USING A HIERARCHICAL APPROACH TO MODEL SOURCE-SINK DYNAMICS FOR NEOTROPICAL-NEARCTIC SONGBIRDS

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SERDP
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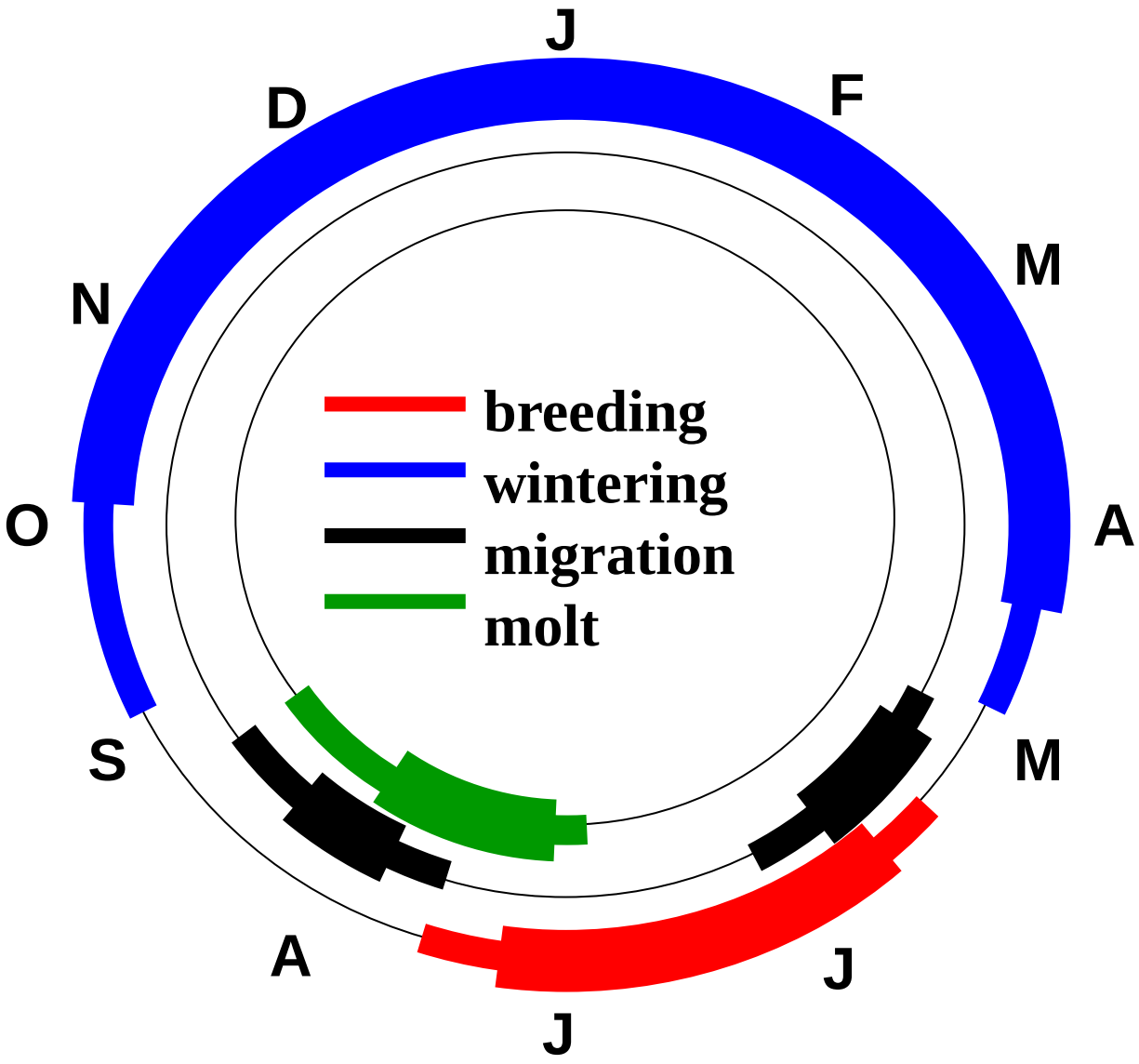


Periods of the annual cycle are inextricably linked

RC-2121: SS Dynamics for Neotropical Songbirds

Problem Statement

- *No adequate full-life cycle model of source-sink dynamics exist for avian species of concern*

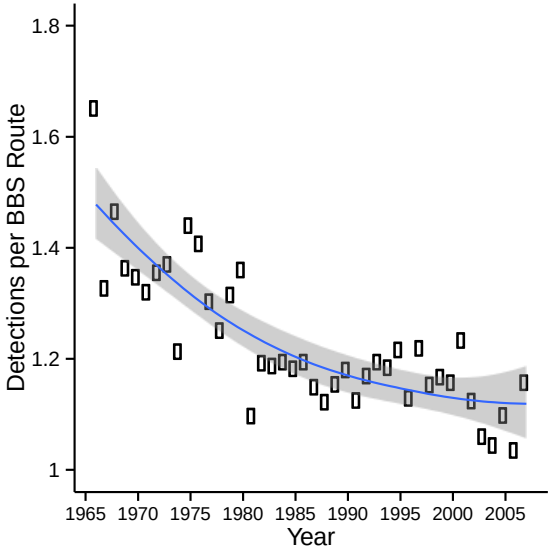
Research Objectives

- *Characterize WOTH populations dynamics to inform conservation and management on military installations*
- *Collect parallel data on the entire community of birds to test these ideas*

Project Progress and Results

- *Demographic data to parameterize model*

Next Steps and what do you need?



Project Team

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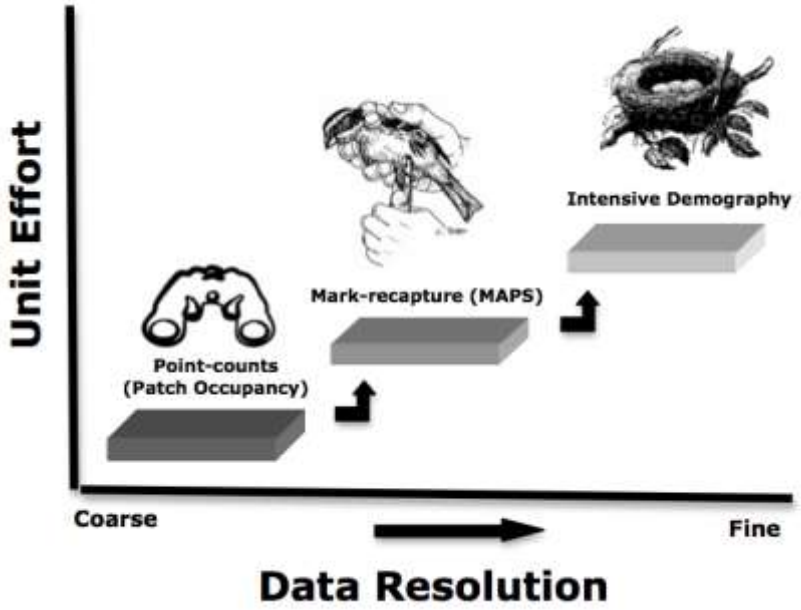
Objectives

