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Environmental Data
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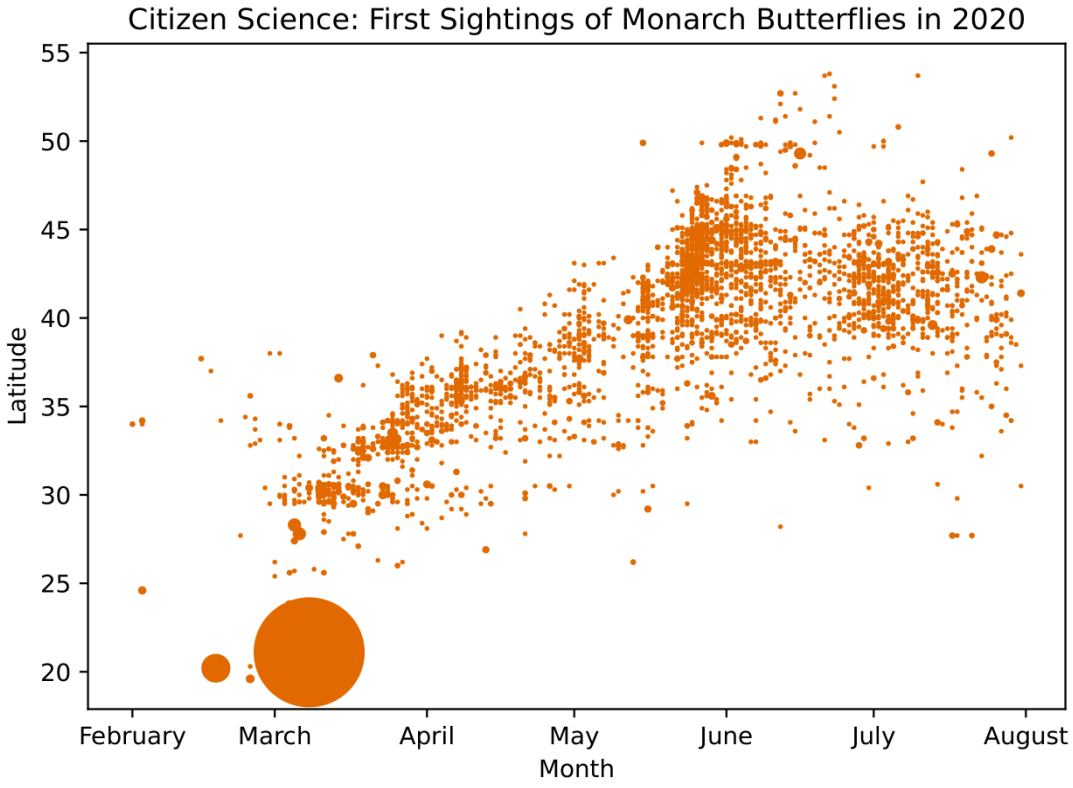
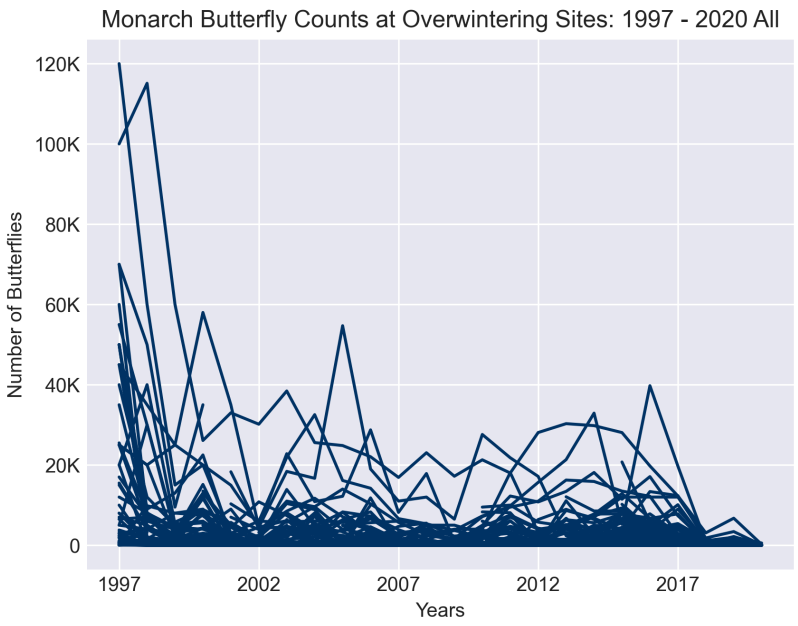
Declining Monarch Populations and Pesticide Use: A Data Exploration Using Python

