Do forest vegetative composition and localized temperature affect bird breeding population abundance trends?

Forest microclimate and composition mediate long-term trends of breeding bird populations

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Topic Summary Can old growth forest stands buffer the impacts of climate change on migratory bird populations? Researchers investigated this question by testing two hypotheses over an eight-year period. 1) Does old growth forest provide cooler microclimates, which were more suitable for bird species' physiological limits? 2) Does the more complex composition and structure of old growth stands dampen the effect of warmer temperatures, possibly through later or more prolonged prey availability?

How many bird species were included in analyses?

- Twenty species of birds were observed often enough temporally and spatially to include in analyses. Of these, seven species declined, nine increased, and four did not trend up or down.

Did microclimate buffering occur in old growth stands?

- Microclimate buffering occurred for six species. For five species, abundance was neutral or declined at lower rates in cooler microclimates, especially for Wilson's warbler, hermit warbler, and chestnut-backed chickadee. Varied thrush increased in abundance at higher rates in warmer areas.

Did higher compositional and structural complexity dampen climate or temperature effects?

- Higher compositional diversity reduced the impacts of warmer microclimates on abundance trends for two species, Wilson's warbler and red crossbill, which provides support for the insurance hypothesis.

What are the characteristics of stands with cooler temperatures?

- Microclimates that are in old-growth forest, at high elevation, or with concave micro-topographies tend to have cooler summer temperatures. Therefore, protecting these stands will have the greatest benefit for warm sensitive species as macroclimate warms.
- Forest complexity was not correlated with temperature. Elevation and micro-topography were important factors influencing temperature. Forest stands at higher elevations and with complex topographical structure should be included in management plans.

Can managed forest be part of the effort to protect cooler microclimates?

- Plantation stands exhibiting complex structure and composition characteristic of old-growth forest may have similar positive benefits for breeding bird populations. Characteristics associated with old-growth are greater structure and composition, taller, larger trees, higher biomass, and lower understory cover and richness.

How can managers use this information in forest management plans?

- Forest stands with the potential to provide microclimate buffering could be identified for conservation protections. These stands would include those with old growth, at higher elevations, or with complex terrain.
- Forest Management plans could be implemented to encourage the greater complexity and other characteristics associated with old growth stands in managed forests in order to create microclimate refugia across the Pacific Northwest.

Research Approach/Methods

- Researchers did 10-minute avian surveys at 184 points in the HJ Andrews Experimental Forest from 2009 to 2018. They recorded 23 species at more than 2% of the visits across all 184 points.
- They used data loggers to record temperature and light during May and June at each survey point as a measure of microclimate during breeding season.
- The authors performed vegetation surveys in 25-m diameter plots at each point in 2018. They identified understory woody vegetation and measured percent cover of woody vegetation. They also identified and counted standing live and dead trees > 6 cm diameter at breast height and measured a subset of fallen trees and stumps to calculate the volume of course woody debris.
- They used data from a 2016 LiDAR flight to determine canopy characteristics above 12m, including average canopy height and tallest tree height. They also extracted site elevation from a LiDAR-based model.
- The authors used principal component analysis to create a composite index of breeding season temperature and two indices capturing the multidimensional forest vegetation characteristics.
- They used dynamic N-mixture models, which are designed to model population trends as a rate of change in abundance while accounting for imperfect detection, to test the microclimate buffering hypothesis and the insurance hypothesis.

Keywords biodiversity conservation, climate refugia, forest ecosystem, global warming, H.J. Andrews Experimental Forest, long-term ecological research, old-growth forests, redundancy hypothesis, bird breeding population trends, forest microclimates

