Bees as Ambassadors for Plant Awareness and Conservation

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March 2026

Abstract

Because of their abundance and sessile nature, plants often blend into the landscape, which can lead many people to be unaware of, uniformed, or uninterested in them. This phenomenon, known as "Plant Awareness Disparity" (PAD), contributes to a lack of support for the conservation of plants relative to animals. Strategies for mitigating PAD across diverse demographic groups remain poorly understood. To address this gap, we surveyed 318 people in Southeast Michigan with a combination of quantitative and qualitative questions designed to assess the four axes of PAD: Attention, Attitude, Knowledge, and Relative Interest. Results were statistically analyzed across gender, education, and age groups and assessed in the context of strategies for mitigation across demographics and axes. We found greater Relative Interest and Attention toward plants in non-males compared to males and greater Knowledge in the 18-29 age group relative to those 30 and over. Most notably, in a question where participants were asked to construct an ecosystem using abiotic and biotic features, bees were the most commonly selected biotic feature across demographics. We discuss how future plant conservation campaigns can overcome PAD by employing bees as "ambassadors" to increase care for plants and support for policies that protect threatened plant species. This strategy could close demographic gaps in PAD and increase support for plant conservation policies, benefiting society and natural environments.

Introduction

One of the most successful conservation campaigns in recent years educated the masses about the importance of bees [1], which has coincided with intensification of policies to protect pollinators [2]. Paradoxically, these campaigns still underappreciate plants, even though safeguarding plant reproductive success is ultimately their goal when highlighting the importance of pollinators. Despite bees being known as pollinators of many of the crops we eat, many people exhibit an unconscious bias known as "plant awareness disparity" (PAD; [3]), the tendency to be unaware of, underappreciate, and be uninformed about plants relative to animals [4]. Prior research has suggested that PAD is responsible for a dearth of both scientific work on the conservation of plants relative to animals [5], and policies protecting plant species from detrimental human activity [6]. Despite the prevalence of studies conducted to understand PAD, it is very challenging to "break the cycle" of PAD and improve people's empathy and consideration for plants [7]. Part of this difficulty

may be related to a lack of understanding about how the various axes of PAD differ across demographics (see [8, 9]) and that deeply studying these demographic differences might help mitigate ongoing anthropogenic plant extinction and endangerment. Therefore, we surveyed to evaluate how the different axes of PAD (Attention, Attitude, Knowledge, and Relative Interest, sensu [10]) vary across different demographics (specifically age, gender, and education level) in Southeast Michigan intending to inform future initiatives to improve people's perceptions of plants. As part of the survey, we also assessed the potential of leveraging bees as ambassadors for plant conservation across demographics.

Survey Methodology

The survey employed a mixed-methods approach of Likert-scale quantitative questions and qualitative questions aimed to integrate objective numerical data with subjective experiences. Prior to commencing subject recruitment, we obtained approval from the University of Michigan's Health Sciences and Behavioral Sciences Institutional Review Board, which ensures that research involving human subjects follows federal and university regulations, poses minimal risk to subjects, and guarantees the protection of subjects' data (IRB number HUM00263691). The survey was deemed to pose "no more than minimal risks" due to the limited interactions with participants, and any possible risks were outweighed by the benefits of understanding PAD in greater depth.

To recruit subjects, we pinned posters with the link to our survey around the University of Michigan (U-M) campus in Ann Arbor, Michigan, USA, made posts containing the link on various social media websites, and issued a geographically-weighted randomized targeted email to 2,500 U-M students. The survey title "Perceptions of Nature" was purposely vague so as to not bias subjects through revealing the focus of the study. Our survey employed five Likert-scale questions that were used to calculate PAD scores: (1) "When I walk outside, I notice the plants around me", designed to evaluate Attention; (2) "I have lots of good memories and experiences with plants" and (3) "In my free time, I enjoy going out to spend time in nature", both of which were designed to evaluate Attitude; (4) "I would rather have plants than animals in my house", designed to evaluate Interest; and (5) "I perceive grass as living", designed to evaluate Knowledge. To calculate PAD scores across participants based on answers to these questions, we converted answers on a five-point scale from "Strongly Disagree" to "Strongly Agree" to numerical scores 1 through 5. We then adapted Parsley's PAD-Index framework [10] to generate composite scores for each component and total average PAD scores across the four axes.

