

Article

Barriers to Native Plantings in Private Residential Yards

Amélie Davis ^{1,2,*}  and Jessica Stoyko ²

¹ Department of Economics and Geosciences, United States Air Force Academy, Colorado Springs, CO 80921, USA

² Department of Geography, Miami University, Oxford, OH 45056, USA

* Correspondence: amelie.davis@afacademy.af.edu or davis.amelie@miamioh.edu

Abstract: In urban areas, private yards can make up large portions of the available “green space” which can be used to provide resources for many species, including birds, and pollinators. If residents are persuaded or willing to plant certain native plants, the aggregate effect of these plantings could be hugely beneficial for key pollinator species. The objectives of this study are to uncover impediments to adding different types of pollinator-beneficial plants to private yards, as well as ascertain which incentives to plant these native plants might be most persuasive, and finally determine if there are procedural knowledge gaps in how to plant, care for, or where to purchase three pollinator-beneficial plants. In this study, we randomly selected properties in two counties in southwestern Ohio along two gradients: parcel size and parcel valuation (as a proxy for income). Two hundred surveys were distributed and 113 were returned (57% response rate). We find that, in aggregate, respondents do not have a strong intent to plant these native plants, especially *Asclepias syriaca* (a milkweed that serves as host plant to the iconic monarch butterfly; *Danaus plexippus*) and, surprisingly, the intent to plant these does not differ statistically even when help with costs, labor, or the provision of online resources are offered. We also find that the reported knowledge of where to purchase wildflowers is significantly higher than how to care for them and how to plant them. Lastly, respondents are much more confident in how to take care of trees compared to the three pollinator-beneficial plants shown in the survey. We discuss the implications of these findings for outreach and extension purposes.

Keywords: human-environment interactions; ecosystem services; education; habitat; bees; urban; peri-urban; garden; intent; pro-environmental behavior



Citation: Davis, A.; Stoyko, J. Barriers to Native Plantings in Private Residential Yards. *Land* **2023**, *12*, 114. <https://doi.org/10.3390/land12010114>

Academic Editors: Alessio Russo and Giuseppe T. Cirella

Received: 15 December 2022

Revised: 28 December 2022

Accepted: 29 December 2022

Published: 30 December 2022



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1. Introduction

As humans continue to appropriate Earth’s resources [1], finding novel ways to provide habitat and resources for species other than humans is needed. One of many potential approaches is to add native plants to private yards or gardens in urban, suburban and exurban (i.e., peri-urban) areas. Indeed, yards can positively contribute to species richness and abundance of some species [2,3], especially if they contain native plants [4]. In particular, private yards can provide enough floral resources and diverse plants necessary to maintain bee communities [5]. They have the potential to provide many more needed resources for bees, but also iconic species such as the monarch butterfly, i.e., *Danaus plexippus* [6–8]. However, this opportunity depends on what is planted (or not) in these private gardens as not all green spaces are created equal.

Given that residential gardens operate as a complex adaptive socio-ecological system, the plants that are found in yards are a result of a multitude of interacting and multiscalar human and ecological drivers [9,10]. The decision to add native plants in particular (or keep the native species that were planted by a previous owner, or the landscape architect/contractor) can be viewed through the lens of pro-environmental behavior model [11] and will depend on many factors including attitudinal and structural factors (e.g., plant aesthetics, time, values), the influence of formal and informal institutions (e.g., homeowners

association rules; [9]), impact, procedural, and normative knowledge [12], knowledge of the plants' ecological value, social norms [13], income [14], and habits [11] to name a few.

