





More information:

<https://storymaps.arcgis.com/stories/a569e35dcf204f1aad72cac3fb4b6bab>, <https://darksky.org/news/what-you-should-know-about-bird-migration-and-light-pollution/>

# How to Study Migratory Birds?

## Intrusive methods

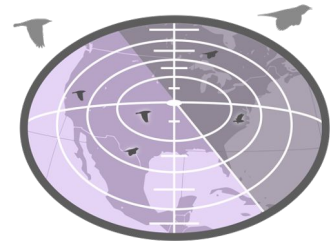


Duke Nicholas School graduate students and their annual field class on the population and survival analysis of sooty terns at the Dry Tortugas National Park, FL | Photo credit: Christen Martens (Duke 23')

## Non-Intrusive methods

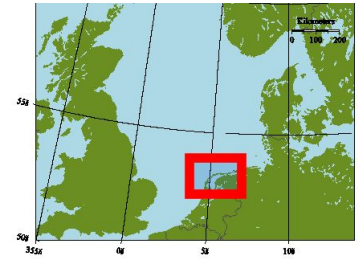


eBird  iNaturalist

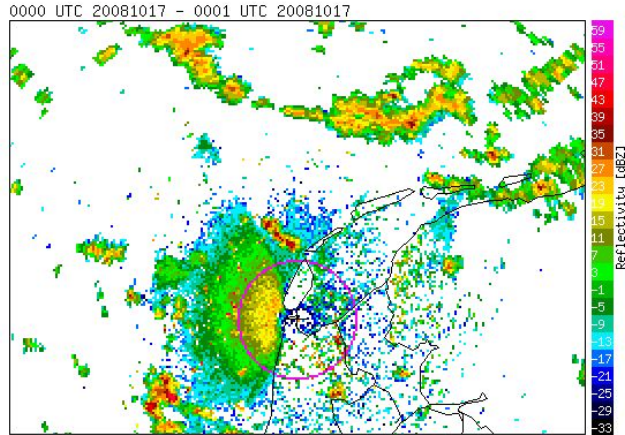




# How is it Possible to Extract Biological Activities?

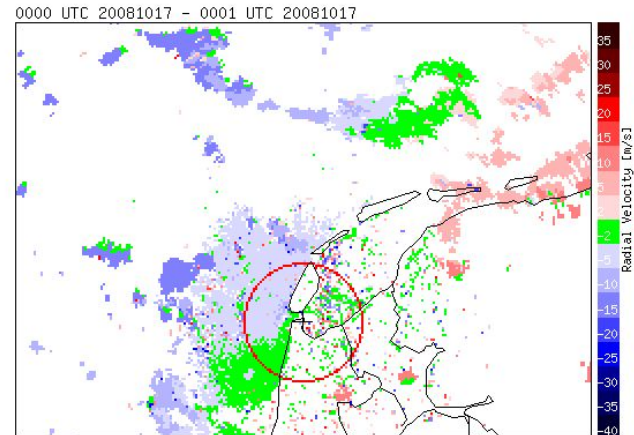