I. Test and validate three methods for identifying sources and sinks for the Wood Thrush:

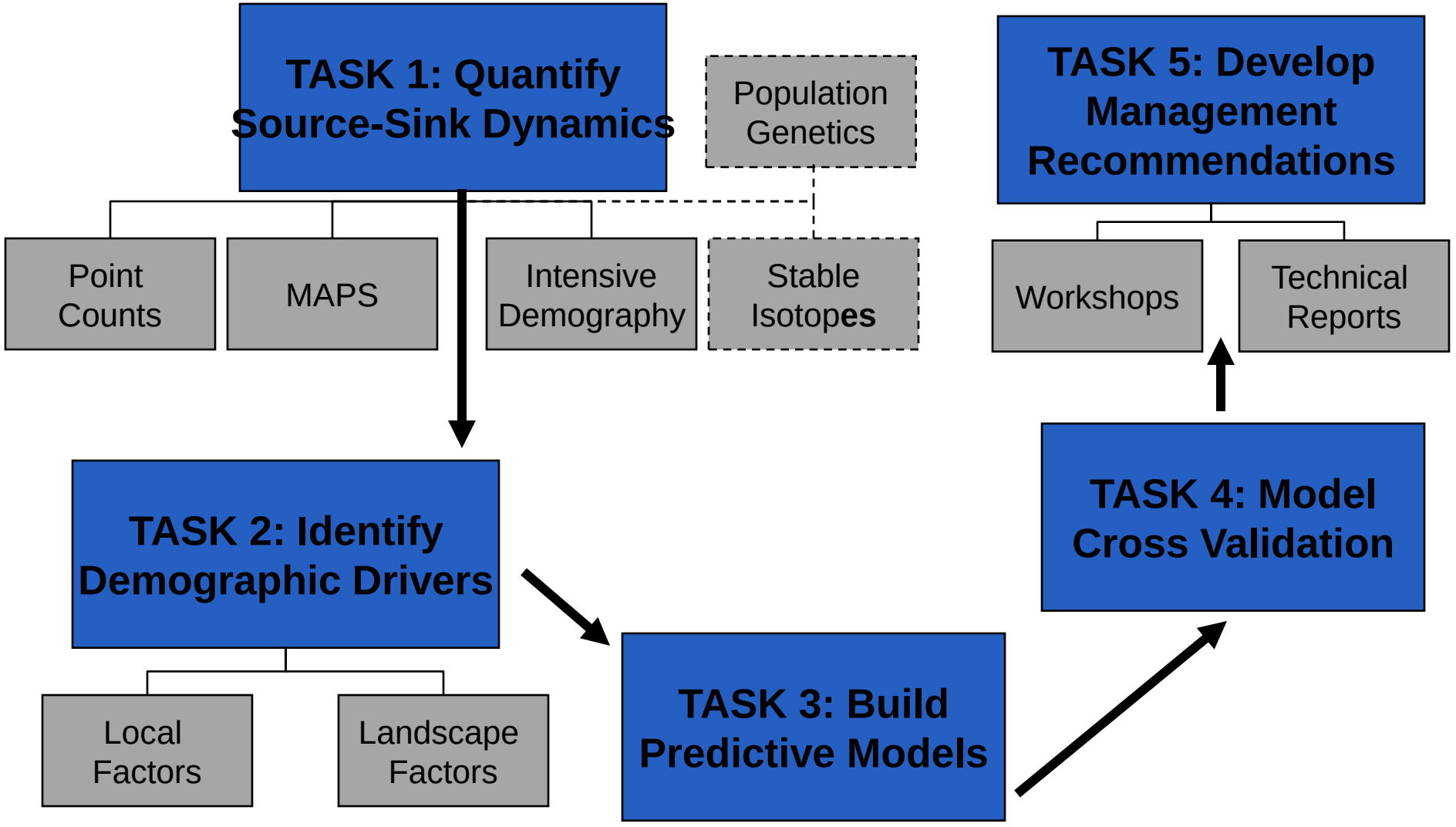
1) Point counts (patch occupancy)
2) Constant effort mist-netting (MAPS)
3) Intensive demographic studies



II. Determine local and landscape characteristics that predict sources-sink dynamics.

III. Use empirical data collected in Objectives 1 and 2 to construct predictive models of regional population persistence.

Overall Approach



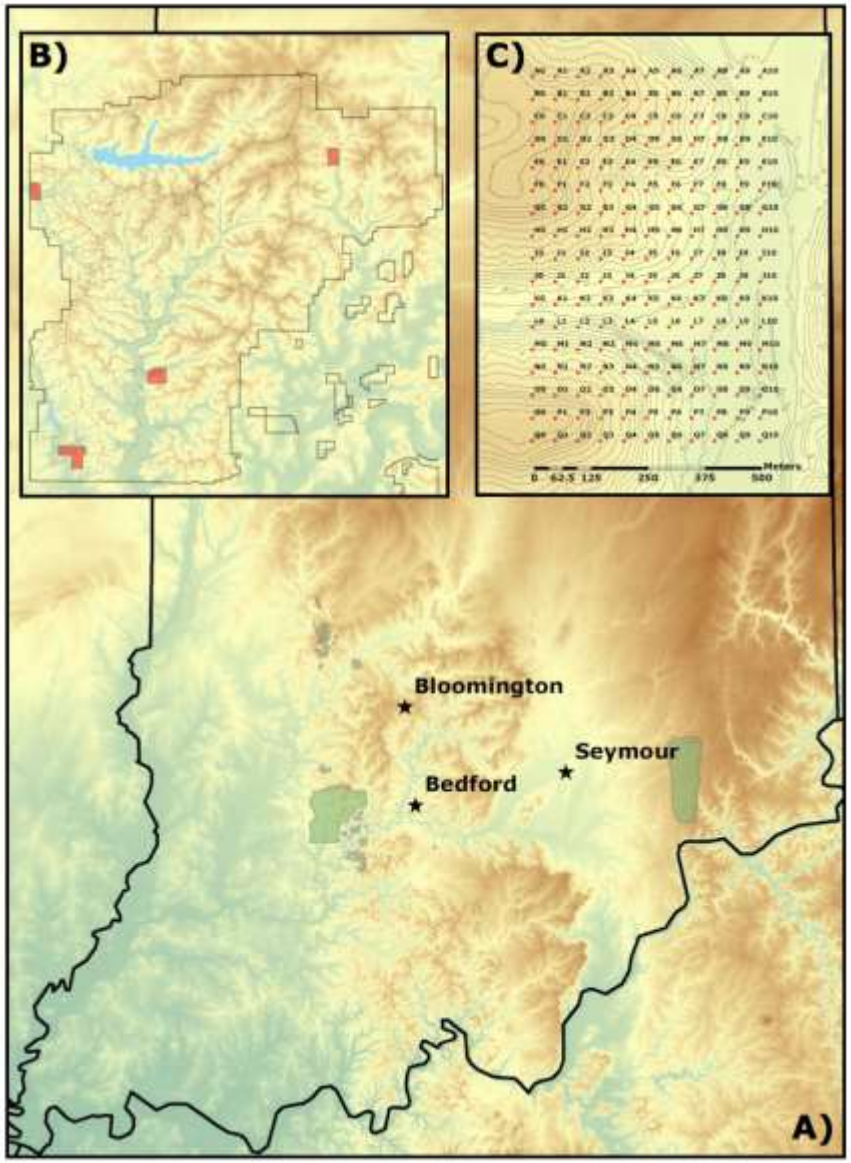
Technical Approach

TASK 1: Quantify Source-Sink Dynamics

- Point Counts
- MAPS
- Intensive Demography
- Population Genetics
- Stable Isotopes

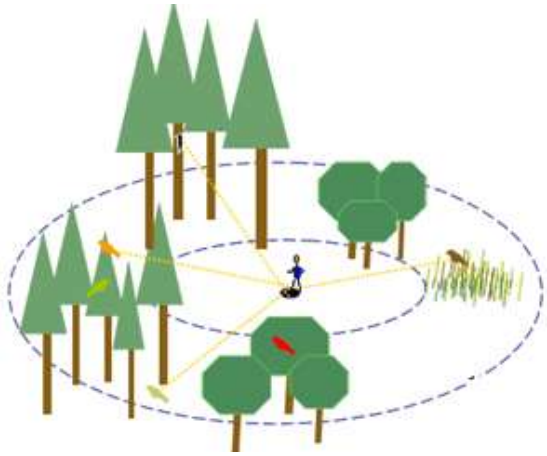
Study Sites

- DoD Installations (BONWR and Crane) represent large contiguous forest patches with different management practices
- Four IDNR properties represent smaller fragmented patches
- The spatial proximity of study sites allows us to capture local and regional population processes
- Point-counts, MAPS and intensive demographic data are collected at 12 study plots (37-63 ha)



Methods - Point Counts

- **Stratified Random Sampling Design (n = 497 patches) to capture variation in patch size and regional forest cover**
- **685 point counts (3 temporal replicates) on 21 different publically-owned (IDNR) properties**
- **Density and detection probability using distance sampling**
- **Design enables the examination of 1) occupancy, 2) colonization and, 3) extinction**



Methods - MAPS

- Constant effort mist-netting
- MAPS stations net arrays within the 12 demographic plots
- Birds are captured, banded sexed and aged using plumage characteristics
- Mark-recapture is used to estimate survival and recapture probability
- Productivity is measured as the ratio of juveniles to adults

Methods - Demography

- **Number of pairs monitored annually (25-40/plot; ~1400 total)**

- **Per capita rates include:**

1) Annual adult survival: mark-recapture

2) Fecundity

a) nest monitoring/survival

b) rebreeding probability

c) # offspring/ female

3) Juvenile survival: radio-telemetry

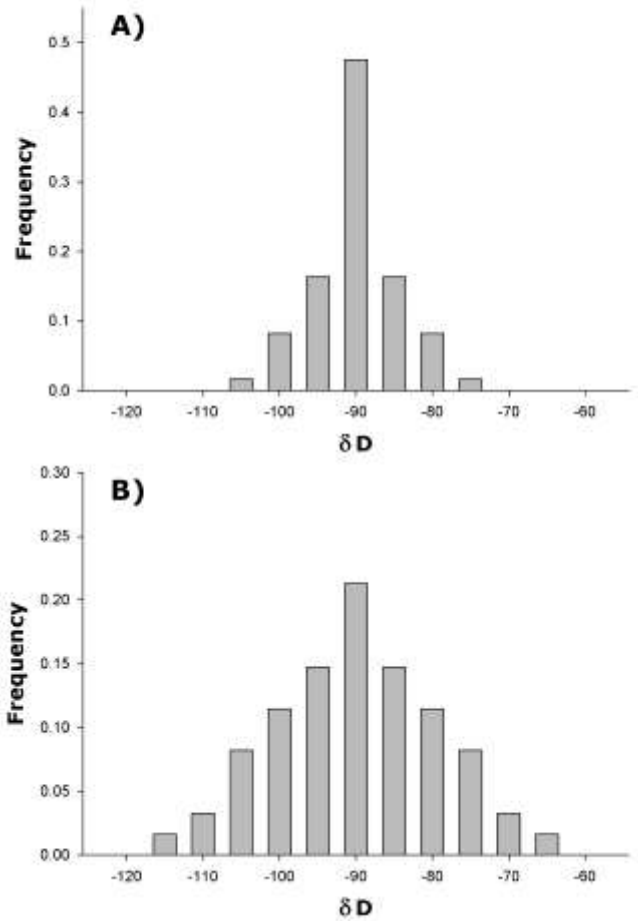
4) Transition probabilities: next slide

Methods – Demography
Transition probabilities

- **Few source-sink studies measure immigration/emigration**

- **We plan to use three approaches to measure stage-specific transitions**
  1) **Mark- resight (recruitment events)**
  2) **Stable Isotopes**
  3) **Population genetics-SNPs**