The second part of our survey aimed to assess subjects' Relative Interest in plants and bees by tasking subjects with the following qualitative question: "Create an ideal ecosystem." In their answers, respondents could select only two landscape features and two living organisms from the following list of options: tiger, snake, sunlight, moss, tree, grass, bees, pond, deer, flowers, and butterfly. Low interest was demonstrated by selection of more than two living organisms (e.g., "sunlight," "flowers," "bees," and "grass") because such an answer indicated that the respondent conflated plants with landscape features, meaning that they do not perceive plants as being alive.

To assess how different demographics perceive bees and plants as key parts of natural ecosystems, the final part of our survey requested that subjects provide anonymous demographic data (age, optional gender identity, education level). We used this information to examine correlations between these demographics and PAD scores. Specifically, we employed independent t-tests to compare scores between specific demographic groups (e.g.,

high vs. low education) and identify any significant (i.e., $p < 0.05$) disparities, and we used both Conover's All-pairs test [11] and chi-squared tests to evaluate whether differences were significant across several demographic groups.

Survey Results

Our survey had a total of 318 respondents. Most belonged to the 18-29 age range (82.6%), identified as female (60.3%), and reported having some college education (36.3%). The median PAD-Index across all respondents was 4 (20/25 points on the index); 20 participants scored below 4 and no participants scored below 2, indicating that PAD is relatively low in Southeast Michigan (Fig. 1A).