While the pro-environmental behavior model (or variations of it) is generally accepted, the weight of influence of the variables that comprise it varies depending on which pro-environmental behavior is considered. Furthermore, Kollmuss and Agyeman [11] specify how there can exist a gap between a) environmental knowledge, values, attitudes, and awareness, and b) pro-environment choices and behaviors. This gap can be explained by the presence of barriers to executing the "desired" behavior including external incentives (socioeconomic and cultural factors for example), strength of internal incentives (e.g., value system), negative or insufficient feedback about the particular pro-environmental behavior, old behavior patterns (i.e., habits), lack of time, weak environmental consciousness, and knowledge gaps [11]. In order to design effective programs to elicit pro-environmental behaviors, it is important to know the strength of the aforementioned drivers as well as the perceived or real benefits and barriers to desired behaviors and the perceived or real benefits and barriers to the competing (undesired) behaviors [15].

Known barriers to adding native plants to landscapes include their lack of availability in wholesale and retail nurseries [16], preferences for some homeowners for large flowers and wide green leaves [17], the thought that yards that include these plants can seem "messy" [18,19], pressure from social norms [13,20], the "belief that native plants belong in the city" [14], influence of socioeconomic factors [14,21], maintenance needs [22] and people's familiarity with the plants [23], but also characteristics of yards themselves including yard size [24]. While much has been done in this regard few studies compare people's desire to plant different native plants, as well as procedural knowledge of planting native plants and how that interacts with intent to plant these plants.

Consequently, ascertaining people's intent to plant various native plants within the context of the timing of when to plant them, or whether some barriers such as help with purchasing the seeds, or the labor that needs to go into planting or knowledge of how to plant, purchase and care for these plants is needed. Additionally, understanding if certain native plants are more or less desired could be useful as well. Finally, trying to uncover knowledge gaps surrounding key aspects of adding these plants to yards can also help in designing programs to help homeowners add natives to their gardens.

The objectives of this study are to uncover impediments to adding different types of pollinator-beneficial plants to private yards, as well as ascertain which incentives to plant these native plants might be most persuasive, and finally determine if there are procedural knowledge gaps in how to plant, care for, or where to purchase these pollinator beneficial plants. We focus on the following pollinator beneficial plant types: purple coneflower (*Echinacea purpurea*), common milkweed (*Asclepias syriaca*), and wildflowers (multiple spp.). We ask the following questions:

1. Is there a difference in mean stated willingness to add the pollinator beneficial plants shown in the survey based on offers of different types of assistance (e.g., help with cost or labor) or the timing of when to plant pollinator beneficial plants (this season or next time changes will be made to respondents' landscaping)?
2. Is the self-disclosed knowledge of how to plant, care for, and purchase *E. purpurea* statistically different, i.e., do the respondents report they are more or less knowledgeable about planting, caring, or purchasing *E. purpurea*? Similarly, is the self-disclosed knowledge of how to plant, care for, and purchase *A. syriaca* or wildflowers statistically different? Additionally, is the self-disclosed knowledge of how to plant and care for trees significantly different?
3. Does self-disclosed knowledge of how to plant, care for, and purchase pollinator beneficial plants differ between the different plant types shown in the survey, e.g., do the respondents feel more knowledgeable about planting *E. purpurea* compared to wildflowers or *A. syriaca* and so forth? For this question set, we also compare some of the answers to the self-disclosed knowledge of planting and caring for trees as a comparison group.

4. What are the most frequently cited barriers to adding the plants shown in the survey to respondents' yards?

The results of this research could be used to develop and tailor outreach and extension materials and programs designed to increase pollinator beneficial plantings in the Midwestern United States.

2. Methods

2.1. Study Area and Sampling Approach

The study area consists of two counties in the midwestern United States of America (U.S.A.): Darke and Miami counties. Both are located in Southwest Ohio and sit within the Dayton-Springfield-Sidney Combined Statistical Area delineated by the U.S. Census Bureau. Combined Statistical Areas are defined by the Census Bureau as "the county or counties (or equivalent entities) associated with at least one core (urbanized area or urban cluster) of at least 10,000 population, plus adjacent counties having a high degree of social and economic integration with the core as measured through [strong] commuting ties". Both Darke and Miami counties contain medium-sized cities (Greenville, Troy, and Piqua) and exhibit suburban to rural urbanization patterns, especially moving north, i.e., away from Dayton, Ohio (Figure 1). Except for the urbanized areas with strong suburban and exurban (peri-urban) development, the region is mostly agricultural, dominated by corn and soybeans, with some forest remnants.

