**Decline in arthropod abundance likely due to climate change**

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Bowden, J. J., Hansen, O. L. P., Olsen, K., Schmidt, N. M., & Hoye, T. T. (2018). Drivers of inter-annual variation and long-term change in High-Arctic spider species abundances. *Polar Biology*, *8*, 1635. https://doi-org.nuncio.cofc.edu/10.1007/s00300-018-2351-0

Harris, J. E., Rodenhouse, N. L., & Holmes, R. T. (2019). Decline in beetle abundance and diversity in an intact temperate forest linked to climate warming. Biological Conservation, 240. https://doi-org.nuncio.cofc.edu/10.1016/j.biocon.2019.108219

Arthropods are important indicators of changing environmental conditions because they are sensitive to changing temperatures and other environmental factors (Bowden et al., 2017). Arthropods play a vital role in ecosystem processes, serving as top predators and detritivores; when these organisms are lost, there are changes in predator-prey relationships as well as changes in the biodiversity of the habitats in which they are found. This knowledge has proven to be beneficial in understanding how arthropod diversity and abundance has changed in response to climate change and consequently, what conservation and management practices need to be implemented.

Long-term studies provide information, such as repeated measurements over multiple years, that can otherwise not be recorded during short-term studies. Therefore, long-term studies are beneficial to understanding changes in ecosystems due to time-lags. Two long-term studies investigated the possible reasons for declines in arthropod abundances. Harris et al. (2019) investigated the direct and indirect effects of climate change on the abundance and diversity of Coleoptera. Similarly, Bowden et al. (2017) investigated Aranea abundance and diversity in response to changes to weather throughout the year in addition to changes in climate.

Harris et al. (2019) collected beetle specimens from Hubbard Brook Experimental Forest (HBEF) between 1973-1977 and 2015-2017. Specimens were collected via the window trap method, in which specimen flew into a sheet of glass or plexiglass and fell into a container of soapy water. Taxa accumulation curves were constructed to determine if the specimens collected represented the total number of species that were present in the forest during the respective time periods. The researchers determined that 19 of the 50 taxa collected between 1973 and 1977 were not present in the taxa collected from 2015 to 2017, a decline of 39 percent. In addition, no new species were found during the 2015-2017 collection period. This decrease in collected taxa illustrates that the decline in arthropod diversity is likely due to climate change because other primary factors, such as habitat fragmentation and degradation, were controlled for in HBEF. Generalized Regression was used to determine differences between capture rates over the two different time periods; this illustrated that the mean capture rate declined by 83 percent from 1973 to 2017 (Figure 1). The decrease in collected taxa and the decline in capture rates illustrate that abundances of Coleoptera are being negatively influenced by warming temperatures.

Bowden et al. (2017) reached similar conclusions in a study of specimens from the Zackenberg Basic Monitoring Programme in Greenland. Spider specimens were collected from six plots between 1996 and 2014 using pitfall traps, in which specimens fell into a cup buried in the ground that contained a mixture of water and detergent. Species abundance levels across the six different habitat plots were calculated using a method that controlled for differences in trapping numbers and a method that controlled for inter-annual weather variations, such as changes in rain and snow levels. Both methods yielded similar results in that two species abundances declined significantly (Figure 2). *Colinsia thulensis* and *Erigone psychrophila* were found to have significantly declined from 1996 to 2014 along with increased temperatures and decreased snow depth. Interestingly, Bowden et al. (2017) found that rising temperatures and a decrease in the previous year's summer precipitation levels reduced most species abundances; however, most species abundances increased with deeper snow levels in the previous winter. Harris et al. (2019) saw the same phenomenon with beetle abundances in that deeper snow depths resulted in increased abundances in Coleoptera the following summer. Determining how deeper snow depth increases arthropod abundances needs further investigation.

Harris et al. (2019) and Bowden et al. (2017) illustrated that arthropod diversity is declining in areas all over the world in response to the indirect and direct effects of climate change. The decline in arthropod diversity is speculated to impact ecosystem processes and total forest biodiversity (Harris et al., 2019). Harris et al. (2019) reported that changes to community and ecosystem processes are still unknown; however, Bowden et al. (2017) suggest that the decline in arthropods will cause adverse effects throughout the rest of the ecosystem, including trophic cascades and population dynamics. Trophic cascades will result from the decrease in arthropods as predators which will subsequently alter the rest of the ecosystem structure as well as the predator-prey ratios. In addition, population dynamics in the form of species interactions will profoundly change due to changes in species abundances.

These two studies took place in areas that are relatively undisturbed by humans: the temperate northeast of North America and the High-Artic of Greenland. While these studies offered great insights into how arthropods are responding in untouched nature, it would be more realistic to perform similar studies in areas that are in contact with humans to discover how humans are affecting abundances. A better understanding of what ecosystem changes will occur and how these changes will affect biodiversity in response to human activity is necessary in order to implement conservation strategies to preserve the diversity of this planet.

