

Effects of fire, extreme weather, and anthropogenic disturbance on avian biodiversity in the United States

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Introduction

- Biodiversity is generally related to three broad factors: habitat structure, climatic stability, and productivity.
- However, biodiversity is by no means static. For example, avian species richness can change substantially within one decade with no obvious pattern of increase or decrease (Fig. 1).

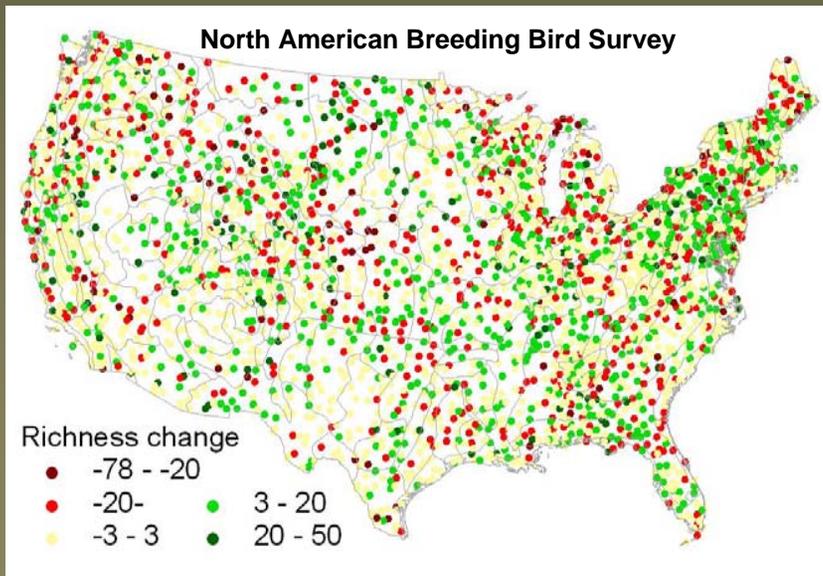


Fig. 1. Avian species richness change 1990 – 2000

- This raises questions concerning the dependence of biodiversity pattern on local disturbances (Fig. 2), which influence habitat structure, climatic stability and productivity.
- Many species are adapted to natural disturbance; However, anthropogenic disturbance can negatively affect biodiversity.
- Furthermore, the relationship between biodiversity and disturbance is complicated by differences between species' response and the type and magnitude of the disturbance.
- Therefore, our goal is to advance understanding of these complex relationships through analysis of avian biodiversity at broad spatial scales.

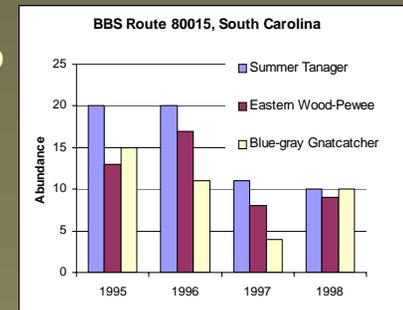


Fig. 2. Decrease in abundance of three bird species on BBS route 80015 affected by a 1997 Hurricane

Objectives

- **Our overarching goal is to measure and predict the effects of disturbance events on avian biodiversity**
- We will undertake the following four objectives
- Understand the effects of extreme weather, specifically hurricanes and tornadoes, heat waves, and droughts, on avian biodiversity;
- Understand the effects of fire on avian biodiversity
- Understand the effects of human disturbance, specifically clearcuts, fragmentation, and housing development, on avian biodiversity; and
- Test hypotheses regarding the effects of disturbance events on bird species richness, similarity, and the abundance of selected common and rare species.

Approach

- We study three broad disturbance types (extreme weather, fire, and anthropogenic disturbance) and their effects on different aspects of avian biodiversity (species richness, similarity of the avian community, and abundance of selected species)
- We use data from the Breeding Bird Survey (BBS), which provides annual data on avian biodiversity across the conterminous United States since 1966.
- In a quasi-experimental design, we will pair BBS routes that experienced disturbance with BBS routes that remained undisturbed. Historic BBS data will provide pre-treatment data, and undisturbed routes will function as controls.
- We will use the Akaike information criterion coupled with stepwise model building, Bayesian hierarchical modeling, combined with a Bayesian analog of AIC, and the Deviance Information Criterion for model selection and model comparisons.