Images
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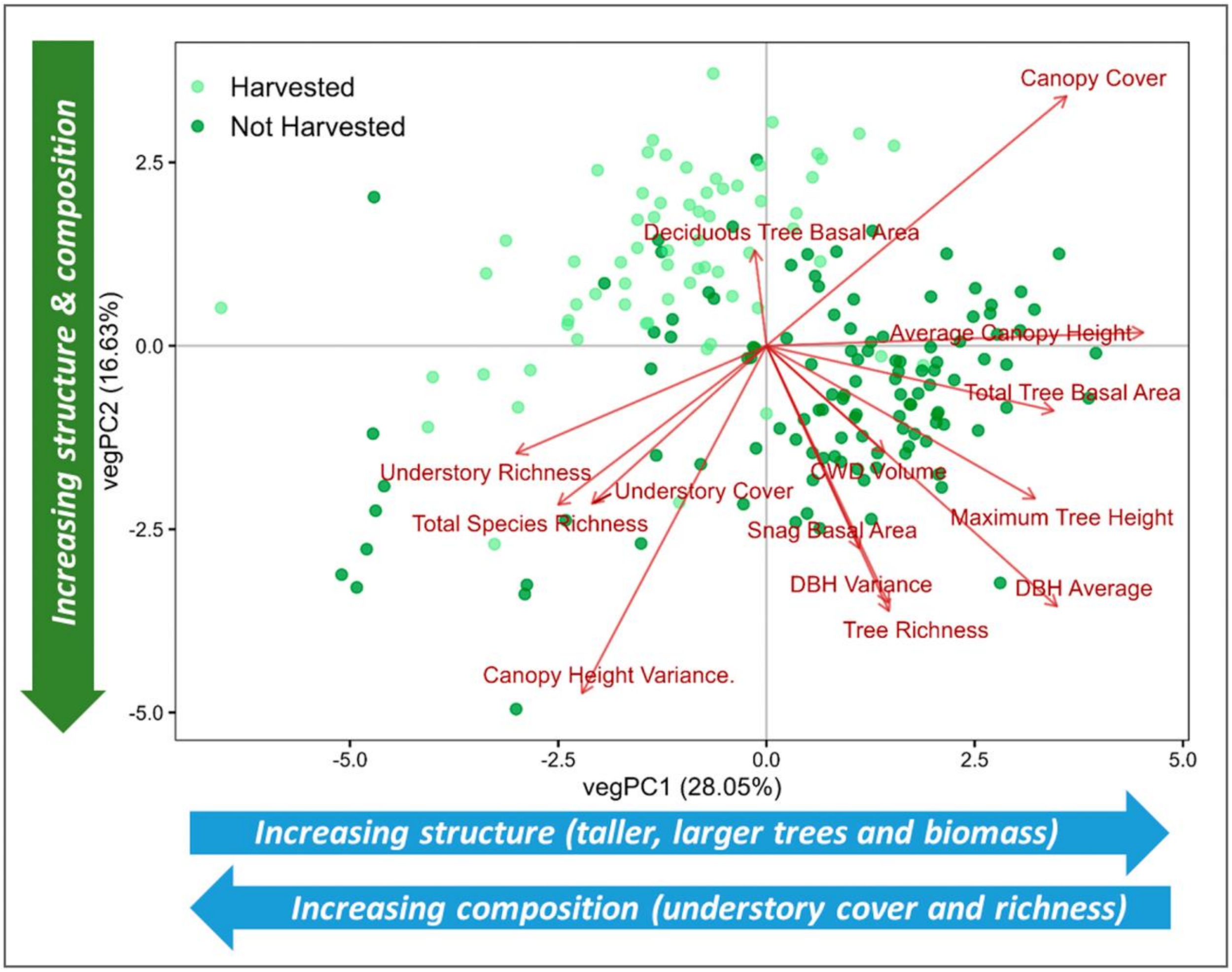

Figure 3 in Kim et al. 2022. PCA bi-plot for principal component 1 and principal component 2. Distribution of sample plots on the first and second principal component axes (dots), showing plots located in stands with harvest history (light green) and no harvest history (old-growth;dark green). Vegetation variable loadings for each covariate on the two principal component scores (vegPC1, vegPC2) are shown as vectors with labels. Note that higher vegPC1 is positively related to higher average canopy height, total tree basal area, maximum tree height, average diameter at breast height (DBH) and canopy cover. On the contrary, lower vegPC1 is positively related to higher understory plant richness, cover and total species richness. On the second axis, higher vegPC2 is related to higher canopy cover and low canopy height variation, and basal area of deciduous tree species. Deciduous tree species basal area was not related to total tree basal area, as they are relatively rare in our coniferous forest. Lower vegPC2 is positively related to understory, tree and total species richness, snag basal area and coarse woody debris (CWD) volume, and high variation in canopy height.

