

# Effects of Climate on Western Bumble Bee Declines in North America Now and in the Future

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The Western bumble bee (*Bombus occidentalis*), once common throughout Western North America is under consideration for listing by the U.S. Fish and Wildlife Service (USFWS). To support the USFWS Species Status Assessment of the Western bumble bee we assessed the relative influence of climate, landcover, and pesticides on the trends in occupancy for the Western bumble bee across its range in the conterminous United States. We used a Bayesian hierarchical occupancy model leveraging 14,457 surveys conducted over 23 years (1998-2020). We found strong support for a negative relationship between occupancy and two climate components: temperature during the warmest quarter and cumulative years of drought. We also found a complex relationship between the presence of Western bumble bee and landcover types with the species being more common in areas of increased forest and shrub cover. These relationships are non-linear and suggest forest/non-forest edge is an important habitat characteristic. We found variable declines in ecoregions across the species range from moderate declines in the Greater Yellowstone Ecosystem (-15%) to much steeper declines in the Cascades-Sierra Nevada-Coastal forests of the western US (-62% to -75%). In Montana, predicted declines are largest in the semi-arid prairies of the Eastern portion of the state (-53%) but still evident in the mountainous Western portion (-37%). We also used a range of future scenarios (based on 4 climate models, 2 emission scenarios, and 3 landcover forecasts) to project occupancy (2050's) and found continued range-wide declines even under the most conservative scenarios.