The Potential Correlation Between the Biodiversity of Pollinators and Waste Production of Humans in Tonnage on a Temporal scale at UCLA

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Abstract

Human activity in the form of waste production could potentially impact biodiversity levels of species as studies have shown that it could have an effect on the survival of those that live in urban areas. As a result, we hypothesized that there is a significant potential correlation between the biodiversity of pollinators and waste production of humans in tonnage on a temporal scale over the past six years at UCLA. Existing data reports from iNaturalist, UCLA Sustainability, Cal Fire, and the Los Angeles Almanac were used to compute statistical analysis tests. Linear regression and correlation tests were done using the XLMiner Analysis ToolPak extension on Google Sheets.

Results found indicated a statistical significance between waste production and pollinator biodiversity. Additional tests performed to contextualize these results either strengthened the hypothesis, as in the case of species abundance of the Dark Eyed Junco, wildfires, and drought, or were inconclusive in their support (species abundance of the Western Honeybee). These findings indicate further research on the topic may be beneficial to expand knowledge on the ecological impacts of waste.

Introduction

Inspiration for this study stems from University of California Los Angeles (UCLA) initiative to become a zero waste institution by 2025, which includes policy targets of 90% waste diversion and 25% waste generation reduction within the next three years (UCLA Sustainability, 2022). This initiative has resulted in a rise of waste management efforts, which include proper waste sorting techniques (color coordinated disposal bins), and decreased overall waste produced per person, per department, and per region of campus. With the increased awareness of proper

waste management, this study sought to examine biodiversity rates within UCLA's campus in light of this environmental and ecological initiative.

In a study designed to examine the effects of waste management on rural environments, both animal environment and vegetation had density indicator values above the average of 3 with 3.425 and 3.400 respectively (Norouzi, Guarani & Abdolhossein 2021). This analysis helped highlight how rural areas, that were adjacent to rapidly-growing urban environments with proper waste management, had better thriving animal habitats and plant life. Another study evaluated landfills where trash was sorted properly and found that landfills were a source of food for threatened species in about 6.3% of all surveyed groups (Plaza & Lambertucci, 2017). Such projects demonstrate how appropriate waste management can provide resources for species residing in surrounding areas, and could potentially improve their survival, reproduction, and general fitness.

For organization and simplicity, we broadly classified our target species of birds and insects as pollinators. Some insect populations, like the Black Soldier Fly, have commensalistic relationships with waste produced and have been found to convert organic food waste into functional proteins and other materials like organic fertilizers (Purkayastha & Sarkar 2022). Birds, additionally, have an established ecological relationship with insects as insect predators. Both insects and birds interact with flora for pollination and nectar, thus we classified them as pollinators. This generalization of species would offer a better overview of how biodiversity has changed on a more concise scale, as it would consider wider parameters to explore the context of the study.

In general, this study aimed to explore the potential correlation between the biodiversity of pollinators and waste production of humans in tonnage on a temporal scale over the past six

years at UCLA. The null hypothesis was that there was no statistically significant correlation between the biodiversity of pollinators and waste production of humans in tonnage on a temporal scale over the past six years at UCLA. Municipal Solid Waste (MSW) production was used as the variable to quantify human activity, as an increase in human activities, like the running of businesses, offices, and restaurants, might generate more waste as a by-product. Consequently, we predict that reduced human interference in the form of waste production will potentially be reflected in an increase in biodiversity levels of pollinators at UCLA..

Species abundance of the two most observed species, the Dark Eyed Junco (*Junco hyemalis*) and Western Honey Bees (*Apis mellifera*) were used in additional tests to analyze the effects of MSW on pollinators in a different quantified manner to explore the hypothesis further. In addition to our investigation of MSW and biodiversity, we surveyed the influence other external factors could potentially have on biodiversity, which might provide more insight into our overall findings. The potential confounding variables tested include the severity of wildfires in Los Angeles county in the acres and inches of rainfall in Westwood from 2015 to 2021. Both variables, to varying degrees, impact the survival and reproduction of pollinators species and would be important to analyze all possible determinants (Bartzke et al., 2018; He et al., 2019).