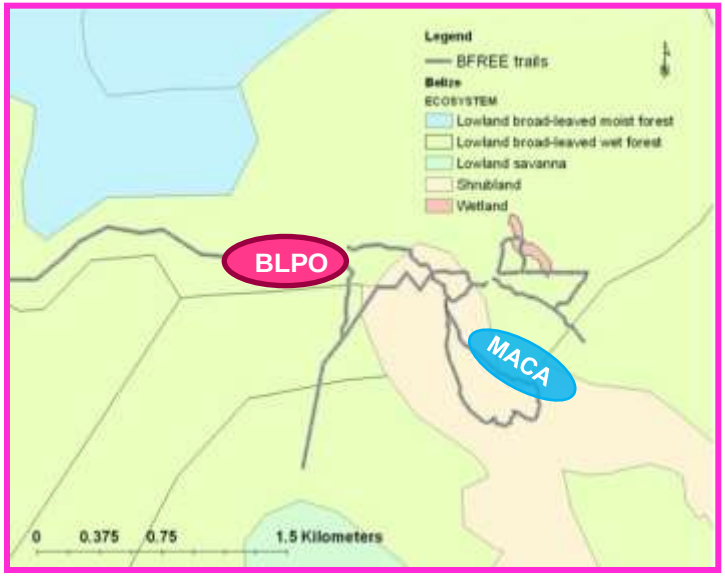
- **Probabilistic assignment techniques based on local isotope signatures and allele frequencies**



Methods – Demography
Non-breeding Season

- **Full annual cycle approach using vital rate data from non-breeding sites in Belize**

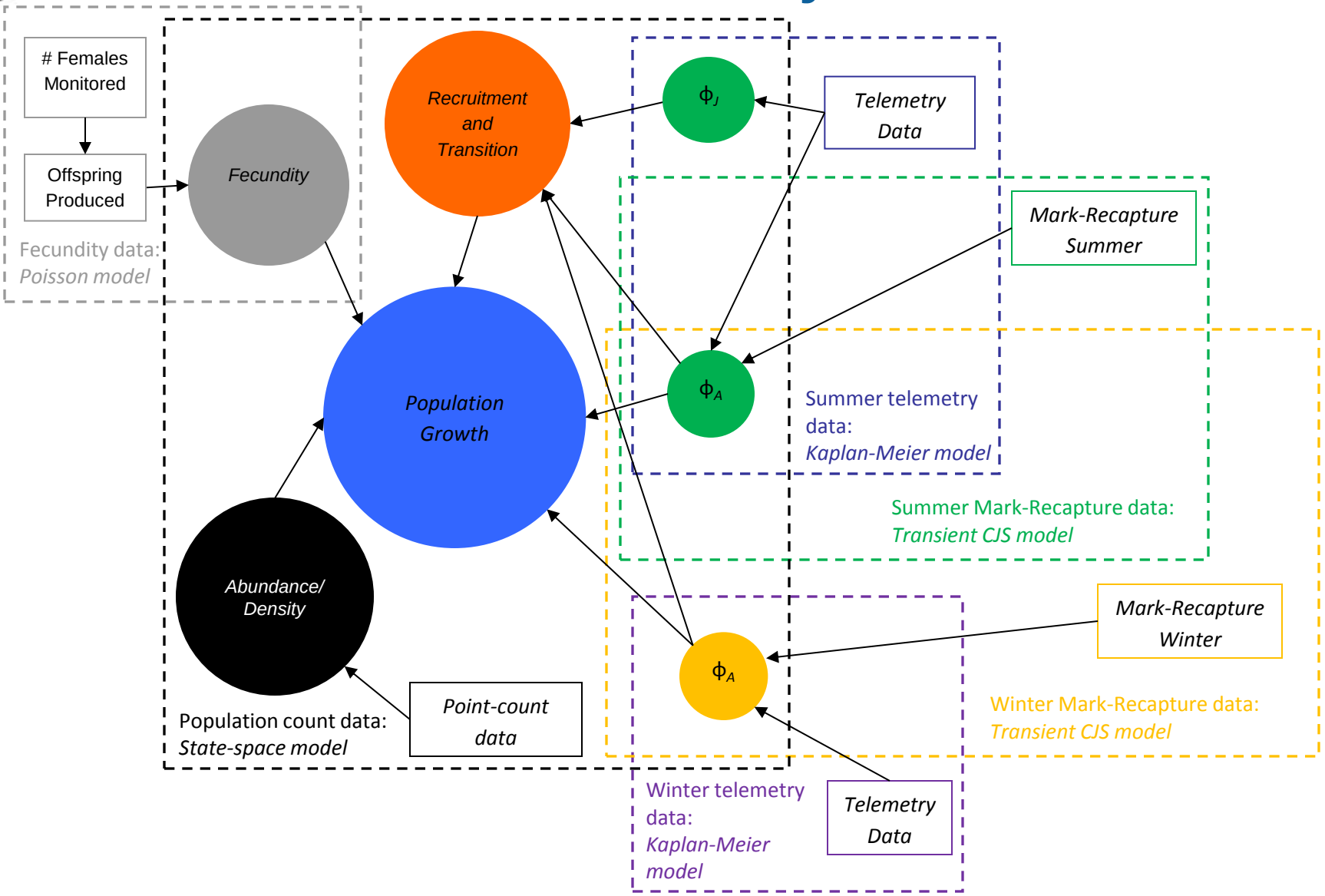
- **BFREE Study Plots for Demography**
  - **Macaw (MACA)- Xeric Second Growth Habitat**
  - **Blue Pool (BLPO)- Mesic Primary Forest Habitat**



Methods
Full Annual Cycle Integrated Population Model

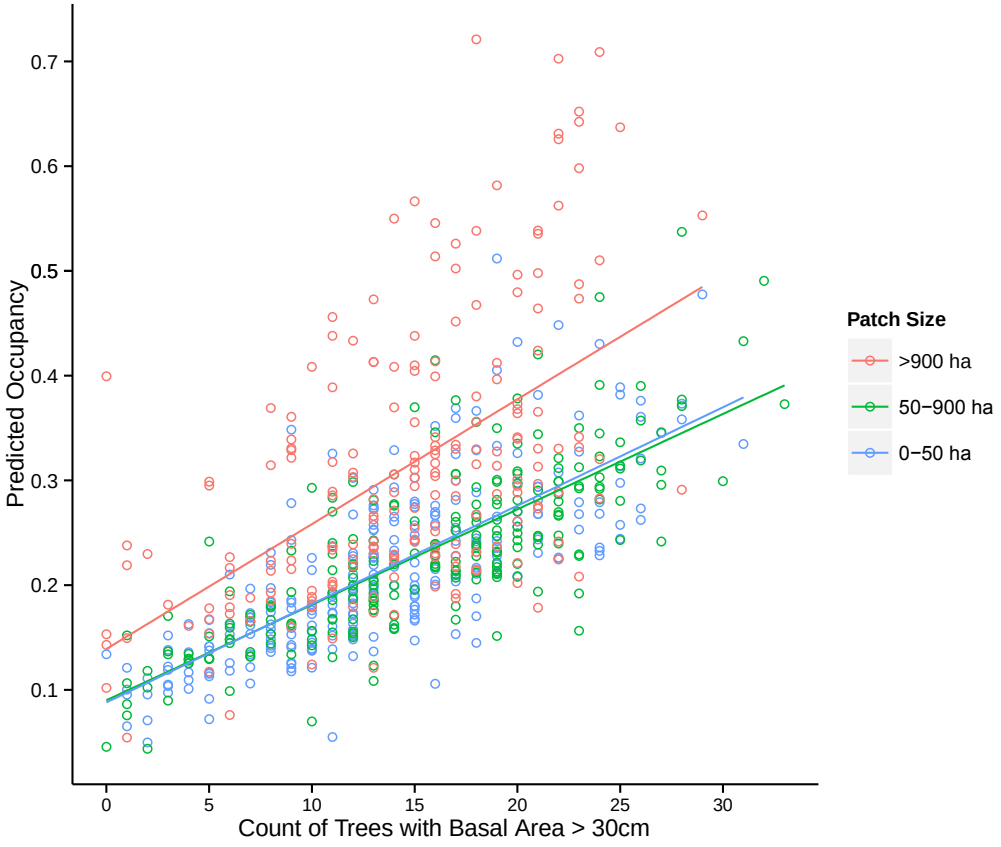
- **Integrated population models (IPM) combine sources of data (mark-recapture, point-counts, telemetry, etc.) to estimate spatial and temporal variation in population growth**
- **IPMs can increase precision in estimates of demographic vital rates and population growth parameters by the incorporation of stochasticity and density dependent regulation**
- **IPMs assess population viability via future projections and sensitivity analyses**
- **IPMs can incorporate ecological covariates to investigate the mechanistic causes of variation in population growth**

