Is Climate Change Exacerbating Bee Decline?

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HYPOTHESIS

We hypothesize that as the environmental stresses posed by climate change become more severe, pollinator populations will be negatively impacted, and so therefore bee populations will continue to decrease.

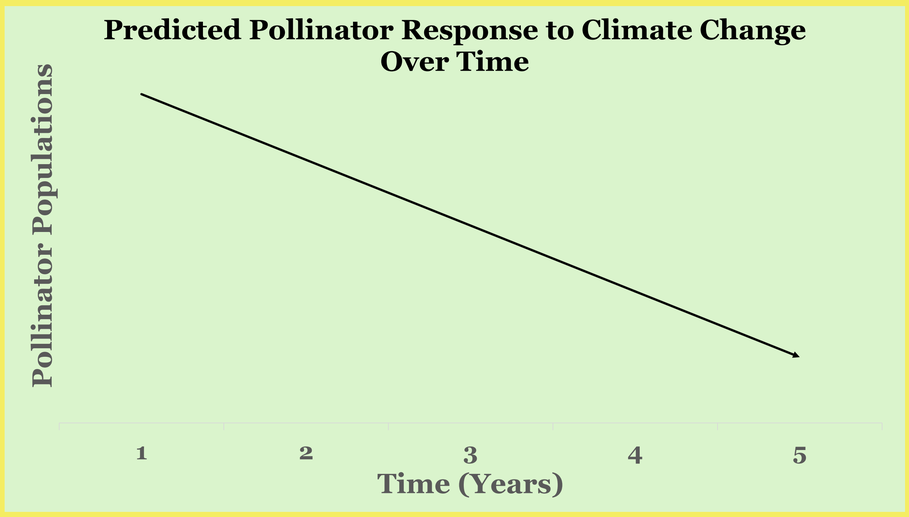

Fig. 1 Hypothesis on the relationship between years and pollinator decline as years continue with exacerbated conditions due to climate change

PREDICTION

- We predict that rising temperatures, changes in precipitation, and other extreme weather patterns resulting from climate change will cause an increasingly severe decline in bee colonies.
- Our hypothesis and prediction are based on the knowledge that climate change has many negative impacts on ecosystems in general, and often causes a decrease in biodiversity. This then would impact bee populations in the ecosystem as the decrease in resources leads to a lower carrying capacity which would directly cause honeybee numbers to decline. The purpose of this research and experiment is to draw better conclusions about how climate change will impact honeybee populations due to changes in temperature and precipitation patterns.

BACKGROUND & MOTIVATION

Because 87% of the world's angiosperm species require pollination, it is considered an essential ecosystem service and a component of biodiversity. The production of fruit and seeds that require pollination is crucial for both anthropogenic agricultural production, food security, and the basic stability of ecosystem biodiversity. (Bartomeus, p. 4656; Potts, p. 345)

In the past several decades, there is evidence of a decline in wild and domestic bee species. The potential drivers of this decline include habitat loss, agrochemicals, competing species, and in more recent years, these losses have been tentatively linked to climate change, posing increasing risks to ecosystem stability and human food systems. This has severe implications on human food sources as national croplands, such as those in the Midwest and California are experiencing increasing dependence on pollinators for fruit and seed production. (Sidder, 2017) About 60 percent of these species do not reach their full reproductive potential when bee species richness and evenness are limited. (Aizen, p. 1572)

While there are significant ties to climate change, there is limited research into the specific impacts of climate change pressures on pollinator species. For example, honey bee populations have exhibited a phenomenon called colony collapse disorder, in which the majority of worker bees abandon their queen and colony with plenty of resources and leads to an even steeper decline in bee populations. However, there is little research into the precise ecological causes of this phenomenon and whether they can be linked to climate change. For this reason, future research into the impacts of temperature and precipitation fluctuations on bee populations would enable scientists to direct more effective conservation efforts toward mitigating the recent decline of pollinator species.

STUDY DESIGN

To conduct our experiment, we will observe the health of different beehive populations in the crop-dense valleys of central California, where agricultural operations are most pollinator-dependent. Five greenhouse facilities, containing three hives each, will simulate varying climatic conditions and be monitored by data collectors for two years to determine the potential impacts of climate change on the seasonal patterns of pollinators. Each of these facilities will contain a mixture of native vegetation and wildflowers found in local bee habitats alongside common domestic crops of the region (i.e. avocados, oranges, vine fruits, etc.) Each of these enclosed indoor biomes will be enclosed so that we can manipulate internal temperatures and artificial precipitation with dispersed sprinklers and heat lamps. The following variables will be measured in the five different trial greenhouse facilities:

Facility 1: the three beehives in this greenhouse will act as a control and experience *no change* in temperature or precipitation from their native region (regular seasonal temperatures and precipitation of the region will be mimicked with this facilities sprinklers and heaters)

Facility 2: the three hives in this greenhouse will experience an *increase* in average temperature (manipulated by heat lamps) of 2 degrees Celsius in the first year, followed by an increase of 3 degrees Celsius in the second year

Facility 3: the three hives in this greenhouse will experience a parallel *decrease* in average temperature of 2 and 3 degrees Celsius in each successive year

Facility 4: the hives in this greenhouse will experience a 10% *increase* in precipitation (conducted via timed sprinkler mechanisms), followed by another 10% increase in the second year