Using UCLA's species biodiversity as a model system to understand the ecological impacts of waste on college campuses, its tangible findings could potentially be used to help biologists, city planners, and other civilians recognize how human influence affects the environment. We hope our findings could potentially be amplified and implemented in other areas of urban environmentalism and species conservation on both smaller and larger scales. This research is particularly important to species that are situated in urban areas and have higher

chances of interactions with humans that result in greater susceptibility to vulnerable events like habitat destruction.

Methods

A. Biodiversity and Abundance of Pollinators Data

iNaturalist is a global platform that allows individuals to upload and record observations of many species groups (www.inaturalist.org; Nugent, 2018). Birds and insects are two specific animal pollinators found in iNaturalist observation reports. The report extracted included 3594 observations of birds and insects recorded on the UCLA campus from 2015 to 2021. The CSV file of the iNaturalist report was uploaded to a Google Sheet and sorted by year. The overall number of species in each year was totaled, including the number of observations for each species. The biodiversity index was computed by dividing yearly species richness with the yearly total number of observations. In addition to species richness and biodiversity, abundance was calculated for two of the most observed pollinators. The abundance of Dark Eyed Juncos *(Junco hyemalis*) and Western Honey Bees (*Apis mellifera*) was calculated by dividing the number of individual sightings, by the number of observations in a given year.

B. Municipal Solid Waste (MSW) Data

The MSW data was obtained from UCLA Sustainability. The MSW data included waste in tonnage from the UCLA campus from 2015 to 2021. The data was uploaded to Google Sheets.

C. Confounding Variables: Wildfires and Drought

Wildfires, a potential confounding variable, were measured in acres burned in Los Angeles County and were acquired from the Cal Fire website (www.fire.ca.gov). The data was minimized to only include acres burned in Los Angeles County from 2017 to 2021. The second

potential confounding variable, drought, was measured in inches of rainfall in Westwood and was obtained from the Los Angeles Almanac website (www.laalmanac.com).

D. Statistical Analysis

The first statistical analysis performed was on MSW and the biodiversity of pollinators. The independent variable was the amount of MSW collected annually, while the dependent variable was the biodiversity of pollinators. The second analysis was based on the amount of MSW collected each year and the abundance of Dark Eyed Junco. The independent variable was the amount of MSW collected yearly, while the dependent variable was the abundance of the Dark Eyed Junco.For the third analysis, the independent variable was the amount of MSW collected yearly, while the dependent variable was the abundance of the Western Honey Bee. The last two analyses were on the potential confounding variables of wildfires burned measured in acres in Los Angeles County and drought measured in inches of rainfall in the Westwood area. For the first potential confounding factor, the independent variable was acres burned in Los Angeles County, while the dependent variable was the biodiversity of pollinators. The independent variable of the second potential variable was the drought measured in inches in rainfall in Westwood, and the dependent variable was the biodiversity of pollinators.

Before running the statistical test, the year 2020 was removed from the biodiversity, MSW, and abundance data to increase the fit of the model. Based on all of the independent and dependent variables being interval-parametric, the statistical tests used were linear regression and correlation tests. Using the XLMiner Analysis ToolPak extension on Google Sheets, a linear regression and correlation test were computed for each of the comparisons. The results of linear regression provided residual outputs for each statistical test. The residual outputs from each linear regression test were used to plot trend lines on a temporal scale.

Results

A. Biodiversity of Pollinators and Municipal Solid Waste (MSW) at UCLA (Figure 1)

In a correlation test between the biodiversity of pollinators and the MSW produced at UCLA, the correlation coefficient obtained was -0.56. Additionally, a regression analysis was performed, and a significant p-value of 9.74×10^{-7} was obtained, in addition to the value of R-squared being 0.31. Results for this test are illustrated in Figure 1.

B. Species Abundance of the Dark Eyed Junco and the Western Honey Bee and Municipal Solid Waste (MSW) at UCLA (Figures 2; Figure 3)

A correlation test between the species abundance of the Dark Eyed Junco (Junco hyemalis) and MSW produced at UCLA yielded a correlation coefficient of -0.058. A linear regression analysis yielded a significant p-value of 4.87×10^{-7} and a R-squared value of 0.0033. Results for this test are illustrated in Figure 2.

A correlation test between the species abundance of the Western Honey Bee (Apis mellifera) and MSW produced at UCLA yielded a correlation coefficient of 0.31. A linear regression analysis yielded a significant p-value of 1.88×10^{-4} and a R-squared value of 0.099. Results for this test are illustrated in Figure 3.

