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## Between a Rock and a Hard Place: The Impacts of Climate Change and Housing Development on Breeding Birds in California

Climate change is projected to alter the distributions of many birds. However, where a species will be able to persist is determined not only by climate, but by habitat availability as well. Land-use change continues to threaten wildlife by contributing to habitat loss and degradation.

High-density urban development has often been identified as a primary threat to native species, but lower density suburban or exurban development can also affect species negatively. In the United States, low-density housing development is the fastest growing form of land-use change.

We used species distribution models to investigate the potential impacts of both climate change and housing development on 64 breeding birds in California representing six major vegetation communities.

We found that development accounted for 32% of the overall reductions in future species distributions. Oak-woodland associated species may see the greatest impact from development - equal to 80% of their total losses - while coniferous forest associated species may see the greatest losses due to climate with relatively little impact from development.

The combined impacts of climate and development will vary across the landscape. The Sierra foothills, for example, may see increases in species richness, but housing is also projected to increase in this same region. The Central Valley, on the other hand, may see climate driven decreases in species richness as well as large increases in development.

Our analyses suggest that the cumulative effects of future housing development and climate change will be large for many bird species, and that some species projected to expand their distributions with climate change may actually lose ground to development. This suggests that a key climate change adaptation strategy will be to minimize the impacts of housing development in California.

### Main Points

- Climate change and housing development models were used to identify and compare the future impacts of each on breeding birds in California.
- Housing development accounted for 32% of overall reductions in projected species distributions.
- Even if climate change leads to an increase in the area of a species' occurrence, the gains could be partially or completely undermined by development impacts.
- Low density "exurban" housing accounted for two thirds of the development driven losses to species distributions.
- A key climate change adaptation strategy will be to minimize the impacts of housing development and growth.

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