Presentation 4:

Multi-Species Integrated Species Distribution Modeling in *PointedSDMs*

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Introduction to Multi-Species ISDMs

- Extend single-species models to analyze multiple species simultaneously
- Potential benefits:
  - Improved estimates for rare species
  - Better understanding of community-level patterns
  - More efficient use of data

The *Setophaga* Example

- Three warbler species in Pennsylvania:
  - *Setophaga fusca* (Blackburnian Warbler)
  - *Setophaga caerulescens* (Black-throated Blue Warbler)
  - *Setophaga magnolia* (Magnolia Warbler)
- Data sources: eBird, BBS, BBA
- Environmental covariates: Elevation, Canopy cover, Coniferous forest cover

Model Initialization

```
speciesModel <- startSpecies(SetohagaData,
    Boundary = PA, Projection = proj,
    Mesh = mesh, responsePA = "NPres",
    trialsPA = "Trials",
    pointsSpatial = NULL,
    spatialCovariates = covariates,
    speciesName = "Species_name")
```

Spatial Effect Structures

1. Independent (Replicate)
2. Shared
3. Copied

Independent Spatial Effects

- Default multi-species model assumes each species has unique spatial field
  - i.e., each treated as a `replicate`

```
startSpecies(..., speciesSpatial = "replicate",
    ...)
```

Shared Spatial Effects

- If species are assumed to have a common spatial field, we can specify it is `shared`

```
startSpecies(..., speciesSpatial = "shared",
    ...)
```

Copied Spatial Effects

```
startSpecies(..., speciesSpatial = "copy",
    ...)
```

Species-Specific Covariate Effects

```
speciesModelConif <- startSpecies(...,
    spatialCovariates = all_covariates,
    speciesEnvironment = TRUE)
speciesModelConif$changeComponents(removeComponent = "Setop
```

Bias Correction in Multi-Species Models

```
speciesModel$addBias(datasetNames = "eBird")
biasEst <- fitISDM(data = speciesModel,
    options = modelOptions)
plot(predict(biasEst,
    ..., bias = TRUE))
```

Model Comparison

```
CopyspeciesEst$dic$dic
speciesSharedEst$dic$dic
speciesCopyEst$dic$dic
speciesEstConif$dic$dic
biasEst$dic$dic
```

Ecological Implications

- How do spatial effect structures affect species predictions?
- What can we learn from species-specific covariate effects?
- How does bias correction impact our understanding of species distributions?

Next Steps

- Questions and discussions
- Hands-on exercise: Fitting multi-species models to your own data

References