking birds**
   - *develop methods for analyzing tracking data*

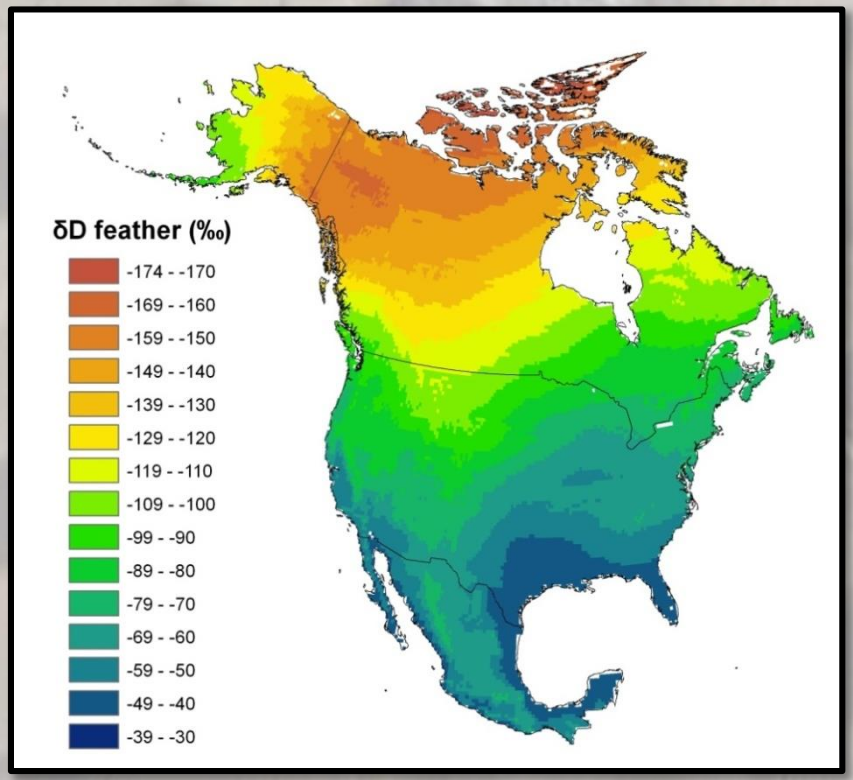
2. **Inform regional siting**
   - *where birds are moving offshore*

3. **Assess vulnerability**
   - *big movements, or many short flights*
   - *time spent in Gulf of Maine*
   - *movement patterns differ by demographic groups*

4. **Inform operational strategies**
   - *how weather influences movement patterns*
   - *when birds are moving offshore*

Methods




δD feather (‰)
-174 - -170
-169 - -160
-159 - -150
-149 - -140
-139 - -130
-129 - -120
-119 - -110
-109 - -100
-99 - -90
-89 - -80
-79 - -70
-69 - -60
-59 - -50
-49 - -40
-39 - -30

