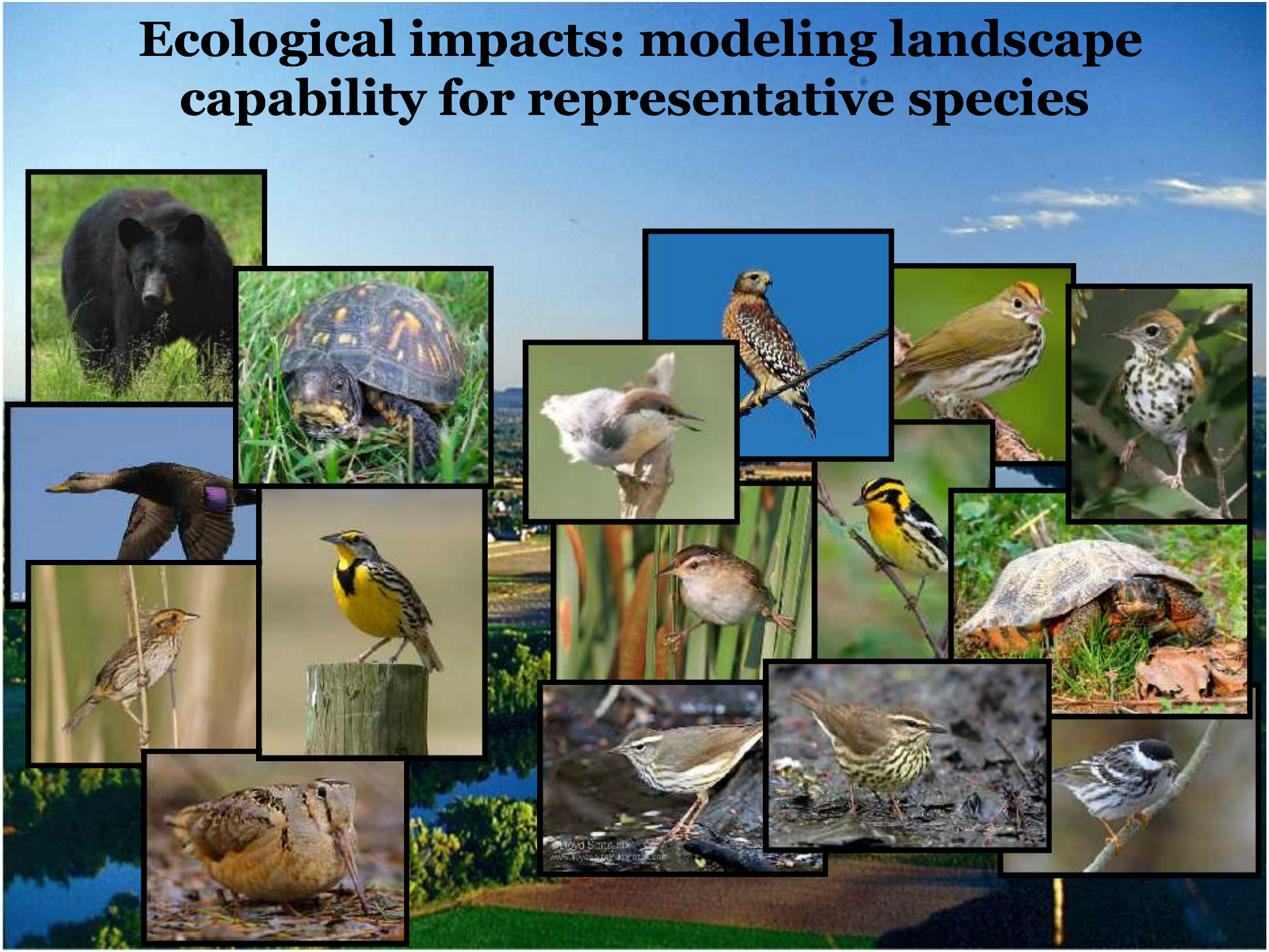
Ecological impacts: modeling landscape capability for representative species

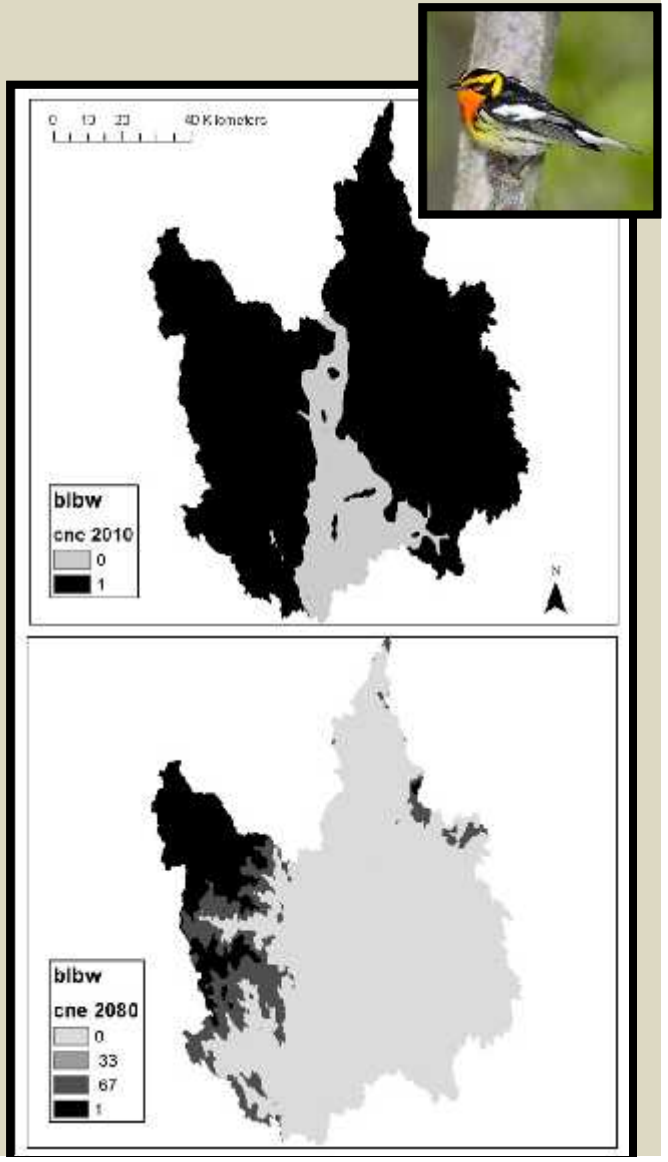


Landscape Assessment

Species habitat models

Landscape Capability (LC)
Phase 1

- Based on HRC (ha)
- Future change measure by proportional Δ LC under 3 climate response assumptions
  - None = habitat only in current CNE
  - Immediate range contraction = habitat only in areas that remain in CNE
  - Immediate range shift = habitat in suitable climate



Landscape Assessment

Species habitat models

Problem: Would be useful for LC to be translated to index of population potential

- Can be used as measure to reflect capability of the current landscape compared future change

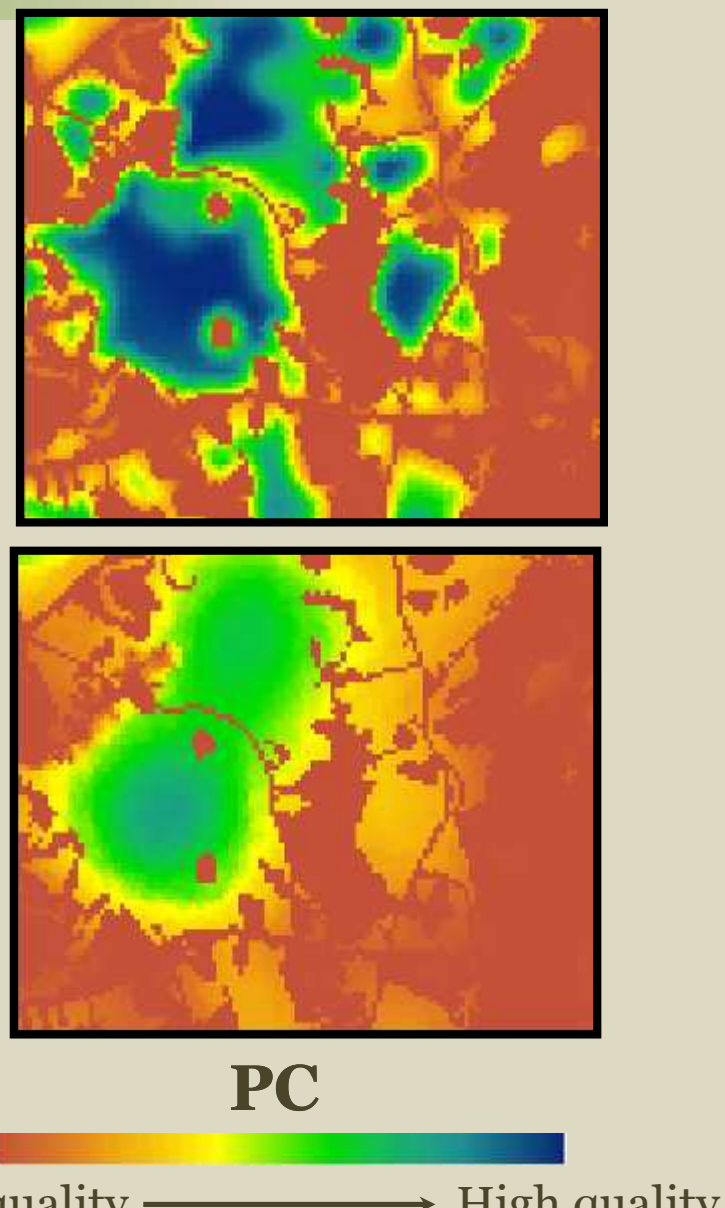
- Will address a few caveats later

Landscape Assessment

Species habitat models

Step 1: Convert HRC to PC

- HRC reflects the quantity, quality, and accessablity of local resoures at the HR scale
- Does not directly distinguish between a good isolated HR and a HR in a neighborhood of good HR's
- Similar resistant kernel approach but at larger bandwidth scale (5x)

