How does forest degradation impact bird habitats and population abundances?

Forest degradation drives widespread avian habitat and population declines

Citation Betts, M.G., Yang, Z., Hadley, A.S., Smith, A.C., Rousseau, J.S., Northrup, J.M., Nocera, J.J., Gorelick, N., and Gerber, B.D. Forest degradation drives widespread avian habitat and population declines. *Nat Ecol Evol* 6, 709–719 (2022). https://doi.org/10.1038/s41559-022-01737-8

Is the type of forest habitat more important for bird populations than just forest cover?

Does forest management for harvest impact bird species populations even with no net loss in the amount of forest cover? In this study the authors test whether forest degradation, simplification of forest composition and age-class truncation caused by logging and replanting cycles, drives habitat loss and population decline in forest-associated bird species. They used species-specific habitat estimates and breeding bird population surveys to determine the amount of forest degradation and whether this degradation was associated with population declines.

Did bird habitat decline over the study period?

- Most of the bird species, 66%, had net habitat loss over the 35-year study period and 93% had habitat loss over the most recent decade. During that time forest cover has increased 6.5% while old forest decreased 39%.

Did bird populations decline over the same period as habitat decline?

- Breeding bird population size tracked with the amount of available habitat for 51 of the 54 species. Loss of habitat was associated with population declines in the same year. Over the study period, only three species had net population growth.
- Thirty-nine of the 54 species had overall population decline over the study time period and for 15 species the decline was severe, greater than 5% per year.

What types of habitat were species with declining populations most associated with?

- Most species with declining habitat and population size are associated with old forest, but some species associated with early successional forest are also in decline.

Can we expand this approach in other areas? What other lessons can be used going forward?

- The modeling approach described here could be used to estimate habitat amount and net change for the 54 study species over their entire ranges by expanding the area analyzed to all eastern North American forests. The resultant data could then inform decisions about whether species should be listed as threatened or endangered.
- Describing species-specific forest habitat loss and identifying it as a mechanism for population decline would have been impossible using coarse scale habitat descriptors. The category ‘forest cover’ is too course if diversity in structural and age composition are important habitat components.
- Biodiversity may also be impacted by changes in habitat caused by forest management practices. This is an area that should be the focus of further research.

What actions can be taken to limit the impact of habitat degradation and loss?

- Forest management practices that replace naturally complex forest with stands simplified by species and age-class may need to be confined to the areas they currently occur. Old forest stand reserves could be created to maintain habitat for avian species.

Research Approach/Methods

- The authors collected data on populations of 54 forest-associated bird species during 12,272 5-minute point counts from 2006 to 2010 across the core of the Acadian forest in Canada. They estimated overall population trends for all species.
- They used Google Earth to collect remotely-sensed data on six visible Landsat bands, which they used as predictive variables to model habitat distribution of each bird species and tested the models' prediction success using hold-out data.
- The researchers used model output to characterize habitat changes between 1985 and 2020. They then used an independent bird population dataset to test whether the amount of habitat was positively related to bird abundance and whether areas that lost habitat in a specific year had a bird population decline in the same year.
- They also tested whether specific measures of habitat degradation, such as clearcutting, where associated with reduced habitat.

Keywords conservation biology, forest ecology, biodiversity, avian habitat, avian population decline, forest degradation