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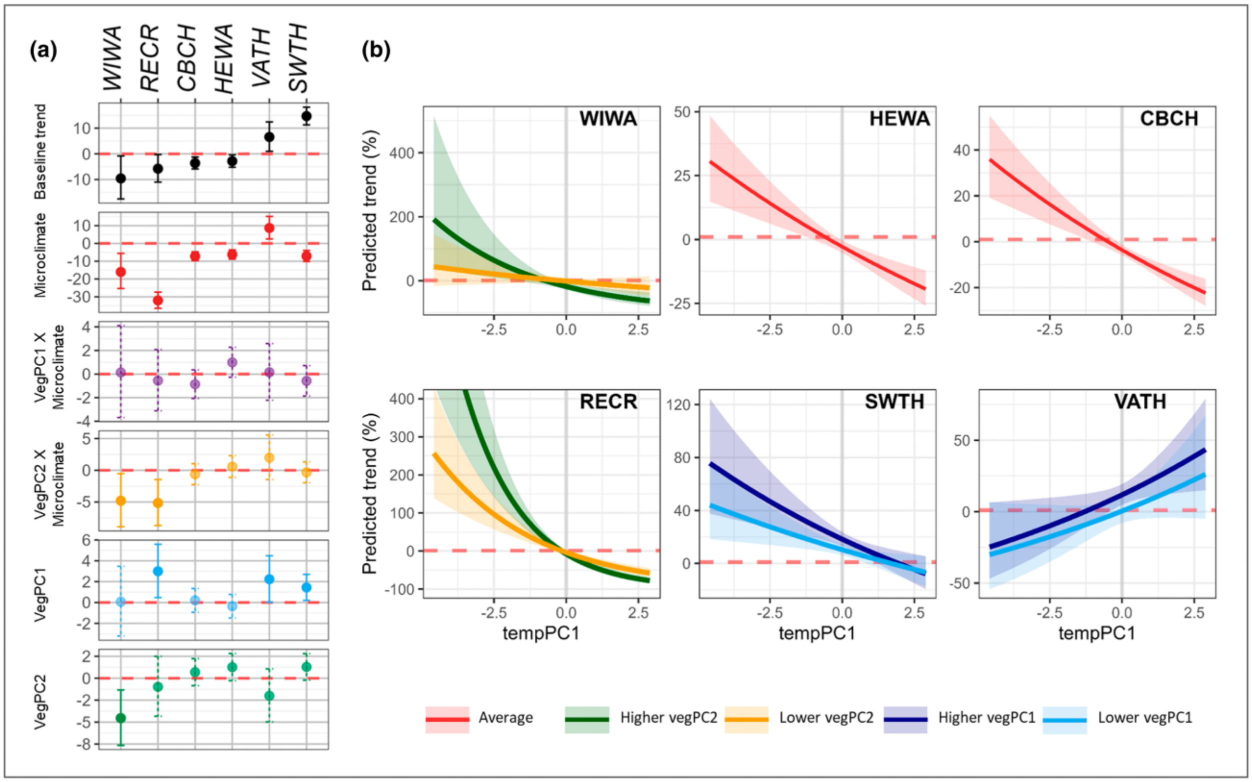

Figure 5 in Kim et al. 2022. (a) Estimated standardized covariate effects on population trend models of six species that support the hypotheses. The *Y*-axis indicates the percent change in population trends per unit change in each covariate, and the dotted red horizontal line indicates no change. (b) Fitted trend estimates of models with 90% confidence intervals, predicting trend (% change in abundance) as function of microclimate temperature (tempPC1), and its interaction with vegetation (vegPC2) for Wilson's warbler (WIWA) and red crossbill (RECR). Swainson's thrush (SWTH) and varied thrush (VATH) plots show additive main effects of vegPC1 on trends. Covariates that are not presented in this panel are held at their mean values.