Remote sensing data

- We use remote sensing data from MODIS, Landsat TM/ETM+ and the LEDAPS data products to identify disturbed and undisturbed BBS routes and to measure the magnitude of disturbance events (Fig. 4).
- Hurricane and tornado paths, Palmer drought index (Fig 3), and U.S. Census data will be used in addition to identify potentially disturbed BBS routes.

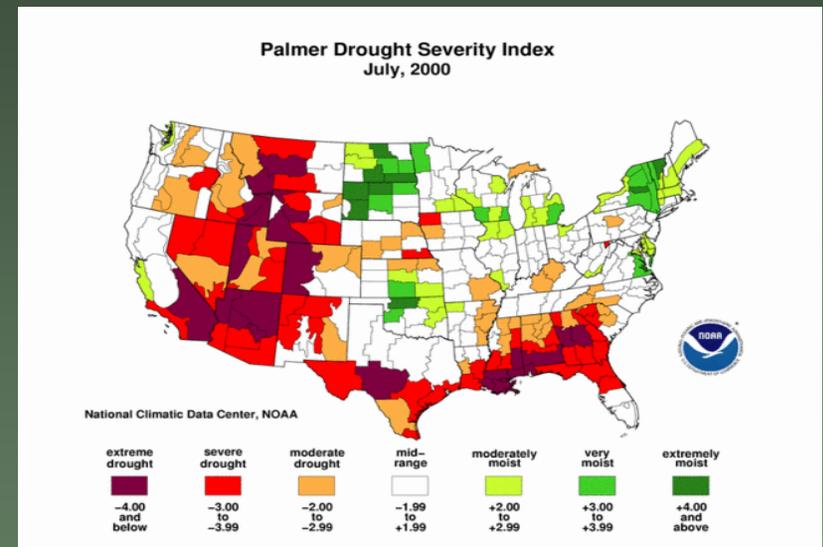


Fig. 3: Palmer Drought Index, 7/2000

Remote sensing data

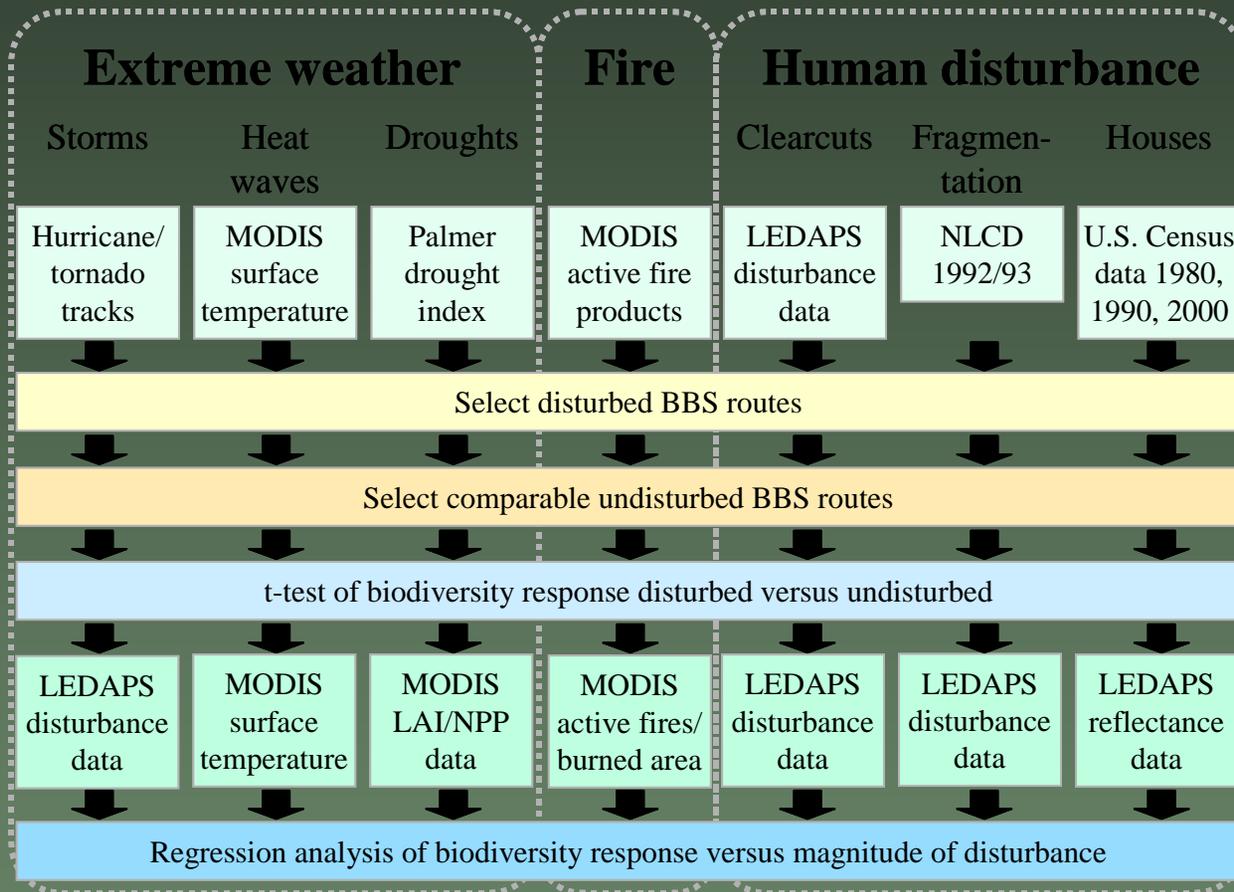


Fig. 4: Analysis steps for the seven disturbance processes to be analyzed. Data to be used to select disturbed routes is highlighted in pale green at the top. Sample selection is highlighted in the beige colors. Statistical analysis is highlighted in the blue colors. Remote sensing data that will quantify disturbance magnitude is highlighted in the darker green towards the bottom.

Prior Results

- Pidgeon, A. M., V. C. Radeloff, C. H. Flather, C. A. Lepczyk, M. K. Clayton, T. J. Hawbaker, and R. B. Hammer. The association of forest bird species richness with housing density and landscape patterns across the United States. *Ecological Applications*, *in review*.