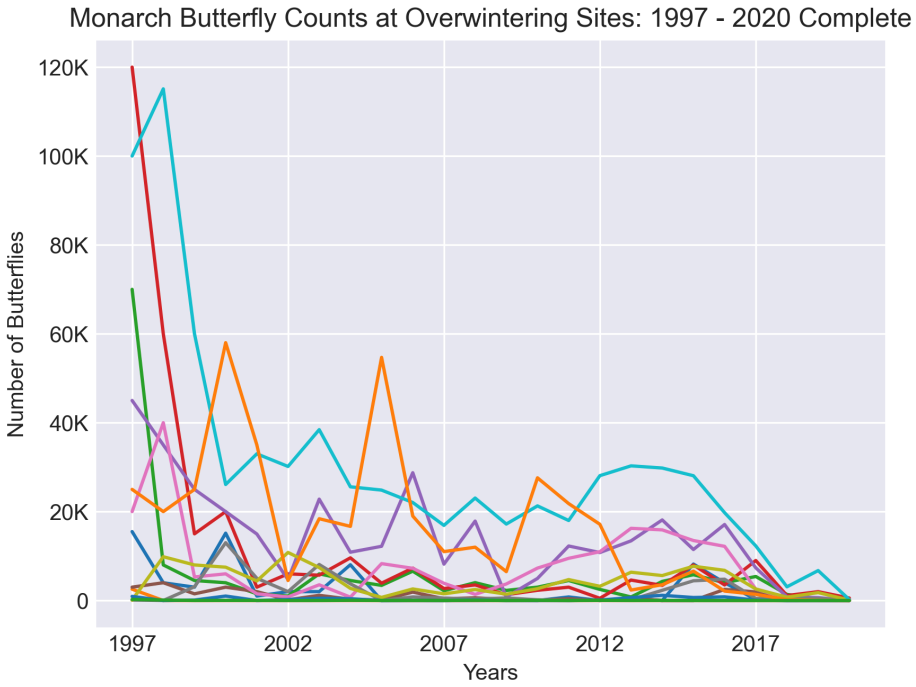
Danaus Plexippus, commonly known as the Monarch Butterfly, is a symbol of beauty and nature like no other. This butterfly has become the most iconic pollinator in North America. It's large wings, striped with orange and black, are instantly recognizable. Every single year, the species takes on a spectacularly impressive multi-generational migration between overwintering sites and breeding sites, spanning a distance of over 3,000 miles.



The organization Journey North records citizen science sightings of monarchs during their migration. Citizen scientists can register and report adult monarchs, monarch eggs, monarch larvae, or milweek sightings. The graph above is made from their 2020 reportings. The size of the dot indicates how many butterflies were seen. One instance, the large circle in early March, is a definite outlier. Citizen science data is excellent because a study can broaden its research while simultaneously increasing citizen engagement in science. One of its drawbacks is large outliers, such as this one, that were most likely created by mistake.