C. Wildfires and Biodiversity of Pollinators (Figure 4A)

The potential confounding variable of wildfires, measured in acres burned in Los Angeles County, and the biodiversity of pollinators on UCLA's campus were used to perform a correlation test. The correlation coefficient was 0.12. A linear regression test resulted in an

R-squared of 0.014 and a non-significant p-value of 0.85. Results for this test are illustrated in Figure 4A.

D. Drought and Biodiversity of Pollinators (Figure 4B)

A correlation analysis was performed between a second potential confounding variable of water drought, measured in inches of rainfall in Westwood, and the biodiversity of pollinators. The correlation coefficient between biodiversity of pollinators and average rainfall in Westwood in inches was 0.11. A linear regression test resulted in a non-significant p-value of 0.82 and a R-square value of 0.012. Results for this test are illustrated in Figure 4B.

Discussion

The results of our main investigation indicate there is a potential correlation between the biodiversity of pollinators and MSW produced at UCLA. With a negative correlation coefficient, the two variables were inversely related, as we predicted. However, the regression analysis indicated a high level of variability around the regression line. Given the significant p-value, we were able to reject our null hypothesis to an extent, as the results indicate a correlation, but not necessarily a strong one. To further explain, the results show an increase in MSW may be correlated with a decrease in biodiversity, and vice versa. Although, this is not to say an increase in MSW caused a decrease in biodiversity, as the nature of our results cannot indicate causation. Because the correlation discovered may not necessarily be particularly strong, multiple tests were performed to contextualize our results further.

The first of the additional tests was performed on the species abundance of the Dark Eyed Junco and the Western Honeybee with MSW to further analyze potential influences of MSW on

pollinators using different measurements. The results were similar to those testing biodiversity, and significant statistical relations were found, indicating support for our hypothesis. However, unexpected results for the honeybee indicated a direct relationship with MSW, which obscures these results. For this reason, these results cannot greatly strengthen our findings on biodiversity, and revised methods for calculating species abundance may be necessary to do so.

Large-scale wildfires, such as those experienced by California more recently, might actually damage biodiversity, although the specific effects are still unclear (Pastro et al., 2011). Additionally, drought is known to negatively impact biodiversity and ecological structures (Clark et al., 2016). As potential confounding variables, tests on wildfires and drought were performed and indicated no statistically significant relationship with pollinator biodiversity. While more confounding variables may exist, these tests strengthened our original results, as connections with MSW were more significant than those of wildfires or drought.

In regards to obstacles encountered, the program iNaturalist, while helpful and convenient, may not be the most reliable source for data on pollinators. The platform is not necessarily used in every encounter with a pollinator, and thus the number of observations on iNaturalist may not accurately depict pollinator populations. There was also no way to control for individuals being counted multiple times as separate observations on iNaturalist, which was relevant to the species abundance data. In addition, statistical capabilities were limited within the timeframe of this project, as other programs such as R could have more accurately calculated our results and generated figures. Lastly, due to the global pandemic of COVID-19, the year 2020 was removed from our data, as it was an outlier. This may be due to the unique environments fostered during this period, as the mandated stay-at-home orders could have impacted individuals available to make iNaturalist observations.

The pandemic and its impacts on waste management and biodiversity is one of many extensions to this research that may be performed. An analysis of MSW and pollinator biodiversity before, during, and after the pandemic may provide more in-depth perspectives on the presence of humans affecting biodiversity through the MSW they produced. The expansion of the geographical bounds of the data collected may also greatly benefit this research, as comparisons with other college campuses, other urban areas, or even rural areas could further contextualize our original results. More potential confounding variables, such as measurements of pollution or climate change, could also be added to reweight our results accordingly.

Overall, it cannot be definitively concluded that a strong correlation between MSW produced and pollinator biodiversity exists, but we were able to reject the null hypothesis that a correlation of sorts was found. Our results may serve as preliminary findings that may indicate this as an interesting and possibly impactful field for future research.