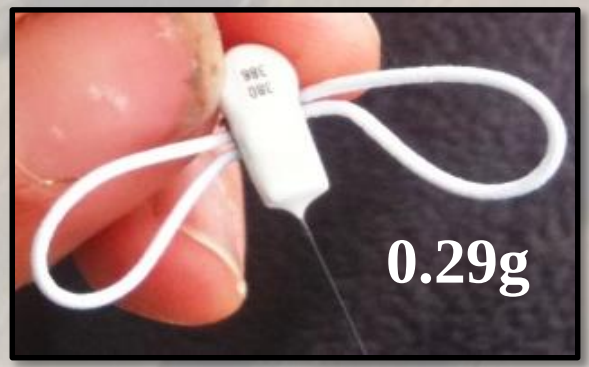
Methods

Blackpoll Warbler
(*Setophaga striata*)
N=72

Longest known over-water migration of any songbird

Petit Manan NWR
Fall 2013 and 2014

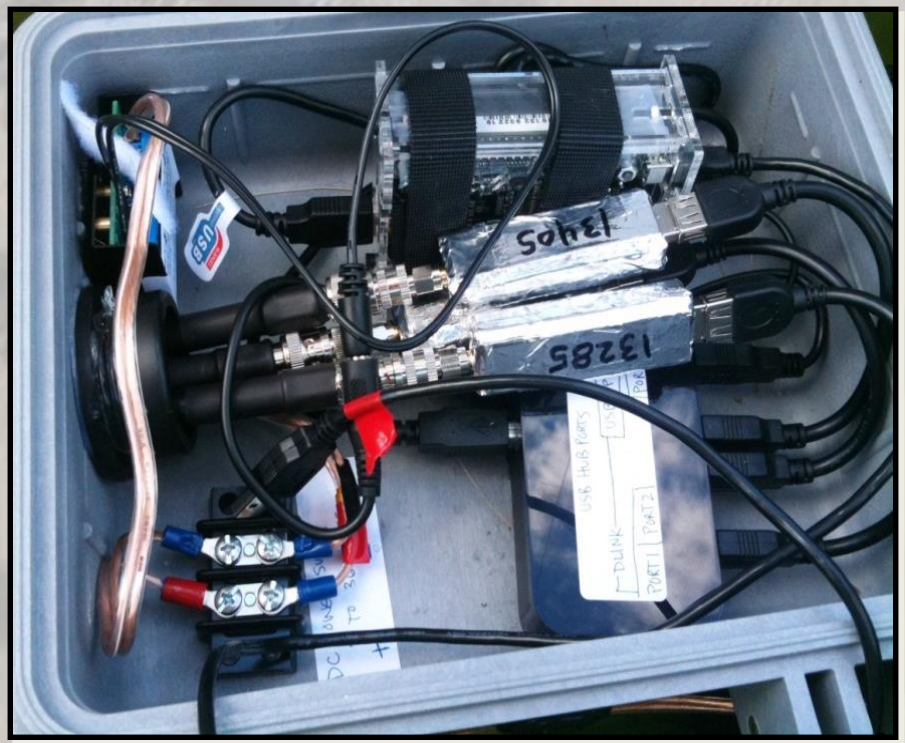
Nano-tag



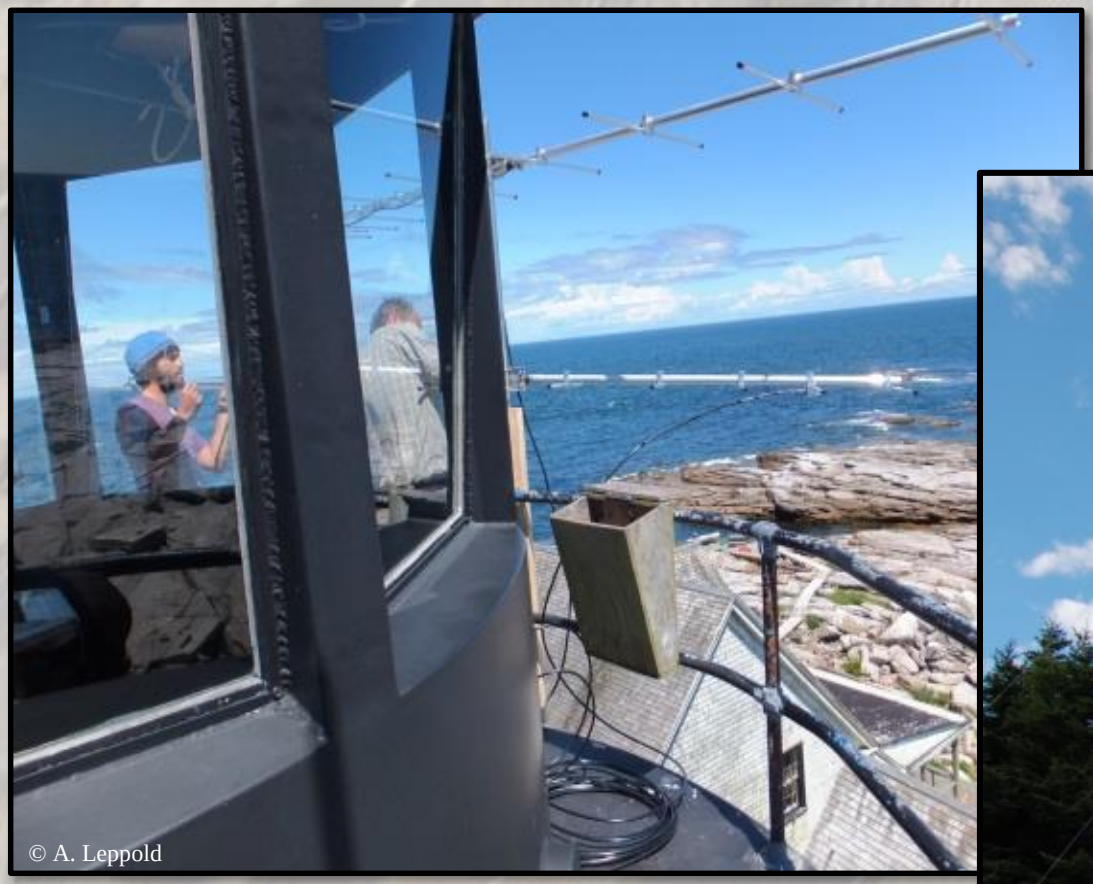
Red-eyed Vireo
(*Vireo olivaceus*)
N=108