How many animals?  
**reflectivity factor**



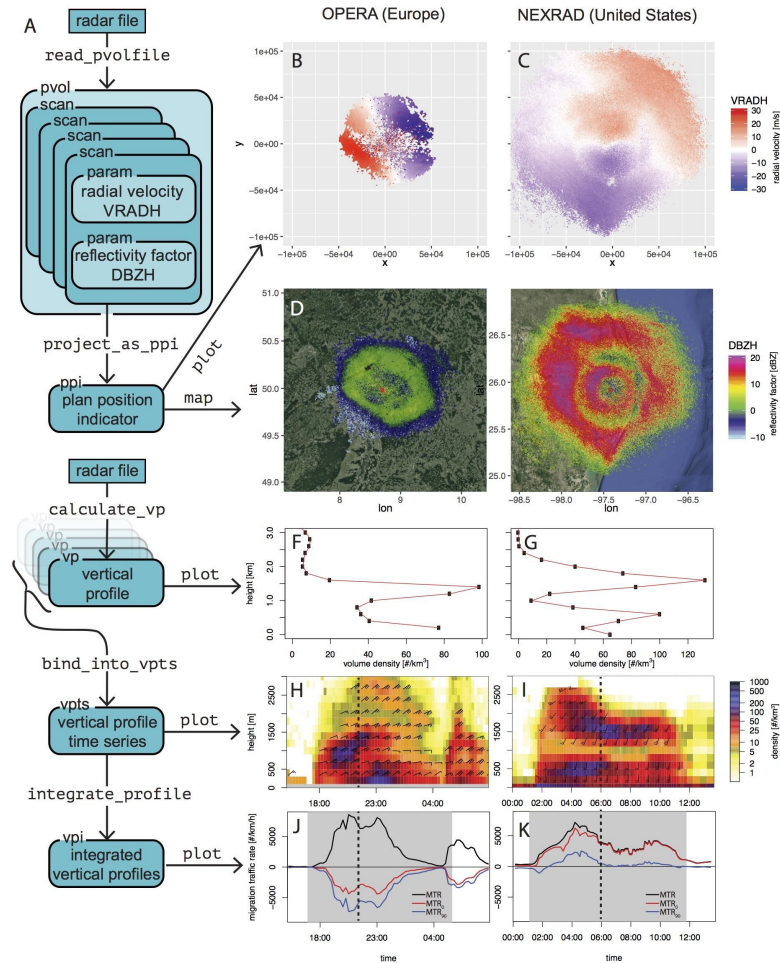
50 km

Where do they move?  
**radial velocity**



# Radar for Aeroecology Workflow

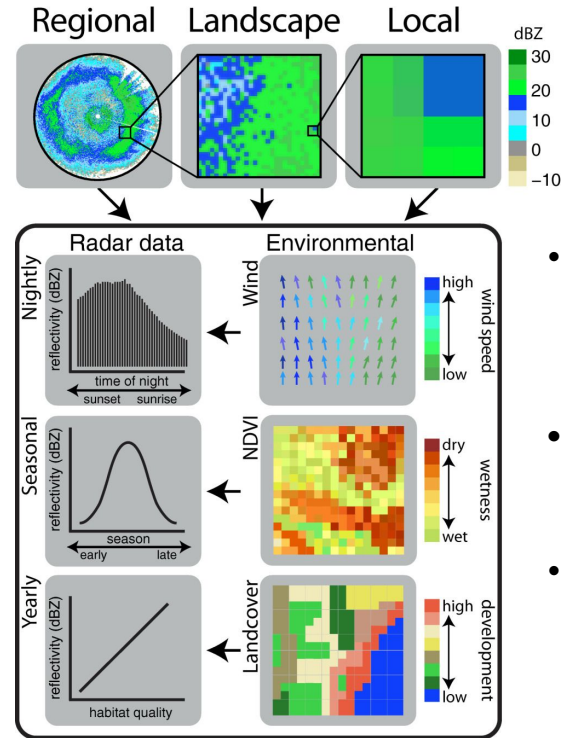
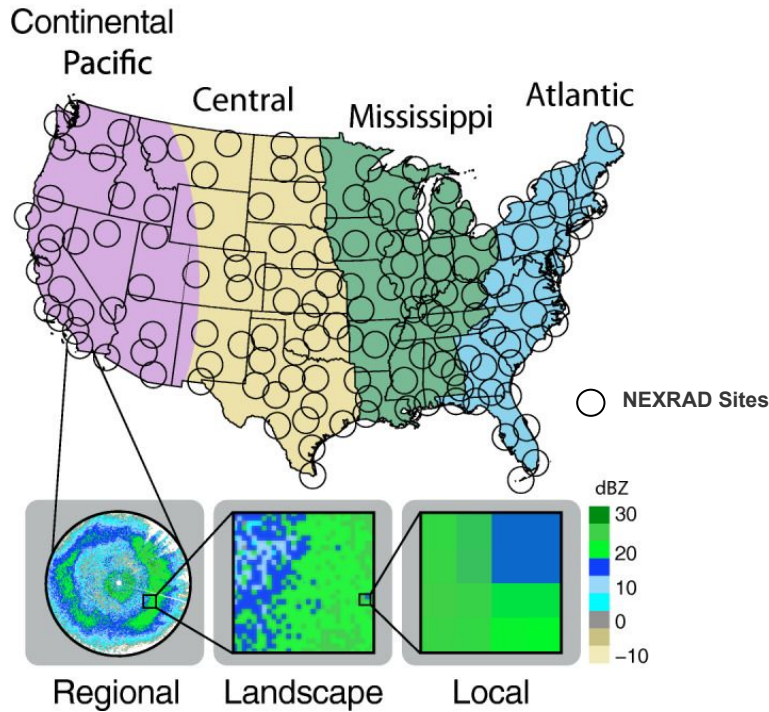
- Access radar files
- Data Screening with [BioRad](#) and [MistNet](#)
  - Remove precipitation & aliasing
  - Estimate animal density
- Construct vertical profile time series
- Integrate vertical profiles
  - Vertically integrated animal density



Dokter, A. M., Desmet, P., & Van Hoey, S. (2022). bioRad: Biological Analysis and Visualization of Weather Radar Data: v0. 6.0.