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Figures

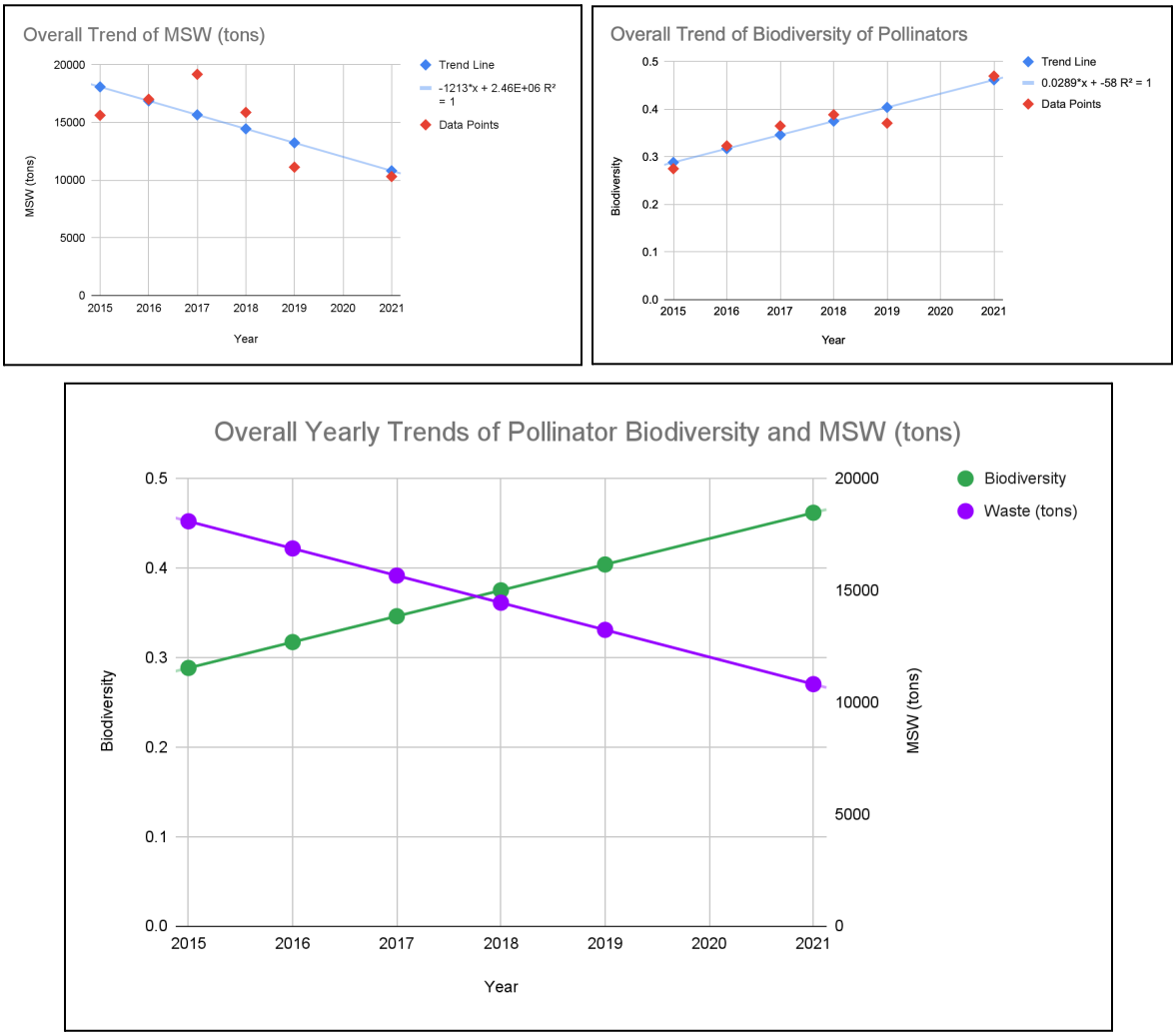

Figure 1: A) The overall trend of MSW in tonnage on a temporal scale on UCLA campus. B) The overall trend of biodiversity of pollinators on a temporal scale on UCLA campus. C) An overlay of the yearly trends of pollinator biodiversity and MSW in tonnage on a temporal scale on UCLA's campus.