Images

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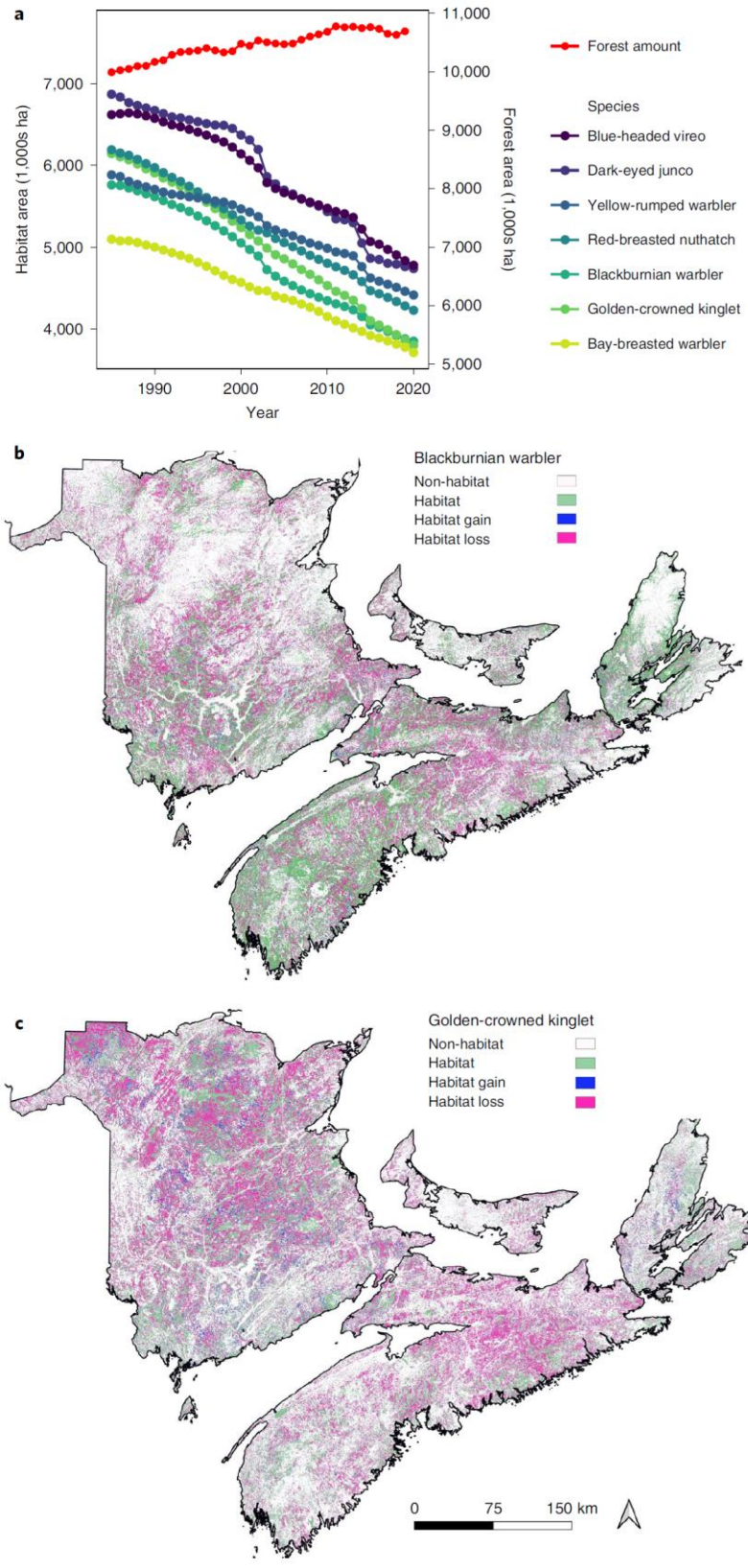
a
Habitat area (1,000s ha)
Forest area (1,000s ha)
Year
1990
2000
2010
2020
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
Forest amount
Species
Blue-headed vireo
Dark-eyed junco
Yellow-rumped warbler
Red-breasted nuthatch
Blackburnian warbler
Golden-crowned kinglet
Bay-breasted warbler
b
Blackburnian warbler
Non-habitat
Habitat
Habitat gain
Habitat loss
c
Golden-crowned kinglet
Non-habitat
Habitat
Habitat gain
Habitat loss
0
75
150 km

Fig. 3 in Betts et al. 2022| Forest degradation rather than loss drives habitat declines in old forest-associated bird species. **a**, Habitat trends (1985–2020) for the seven bird species exhibiting the greatest population declines according to SDMs; all of these species are old forest associated. During the same time interval, total forest cover did not decline (red line, right axis), indicating that habitat loss is a function of forest degradation rather than loss. **b**,**c**, Predicted habitat loss (pink) and gain (blue) between 1985 and 2020 for two example species: Blackburnian warbler (33% habitat loss; **b**) and golden-crowned kinglet (38% habitat loss; **c**). Habitat loss was quantified using SDMs with Landsat data as independent variables strongly predicted population trends for forest bird species.