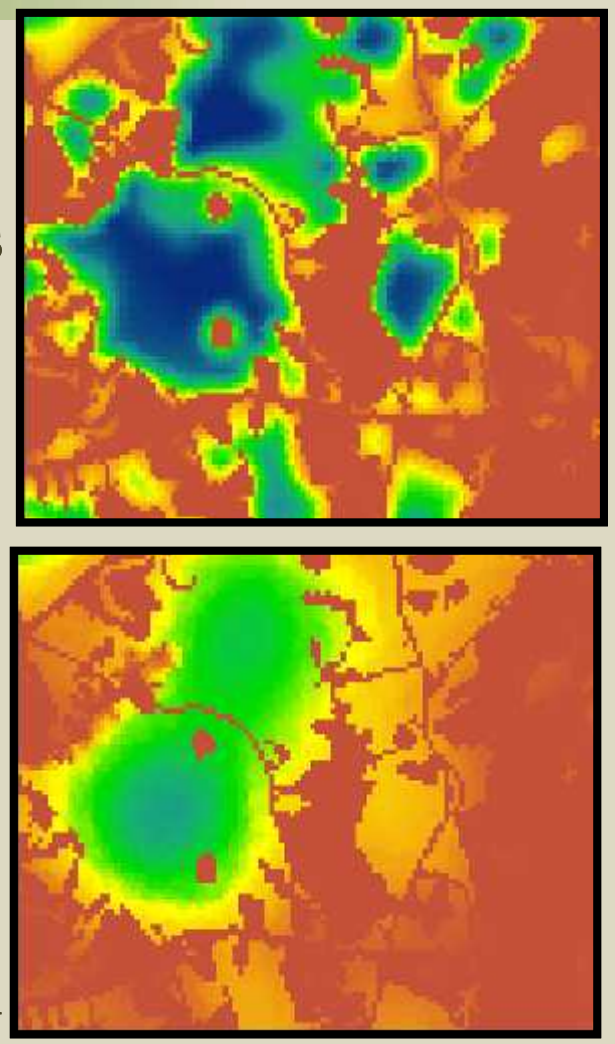


Landscape Assessment

Species habitat models

Step 1a: Determine PC bandwidth

- What scale reflects co-occurrence that is most strongly associated with occupancy after controlling for local habitat capability
- Scale determined in a logistic regression approach, compare models at various PC bandwidths
- response = eBird pres/abs
- Predictors = HRC, detection covars
- Candidate models vary in PC bandwidth
- Compare AIC