Full Annual Cycle IPM



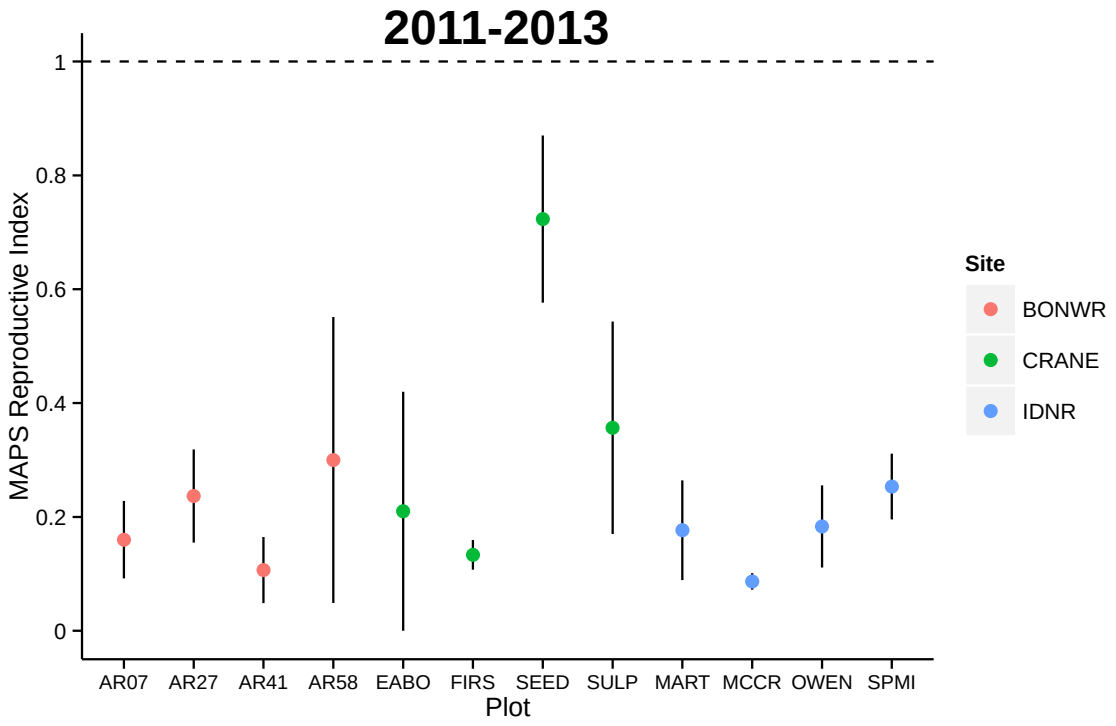
Results - Point Counts & Occupancy

- **6,083 bird surveys at 690 points (WOTH detected @ 69%)**
- **Both local (stand age) and landscape (patch size) are important for Wood thrush occupancy**
- **Local and landscape features interact with occupancy being significantly higher above a certain patch size threshold**



Results - MAPS

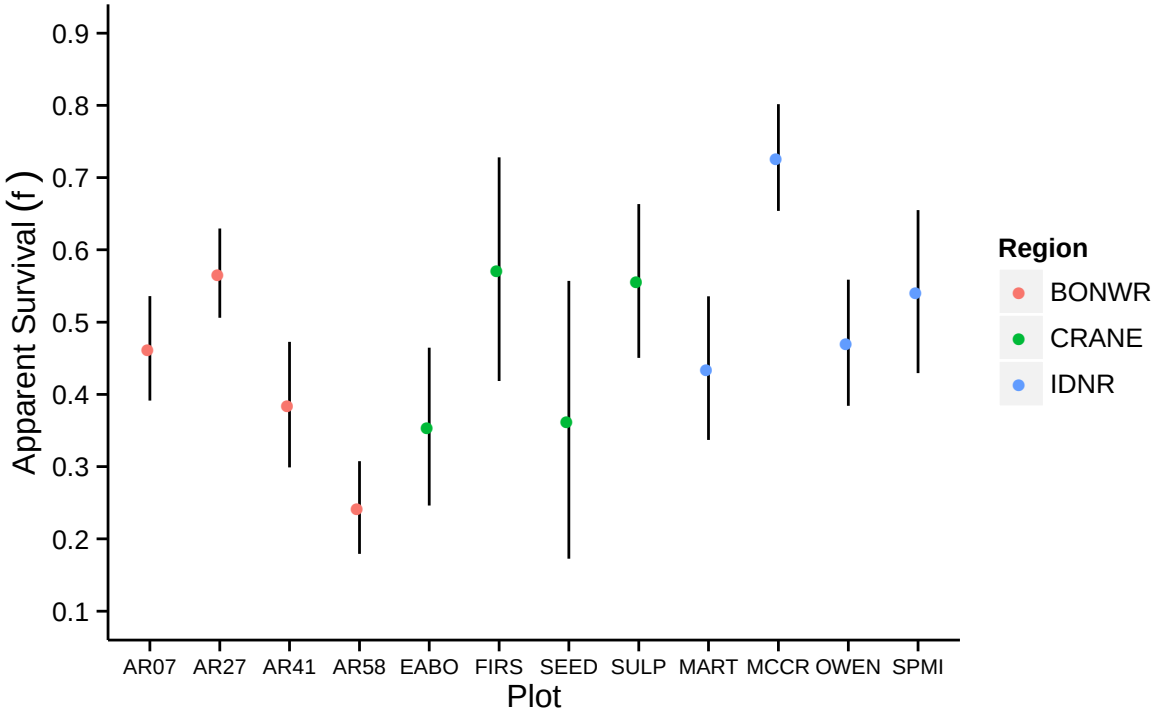
- **MAPS RI measures “local” fecundity using ratio of HY/AHY**
- **Substantial annual variation in some plots as measured by SE**
- **Using this metric females appear to be incapable of replacement**



