

# Effects of Trait-Urbanization Relationships on Avian Genetic Diversity in Europe and North America

Ross Torrie

Supervised by Dr. Chloé Schmidt; Dalhousie University Biology Department

## Background

- Urbanization is one of the most rapid and extreme forms of human-driven landscape transformation, habitat fragmentation, and introduction of multiple anthropogenic stressors.
- Changes created by humans force species to adapt; some species successfully exploit urban environments (rats, pigeons, etc.).
- Understanding how urbanization affects genetic diversity is crucial as it informs us of adaptive potential, population resilience, and long-term persistence.
- This study uses a macrogenetic framework to examine avian genetic diversity across North America and Europe to test whether species traits explain variation in genetic responses to urbanization.



Figure 1 Visualization of fragmentation and species richness in urban areas. Created using BioRender (2026)

## Predictions

Genetic responses to urbanization are expected to be trait-dependent. Sensitive species are expected to show reduced genetic diversity and greater population differentiation in more heavily human-modified environments. Two key traits were identified and tested:

**Habitat type** aims to capture differences in specialization, with species from marine, coastal, and wetland habitats expected to show stronger negative genetic responses.

**Dispersal ability**, measured using the Hand-Wing Index (HWI). Species with higher HWI are expected to maintain greater gene flow among fragmented urban populations and therefore greater genetic diversity as urbanization increases.



## Methods

### Genetic Data

- Microsatellite datasets for North American and European birds were compiled from the Dryad repository using a programmatic search in R. Only wild populations with adequate sample sizes and spatial data were included.
- Gene diversity, rarefied allelic richness, population-specific  $F_{ST}$ , and contemporary effective population size ( $N_e$ ) were estimated for each dataset.

### Trait Data

- Species-level trait data obtained from the AVONET database. Analyses focused on hand-wing index and native habitat type.

### Urbanization Metrics

- Urbanization was quantified using the Human Footprint Index.
- Values for both metrics were extracted within a 5 km radius of each sampling location, with ocean areas masked.



Figure 2 Urban birds perched on wiring



Figures 3a (left) and 3b (right) maps of Europe and North America with points indicating sample site (n=340) locations



### Modelling

- Bayesian generalized linear mixed models were used to test relationships between genetic metrics and urbanization.
- Species included as random effects to account for non-independence and different genetic diversity baselines.



Figure 4 A Seagull indulges in junk food

## Results

### Habitat

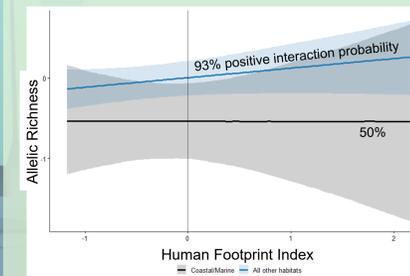


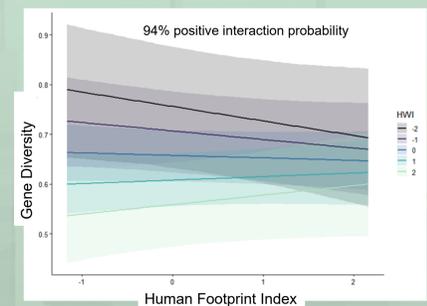
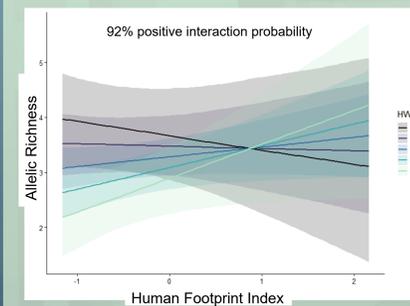
Figure 7 Allelic Richness trends positively with HFI in non-aquatic birds. However, there is no direction to the interaction in aquatic birds.



Figure 8 Ducks on the ice in downtown Halifax

No evidence for interaction between aquatic habitat type and urban genetic tolerance.

### Dispersal Ability



Figures 9a (left) and 9b (right) Birds with better dispersal ability have increased genetic diversity in cities. Allelic richness (left) and gene diversity (right) have a high probability of increasing in better dispersers as HFI increases.

Neither effective population size nor population differentiation had such high probability of positive interaction, but both trended positively.

## Results

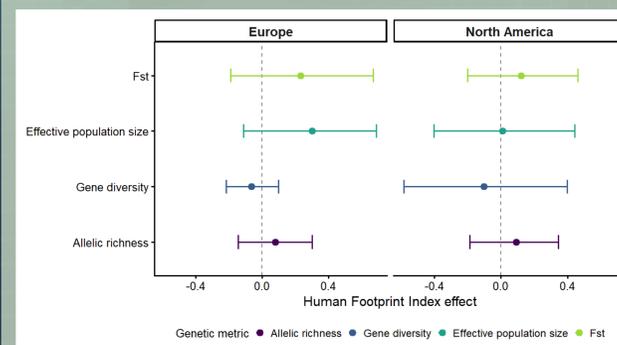


Figure 5 Orchard Plots depicting average relationship between HFI and genetic diversity in both Europe and North America.

## Discussion

- No consistent relationship between urbanization and genetic metrics across species.
- Species-specific responses to urbanization depend on species traits.
- Effective dispersers may have a better chance at maintaining genetic diversity.
- When contrasted with other taxa, birds flight ability may enable them to maintain large, highly-connected, genetically diverse populations in city habitats.



Figure 10 A flock of pigeons congregates outside an apartment building