Using parcel data obtained from Darke and Miami Counties' assessors in 2019 we selected parcels for which the land-use code was single-family residential. From the 81,859 parcels located in both counties, we were left with 16,390 candidate properties. From those, we randomly selected 200 properties along two strata, i.e., property valuation and parcel size, so that we could ensure a range of respondents from various socio-economic backgrounds and property types. The selected households received a survey that shows pollinator beneficial plants native to the region but of differing appearance, management needs, and pollinator service. These were purple coneflower (*Echinacea purpurea*), common milkweed (*Asclepias syriaca*), and wildflowers (multiple spp.).

We ascertained respondents' knowledge of each plant and willingness to add each plant to their yards by asking respondents to rate on a 5-point Likert scale of "Strongly Disagree," "Disagree," "Neither Agree Nor Disagree," "Agree," and "Strongly Agree" whether they: (1) know how to plant, (2) how to care for, (3) where to purchase seed, (4) whether they would add (or add more) of the plants shown in the survey to their yard next year, (5) whether they would add (or add more) of these plants to their yard next time they made changes to their landscape, (6) would likely add these plants if help with seed cost was provided, (7) would likely add these if online resources regarding the purchase, planting and care of these plants was received, and (8) would likely add these plants if help with labor is received. For comparison purposes, we also asked some of the aforementioned questions for trees in general. The full survey instrument can be found in Appendix A.

Surveys were dropped off or left with respondents in Darke and Miami counties, Ohio. Selected residents were contacted up to four times total. All initial surveys were distributed from mid-July to mid-August 2019. The first contact consisted of dropping off the survey at people's homes without prior contact or notification. If a resident did not answer, the clear bag containing the survey and a \$2 bill (as incentive) was hung on the doorknob for the respondent to find later. The second contact consisted of a postcard, sent to all respondents, thanking those who took the survey and gently nudging those who did not, to take the survey. The third contact consisted of another copy of the survey mailed to all the non-respondents two weeks after the second contact. The fourth and final contact was another reminder and thank you postcard. The final postcard emphasized the importance of the residents' individual answers and explained this was the last time we were going to be contacting them. The verbiage for the contact letters and postcards followed examples found in Dillman et al. (2014).

We obtained approval prior to conducting the research through Miami University's Institutional Review Board (IRB). Our project reference number is 03270e.