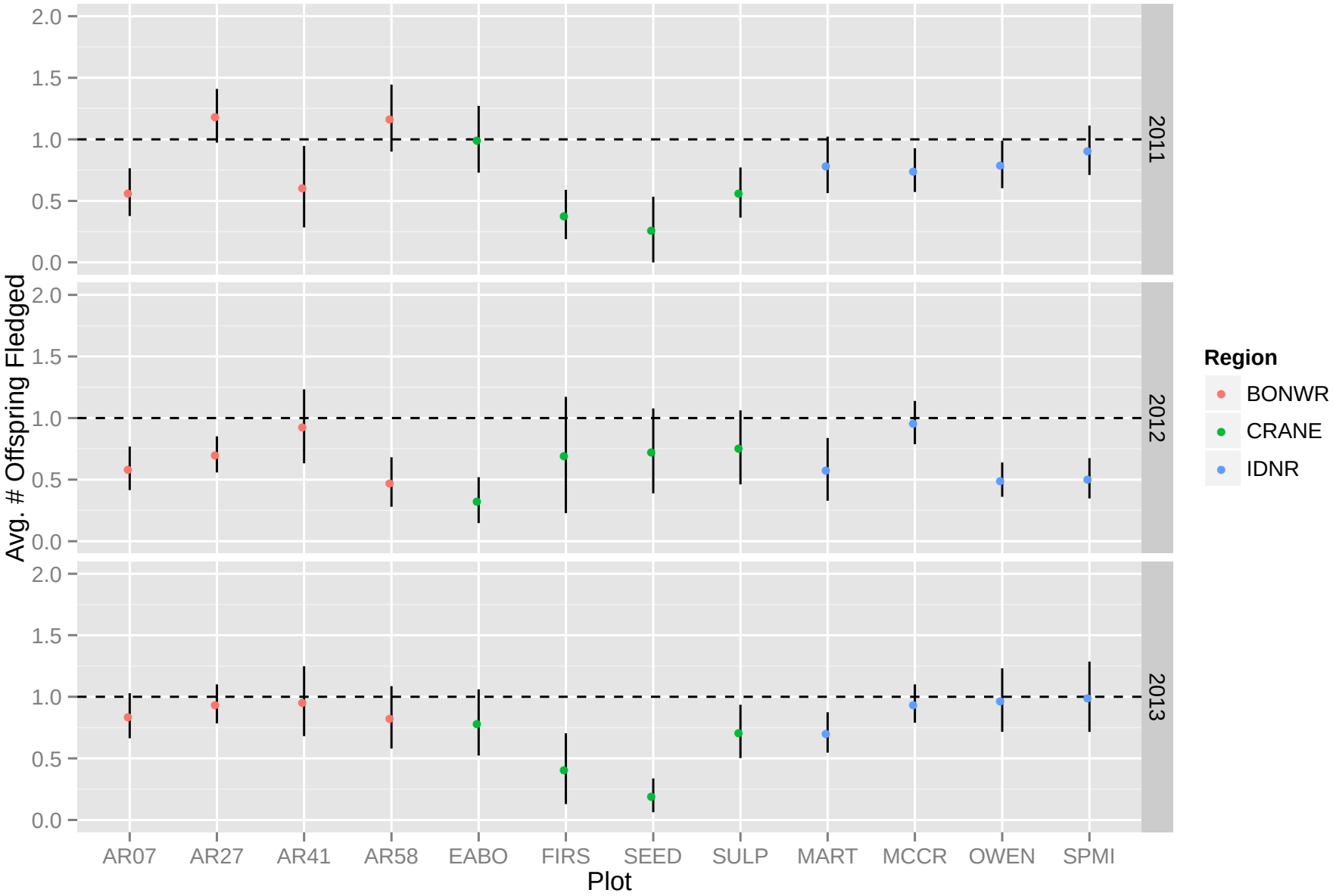
Results - Intensive Demography

Results- Annual Adult Survival

- **CJS survival model after accounting for transience**
- **Estimates range from 0.24 to 0.73**
- **Estimates are higher than previously reported for WOTH (0.47)**

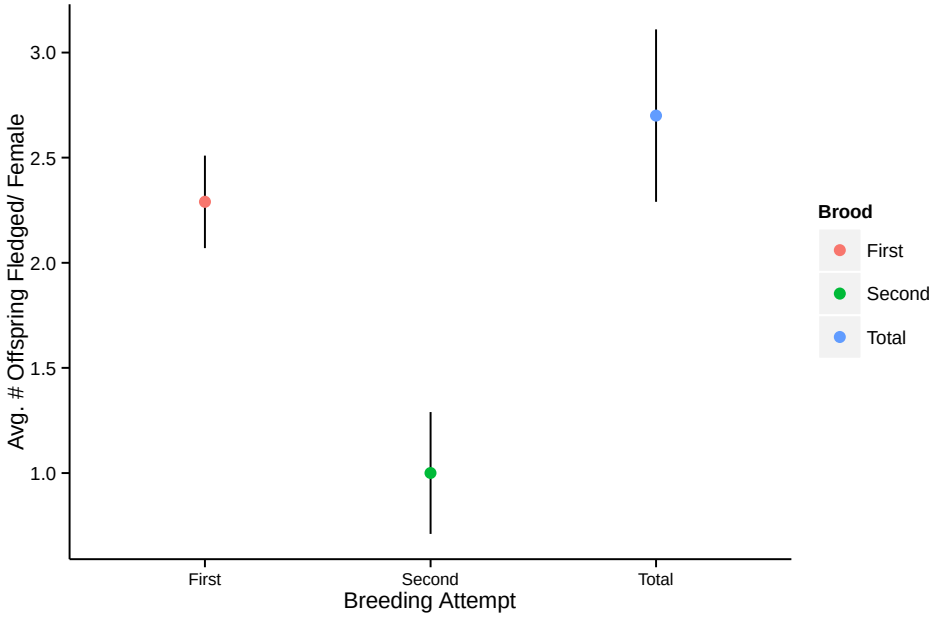


Results- Fecundity



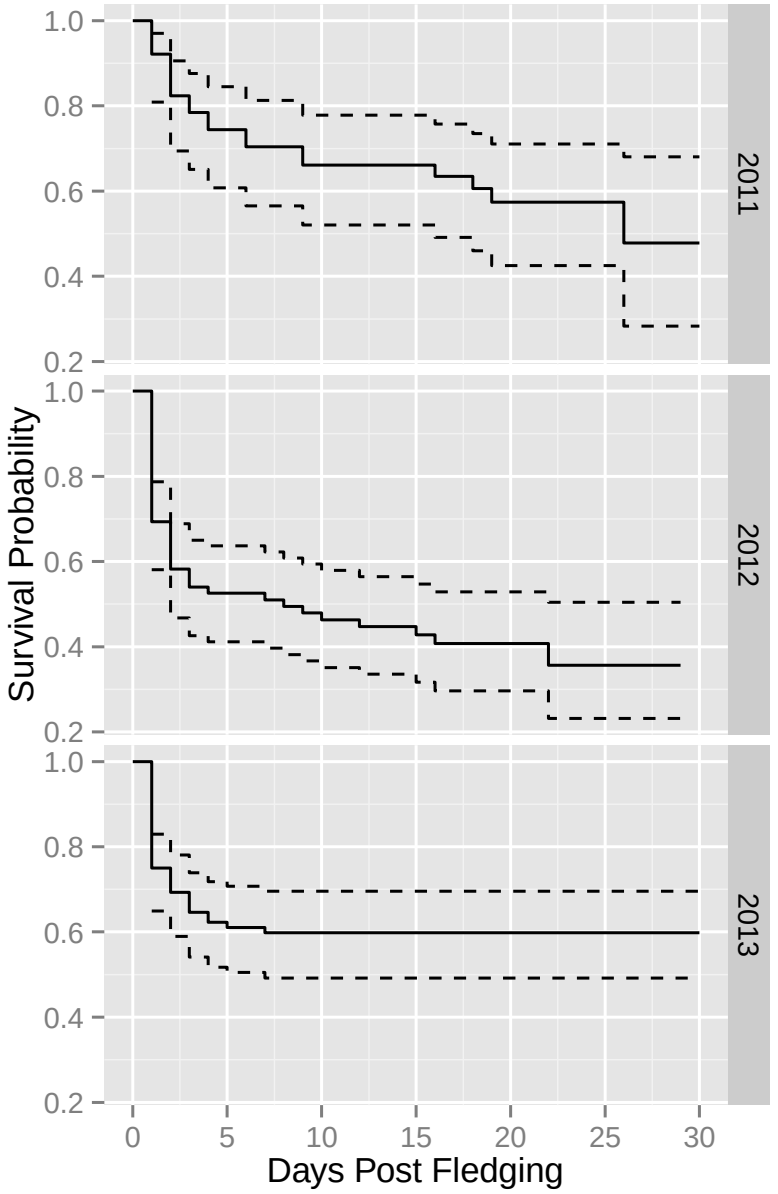
Results- Fecundity (rebreeding)

- VHF Tags to quantify rebreeding probability
  - 2013, n =25
  - 2014, n = 50
- 80% second brood and 10% a third brood
- Quantifying re-breeding will refine and improve fecundity estimates
- How does this vary temporally and with habitat quality?



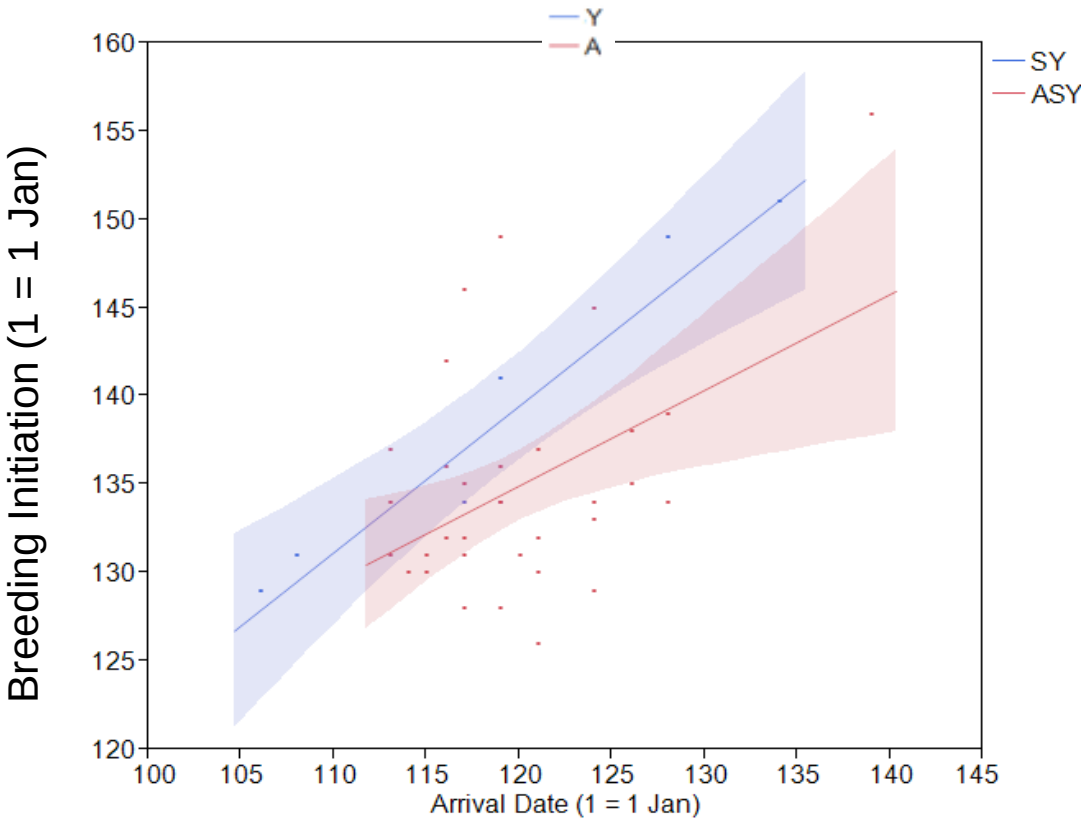
Results- PF Survival

- 215 VHF Radio Tags
- Temporal variation is more important than spatial variation
- 2011 ($\phi = 0.49 \pm 0.11$)
- 2012 ($\phi = 0.35 \pm 0.07$)
- 2013 ($\phi = 0.60 \pm 0.05$)
- $\phi_{CRANE} = 0.48 \pm 0.07$
- $\phi_{IDNR} = 0.55 \pm 0.06$
- $\phi_{BONWR} = 0.42 \pm 0.08$