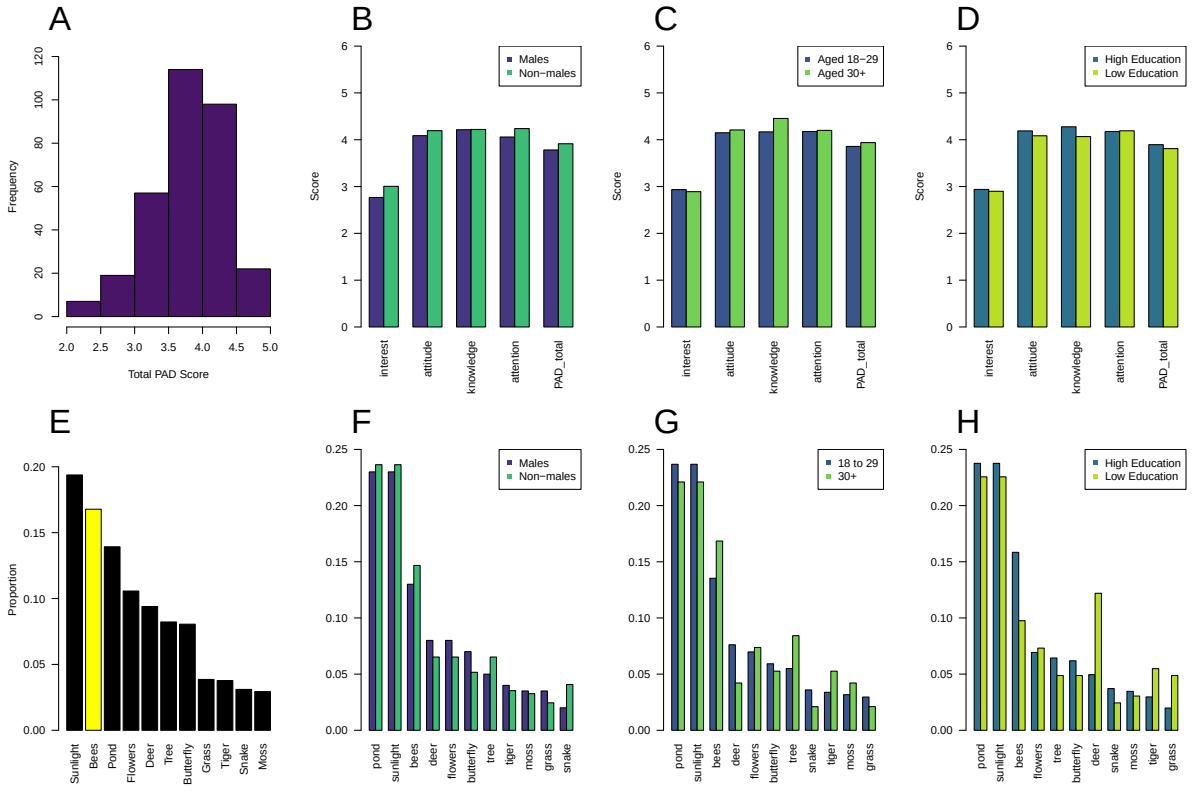

Figure 1: Plots displaying our survey results. (A) Distribution of total PAD scores across all participants. (B) Comparison of mean scores between males and non-males across the four PAD axes and total PAD scores. (C) Comparison of scores between adults aged 18-29 and adults aged 30+ across the four PAD axes and total PAD scores. (D) Comparison of scores between adults with high education and adults with low education across the four PAD axes and total PAD scores. (E) Proportion of responses to question 1 that included each of the possible ecosystem features ("Bees" is highlighted). (F) Proportion of responses to question 1 broken down by gender. (G) Proportion of responses broken down by age. (H) Proportion of responses to question 1 broken down by level of education.

According to t-tests, there were no statistically significant differences in total PAD across gender ($p = 0.054$), age ($p = 0.36$), or education level ($p = 0.23$). However, we did observe some significant differences in PAD-Index scores when comparing individual axes, specifically: (1) across gender identity, where non-male participants scored higher on the index for both Relative Interest (Conover's All-pairs test, $p = 0.038$) and for Attention ($p = 0.051$; see Fig. 1B); and (2) across age groups, where the 18-29 age group achieved the highest Knowledge score on the PAD-Index ($p = 0.031$; Fig. 1C). All other comparisons

between PAD categories and different demographics were not significant, indicating no strong association between PAD scores and most demographic categories we considered.

For the "Create an ideal ecosystem" qualitative question, we found that 66.9% of participants selected bees as one of their living organisms, making bees the second most frequent choice across all options after only sunlight (77.3%). According to a t-test, bees were selected at equal rates in ecosystems designed by participants across both high and low PAD scores ($p = 0.09$), and this finding held true for chi-square tests comparing the rate of bee selection across gender ($p = 0.10$), age ($p = 0.14$), and education ($p = 0.11$) groups.

