The effects of extreme climate events on avian demographics: the role of habitat refugia in mitigating climate change effects

Year 3

Main Goals

Basic science:
Predict the effects of droughts, heat waves, and cold snaps, on bird demographics

Applied science:
Quantify and enhance the role of National Wildlife Refuges and National Forests as refugia for birds during extreme events
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Basic science:
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Abundance declines

Demography
- Lower recruitment
- Higher mortality

Movement
- Out-migration
- Concentrate in refugia
## Evaluation of Extreme Weather and Bioclimatic Data in Gridded Observational Products

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Variables</th>
<th>Time Span</th>
<th>Resolution (km)</th>
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<tbody>
<tr>
<td>CPC</td>
<td>Daily Precipitation</td>
<td>1948-present</td>
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<td>DayMet</td>
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<tr>
<td>TopoWX</td>
<td>Daily Temperature</td>
<td>1948-2012</td>
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<td>UIIdaho</td>
<td>Daily Precipitation, Temperature</td>
<td>1979-2011</td>
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</tbody>
</table>
Weather data sources

- Daymet (recent past)
  - Interpolated from weather stations
  - Daily records, 1980-2012
  - 1 km resolution

- BCCA (climate models)
  - CMIP5 models
  - Daily “data” 1950-2099
  - 4 km resolution
Extreme events data

- Droughts
- Spring Cold Snaps
- Heat Waves
Drought:
Standardized Precipitation Index (SPI)
Standardized Precipitation -Evapotranspiration Index (SPEI)

- **SPI** – a measure of how unusual a precipitation pattern is, standardized among locations.
- **SPEI** – a measure of precipitation deficit
Spring Cold Snaps

From spring onset through July for each year

- Number of days with maximum temperature below 0 Celsius.
- Number of days with minimum temperature below 0 Celsius
- Number of consecutive days of each of above

Nights below freezing after spring
Abundance declines

Demography
- Lower recruitment
- Higher mortality

Movement
- Out-migration
- Concentrate in refugia
Effects of extreme heat on productivity of breeding birds in northeastern United States

Preliminary results:

Productivity = juvenile:adult ratio

Productivity lower in years when there are 3 or more consecutive days of maximum temp > 35°C

For: Gray Catbird, Song Sparrow

No effect was detected for:
Northern Cardinal
American Robin
Effect of weather on survival and reproduction

- Combining MAPS, BBS, and weather data
- Estimating survival, fecundity, density dependence, temporal variability

Capture Probability = \( f(\text{Effort}) \)

Temporal variability, excl. sampling error

Survival = \( f(\text{Density}) \)
Abundance declines

Demography
- Lower recruitment
- Higher mortality

Movement
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Dickcissel and Drought:

2012 abundance deviation
Dickcissel: abundance deviations and Standardized Precipitation - Evapotranspiration Index (SPEI)
Velocity of climate change

Global mean velocity in temperature of 0.42 km yr$^{-1}$
Velocity of change for birds
1950-2011

1950s climate variability based breeding distribution

2000s climate variability based breeding distribution
Birds and current climate change
Distribution shifts

Bird potential breeding distribution velocity (N=241)

Geographic centroid 1950 → Geographic centroid 2011

Increasing Velocity
Birds and current climate change

Velocity of distribution shifts

<table>
<thead>
<tr>
<th>Category</th>
<th>geo.mean</th>
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<tbody>
<tr>
<td>a) All Species</td>
<td>1.22</td>
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<td>b) Migratory Habit</td>
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<tr>
<td>Short Distance</td>
<td>1.32</td>
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<tr>
<td>Long Distance</td>
<td>1.26</td>
<td>98</td>
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<tr>
<td>Permanent Resident</td>
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<td>c) Feeding Guild</td>
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<td>Invertivore</td>
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<tr>
<td>Omnivore</td>
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<td>d) Location of Foraging</td>
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<td>Lower-Canopy</td>
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<td>Aerial</td>
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<td>Ground</td>
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<tr>
<td>Upper-Canopy</td>
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Range shifts in terrestrial systems global average (0.61 km yr^{-1})- Parmesan & Yohe, 2003
Birds and current climate change
Non-uniform shifts

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<tr>
<th>Migratory Habit Guild</th>
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<tr>
<td>Long Distance</td>
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<td>Mean Temp 36m</td>
<td>Precip Driest Qtr 36m</td>
<td>Mean Temp 36m</td>
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<tr>
<td>2 Temp Seasonality 6m</td>
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<td>3 Mean Temp 36m</td>
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<td>Max Temp Warmest Mo 12m</td>
<td>Max Temp Warmest Mo 6m</td>
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</table>

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<thead>
<tr>
<th>Feeding Guild</th>
<th>Carnivore</th>
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<td>Temp Seasonality 36m</td>
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Birds and current climate change
Area of distribution

No Change

Expanding Distribution

Contracting Distribution
Main Goals

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Needs of Land Managers

- Future projections packaged in different ways to meet different needs.
- Strong visuals & indicators for communicating with public and local managers.
- Species and region specificity
- Analysis of velocity of climate space change for many (all) species
- Predicted spatial patterns, return interval of strong precipitation events, and rate of change.
- Clearinghouse/information of existing long-term data sets of animals and plants to study historical responses to extremes.
Conclusions

1. We found great variability in weather data set ability to predict extremes
2. Detected and described strong range movement for hundreds of bird species
3. Have indications that heat waves influence production of young, at least in some species
4. Developed a method to estimate vital rate–weather relationships from a combination of datasets
5. Conducted workshops, seeking input from land managers about most useful questions and data delivery methods.