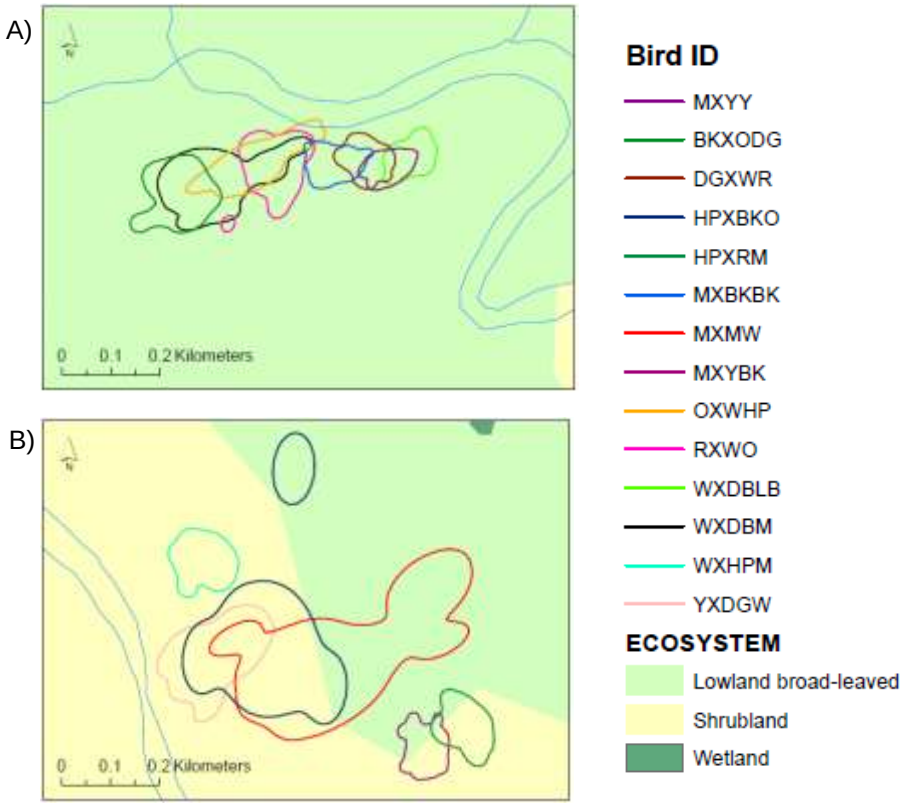
Results- Breeding Arrival

- Determined arrival date of 48 pairs from 2013 to 2014
- Late birds and first year breeders initiated breeding significantly later ($p < 0.0001$; $p = 0.05$)
- No. young fledged and prob. of fledging young increases with body condition as long as breeding is started early enough.
- Does winter departure influence breeding arrival?



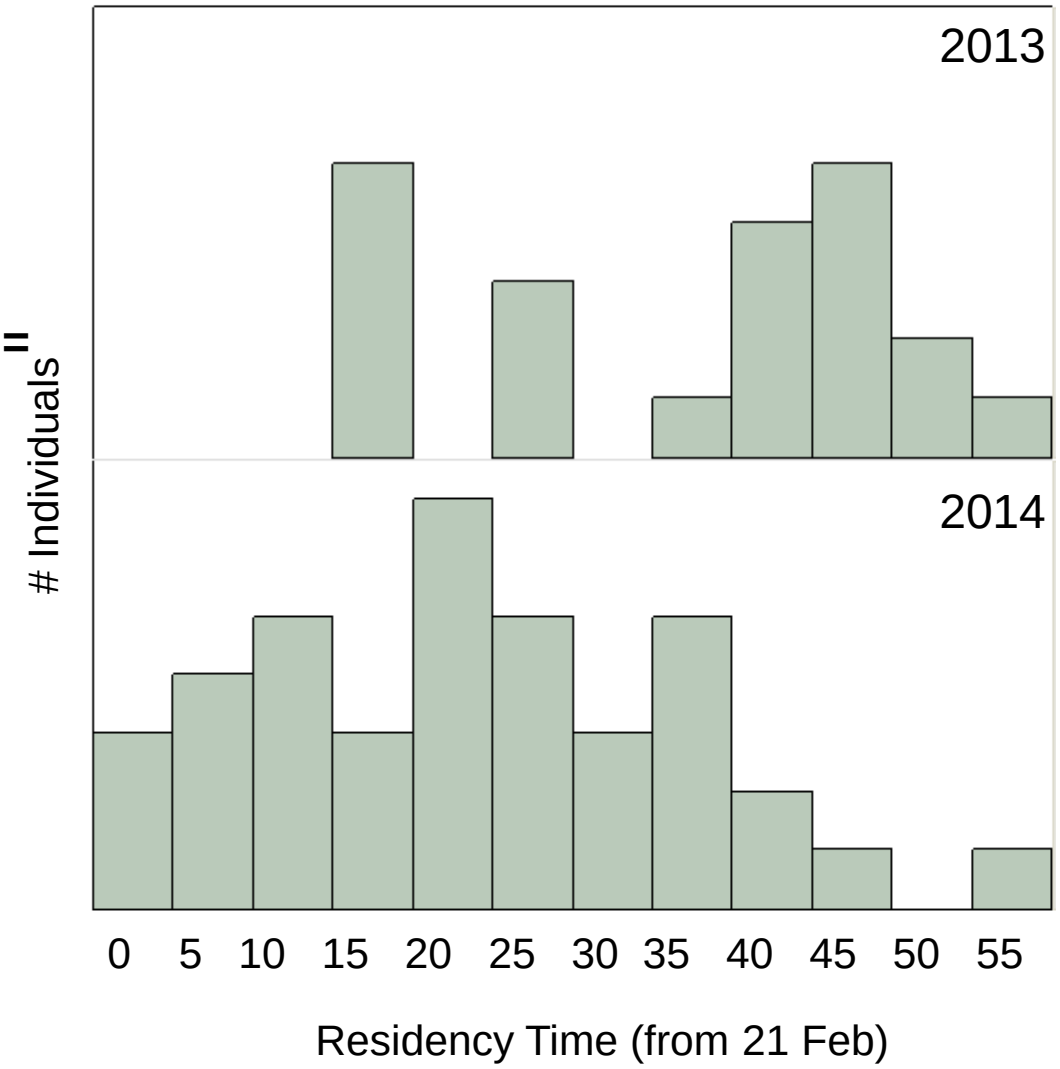
Results- Non-Breeding

- **Birds in dry shrub habitats had larger home-ranges than in primary forest consistent with a food limitation hypothesis**
- **Late season fruit, insect availability and moisture was associated with large home range size.**
- **Changes in insect abundance significantly related to moisture ($F_{1,21}$ = 5.04, p = 0.04, r^2 = 0.194) but not fruit levels.**