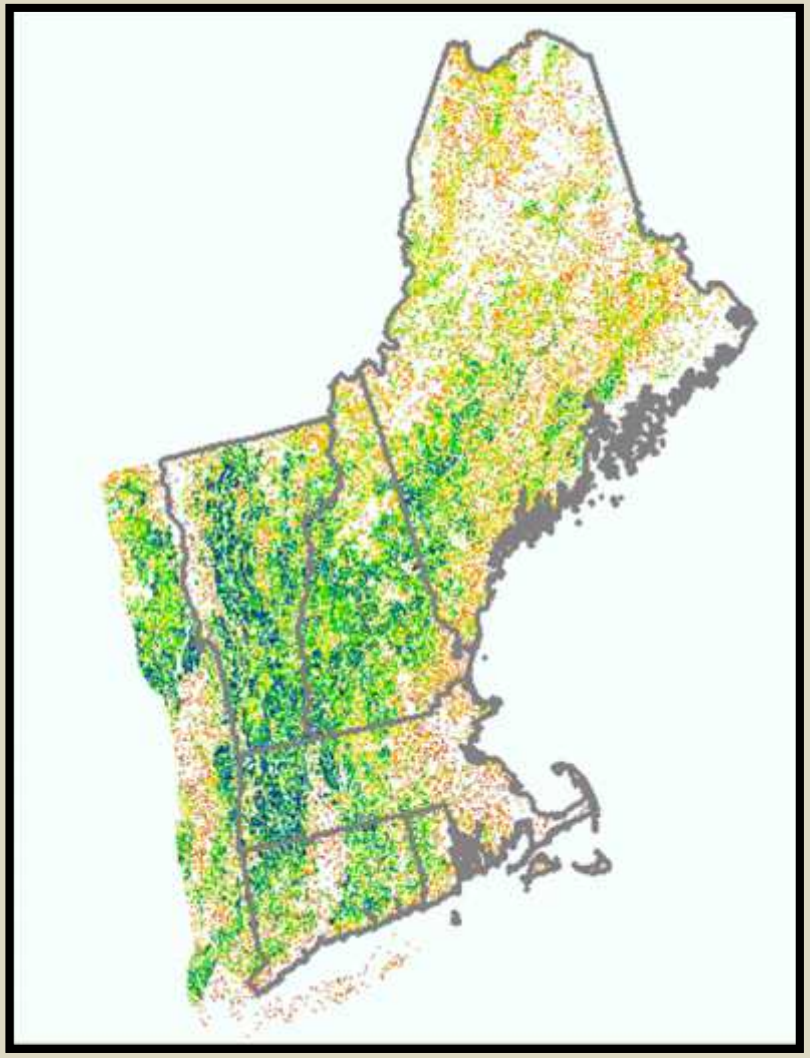


Landscape Assessment

Species habitat models

Landscape Capability from PC

- PC hectares = 4,222,071 ha
- WOTH HR ≈ 2 ha
- WOTH LC = 2,111,035

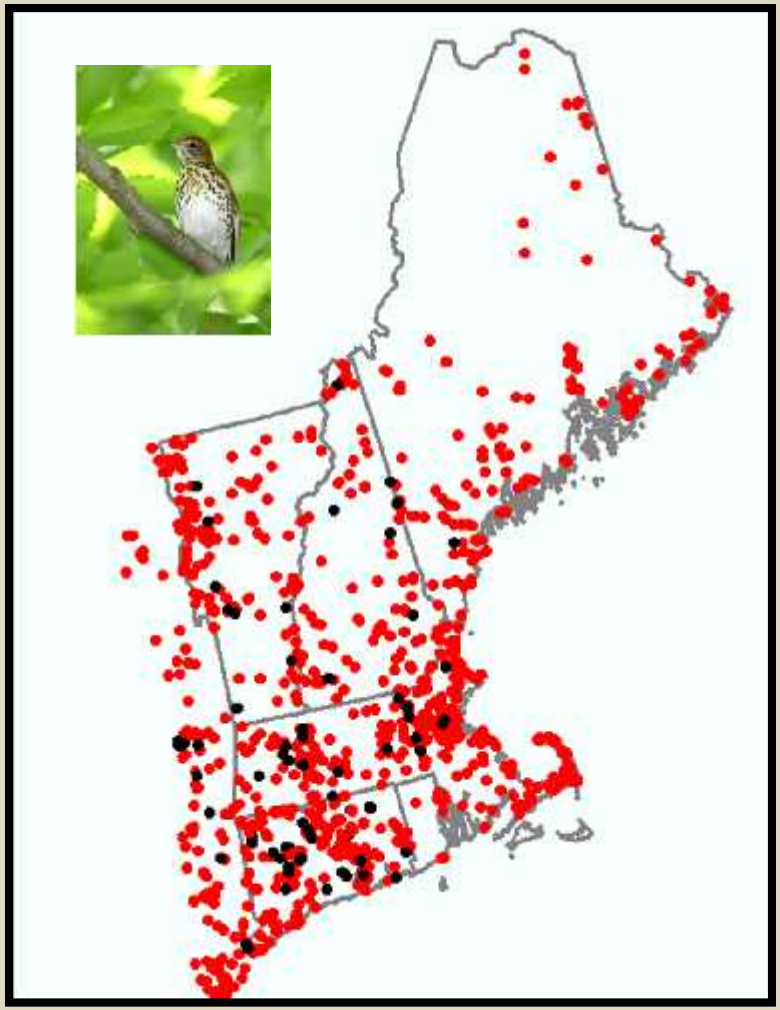


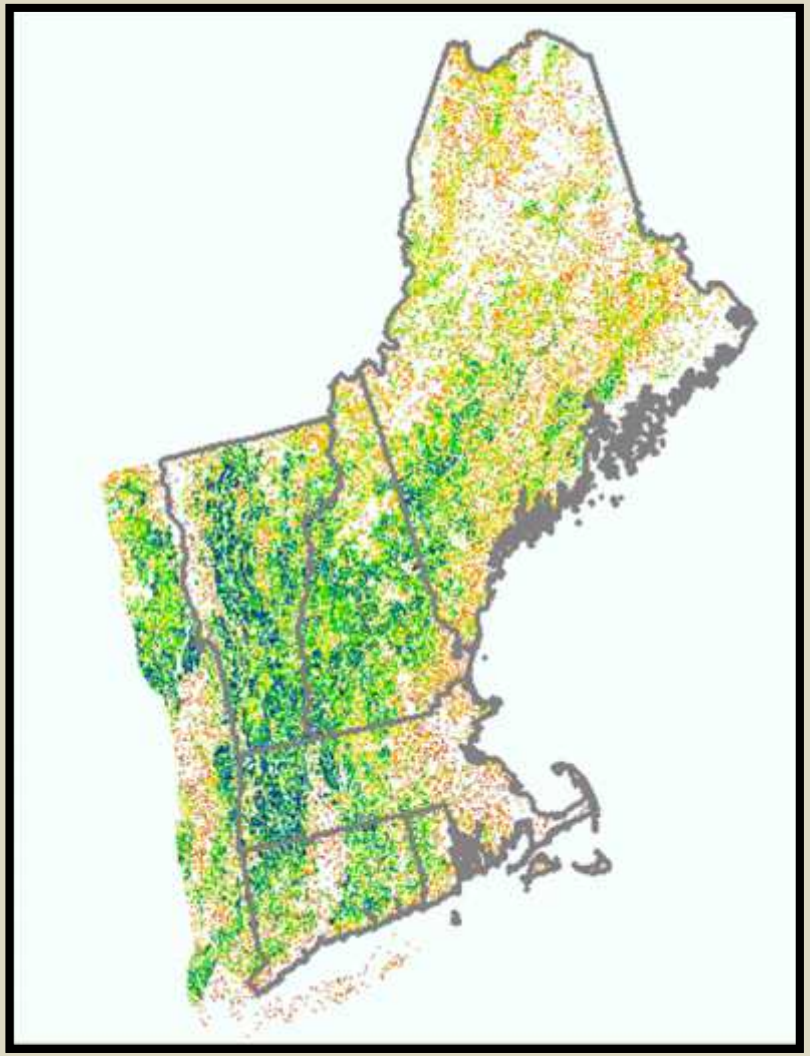
Low quality ⟶ High quality

Landscape Assessment

Species habitat models

What about prevalence?





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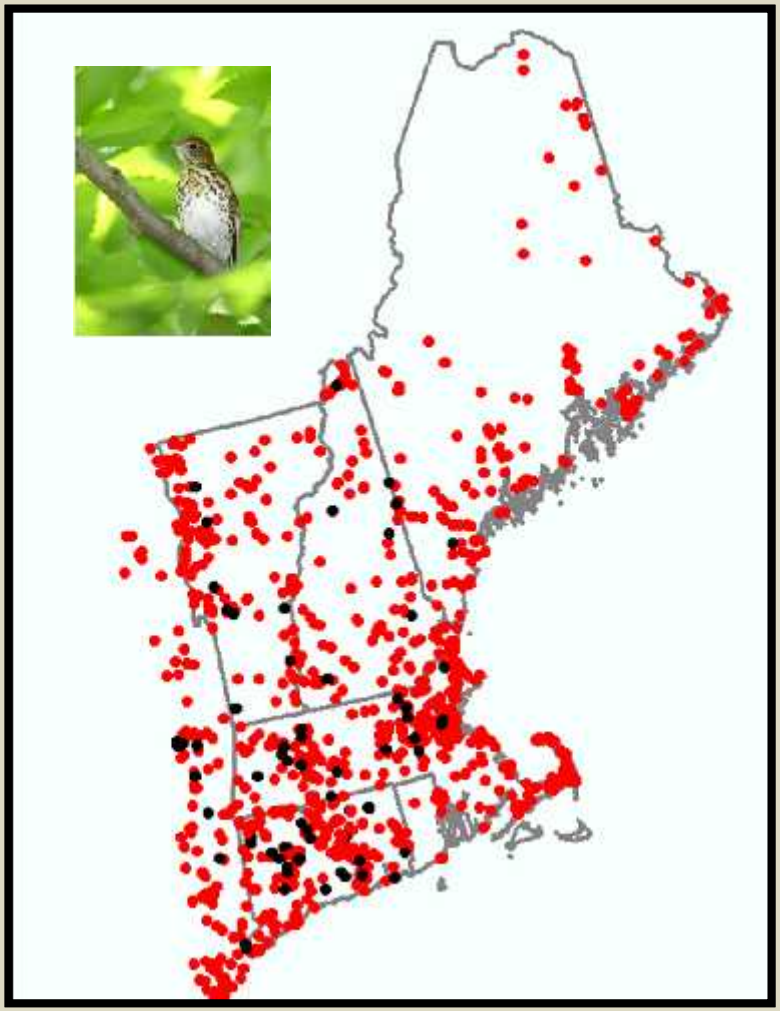
Landscape Assessment

Species habitat models

Step 2: Convert PC to measure of occupancy (prob of occurrence)

- Calculate # of potential HR's under the assumption that capable habitat is occupied in proportion to probability of occurrence
- eBird and CT data, pres/abs
- Fit logistic regression model from data points, response = pres/abs

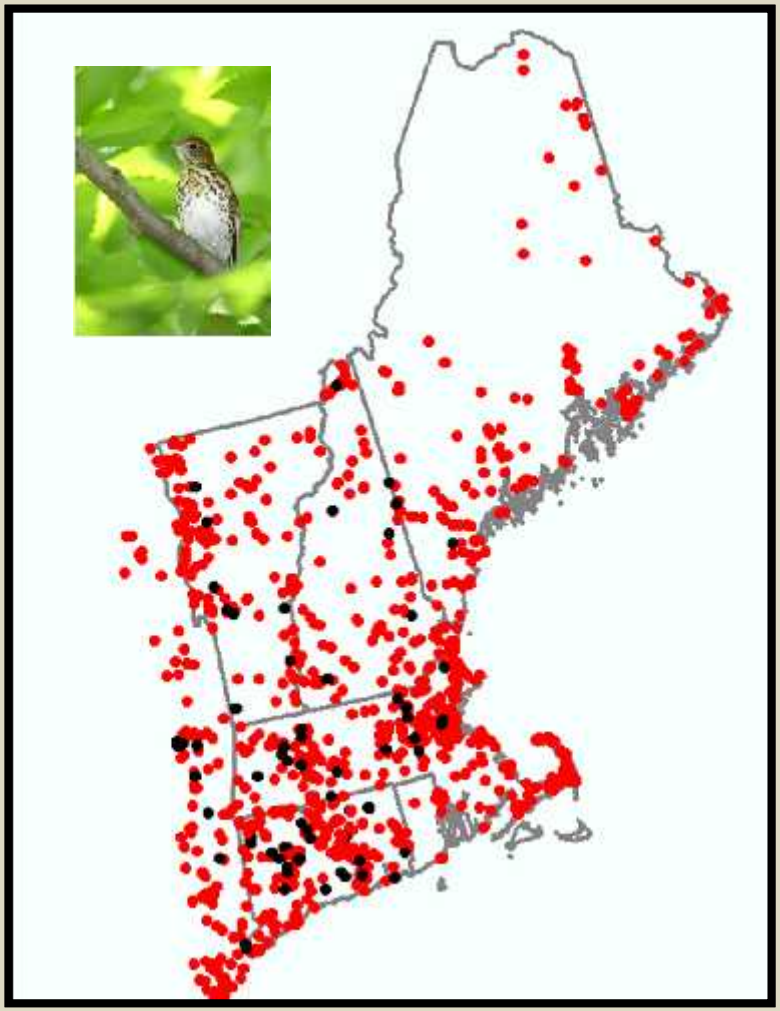


Landscape Assessment

Species habitat models

Step 2: Convert PC to measure of probability of occurrence

- Predictors:
  - For current timestep, fixed coefficients from CNE model
  - Max PC
  - Biogeographic variable as a measure of range core-periphery distance, coarse-scale, Gaussian distance weighted proportion of pres/abs (eBird)
  - Detection covariates