Lin, T. Y., Winner, K., Bernstein, G., Mittal, A., Dokter, A. M., Horton, K. G., ... & Sheldon, D. (2019). MistNet: Measuring historical bird migration in the US using archived weather radar data and convolutional neural networks. *Methods in Ecology and Evolution*, 10(11), 1908-1922.

# Radar for Aeroecology - Spatial and Temporal Scales



- Detect bio-activities up to ~ **80km** away from the radar
- **250m** spatial resolution
- All-year coverage, 360-deg scan per 4-5 minutes

Kelly, J. F., & Horton, K. G. (2016). Toward a predictive macrosystems framework for migration ecology. *Global Ecology and Biogeography*, 25(11), 1159-1165.

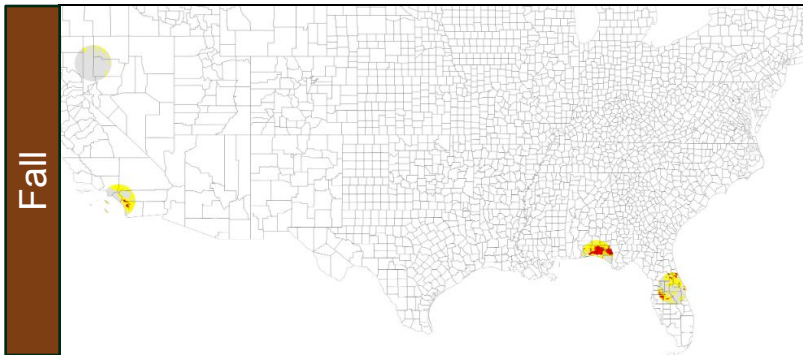
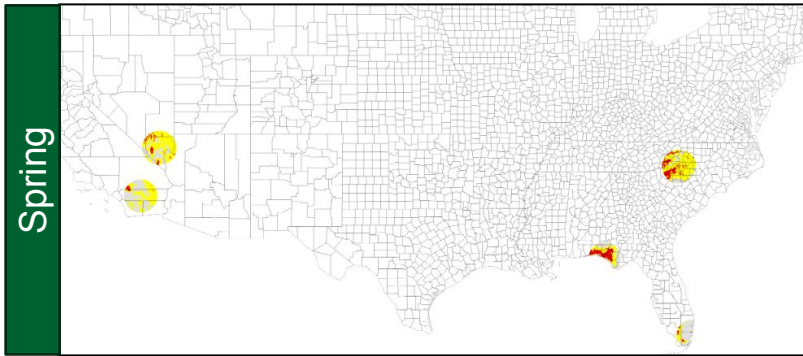
# Will Outdoor Musical Festival Affect Bird Migration?



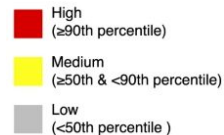
Fireworks, bonfire, LED beams, a huge crowd...

- Light pollution
- Noise
- Habitat/Stopover Site Disturbance

1. What are the spatial and temporal patterns of overlap between outdoor music festivals and bird migration in the contiguous United States?
2. How do outdoor music festivals affect bird migration routes and behaviors?



Relative Migrant  
Stopover Density



- Created 100-km buffers around each outdoor music festival sites to explore the spatial overlap with identified hotspots of Spring and Fall migration

Further steps:

- Before-after quasi-“control” experiment: Each year the outdoor music festivals take place around the same period. Most were suspended in 2020/2021 due to pandemic prevention orders
- Extract the bird migration densities for the nights during and before/after each selected music festival sites.



Horton, K. G., Buler, J. J., Anderson, S. J., & et al. (2023). Artificial light at night is a top predictor of bird migration stopover density. *Nature Communications*, 14, 7446.