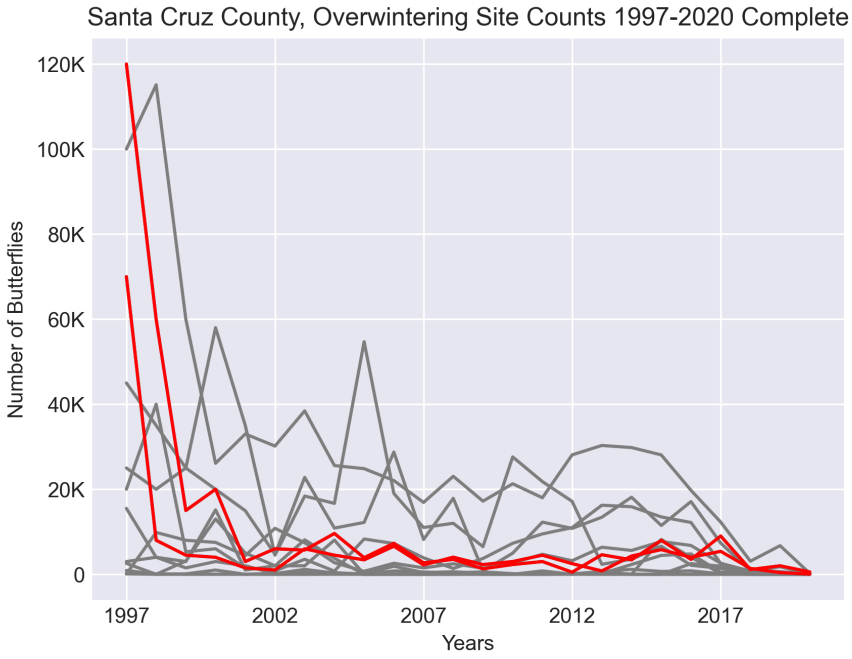


Overwintering sites are southern locations where monarch butterflies cluster to avoid the cold winter months. They huddle together on trees to share warmth, and stay there until the days start getting longer again. There are several hundred known overwintering locations along the coast of California. The Xerces Society's Western Monarch Thanksgiving Count began in 1997 and is the longest running effort to monitor overwintering in California. The counts happen during a three-week period centered around Thanksgiving at over 300 different sites. Biologists, land managers, and citizen scientists all aid in the counting.

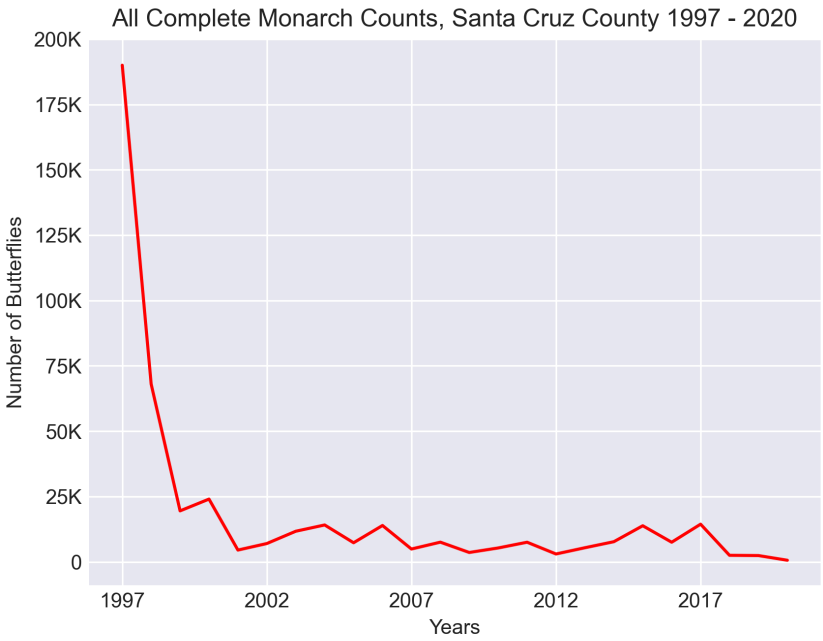


Of the 344 sites included in the Xerces Society dataset, only 13 have complete records for all the years since 1997. These complete records are visualized to the left. There is an obvious, sharp decline visible at all locations.

The Xerces Society is one of the many conservation organizations that have petitioned for the monarch butterfly to be added to the Endangered Species Act. Though a decision has not yet been made, as of December in 2020 the monarch is currently a candidate under the ESA. The U.S. Fish and Wildlife service declared that listing the monarch as endangered is warranted, but is precluded by higher priority species. While organizations like the Xerces Society wait for a decision, the monarch butterfly population is in a steep decline. Western monarchs have declined by more than 99% since the 1980s.