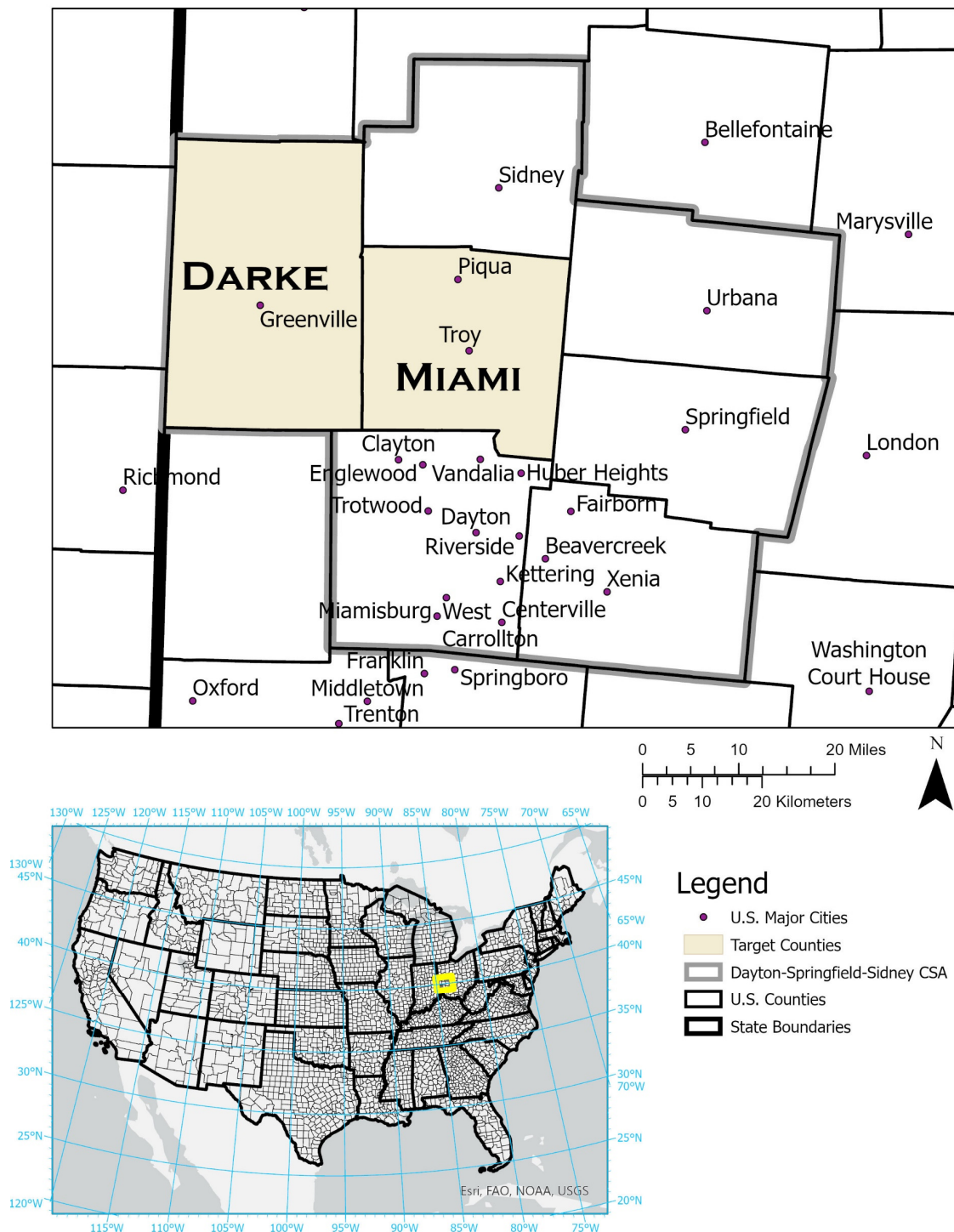


Figure 1. Study area. Study area map displaying the two counties (Darke and Miami counties in Ohio, U.S.A) from which single-family homes were randomly selected. Additionally, shown are states for the conterminous U.S.A. and the Dayton-Springfield-Sidney Combined Statistical Area (CSA) as designated by the United States Census Bureau, as well as cities in the U.S.A. with more than 10,000 inhabitants. The yellow box in the lower map shows the location of the study region with respect to the United States of America (and within the State of Ohio).

2.2. Statistical Analysis

We examined whether the response variables were statistically different for the different groups using one-way Analyses of Variances (ANOVAs) with repeated measures, performed using the *lme* package in R [25]. The stated willingness to add the proposed plants in the following year varied from 1 to 5 with 1 standing for “Strongly Disagree” and 5 “Strongly Agree”, therefore a mean of three stands for neutral responses. For the ANOVAs where the group means were significantly different, we performed post hoc multi-comparison tests with a Bonferroni adjustment for multiple comparisons to determine which group means differed statistically. Prior to performing the ANOVAs, we visually assessed that the data in each group were normal (or for the one-way ANOVAs with repeated measures we examined whether the difference between groups was normal). We used Bartlett tests to check for heteroscedasticity.

Lastly, to categorize the reasons respondents wrote as reasons why they might not want to add the various plant choices shown in the survey, we read their answers twice and grouped the answers into similar concerns and counted the occurrences. Note that not all respondents chose to answer these questions, and that some respondents wrote in multiple reasons.