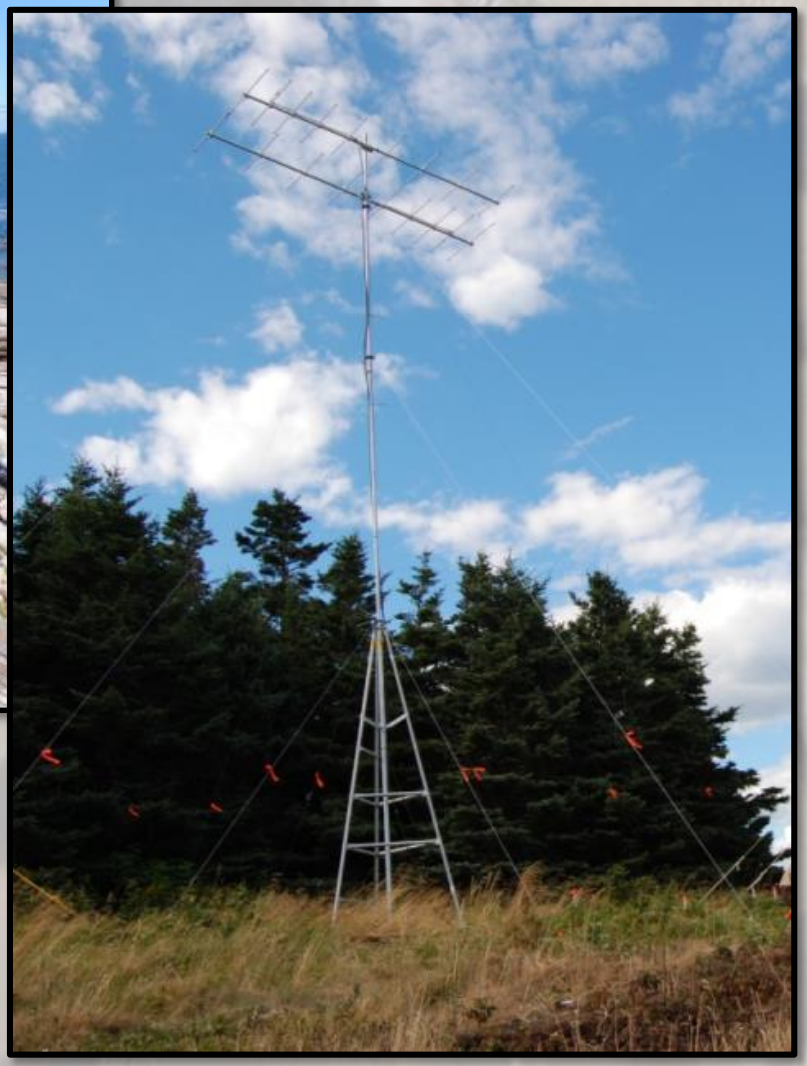
~35% of mortalities at some wind farms

Methods

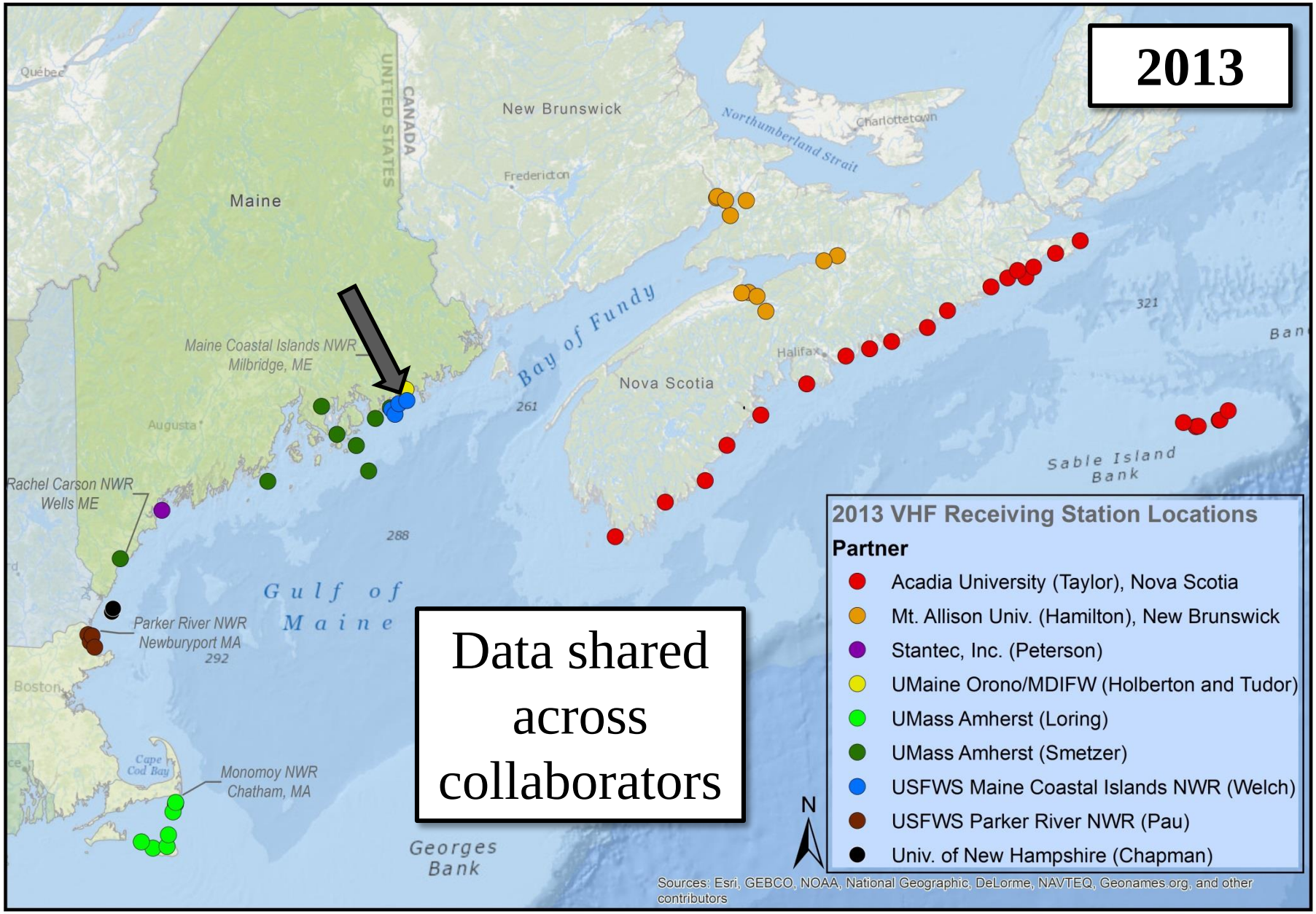


Methods

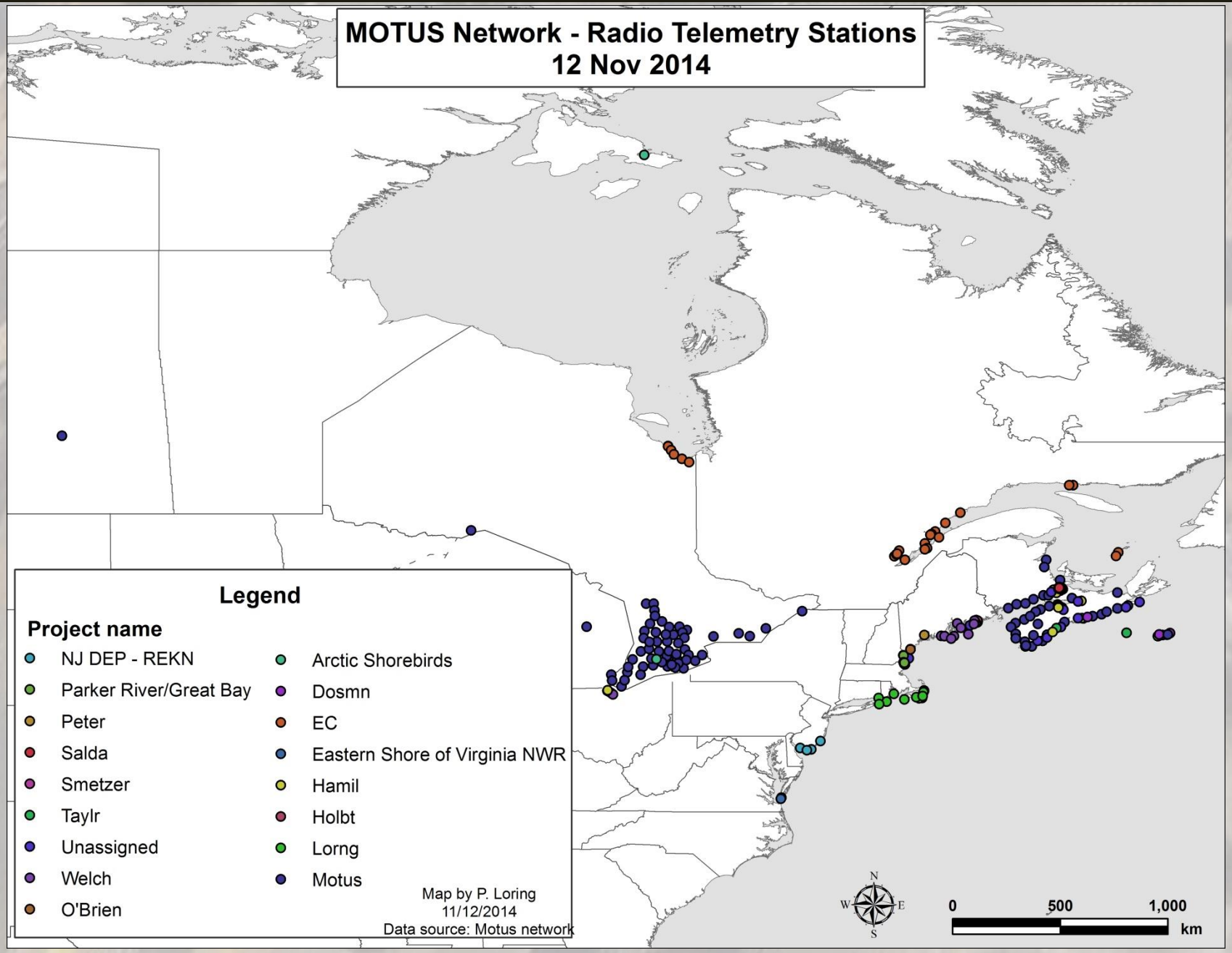




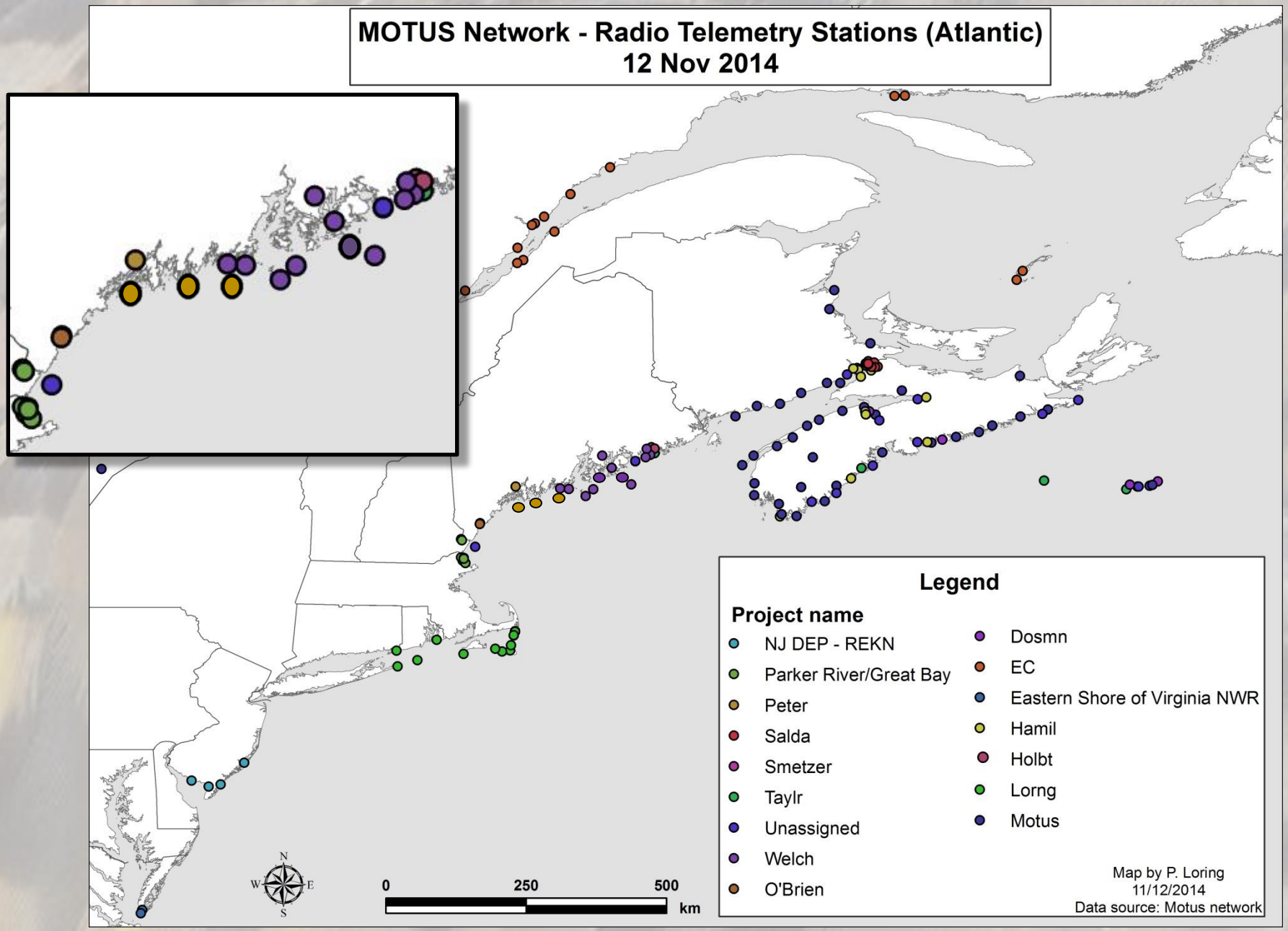
Methods


2013
Québec
UNITED STATES
CANADA
New Brunswick
Maine
Fredericton
Northumberland Strait
Charlottetown
Bay of Fundy
Nova Scotia
Halifax
321
261
Sable Island Bank
Maine Coastal Islands NWR
Milbridge, ME
Augusta
Rachel Carson NWR
Wells ME
288
Gulf of Maine
Parker River NWR
Newburyport MA
292
Boston
Cape Cod Bay
Monomoy NWR
Chatham, MA
Georges Bank
Data shared across collaborators
2013 VHF Receiving Station Locations
Partner
Acadia University (Taylor), Nova Scotia
Mt. Allison Univ. (Hamilton), New Brunswick
Stantec, Inc. (Peterson)
UMaine Orono/MDIFW (Holberton and Tudor)
UMass Amherst (Loring)
UMass Amherst (Smetzer)
USFWS Maine Coastal Islands NWR (Welch)
USFWS Parker River NWR (Pau)
Univ. of New Hampshire (Chapman)
N
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Methods


MOTUS Network - Radio Telemetry Stations
12 Nov 2014
Legend
Project name
NJ DEP - REKN
Parker River/Great Bay
Peter
Salda
Smetzer
Taylr
Unassigned
Welch
O'Brien
Arctic Shorebirds
Dosmn
EC
Eastern Shore of Virginia NWR
Hamil
Holbt
Lorng
Motus
Map by P. Loring
11/12/2014
Data source: Motus network
N
W
E
S
0
500
1,000
km