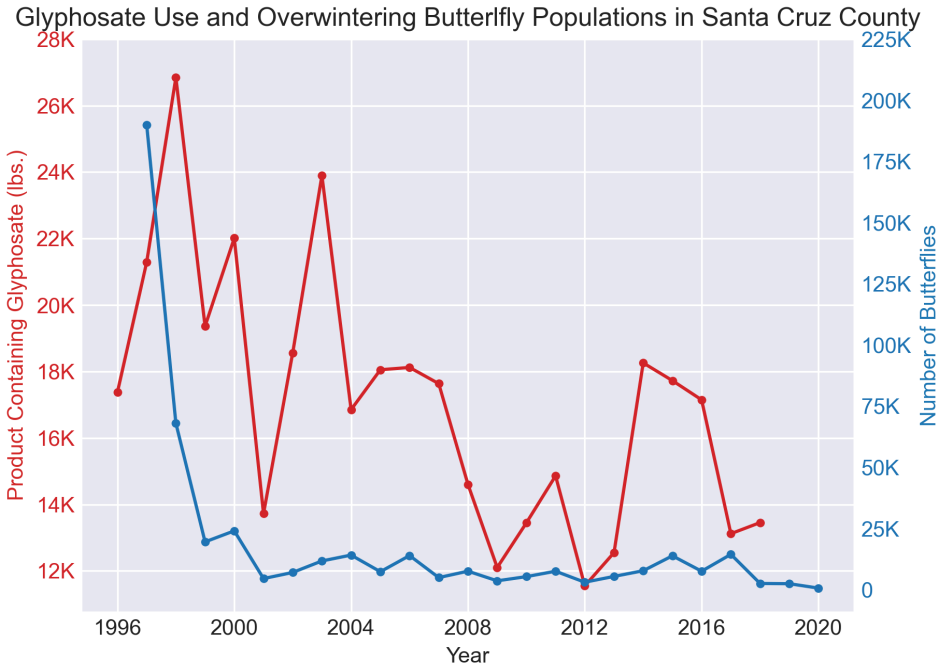


From the Xerces sites with a complete record, we can observe the populations in a single county in California.



During the summer months, monarchs can be found throughout North America wherever their host plant, milkweed, grows. Although adult monarchs feed on the nectar of many plants, monarch larvae only survive off of milkweed. Female monarchs lay their eggs on the leaves of milkweed plants, and the larvae consume the plant for about two weeks before they enter the pupa stage. The monarch population is entirely dependent on milkweed. The disappearance of milkweed is a major contributor to monarch population decline. As agriculture in America relies more and more upon the massive amounts of pesticides necessary to maintain monocropping, plants like milkweed are being systematically eradicated.

Glyphosate, a broad-spectrum systemic herbicide and crop desiccant, is the most common herbicide used to kill milkweed. It has been a registered pesticide since 1974, and has gained popularity for its ability to kill a broad range of weeds. Since 2001 it has been the most widely-used pesticide in the United States. Products that use glyphosate are distributed in various forms, and it's the main ingredient in Roundup. Roundup is sold in tandem with "Roundup Ready" crops, which have been altered to be resistant to glyphosate.



The California Department of Pesticide Regulation offers yearly records of pesticide use within every county in the state. From this database, I collected data from the years in which the Xerces counts take place, and I could compare glyphosate use and monarch overwintering populations within the same county. In the above graph, we can clearly see a peak in glyphosate use correlating to a steep decline in butterfly numbers at the year 1998. While glyphosate use fluctuates between then and 2018, monarch populations never recover.

Accurately assessing insect populations and factors of their decline is difficult, as long-term data is lacking. Until recently, hardly anyone was assessing insect population trends. While the correlation between pesticide use and monarch butterfly decline is clear, some scientists are still debating the causation. There's also the matter of climate change, deaths during migration, and loss of overwintering habitat that all could be responsible. In order to stop the rapid decline of monarch butterflies, more data and data analysis will be needed.

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