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Does pathogen spillover from commercially reared bumble bees threaten wild pollinators?

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The conservation of insect pollinators is drawing attention because of reported declines in bee species and the 'ecosystem services' they provide. This issue has been brought to a head by recent devastating losses of honey bees throughout North America (so called, 'Colony Collapse Disorder'); yet, we still have little understanding of the cause(s) of bee declines. Wild bumble bees (*Bombus* spp.) have also suffered serious declines and circumstantial evidence suggests that pathogen 'spillover' from commercially reared bumble bees, which are used extensively to pollinate greenhouse crops, is a possible cause. We constructed a spatially explicit model of pathogen spillover in bumble bees and, using laboratory experiments and the literature, estimated parameter values for the spillover of *Crithidia bombi*, a destructive pathogen commonly found in commercial *Bombus*. We also monitored wild bumble bee populations near greenhouses for evidence of pathogen spillover, and compared the fit of our model to patterns of *C. bombi* infection observed in the field. Our model predicts that, during the first three months of spillover, transmission from commercial hives would infect up to 20% of wild bumble bees within 2 km of the greenhouse. However, a travelling wave of disease is predicted to form suddenly, infecting up to 35-100% of wild *Bombus*, and spread away from the greenhouse at a rate of 2 km/wk. In the field, although we did not observe a large epizootic wave of infection, the prevalences of *C. bombi* near greenhouses were consistent with our model. Indeed, we found that spillover has allowed *C. bombi* to invade several wild bumble bee species near greenhouses. Given the available evidence, it is likely that pathogen spillover from commercial bees is contributing to the ongoing decline of wild *Bombus* in North America. Improved management of domestic bees, for example by reducing their parasite loads and their overlap with wild congeners, could diminish or even eliminate pathogen spillover.

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