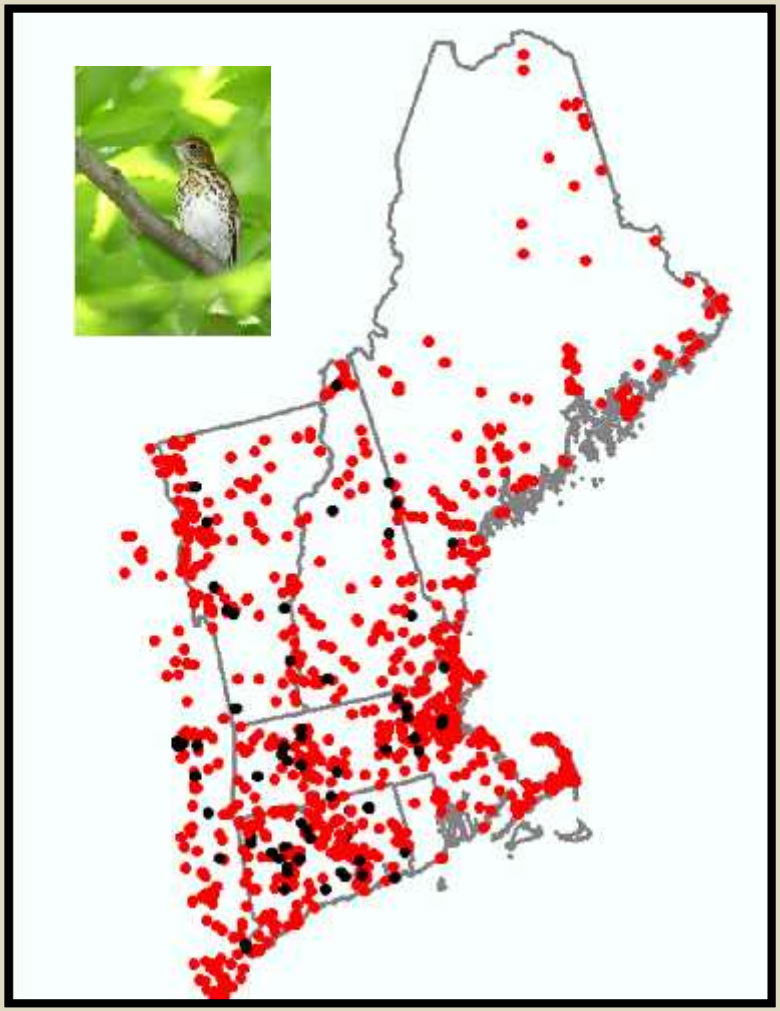


Landscape Assessment

Species habitat models

Step 2: Convert PC to measure of probability of occurrence

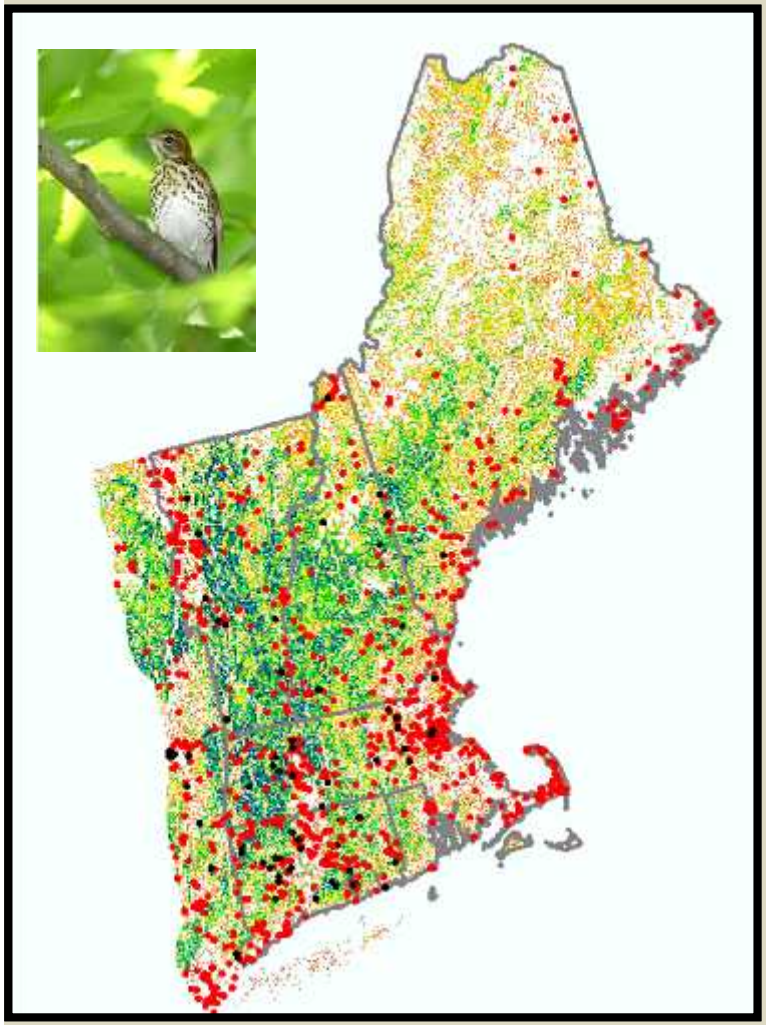
- Apply the fitted model across the landscape
- Occupancy surface defined by PC, climate, and range core-periphery



Landscape Assessment

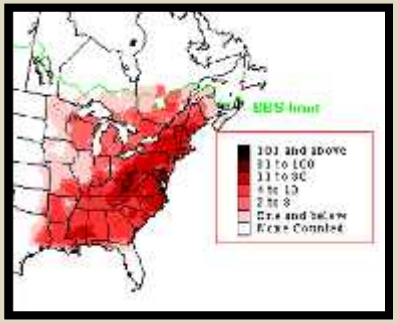
Species habitat models

PC

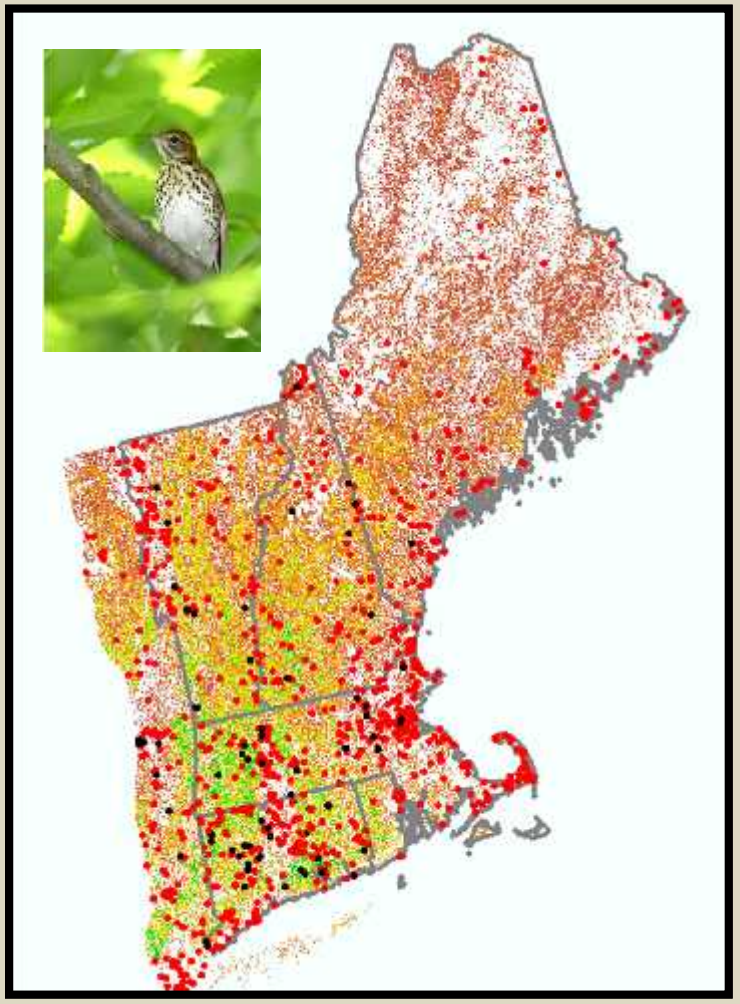


High quality (1)

Low quality (0)