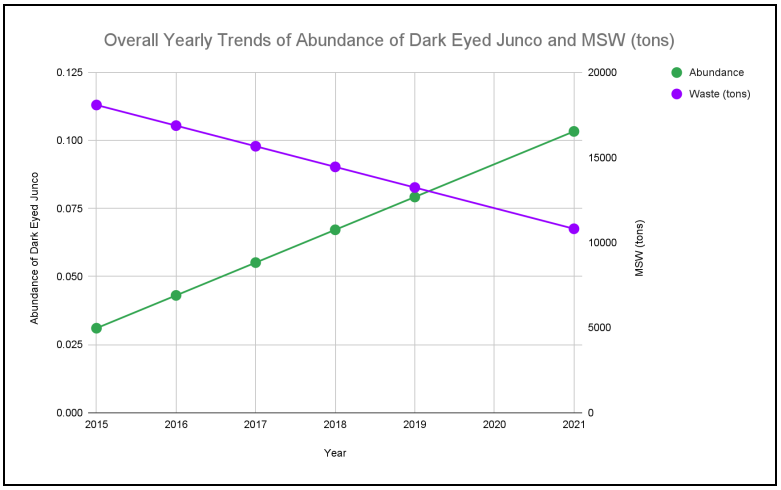

Figure 2: An overlay of the yearly trends of species abundance of the Dark-Eyed Junco and MSW in tonnage on a temporal scale on UCLA's campus.

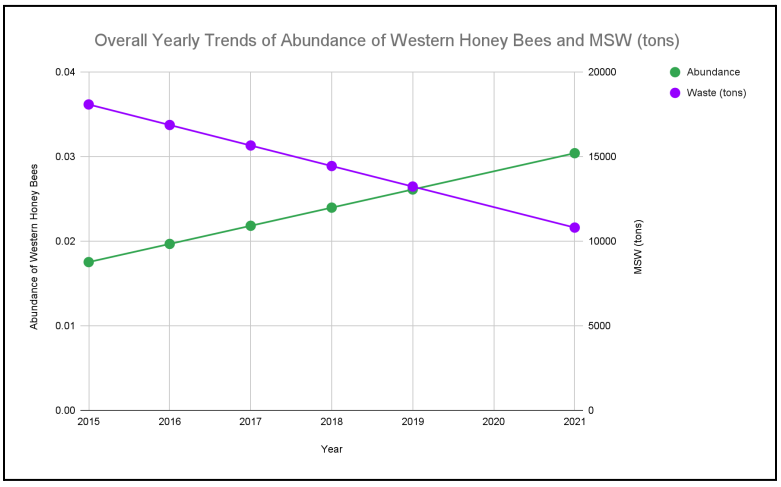

Figure 3: An overlay of the yearly trends of species abundance of the Western Honey Bee and MSW in tonnage on a temporal scale on UCLA's campus.

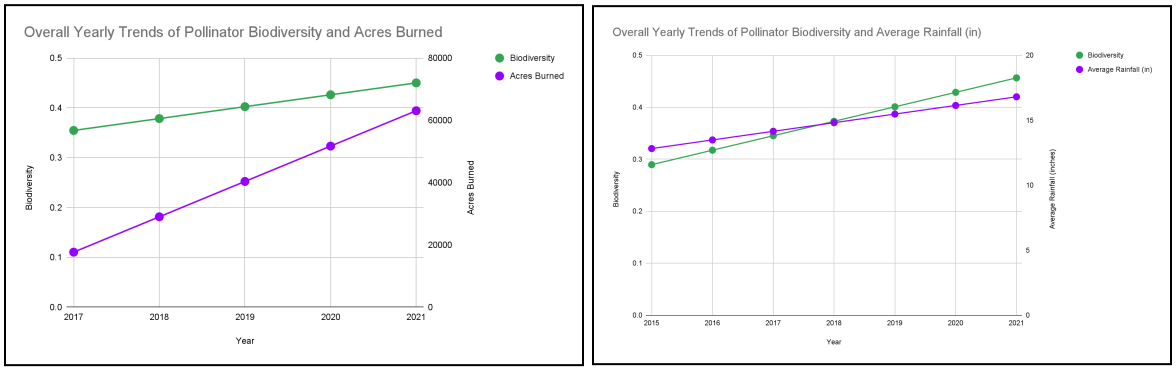

Figure 4: A) An overlay of the yearly trends of the biodiversity of pollinators and wildfires, measured in acres burned in Los Angeles County, on a temporal scale on UCLA's campus. B) An overlay of the yearly trends of the biodiversity of pollinators and drought, measured in inches of rainfall in Westwood, on a temporal scale on UCLA's campus.