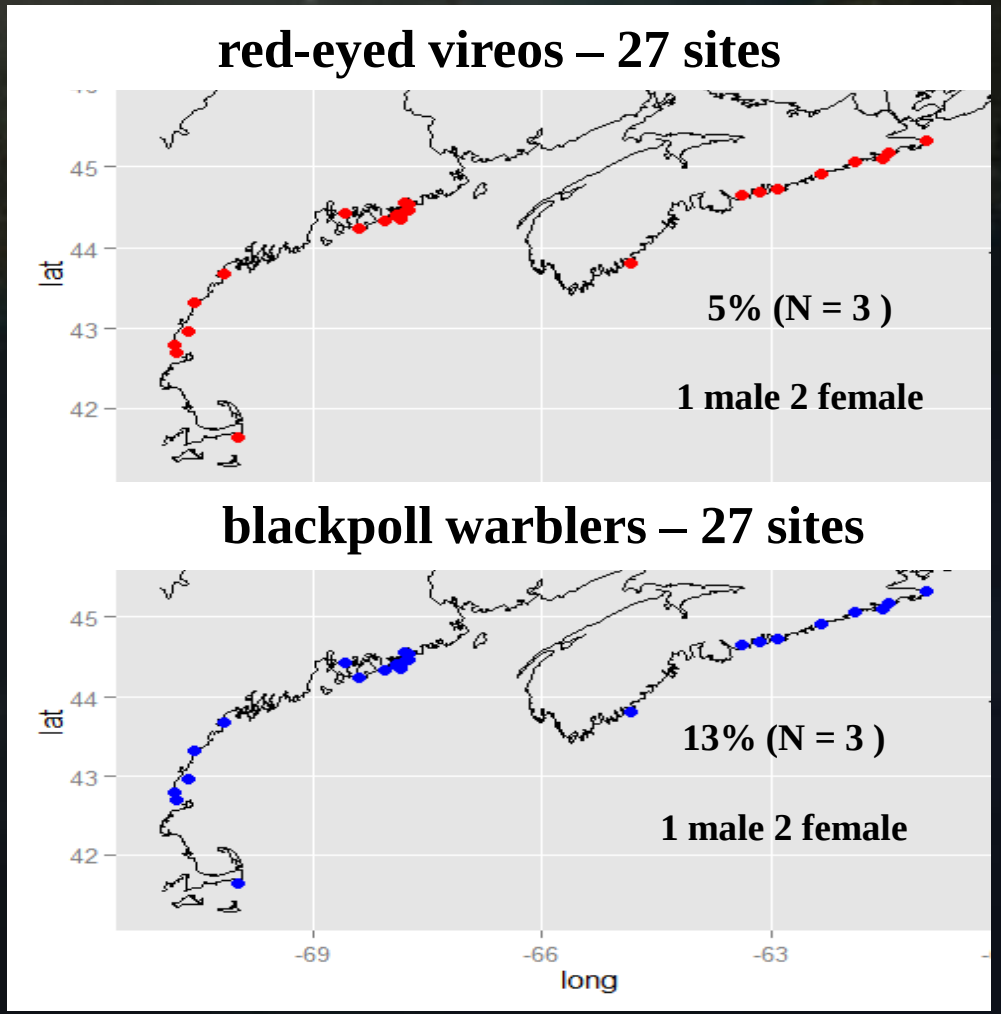
Methods


MOTUS Network - Radio Telemetry Stations (Atlantic)
12 Nov 2014
Legend
Project name
NJ DEP - REKN
Parker River/Great Bay
Peter
Salda
Smetzer
Taylr
Unassigned
Welch
O'Brien
Dosmn
EC
Eastern Shore of Virginia NWR
Hamil
Holbt
Lorng
Motus
Map by P. Loring
11/12/2014
Data source: Motus network
0
250
500
km

Preliminary Results

METHOD WORKS-

- Re-detection rates ~ 70 TIMES greater than with banding
- Over 3.7 M detections
- Minimum 12km detection range
- 2014- detections from VA to Nova Scotia
- Surprising discoveries