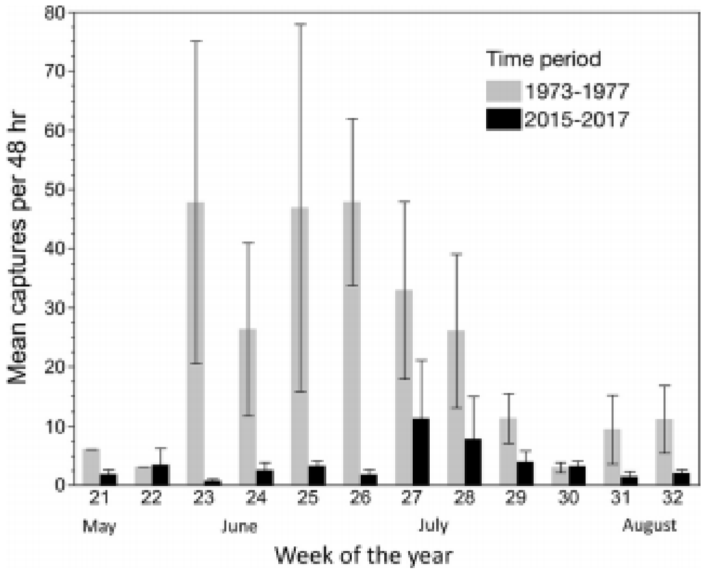


Figure 1. Comparison of mean capture rates per 48 hours of Coleoptera from 1973-1977 and 2015-2017 (from a mean of 23.2 to 3.9; 83% decrease). Harris et al. (2019)

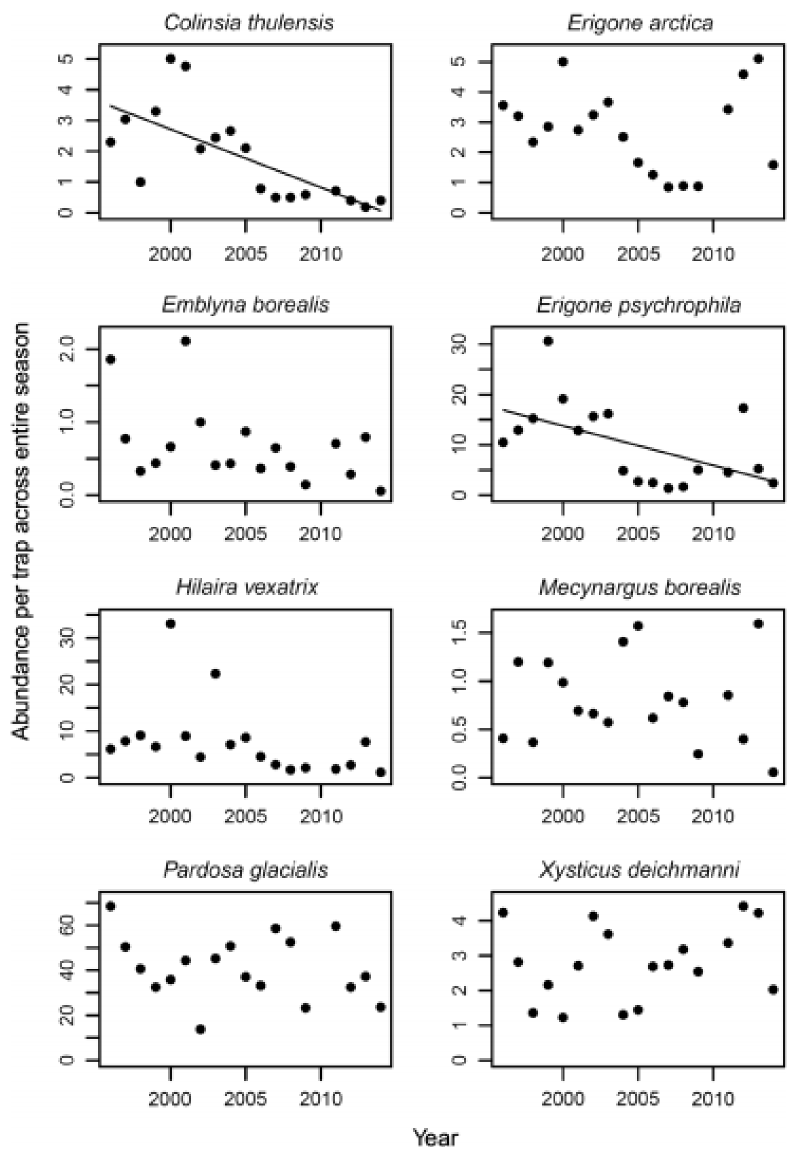


Figure 2. Conventionally calculated species abundances from all habitats tested from 1996-2014. Only significant regression lines are shown in *C. thulensis* and *E. psychrophila,* which were seen to significantly decrease*.* Note the different scales of species abundances. Bowden et al. (2017)