Integrating bioacoustics with high resolution PlanetScope imagery to estimate avian community diversity in Arctic Alaska

I. Shuman[1], D. Yang[2], E. Çoban[3], and N. Boelman[4]

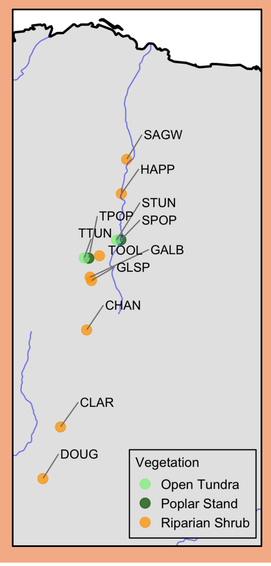
[1]Columbia University [2]Oak Ridge National Lab [3]City University of NY [4]Lamont-Doherty Earth Observatory

Context

Millions of migratory songbirds converge on the Arctic every spring to breed. Environmental change has disproportionately impacted high-latitude terrestrial ecosystems, however, and shifts in the abiotic (e.g. climate) and biotic (e.g. vegetation) conditions threaten the viability of this Arctic "songbird nursery."

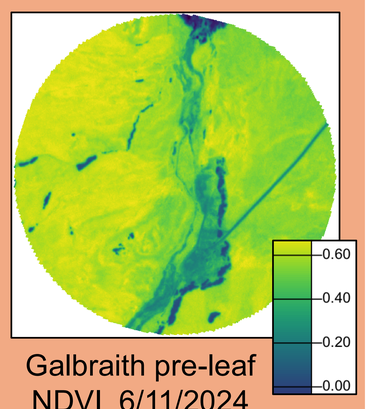
Here, we seek to understand **how the size and diversity of Arctic songbird communities responds to differences in woody vegetation cover.**

We do this by integrating bioacoustically-derived estimates of songbird community diversity with remotely-sensed estimates shrub cover.



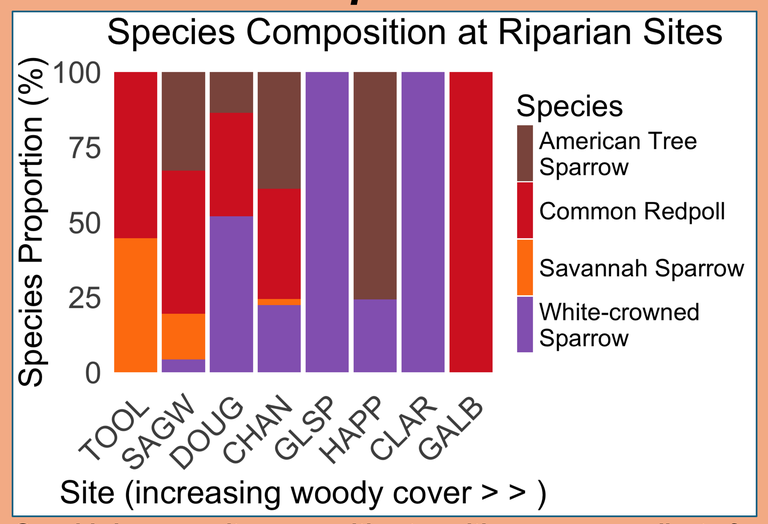
Approach

1. Acoustic recording units (ARUs)
   - ARUs at 12 sites along a latitudinal and vegetation gradient (tundra, shrub, trees)
   - Deep learning model estimates species presence and Bioacoustic Activity Index (BAI)
   - Derive species composition (S), Shannon's Diversity (H), and evenness (J)
2. PlanetScope imagery
   - High spatiotemporal (3m, ~daily) resolution 4-band imagery
   - Snow dynamics, NDVI
   - Pre-leaf NDVI estimates shrub cover at riparian sites