Statistical analyses were performed in R version 3.6.1 (R Core Team, 2019). Aside from those mentioned above, we used the following R packages in our analyses: *foreign*, *ggplot2*, *psych*, *dplyr*, *Rmisc*, *multcomp*.

3. Results

Out of 200 surveys distributed, we received 113 responses (57% response rate). Below, we summarize the research questions and results, including summaries of the statistical analyses if applicable.

3.1. Is There a Difference in Mean Reported Willingness to Add the Pollinator Beneficial Plants Shown in the Survey Based on Offers of Different Types of Assistance (e.g., Help with Cost or labour) or the Timing of When to Plant Pollinator Beneficial Plants (This Season or Next Time Changes Will Be Made to Respondents' Landscaping)?

According to a one-way analysis of variance (ANOVA) with repeated measures, the mean reported willingness to plant *E. purpurea* does not differ between various offers of assistance or timing ($F(4,425) = 0.93$, $p = 0.45$; Table 1). Similarly, two separate one-way ANOVAs with repeated measures indicate that the timing or offer of various types of assistance does not affect the reported willingness to plant *A. syriaca* ($F(4,423) = 0.96$, $p = 0.43$) or wildflowers ($F(4,427) = 1.12$, $p = 0.35$; Table 1).

3.2. Is the Self-Disclosed Knowledge of How to Plant, Care for, and Purchase *E. purpurea* Statistically Different, i.e., Do the Respondents Report They Are More or Less Knowledgeable about Planting, Caring, or Purchasing *E. purpurea*? Similarly, Is the Self-Disclosed Knowledge of How to Plant, Care for, and Purchase *A. syriaca* or Wildflowers Statistically Different? And Is the Self-Disclosed Knowledge of How to Plant and Care for Trees Significantly Different?

We find no difference in the self-disclosed knowledge of how to plant, care for, and purchase both *E. purpurea* and *A. syriaca* ($F(2,214) = 1.25$, $p = 0.29$, and $F(2,210) = 1.40$, $p = 0.25$, respectively). This is not the case for wildflowers ($F(2,216) = 7.72$, $p = 0.0006$, Table 2) or for trees ($W = 55$, $p = 0.003$, Table 2). Note that a Wilcoxon signed rank test had to be performed to ascertain whether planting and caring for trees was different because the difference between the two was severely non-normal. The mean reported knowledge of where to purchase wildflowers ($M = 3.5$, $SD = 1.1$) is significantly higher than how to care for them ($M = 3.3$, $SD = 1.2$) and how to plant them ($M = 3.2$, $SD = 1.2$; Table 2). Similarly, respondents' reported knowledge of how to plant trees ($M = 4.1$, $SD = 0.9$) is significantly higher than how to care for trees ($M = 4.0$, $SD = 0.9$; Table 2).

Table 1. Summary statistics for reported intent to plant the native plants shown in the survey when various types of assistance or options for different timing of plantings are given. Mean $\pm$ 1 standard deviation (SD) and median for stated willingness (i.e., reported intent) to plant purple coneflower, common milkweed and wildflowers if assistance is provided with costs, labor, or provision of online resources; mean $\pm$ 1 standard deviation (SD) and median for stated willingness to add the particular plant within the next year, or the next time landscaping changes are made to the yard. Higher values indicate that the respondent is more willing to plant the plants shown in the survey. The scale varies from 1 to 5, with 5 standing for “Strongly agree,” and 1 “Strongly disagree” so that a value of three is neutral (“Neither agree nor disagree”). All means are below three, but especially for common milkweed. The number of respondents who answered each question is provided in the column labelled n.