Prob. of Occurrence

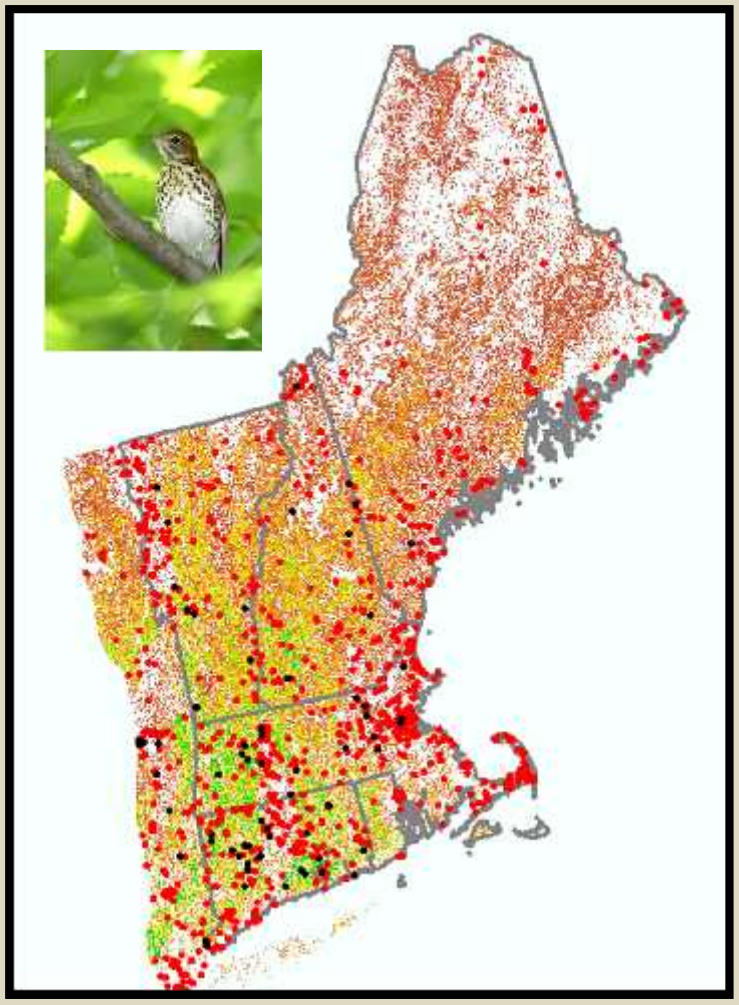


Landscape Assessment

Species habitat models

Step 3: Convert occupancy surface to Landscape Capability

- Occurrence hectares = 980,950 ha
- WOTH HR ≈ 2 ha
- WOTH LC = 490,474 (Occupancy)
- WOTH LC = 2,111,035 (PC)



Low quality ⟶ High quality

Landscape Assessment

Species habitat models

Step 4: Calculate LC metrics for 2030 and 2080

- LC none – apply fitted logistic regression model with 2010 climate values to get occupancy surface; LC will only reflect changes in the occupancy surface due to habitat loss/gain, not climate change
- LC shift – apply fitted logistic regression model with future climate values to get occupancy surface; LC will reflect habitat loss/gain and immediate response to climate change (expansion and contraction)
- LC contract – use the min occupancy surface between LC none and LC shift; assumes species will only respond to climate change via range contraction

Landscape Assessment

Species habitat models

Phase 2 LC metrics

Pros

- Empirically based
- Accounts variability among species in the range of PC values via species-specific probability of occurrence
- Accounts for the spatial variability in species occurrence across its range; does not assume uniform saturation of capable habitat

Landscape Assessment

Species habitat models

Phase 2 LC metrics

Cons

- Requires empirical data (not good for non-birds)
- Assumes population saturation of habitat in proportion to modeled probability of occurrence
- Biogeographic covariates account for spatial variation in prevalence, but is temporally stationary

Landscape Assessment

Species habitat models

Phase 2 LC metrics

WOTH LC = 490,474 territories

Caveats

- Not a population estimate
- An index of landscape population potential to be compared across time and scenarios
- Assumes habitat saturation
- Does not allow unoccupied suitable habitat
- Does not account territory overlap
- More….

Landscape Assessment

Species habitat models

Evaluating representativeness of our representative species

- Use data (eBird) for other species within the cluster to validate representative species model
  - Logistic regression with pres/abs and PC

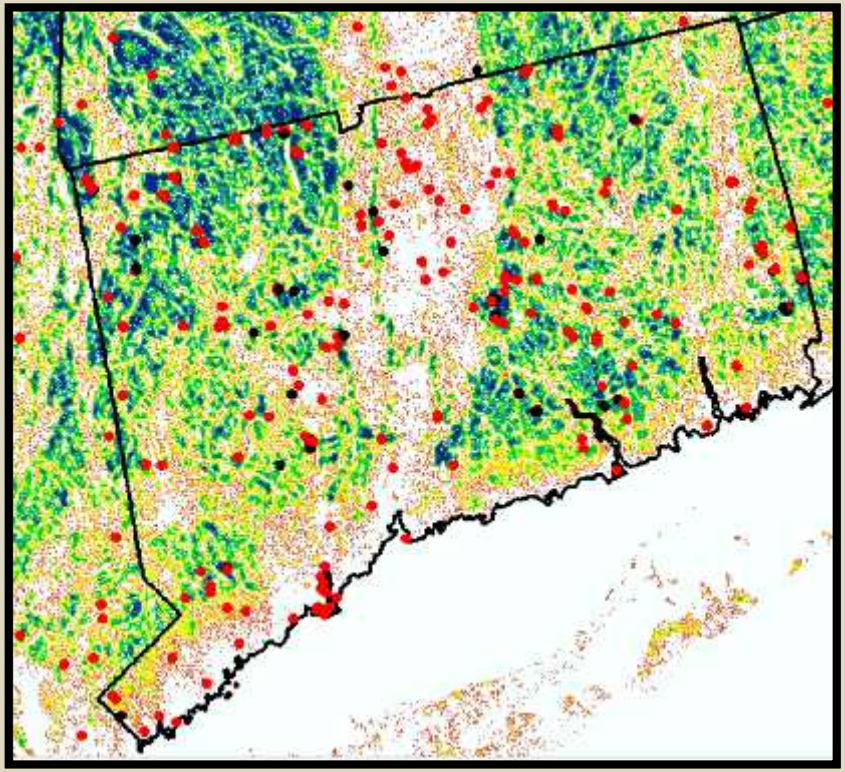
- Can we validate a representative species model with species data outside the cluster?
  - Randomly select species eBird data to validate the model
  - Can we validate the WOTH model with AMRO?