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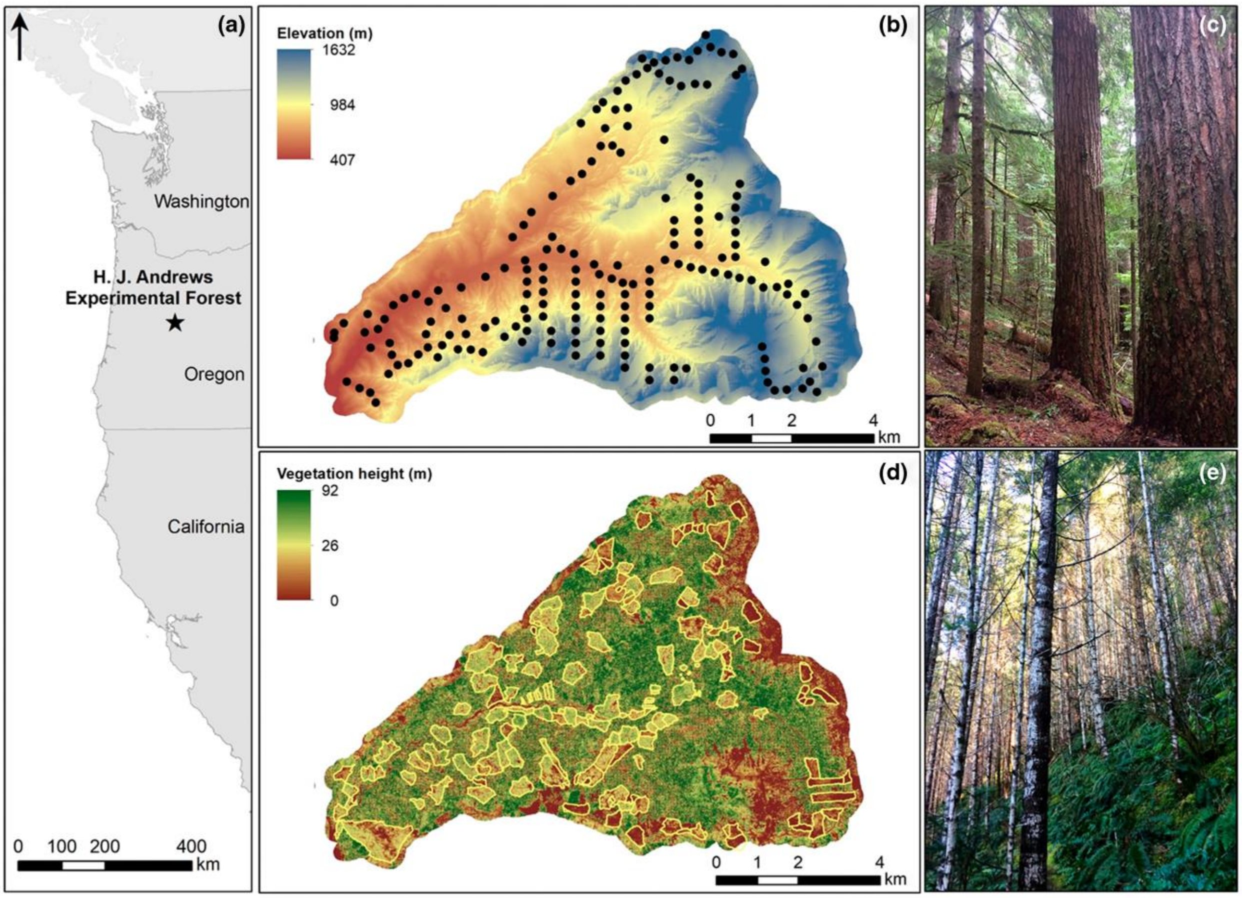

Figure 2 in Kim et al. 2022. Study area map and photographs of typical vegetation in the study area. (a) Location of the study area, H.J. Andrews Experimental Forest in Oregon. (b) Sampling locations (points; black circles) and altitudinal gradient of the watershed. (c) Vegetation height and stands with harvest history (yellow boundaries). (d) Typical old-growth Douglas-fir-Western hemlock forest and (e) Douglas-fir second-growth plantation in H.J. Andrews Experimental Forest.