Plant Type	Variable	Mean $\pm$ 1SD	Median	n	Min–Max
Purple coneflower (<i>Echinacea purpurea</i>)	Help with cost	2.8 $\pm$ 1.2	3	108	1–5
	Help with labor	2.7 $\pm$ 1.2	3	107	1–5
	Plant when change yard next	2.9 $\pm$ 1	3	107	1–5
	Plant next year	2.7 $\pm$ 1	3	107	1–5
	Provide online resources	2.8 $\pm$ 1.1	3	108	1–5
Common milkweed (<i>Asclepias syriaca</i>)	Help with cost	2.4 $\pm$ 1.1	2	107	1–5
	Help with labor	2.4 $\pm$ 1.2	2	107	1–5
	Plant when change yard next	2.3 $\pm$ 1	2	107	1–5
	Plant next year	2.3 $\pm$ 1	2	106	1–5
	Provide online resources	2.5 $\pm$ 1.2	3	107	1–5
Wildflowers (multiple spp.)	Help with cost	2.9 $\pm$ 1.3	3	109	1–5
	Help with labor	2.7 $\pm$ 1.2	3	107	1–5
	Plant when change yard next	2.9 $\pm$ 1.1	3	108	1–5
	Plant next year	2.8 $\pm$ 1	3	108	1–5
	Provide online resources	2.8 $\pm$ 1.2	3	108	1–5

3.3. Does Self-Disclosed Knowledge of How to Plant, Care for, and Purchase Pollinator Beneficial Plants Differ between the Different Plant Types Shown in the Survey, e.g., Do the Respondents Feel More Knowledgeable about Planting *E. purpurea* Compared to Wildflowers or *A. syriaca*, and so Forth

Knowledge of where to purchase the different plants in the survey does differ significantly ($F(2,208) = 44.63$, $p < 2 \times 10^{-16}$, Table 3.) Respondents are significantly less likely to know where to purchase *A. syriaca* ($M = 2.6$, $SD = 1.2$) compared to *E. purpurea* ($M = 3.5$, $SD = 1.1$) as well as wildflowers ($M = 3.5$, $SD = 1.1$). Knowledge of how to care for the plants shown in the survey as well as trees also differs statistically between groups ($F(3,312) = 53.94$, $p < 2 \times 10^{-16}$, Table 3). Respondents are significantly less sure how to care for *A. syriaca* ($M = 2.7$, $SD = 1.2$) compared to *E. purpurea* ($M = 3.4$, $SD = 1.2$), and are much more confident in how to take care of trees ($M = 4.1$, $SD = 0.9$; Table 3) compared to the other three plants shown in the survey. The same patterns can be seen in the responses for how to plant these plants. The mean reported knowledge of how to plant the various pollinator beneficial plant choices shown in the survey differs statistically ($F(3,314) = 53.23$, $p < 2 \times 10^{-16}$) with respondents stating they are much more knowledgeable about how to plant trees ($M = 4.0$, $SD = 0.9$), than *E. purpurea* ($M = 3.4$, $SD = 1.2$) and *A. syriaca* ($M = 2.6$, $SD = 1.1$). Overall, respondents say are much less knowledgeable about planting *A. syriaca* compared to the other plants shown in the survey (Table 3).

Table 2. Summary statistics for reported knowledge of planting, caring for, and purchasing the three pollinator-beneficial plants shown in the survey (as well as for trees as a comparison group). Mean $\pm$ 1 standard deviation (SD) and median for reported knowledge of where to purchase, how to plant, and how to care for purple coneflower, common milkweed and wildflowers. Note that the “where to purchase trees” question was not included in the survey instrument. We conducted three one-way repeated-measures ANOVAs to test whether the mean reported knowledge about how to plant, care for, or purchase each of the plants shown in the survey was different. The groups are the reported knowledge categories. The plant types were *Echinacea purpurea*, *Asclepias syriaca*, and wildflower prairie (multiple species of native plants). Higher values indicate that the respondent believes they are more knowledgeable. The scale varies from 1 to 5, with 5 indicating that the respondent strongly agrees with the statement (e.g., “I know how to care for wildflowers”). A value of one indicates the respondent strongly disagrees with the statement so that a value of three is neutral (“Neither agree nor disagree”). There is no significant difference between the knowledge questions for purple coneflower or common milkweed so no further tests were conducted. For the ANOVA for the wildflowers, the p values reported for the post hoc test of multiple comparisons is Bonferroni adjusted. ^ To compare responses for caring and planting for trees since the difference between reported knowledge of planting and caring for trees is severely non-normal and there were only two groups a Wilcoxon signed rank test is used. The number of respondents who answered each question is provided in the column labelled n. Asterisks *, **, and *** denote 5%, 1%, and 0.1% levels of significance, respectively when testing the null hypothesis that the coefficients equal zero.