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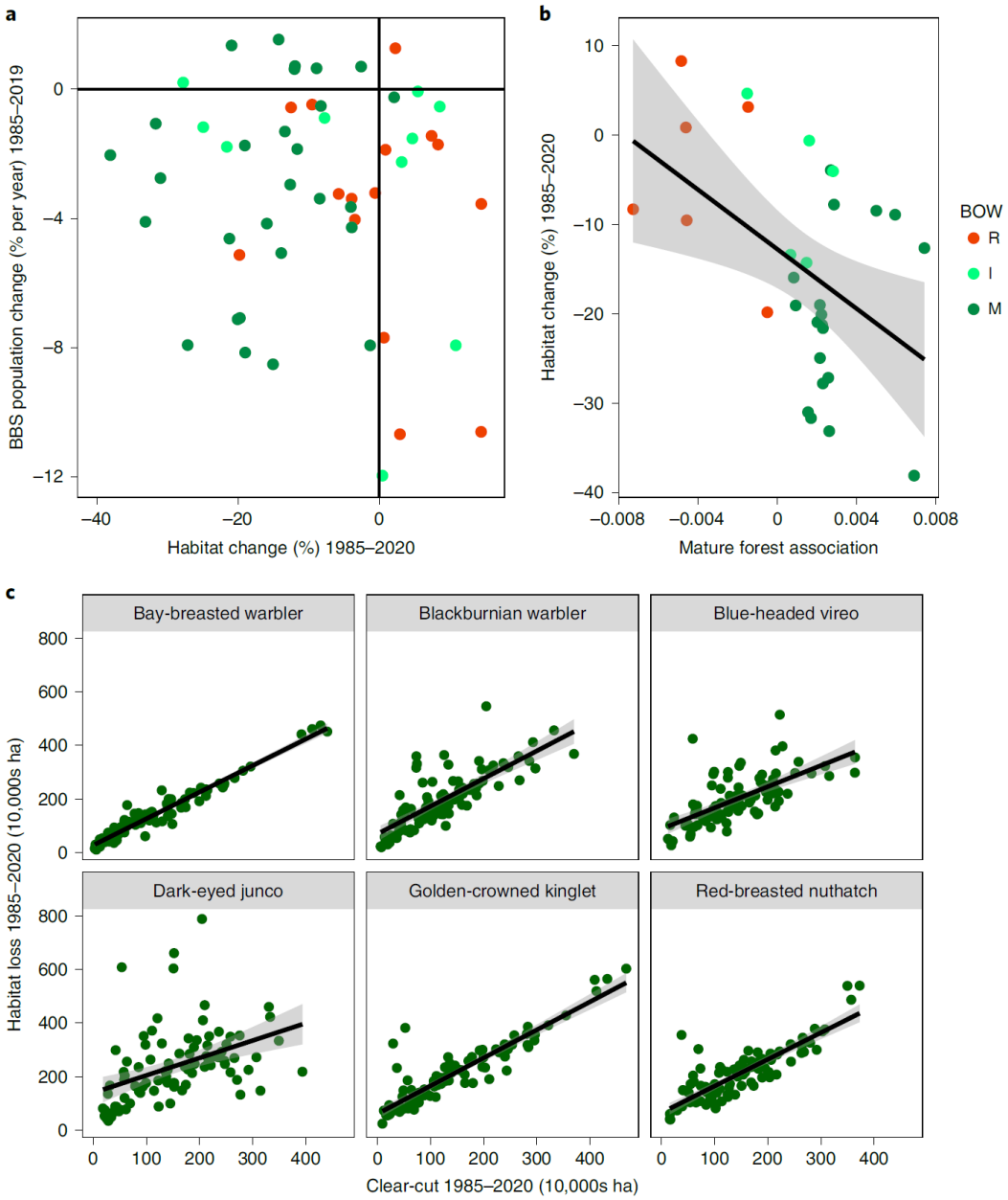

Fig. 4 in Betts et al. 2022| Evidence for the effect of forest degradation on mature-forest bird species. **a**, The relationship between habitat change, estimated from SDMs and independently derived population change estimates from the BBS for the Acadian forest. Bird species of mature (old) forests (M; dark green dots) exhibit the greatest habitat loss; this is generally reflected in strongly negative population trends. Bird species associated with regenerating forest (R; red dots) tend to have stable or increasing habitat but still show BBS population declines. **b**, The relationship between quantitatively derived estimates of mature-forest association and habitat change from 1985 to 2020. Mature forest-associated species tend to be losing the most habitat in relation to immature- (I; light-green dots) and regeneration-associated species. Successional stage categorizations (R, I, M) are from Birds of the World (BOW). The regression line was fit using a hierarchical Bayesian model (Supplementary Methods) and grey shading in **b** shows 95% credible intervals. Only a subset of species is shown in **b** (those with quantitative data for mature-forest associations; Supplementary Methods). **c**, The relationship between area clear-cut occurring from 1985 to 2020 in each species' habitat within a 200 m-diameter buffer surrounding BBS routes (*N* = 90) and habitat loss (1985–2020) at the same scale for six mature forest-associated species. Black lines are regression lines and grey bands are 95% confidence intervals (regression estimates in Supplementary Table 3). As expected, clear-cutting is strongly associated with habitat loss, which indicates that ingrowth of new habitat is rarely compensated for by habitat loss (a signature of forest degradation via old age–class truncation).