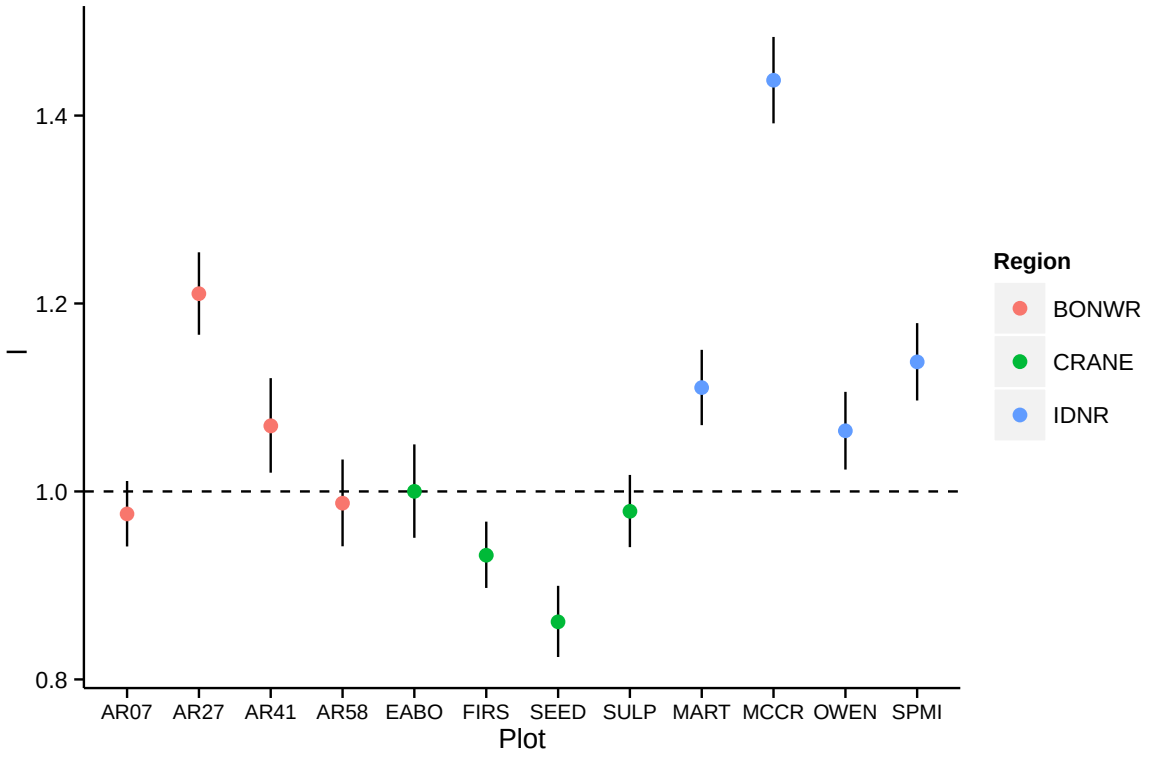
Results- Non-Breeding

- **116 radio tags deployed**
- **Birds depart territories prior to migration. Site persistence was significantly shorter in 2014 (χ^2 = 13.15, p = 0.0003**



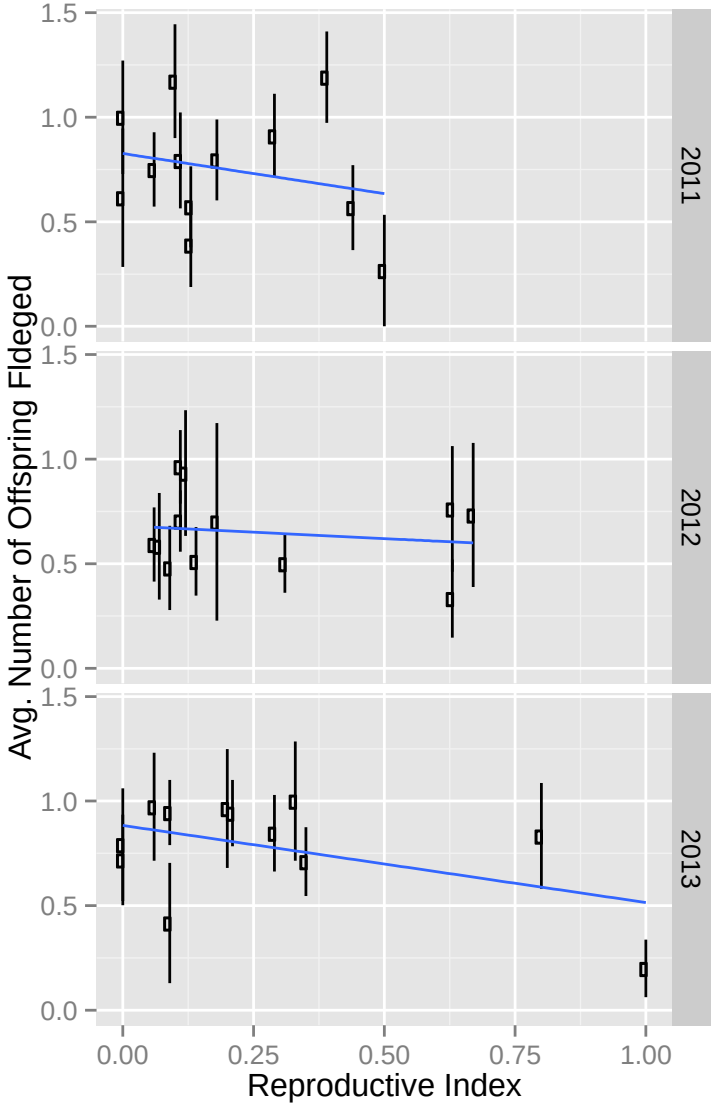
Results- Source-Sink Dynamics

- **Preliminary population growth estimates that incorporate site-specific survival and immigration**
- **Adult survival appears to play a significant role in local population growth**
- **Refine using IPM and scale to the landscape to examine mechanistic drivers of SS dynamics**



Results- Preliminary Comparisons

- **Occupancy positively correlated with population growth and may inform both dynamics and vital rates**
- **Based on three years of data its clear that MAPS reproductive index is not an accurate measure of local productivity**
- **# Offspring Fledged/ Plot should be positively correlated with RI**



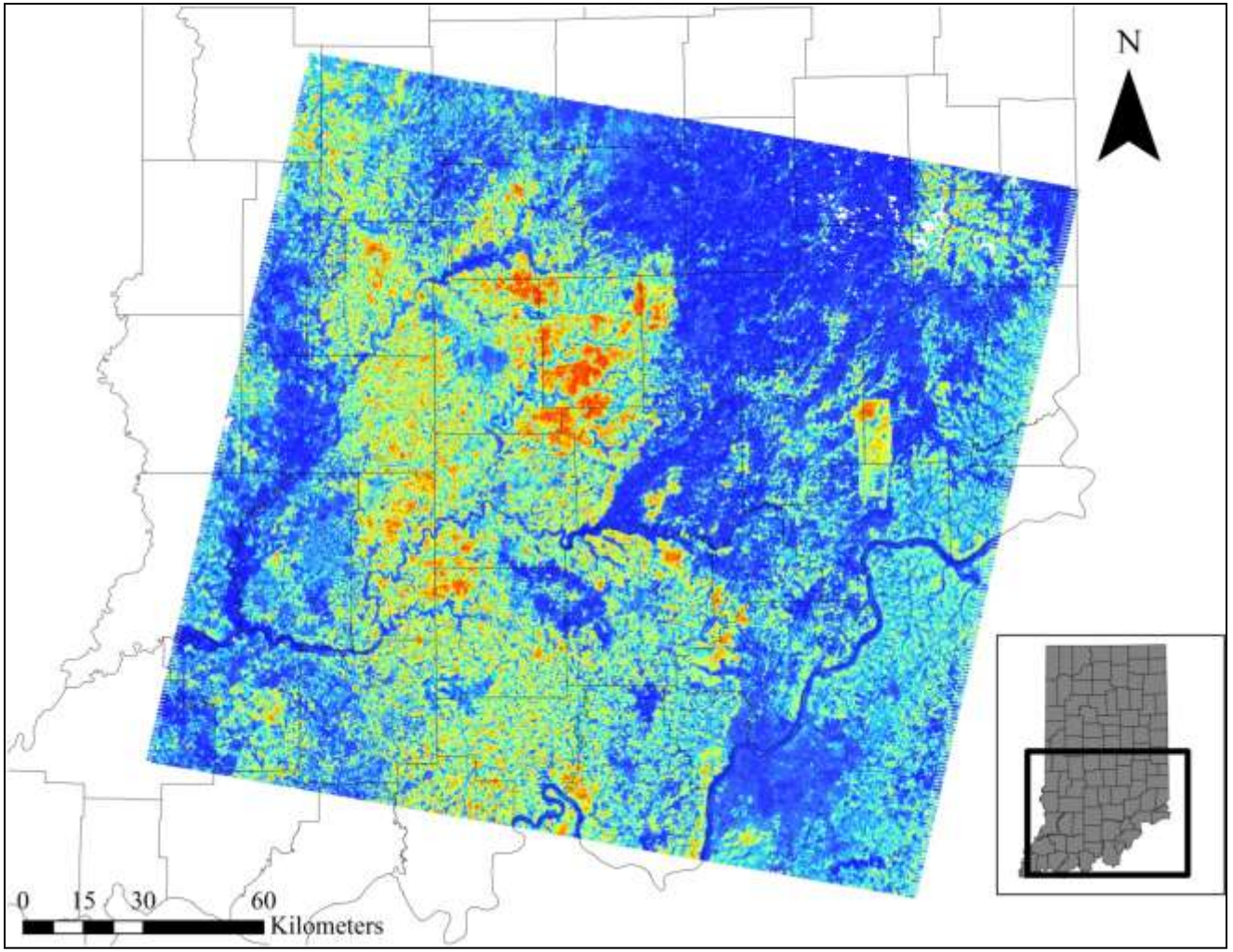
Results- Species Distribution Models

We are also using the point count data along with associated habitat variables to develop species distribution models.