Bees as Ambassadors for Plant Conservation

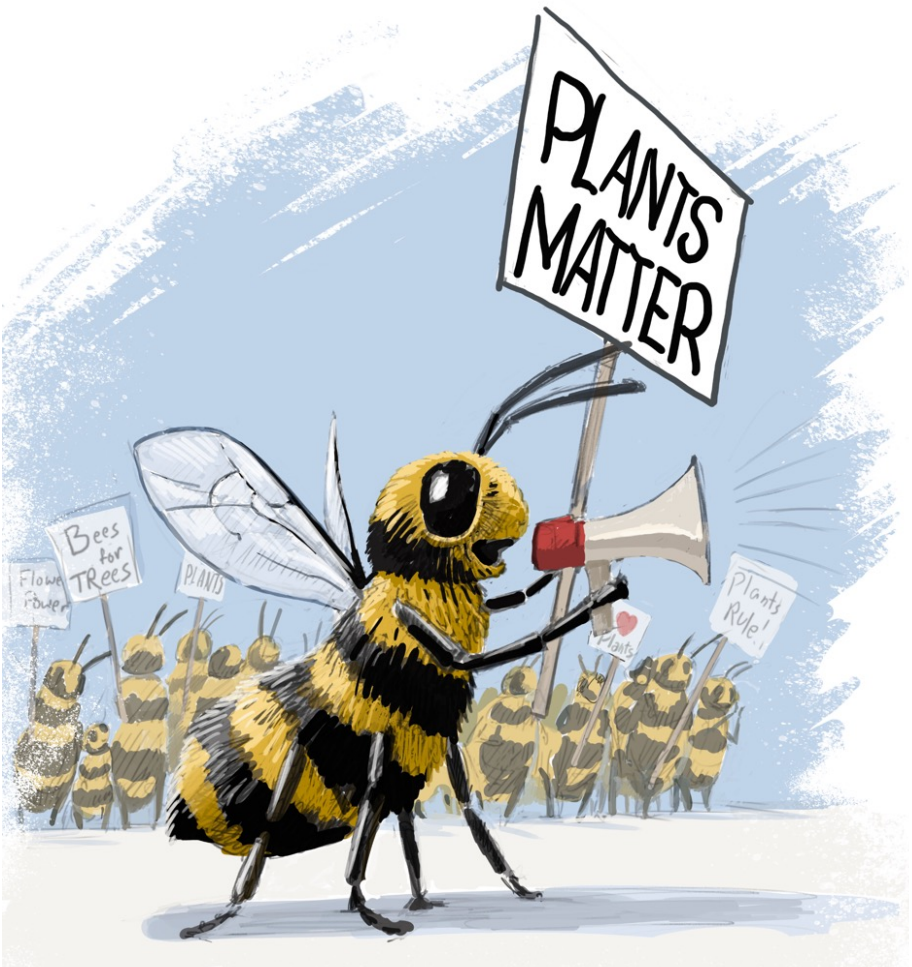

Figure 2: Artist's conception of bees acting as ambassadors for plant conservation. Illustration by John Megahan, University of Michigan Museum of Zoology.

Our identification of significantly lower Relative Interest and Attention in males who answered our survey accords with recent research showing that women generally outperform men in plant awareness [9]. While our determination that adults aged 18-29 exhibit greater Knowledge relative to adults aged 30+ goes against previous research [8, 12], we believe this finding is explained by university students being generally more recently exposed to topics in plant biology than older adults. Our most compelling finding, from

qualitative question 1, was that bees were the organism most frequently included in ecosystems designed by participants (Fig. 1D). This suggests that bees capture the attention and interest of individuals across demographics, a phenomenon that has been documented in other studies (e.g., [13, 14]). This highlights how bees may function as "ambassadors" for plant conservation (Fig. 2), particularly in bridging demographic gaps, such as the greater incidence of PAD among males relative to non-males.

Specifically, conservation strategies should capitalize on widespread public interest in bees by explicitly highlighting bee-plant interdependence, using bees as an entry point to build broader awareness of and support for plant conservation. Our proposal is not without precedents. Some of the most successful conservation campaigns of the 20th century used animals as mascots or "ambassadors," such as Smokey the Bear (see [15]) and Woodsy Owl (see [16]). Additionally, some of the most popular and captivating nature documentaries (e.g., *Planet Earth*, *The Green Planet*) feature shots of plant-animal interactions to inspire a sense of wonder about the natural world. Therefore, this framing can be used to reduce PAD by increasing interest in plants through popular interest in bees, highlighting plants as essential components of ecosystems rather than background elements.

While the rapid increase in awareness of and empathy for the plight of bees is a major positive development for effective conservation policymaking, it is difficult to imagine a similarly successful campaign on behalf of any plant or plants. While overcoming this "zoocentrism" [17] is still a worthy goal for conservationists, we propose leveraging these major gains to introduce more and more aggressive plant campaigns. Now that a baseline has been established, it is time for conservationists to move to the next step, from the main pollinators of natural flora and agricultural crops [18, 19] to that which is pollinated. We hope that future studies will systematically quantify the success of plant conservation and campaigns that employ animal ambassadors to determine whether this strategy is effective. In an era of unprecedented and accelerating anthropogenic global change, where native bees are severely threatened by climate change and the negative environmental effects of industrial agriculture [20], conservationists must be creative in finding effective strategies for increasing awareness and support for powerful environmentalist policies. We only have one planet, after all!

Acknowledgements

We thank scientific illustrator John Megahan for composing Fig. 2.

Author Contributions

AEH designed the survey with contributions from TV. AEH set up and distributed the survey. AEH, TV, ERH all contributed to analyzing and interpreting the data, generating figures, and writing/editing the manuscript.

Data Availability Statement

The data that support the findings of this study and the code used to generate Fig. 1 are freely available on Zenodo at https://doi.org/10.5281/zenodo.18843041

Conflict of Interest Statement

The authors declare no conflicts of interest.