Facility 5: the hives in this greenhouse will experience a 10% *decrease* in precipitation, followed by another 10% increase in the second year

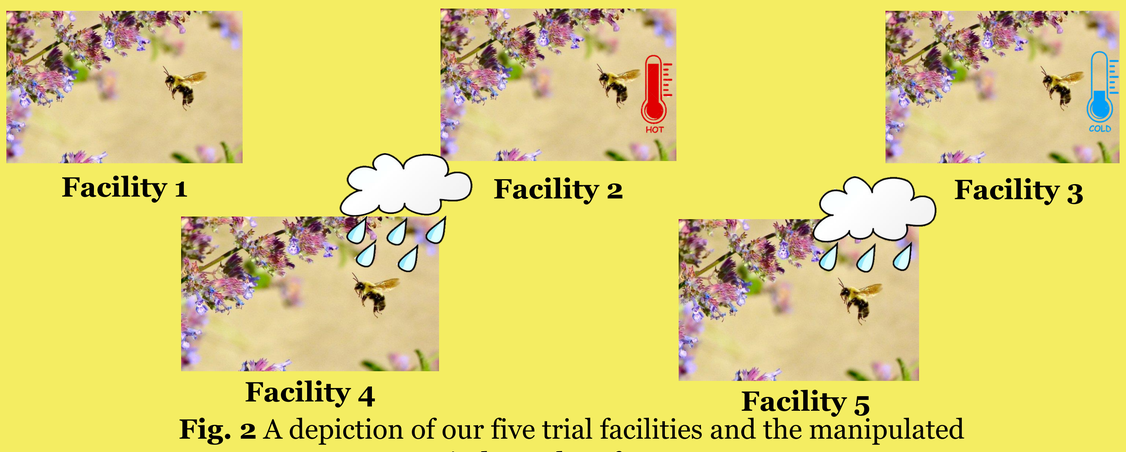

Fig. 2 A depiction of our five trial facilities and the manipulated independent factors

INTENDED ANALYSIS

- The independent variables of this study are temperature and precipitation, while the dependent variable is the number of active worker bees (and number of healthy essential habitat plant species), with a control of there being no change to the actual conditions of temperature and precipitation in the area.
- Since our data is counting the number of active worker bees and the number of healthy habitat plant species against varying amounts of temperature and precipitation, our data is continuous so a regression test should be used for the statistical analysis
- The results of our regression analysis will allow us to determine whether drastic changes in temperature and/or precipitation (both of which are likely to occur due to a changing climate) will have adverse effects on bee populations and their essential habitat.
- The limitations of this study include the two-year timeline, our geographical study location sites in central valleys of California, and the unpredictability of true future climate events.
- The expected benefits of this study (or rationale) would be a greater understanding of the impacts climate change may have on bee populations, which would allow environmentalists to implement more effective conservation efforts to address honeybee declines and the resulting food security crisis.

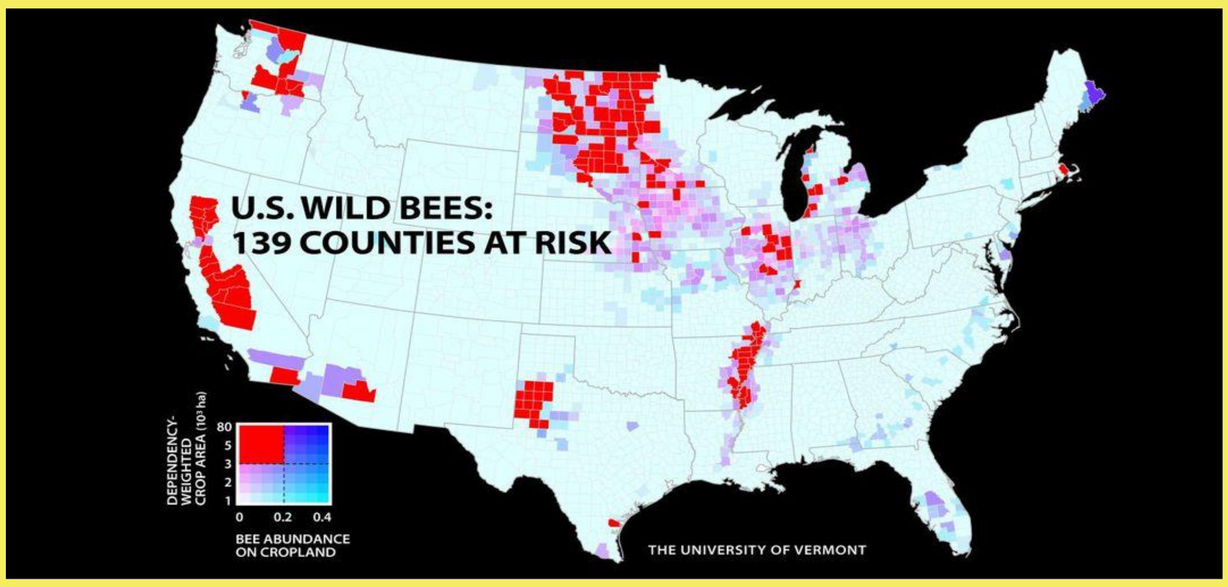

Fig. 3 Dependency weighted crop area and bee abundance on cropland (Sidder, 2017)

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