Spatially explicit models of occupancy for evaluating forest restoration and climate change on the Kaibab National Forest, Arizona

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Introduction

Motivation
Severe wildfires and vegetation type conversions are likely to increase across the western United States as temperatures rise and droughts become more common (Cooke et al. 2005, Notaro et al. 2012). This condition is exacerbated by an historic inability for forest restoration treatments to keep pace with fire risk often due to disagreements about impacts on wildlife species and the challenges associated with monitoring those impacts. The Kaibab National Forest (Arizona, USA) has sought to address these concerns during its current Land and Resource Management Plan revision process by leveraging both ground-based and remotely sensed information to develop landscape-scale, spatially explicit models of occupancy for several passerine species.

Objectives
- Identify important habitat components that could change as a function of land management or climate change.
- Provide a means to monitor the effects of landscape change (e.g., fire, restoration treatments, or climate change) at broad spatial extents.
- Provide the ability to explore trade-offs through simulation of the effects of land management or climate change.

Methods

Avian Surveys: Conducted by the US Forest Service and Rocky Mountain Bird Observatory across the Kaibab National Forest from 2006 – 2009 (Hanni et al. 2009).

Habitat Covariates: Derived for 2006 and 2010 from Landsat 5 TM imagery and USDA Forest Service Forest Inventory and Analysis plots, interagency LANDFIRE data for vegetation type, and derivatives of the National Elevation Dataset. All data were standardized and smoothed to 125m radius to coincide with bird survey transects.

Occupancy estimates: Spatial models of occupancy were built using the single season model of MacKenzie et al. (2006) and 2006 forest structural covariates. All parameter estimates were model-averaged to account for model uncertainty (Burnham & Anderson 2002). Models fit in PRESENCE (v.2.2; Hines 2006).

Results: Important habitat features

Model selection results indicate that occupancy for each species is sensitive to changes in habitat covariates that are likely to change as a function of land management.

Results: Monitoring at landscape scales

Occupancy models allow assessment of trend over broad spatial and temporal scales while reducing bias due to imperfect detection.

Extensions: Evaluating alternatives

A) GRWA (2006)
B) GRWA (2010)

Discussion

Spatially explicit occupancy models are well-suited to identify key habitat attributes likely to be affected by land management activity, monitoring across broad spatial extents, and evaluating future scenarios for Grace’s Warbler, Ruby-crowned Kinglet, and Western Bluebird. Here we used species of interest to the Kaibab National Forest; however, other species more sensitive to landscape change or multi-species composite models may provide more information on the impacts landscape change on biodiversity. We also focused on a subset of habitat covariates that were: a) projected to change as a function of management or climate change, b) could be reliably derived from satellite imagery. Future efforts will focus on including additional biologically important covariates use of hierarchical modeling techniques to evaluate relationships at multiple scales.

Literature cited


Data Availability

US Fish & Wildlife Service

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