References

[1] Wilson, J. S., Forister, M. L., & Messinger Carril, O. (2017). Interest exceeds understanding in public support of bee conservation. *Frontiers in Ecology and the Environment*, **15**(8), 460–466. https://doi.org/10.1002/fee.1531

[2] Medrano-Sánchez, E. J., & Cuenca-Silva, L. S. (2025). Public policies and pollinator conservation: Implications for agricultural sustainability. *Trees, Forests and People*, **21**, 100921. https://doi.org/10.1016/j.tfp.2025.100921

[3] Parsley, K. M. (2020). Plant Awareness Disparity: A case for renaming plant blindness. *Plants, People, Planet*, **2**(6), 598–601. https://doi.org/10.1002/ppp3.10153

[4] Wandersee, J. H., & Schussler, E. E. (1999). Preventing plant blindness. *The American Biology Teacher*, **61**(2), 82–86. https://doi.org/10.2307/4450624

[5] Prokop, P., Masarovič, R., Hajdúchová, S., Ježová, Z., Zvaríková, M., & Fedor, P. (2022). Prioritisation of charismatic animals in major conservation journals measured by the Altmetric Attention Score. *Sustainability*, **14**(24), 17029. https://doi.org/10.3390/su142417029

[6] Margulies, J. D., Bullough, L.-A., Hinsley, A., Ingram, D. J., Cowell, C., Goettsch, B., ... Phelps, J. (2019). Illegal wildlife trade and the persistence of "plant blindness." *Plants, People, Planet*, **1**(3), 173–182. https://doi.org/10.1002/ppp3.10053

[7] Stagg, B. C., & Dillon, J. (2022). Plant awareness is linked to plant relevance: A review of educational and ethnobiological literature (1998–2020). *Plants, People, Planet*, **4**(6), 579–592. https://doi.org/10.1002/ppp3.10323

[8] Linderwell, S., Hargiss, C. L. M., & Norland, J. (2024). Do demographic factors impact plant knowledge and plant awareness disparity? *Natural Sciences Education* **53**(1), e20146. https://doi.org/10.1002/nse2.20146

[9] Sepúlveda, N., López, M., Pinheiro-Costa, B. K., Navareete, A. M., & Mesquita-Neto, J. N. (2025). Addressing plant awareness in Chile: Insights from high school students. *Journal of Biological Education*, https://doi.org/10.1080/00219266.2025.2593853

[10] Parsley, K. M., Bernie, D. J., & Sable, J. L. (2022). Initial development and validation of the Plant Awareness Disparity Index. *CBE Life Sciences Education*, **21**(4), ar64. https://doi.org/10.1187/cbe.20-12-0275

[11] Conover, W. J. (1971). *Practical Nonparametric Statistics*. John Wiley & Sons.

[12] Blue, S., Hargiss, C. L. M., Norland, J., Dekeyser, E. S., & Comeau, P. (2023). Plant blindness represents the loss of generational knowledge and cultural identity. *Natural Sciences Education*, **52**(1), e20106. https://doi.org/10.1002/nse2.20106

[13] Sumner, S., Law, G., & Cini, A. (2018). Why we love bees and hate wasps. *Ecological Entomology*, **43**(6), 836–845. https://doi.org/10.1111/een.12676

[14] Burns, K. L. W., Fitzpatrick, Ú, & Stanley, D. A. (2021). Public perceptions of Ireland's pollinators: A case for more inclusive pollinator conservation initiatives. *Journal for Nature Conservation*, **61**, 125999. https://doi.org/10.1016/j.jnc.2021.125999

[15] Smith, J. M. (1956). The story of Smokey Bear. *The Forestry Chronicle*, **32**(2), 183–188.

[16] Fuller-Bennett, H., & Velez, I. (2012). Woodsy Owl at 40. *Forest History Today*, **Spring 2012**, 22–27.

[17] Hershey, D. R. (2002). Plant blindness: "I have met the enemy and he is us". *Plant Science Bulletin*, **48**(3), 78–84.

[18] Hristov, P., Neov, B., Shumkova, R., & Palova, N. (2020). Significance of Apoidea as main pollinators. Ecological and economic impact and implications for human nutrition. *Diversity*, **12**(7), 280. https://doi.org/10.3390/d12070280

[19] Martins, A. C., Heinrich, L., Hughes, A. C., Seltmann, K. C., Orr, M. C., & Vasconcelos, T. (2025). Plant communities in the Americas are highly bee dependent regardless of biome or local bee diversity. *Global Ecology and Biogeography*, **34**(8), e70101. https://doi.org/10.1111/geb.70101

[20] Decourtye, A., Alaux, C., Le Conte, Y., & Henry, M. (2019). Toward the protection of bees and pollination under global change: Present and future perspectives in a challenging applied science. *Current Opinion in Insect Science*, **35**, 123–131. https://doi.org/10.1016/j.cois.2019.07.008