- Housing density and/or residential land cover are significant predictors of species for all forest bird guilds and in almost all ecoregions in the US
- Housing density is equally detrimental to forest bird species richness as forest fragmentation
- Strongest models for ground nesting, interior nesting and Neotropical migrant guilds

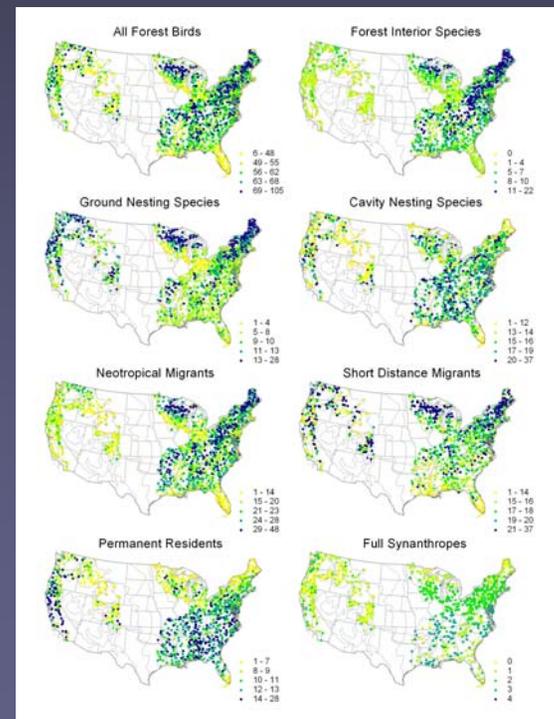


Fig. 6: Species richness in 2000 of different forest bird guilds

Significance

- Understanding what determines biodiversity patterns is one of the major scientific challenges of our times. Disturbance events likely play a major role in determining biodiversity.
- The main goal of this project is to understand the role that disturbance events play in determining biodiversity using existing avian biodiversity data and remotely sensed imagery.
- The main contribution of this study will thus be the advancement of biodiversity theory and disturbance ecology.
- Our focus on fire and human disturbances will provide important information for land managers facing increasing human modification of species habitat.
- And finally, we will develop and apply new remote sensing methods and statistical algorithms to make full use of remotely sensed data for biodiversity science.

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