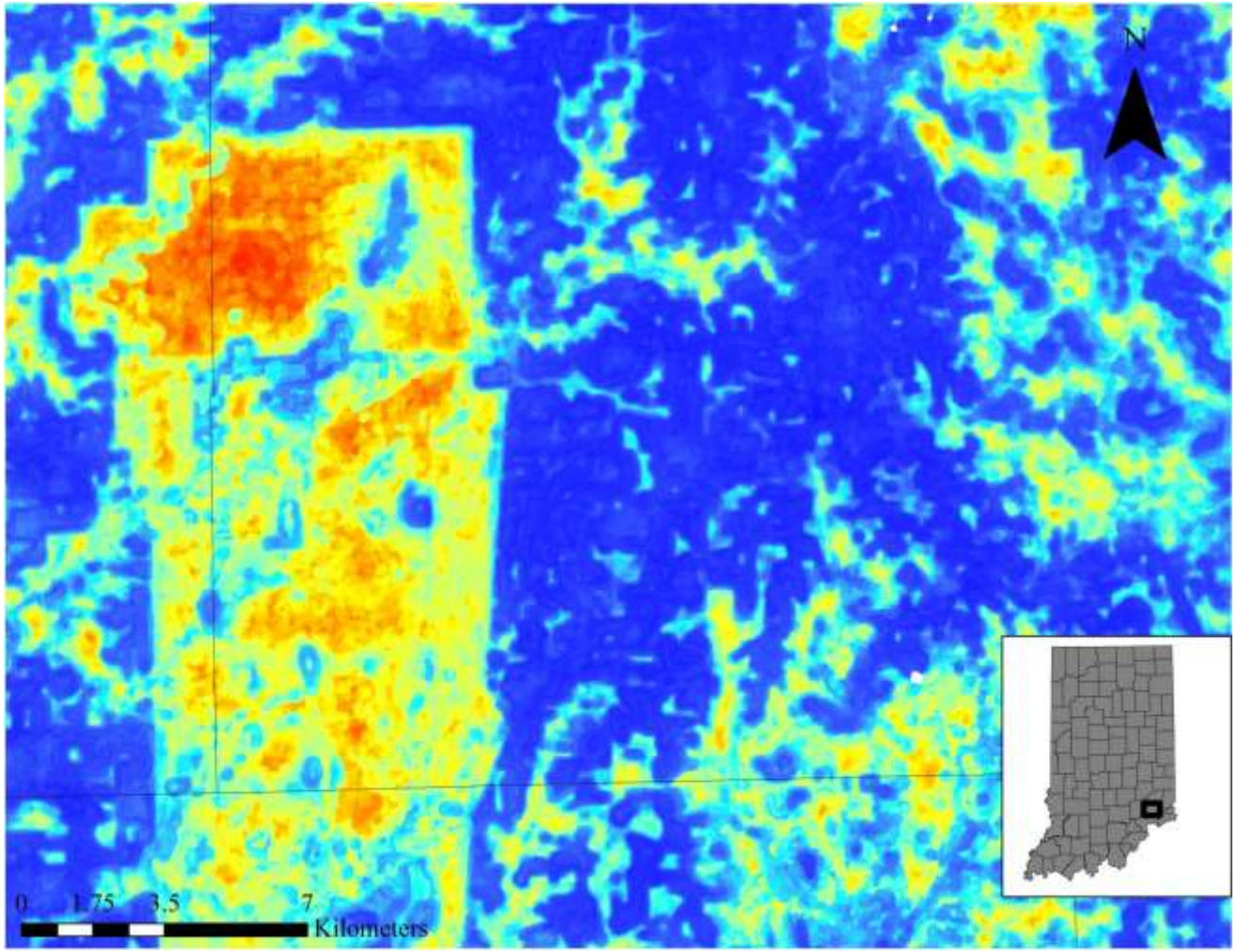
These models are built using 30 m pixel LandSat imagery collected in 2011 as explanatory variables, and frequency of occurrence at each point count station as the response

SDMs identify probability of occupancy for every species for every pixel on the landscape

Results- Species Distribution Models

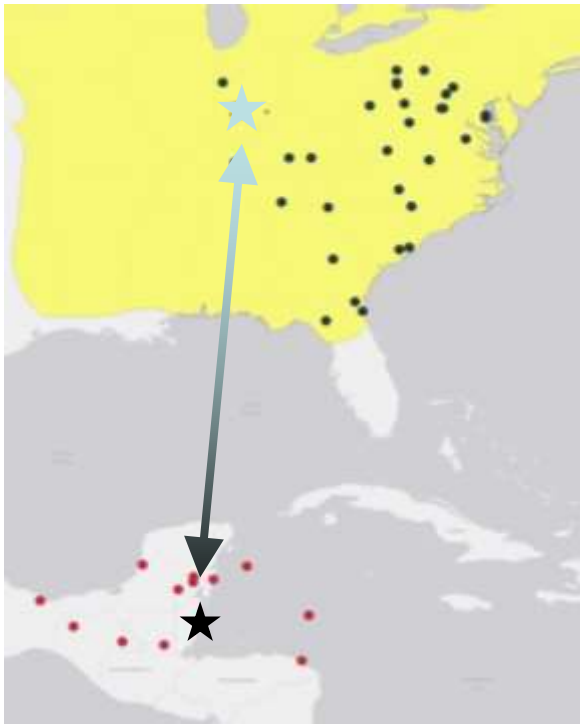


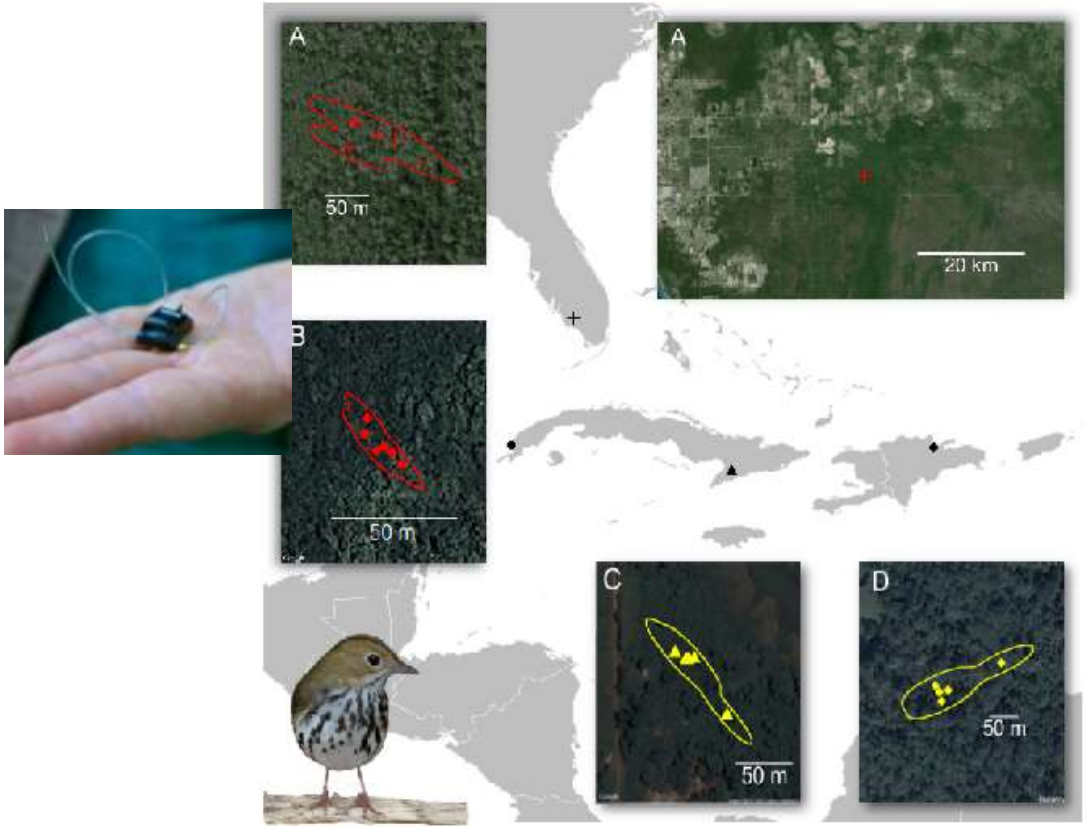
Species-centered approach



Next Steps - Seasonal Interactions

Technology for tracking migratory songbirds still limits our ability to understand migratory songbirds





Miniaturized archival GPS geolocators
10-m accuracy (Hallworth and Marra in review)

Next Steps – Seasonal interactions

North Carolina
Delaware
New York
Indiana
Minnesota

Next Steps

- **Complete all comprehensive demographic analyses and modeling, SDMs and Migratory Connectivity**
- **Scaling up from intense single species to communities**
- **Knowing migratory connectivity is essential!**
- **Using data from the overall regional Wood Thrush project we plan to develop a range-wide conservation plan (along with bird conservation partners) for land managers**
- **Conservation plan will address the causes of population decline and take a structured decision making approach to inform management and conservation actions**

What do you need?

We want to know what land managers and the JV's need for managing bird populations and what format would be the most useful.

Reports?
Primary literature publications?
Managers guide to measuring habitat quality?
Population modeling workshop or guide?
Tools for quantifying migratory connectivity?