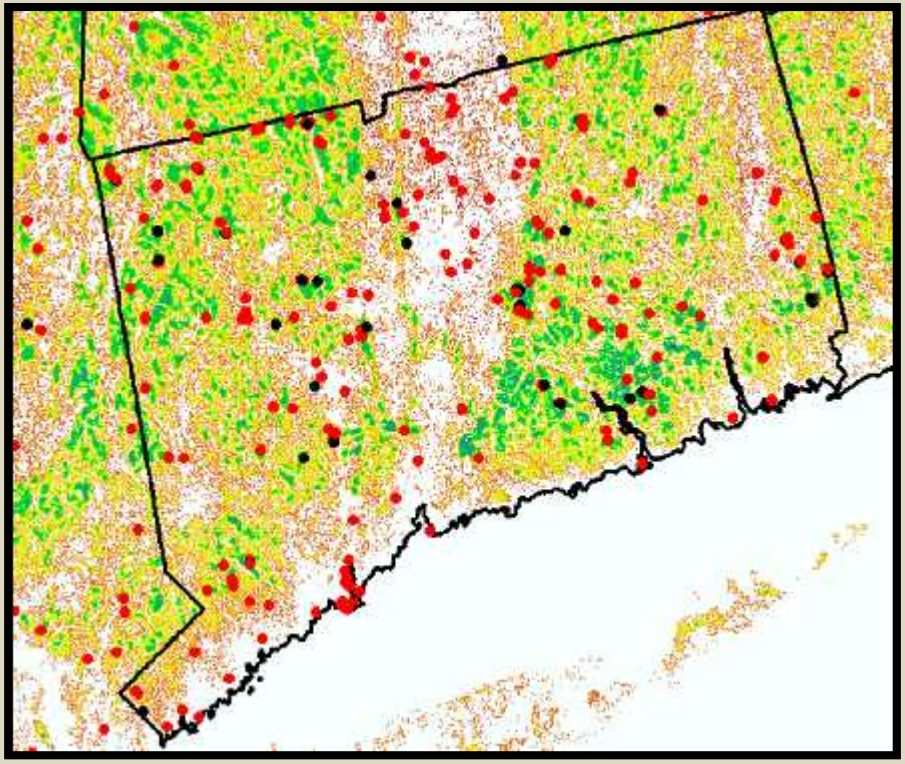
Landscape Assessment

Species habitat models

Landscape Assessment

Species habitat models





Landscape Change, Assessment & Design model

Species habitat models

Population Capability
PC

Home Range Capability
HRC

Home Range Breeding Capability
HRC-B

Post-breeding Capability
HRC-P

Breeding Habitat (Local)
LRA-B

Post-breeding Habitat (Local)
LRA-P

Ecological system
LRB1

Forest structure
LRB2

Small extent development intensity
LRB3

Large extent development intensity
LRB4

Quantity of habitat on the landscape
LRB5

Early successional forests
LRP1

Edges between forests -- open
LRP2

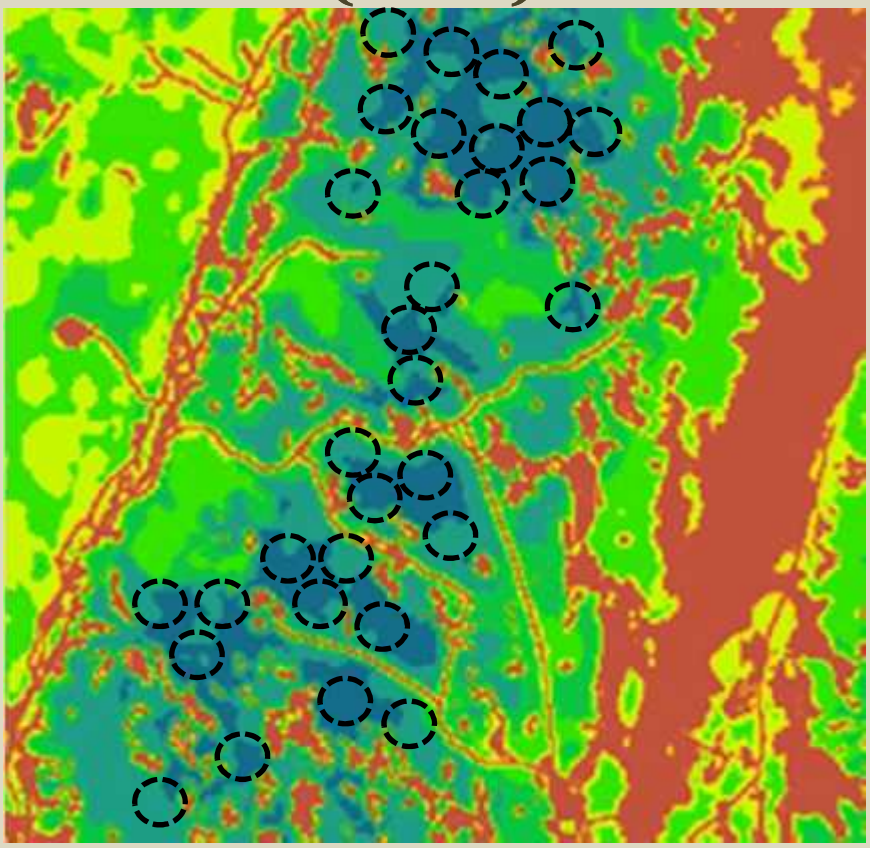
Landscape Change, Assessment & Design model

Species habitat models

Population Capability

- Stochastically selects locations for home range based on HRC
- Minimum HRC
- Mean # realized homeranges
- Can be calculated for future timesteps

Home Range Capability (HRC)



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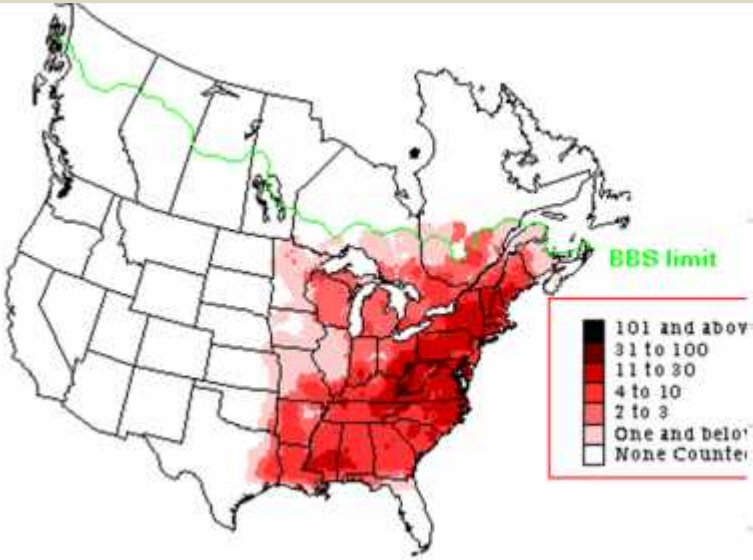
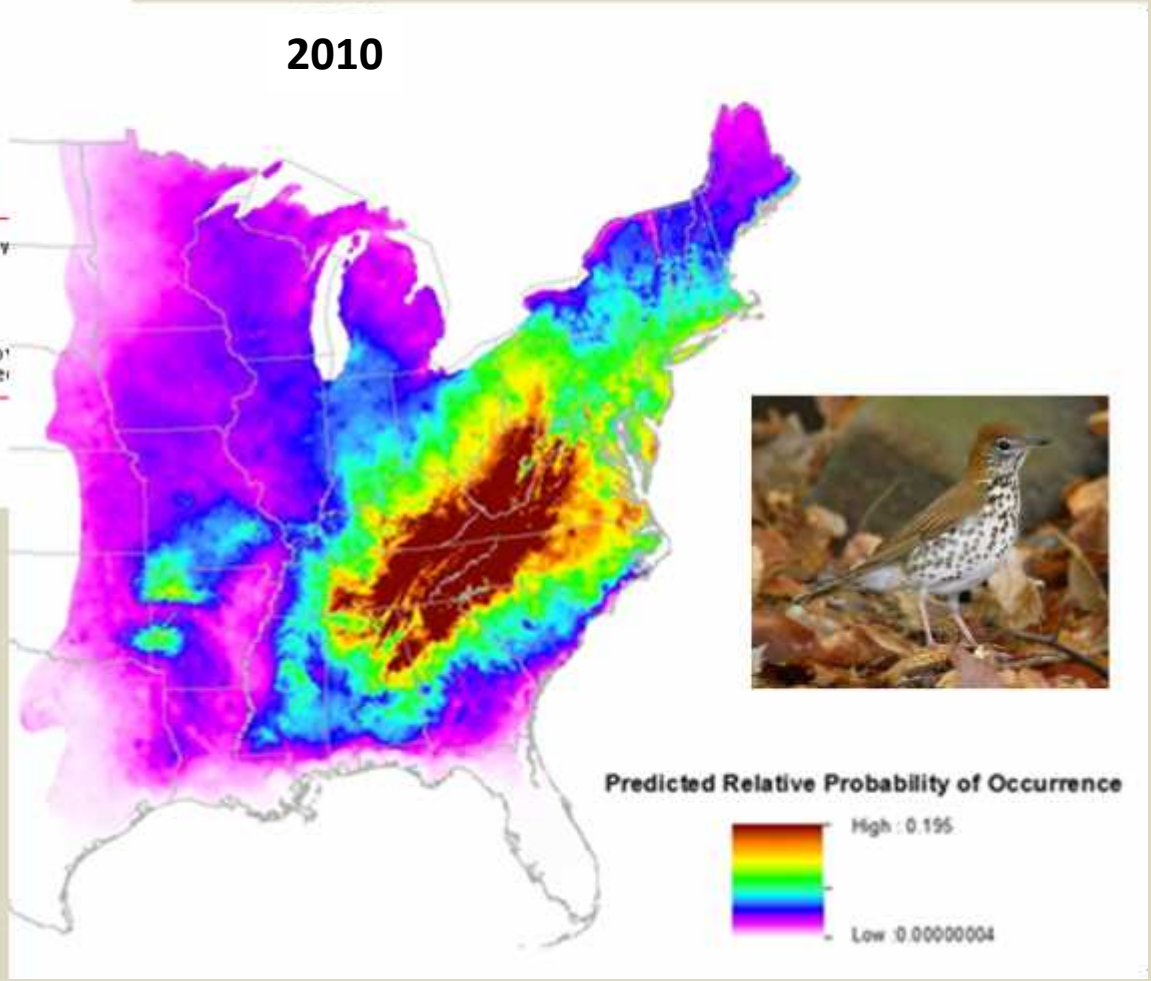
Landscape Change, Assessment & Design model

Species climate niche envelope models

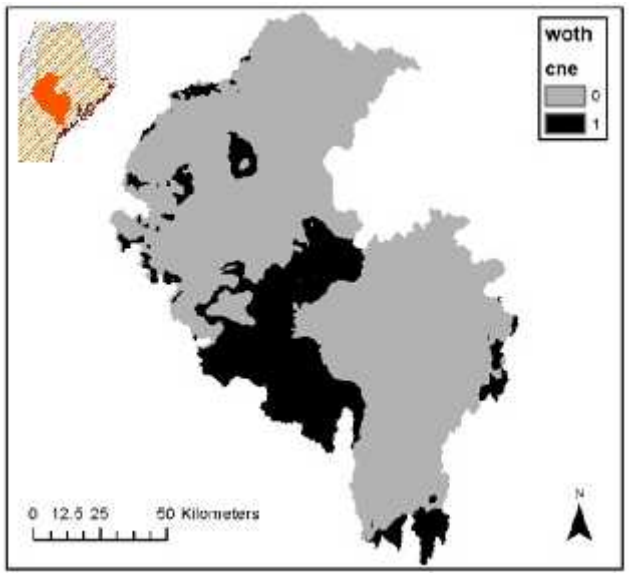


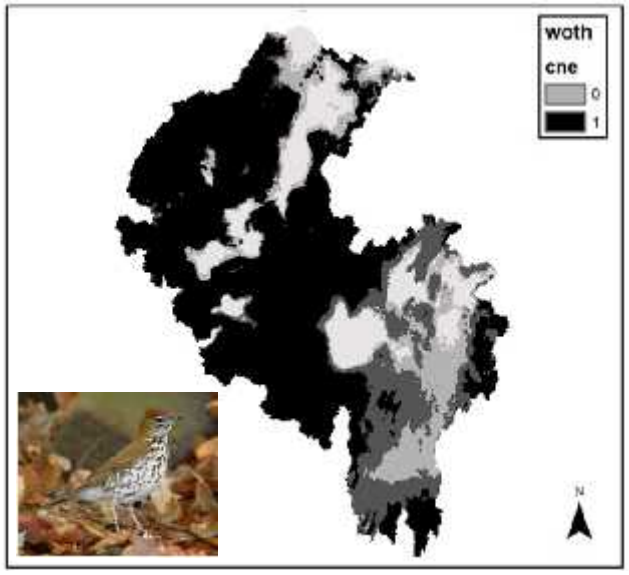
- Logistic regression
- Probability surface
- 95-99% of occurences