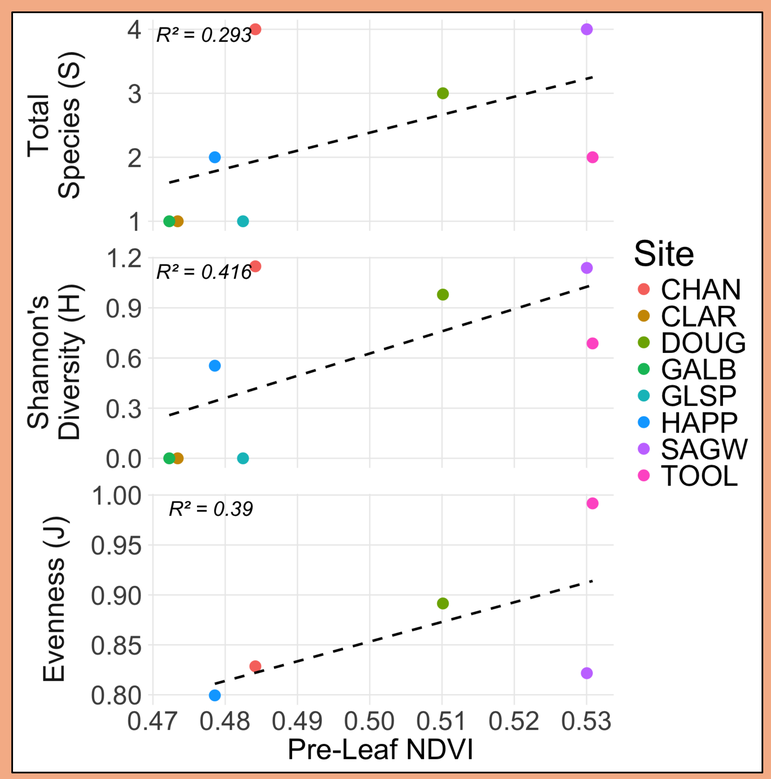


Galbraith pre-leaf NDVI 6/11/2024

Results: Riparian Shrubs

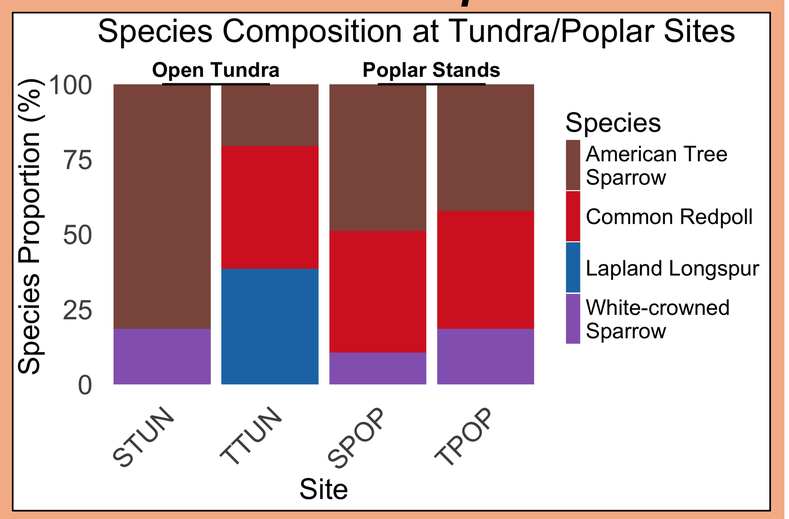


Songbird community composition transitions over a gradient of riparian vegetation. Less woody sites support more species, while 1-2 species dominate at woodier sites.



The total **species count, diversity, and evenness of songbird communities increases at sites with a higher Normalized Difference Vegetation Index** (NDVI) when measured after snowmelt but prior to leaf emergence. Boelman et al. (2011) showed that pre-leaf NDVI is inversely correlated with shrub height and density.

Results: Tundra/Poplar Stands



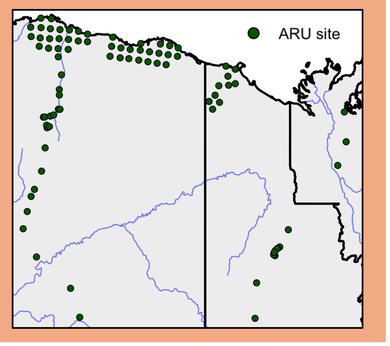
Songbird communities are more similar across sites with like vegetation, not between nearby sites. Poplar sites had slightly higher average S, H, and J than open tundra. Poplar sites had very similar songbird communities (low β diversity); tundra sites were different from one another and poplar sites (high β diversity) and supported a unique species (Lapland longspur at TTUN).

Next Steps

Expand spatial extent of analyses to 86 sites across Alaska, the Yukon, and the Northwest Territories. Leverage data from 2010 – 2024 to **investigate temporal variation** in songbird communities.

Include additional possible predictors of songbird community composition, such as vegetation composition (AVIRIS-NG), vegetation structure (LVIS and LiDAR), food availability (ARUs), and meteorology (SnowModel).

Develop a model to predict spatiotemporal changes in songbird community diversity and force with downscaled climate and vegetation projections to predict future songbird communities.



Questions?

Email me at **ins2109@columbia.edu**!