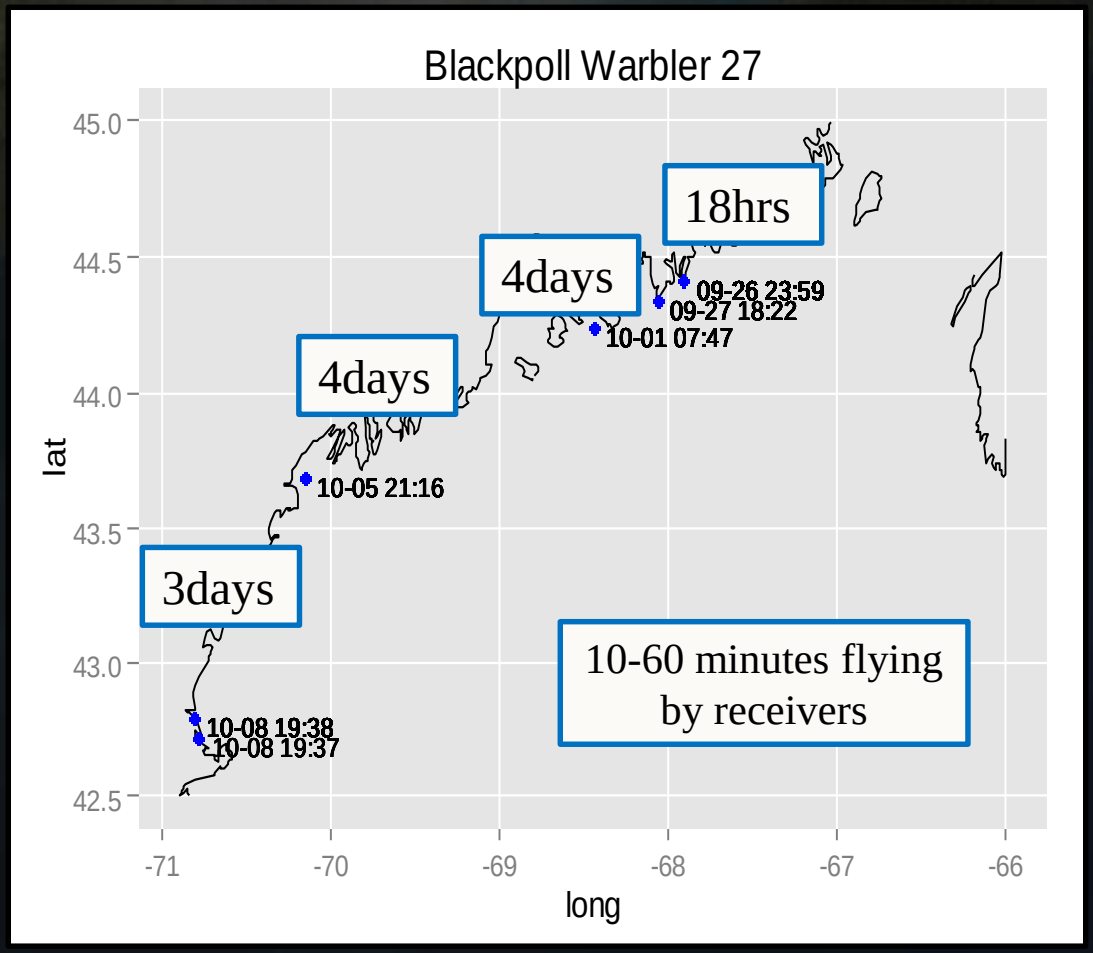
Preliminary Results

BIRDS ARE MAKING SHORT FLIGHTS, FREQUENT STOPS & MOVING SLOWLY

At least one stop
82% (n=19) of blackpolls
30% (n=20) of vireos

More than one stop
26% (n=6) of blackpolls

Blackpolls: 35km/day



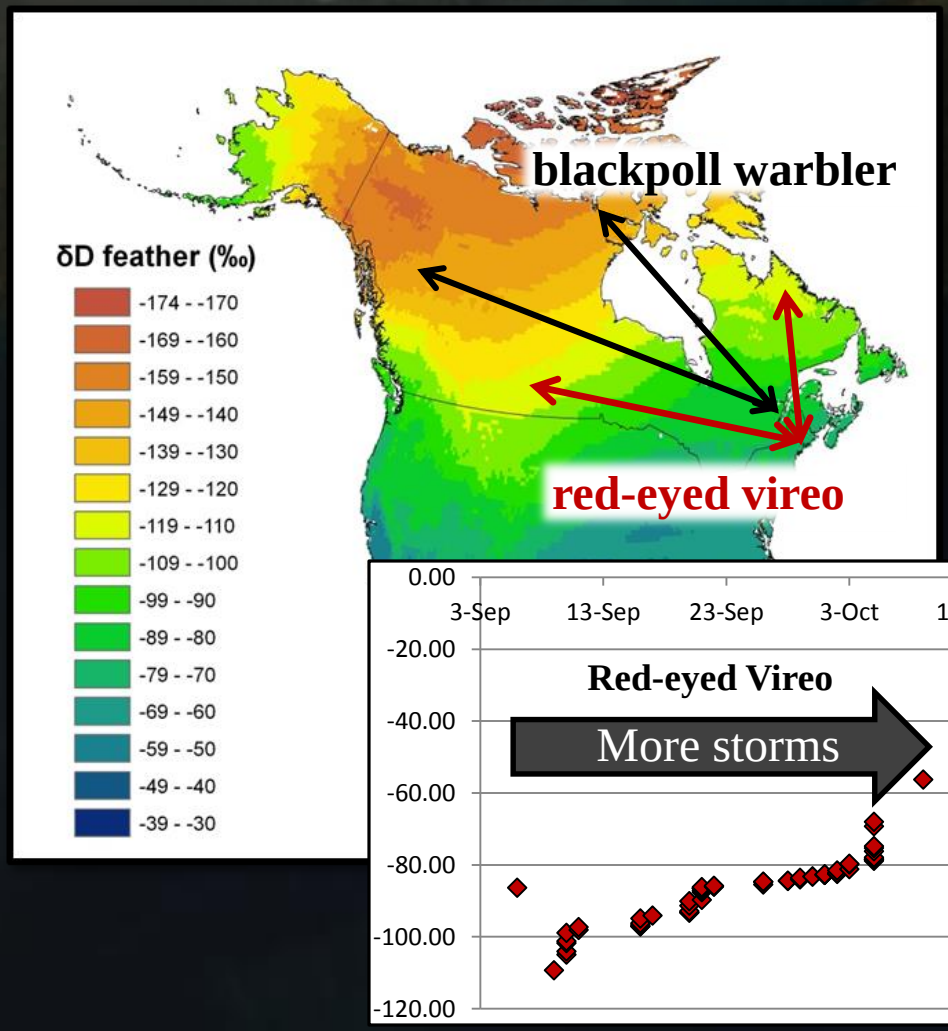
Preliminary Results

MOVEMENT PATTERNS DIFFERED ACROSS DEMOGRAPHICS

Big range in natal origins

Offshore movements:

- Males > females
- Females from closer origins > females from more distant origins
- Timing of movement geographically structured



Next Steps: Data Analysis

State-space models for estimating location and behavior

- Predict future state based on previous states, probabilistically
- *Estimate animal's track*
- *Interpolate location for missing observations*
- *Forecast future movement*

- Predict relative probability of occupancy/use based on bio-geographical variables
- Compare offshore movements between demographic groups
- Feed into GIS decision support models Walt is developing

- Model movements and behavior relative to weather

Next Steps: Interdisciplinary work

Productivity down 50-70%

- *Clutch size down*
- *Chicks starving*

11.7 terns/turbine/yr
(Everaert & Stienen 2007)

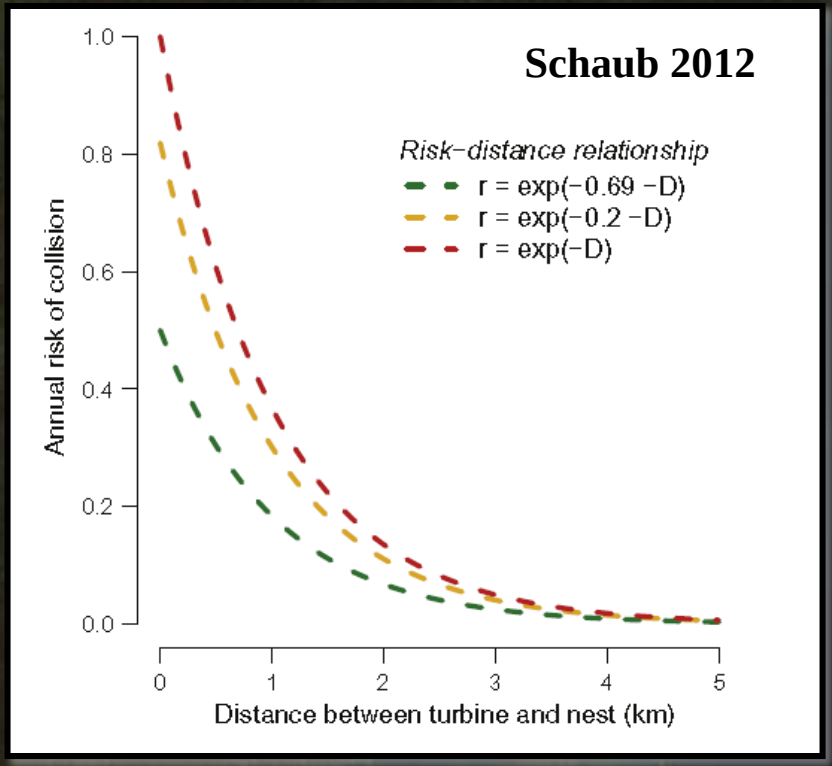
Next Steps: Interdisciplinary work

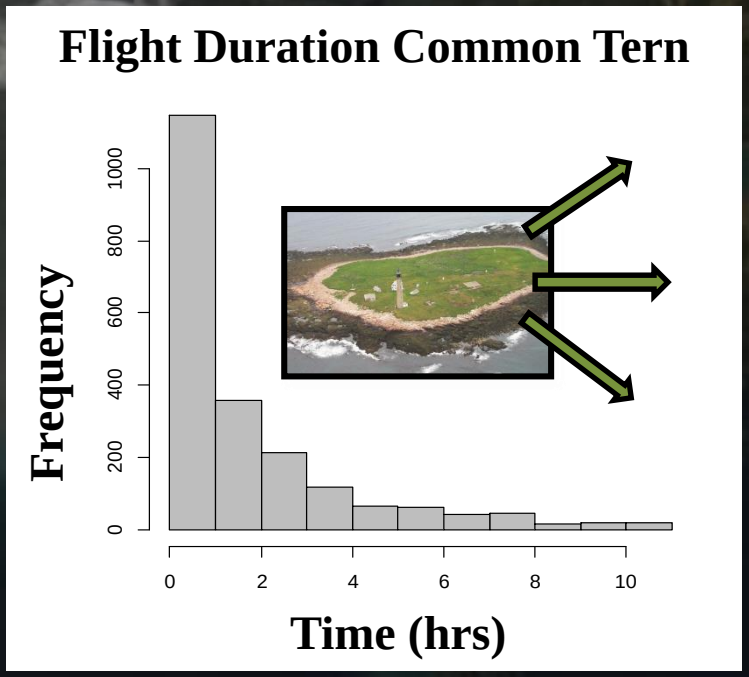
Schaub et al. 2012-

- Effect of turbine number and arrangement on population viability

Cranmer and Smetzer-

- Derive risk distance function for terns
- More realistic wind farm arrangements





- 3-4 years telemetry data
- 20+ years demographic data

Acknowledgements

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- **The brave, strong birds**


Questions?