Landscape Change, Assessment & Design model

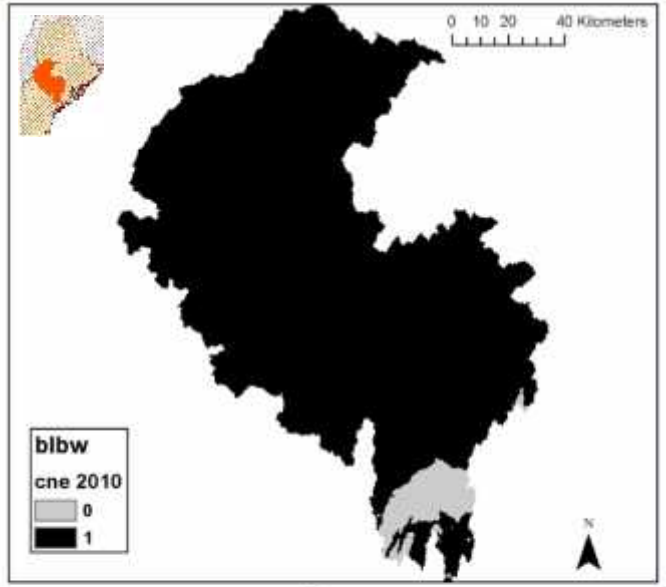
Species climate niche envelope models

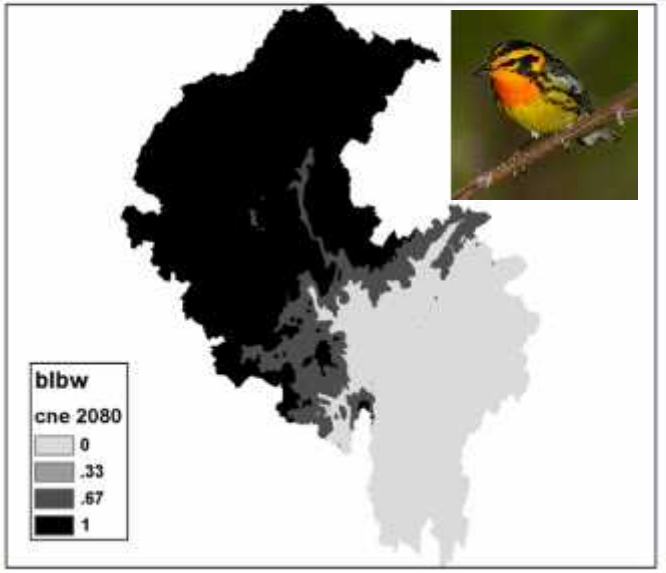




2010

2080



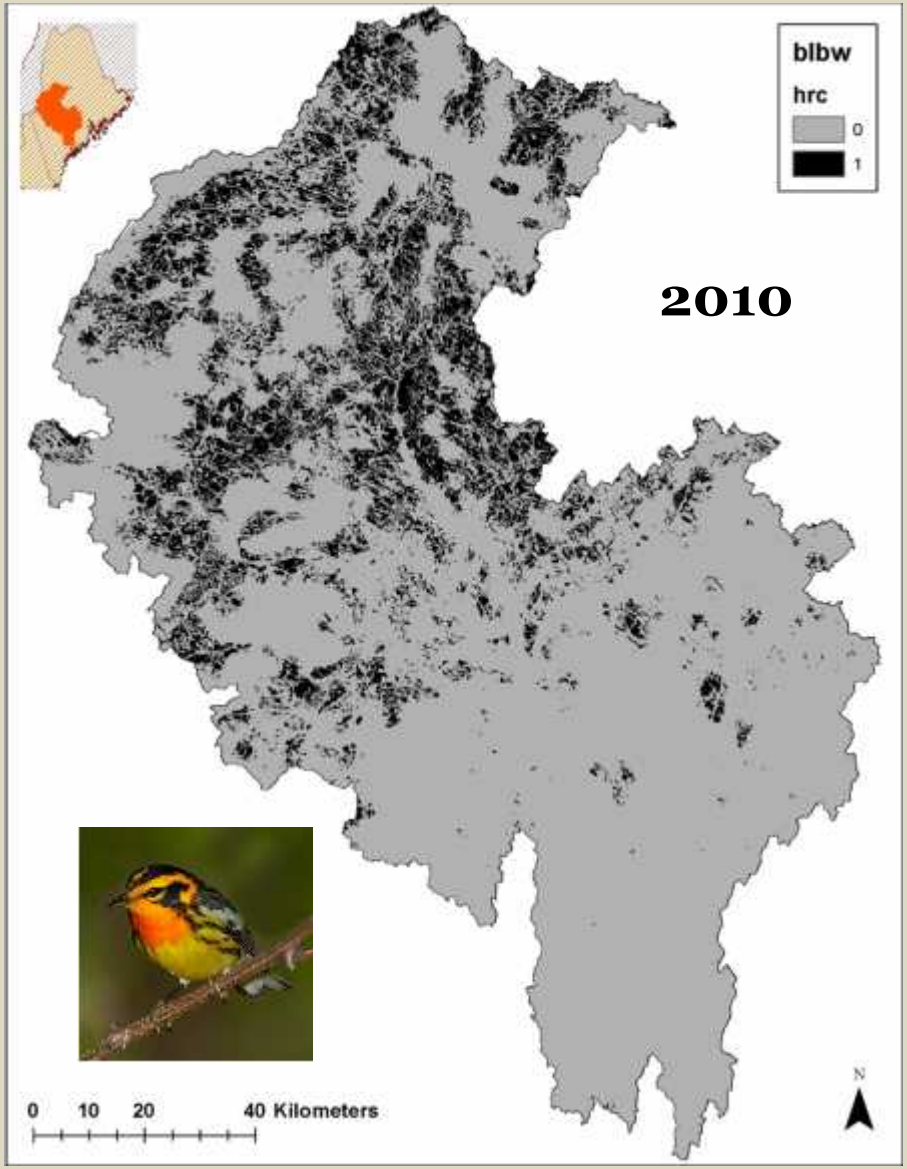


Landscape Change, Assessment & Design model

Species habitat models

Current Optimal Habitat

- 2010
- HRC > 0.5
- Suitable climate

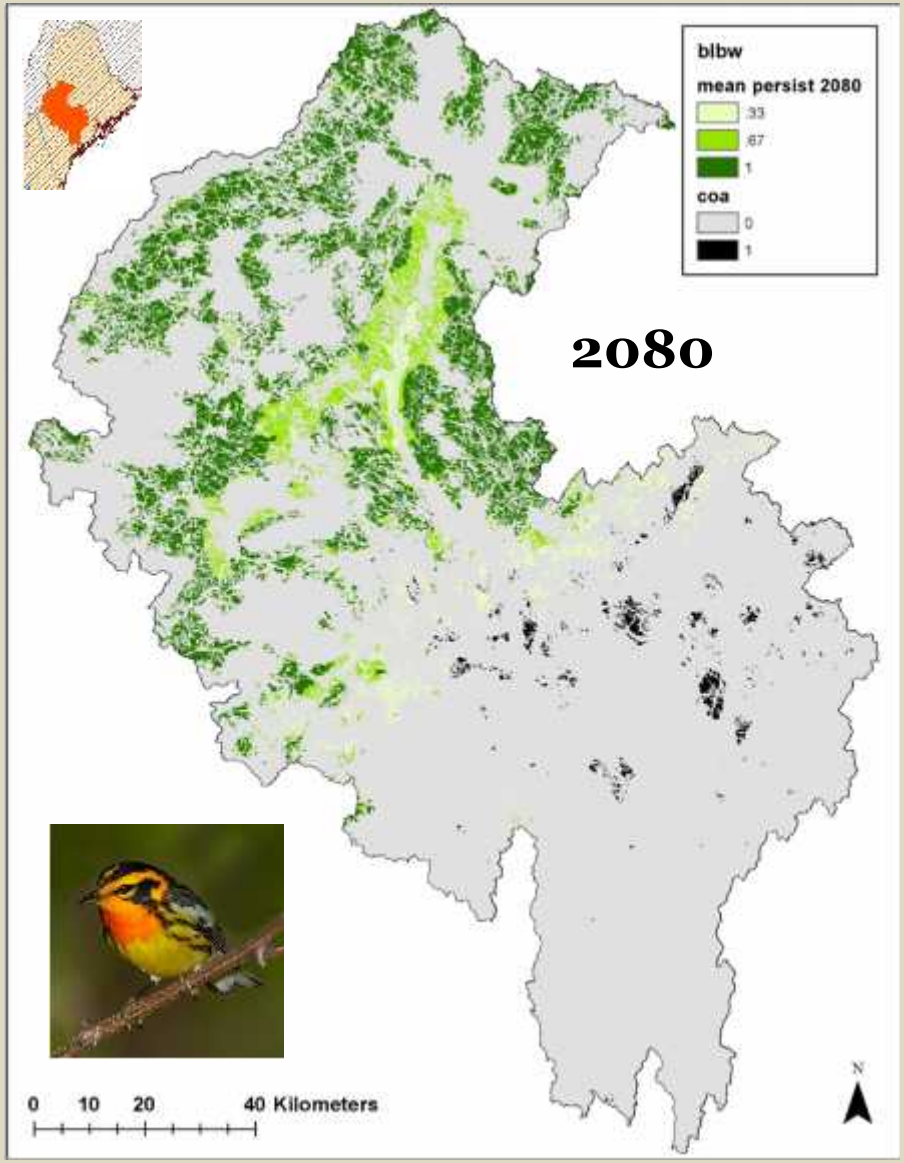


Landscape Change, Assessment & Design model

Species habitat models

Species Persistence

- Suitable habitat and climate in 2010
- Remained suitable habitat and climate in 2080
- Average across 9 scenarios/reps