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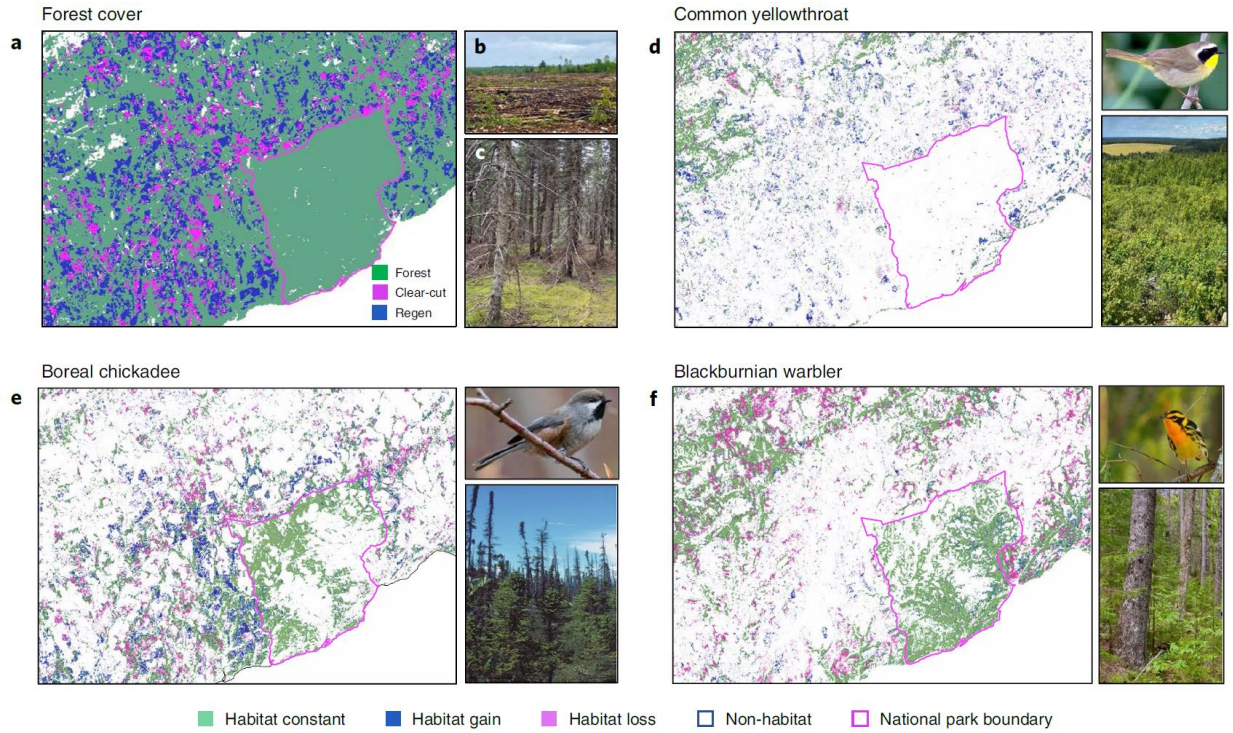

Fig. 2 in Betts et al. 2022| The importance of a species-centred approach to detecting effects of forest degradation. **a**–**f**, Maps showing forest cover (green in **a**), recent clear-cuts (pink in **a**; **b**) and >two-year-old clear-cuts planted, thinned or regenerating (Regen) naturally (blue in **a**; **c**) in relation to SDM-

predicted habitat and habitat changes (1985–2020) for: common yellowthroat (**d**), which is associated with young deciduous forest (net regional habitat gain = +8.3%), boreal chickadee (**e**), associated with old conifer forest (net regional habitat loss = −19.0%) and Blackburnian warbler (**f**), associated with old mixed coniferous/deciduous forest (net regional habitat loss = −33%); see adjacent photos of species-associated forest types. Due to habitat specialization (adaptation to particular forest types and age classes), each species is distributed uniquely across forest landscapes and therefore is differentially affected by clear-cuts and regeneration (**a**). Using coarse definitions of forest change (for example, forest loss or cover) will not effectively quantify species-specific habitat changes over time. SDMs based on Landsat variables enable quantification of annual habitat amounts and the direct effects of spatially congruent forest degradation (for example, changes in structure and composition initiated by clear-cut disturbance) on habitat for each species. Thresholds for quantification of habitat versus non-habitat are provided in Supplementary Table 1. The legend for habitat maps is provided below the figure. Photo credits: boreal chickadee, Iris Kilpatrick; all other photos, M.G.B.