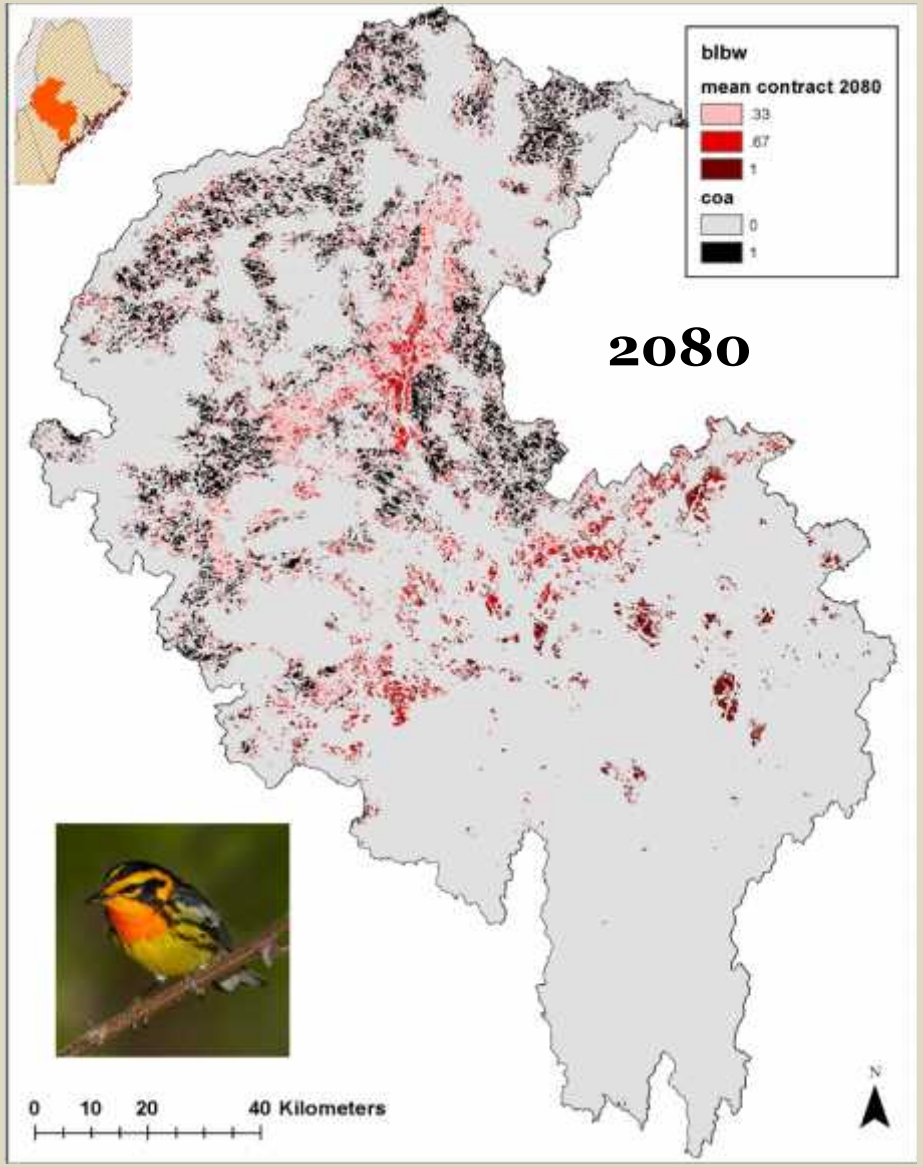


Landscape Change, Assessment & Design model

Species habitat models

Species Contraction

- Suitable habitat and climate in 2010
- Unsuitable habitat and/or climate in 2080
  - Development
  - Succession
  - Climate
- Average across 9 scenarios/reps

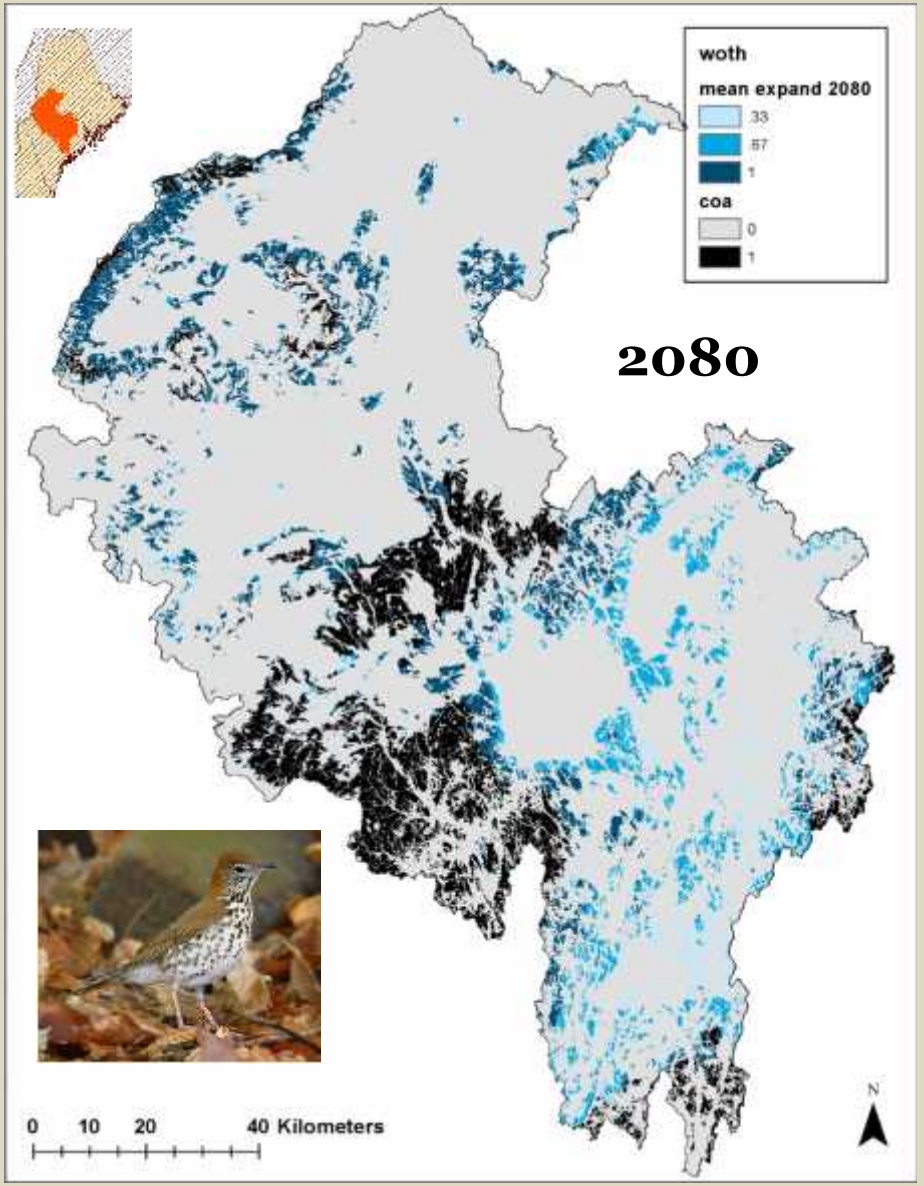


Landscape Change, Assessment & Design model

Species habitat models

Species Expansion

- Unsuitable habitat and/or climate in 2010
- Becomes suitable habitat and climate in 2080
  - Succession
  - Climate
- Average across 9 scenarios/reps



Designing Sustainable Landscapes

Landscape design

- Where to protect habitat to meet population objectives
- Identifying areas on the landscape:
  - Most capable of providing current habitat
  - Most vulnerable to becoming unsuitable
  - Most likely to remain suitable
- Changes in population capability of the landscape over time