Plant Type	Variable	Mean $\pm$ 1SD	Median	n	Min-Max	Tukey's HSD Comparison Plant	Comparison Care
Purple coneflower (<i>Echinacea purpurea</i>)	Know how to plant	3.4 $\pm$ 1.2	4	108	1–5		
	Know how to care for	3.4 $\pm$ 1.2	4	108	1–5		
	Know where to purchase	3.5 $\pm$ 1.1	4	108	1–5		
Common milkweed (<i>Asclepias syriaca</i>)	Know how to plant	2.6 $\pm$ 1.1	2	107	1–5		
	Know how to care for	2.7 $\pm$ 1.2	3	108	1–5		
	Know where to purchase	2.6 $\pm$ 1.2	2	105	1–5		
Wildflowers (multiple spp.)	Know how to plant	3.2 $\pm$ 1.2	3	109	1–5		
	Know how to care for	3.3 $\pm$ 1.2	4	109	1–5	0.2593	
	Know where to purchase	3.5 $\pm$ 1.1	4	109	1–5	0.0488 *	<0.001 ***
Trees	Know how to plant	4.03 $\pm$ 0.9	4	104	1–5		
	Know how to care for	4.12 $\pm$ 0.9	4	105	1–5	0.003 ** ^	

3.4. What Are the Most Frequently Cited Barriers to Adding the Plants Shown in the Survey to Respondents' Yards?

The most oft-stated reasons respondents mention why not to add the plants shown in the survey are a general dislike for the appearance of the plants (especially for *A. syriaca*, and *E. purpurea*), that the plants require or are perceived to require more maintenance than the respondent is willing or has the ability to expend, that the plant(s) spread too much on their own, and for *A. syriaca* that it is considered a weed or invasive plant (Figure 2). Please note that these are reasons specified by the respondents in an open-ended portion of the survey, i.e., there were no predetermined answer choices for this question on the survey. Overall, the reasons respondents list as to why they might not want to add *E. purpurea*, *A. syriaca*, and wildflowers to their landscaping overwhelmingly have to do with visual appeal and appearance, maintenance considerations or lack of knowledge of how to care for these plants, and considerations about the plants spreading beyond the planted area, as well as for *A. syriaca* concerns about it being a weed, or an invasive, or toxic to pets and livestock.

Table 3. Statistical comparisons for the reported knowledge of how to plant, care for, and purchase for the different native plants shown in the survey as well as for trees. Mean $\pm$ 1 standard deviation (SD) and median for reported knowledge of where to purchase, how to plant, and how to care for purple coneflower, common milkweed and wildflowers (*Echinacea purpurea*, *Asclepias syriaca*, and multiple *spp.* of wildflowers, respectively). Note that the “where to purchase trees” question was not included in the survey instrument. We conducted a one-way repeated-measures ANOVA to examine whether the mean reported knowledge about how to plant, *E. purpurea*, *A. syriaca*, and wildflowers were different. The same analyses were conducted for the other knowledge statements, i.e., “know how to care for” and “know where to purchase”. Higher values indicate that the respondent believes they are more knowledgeable. The scale varies from 1 to 5, with 5 indicating that the respondent strongly agrees with the statement (e.g., “I know how to care for wildflowers”). A value of one indicates the respondent strongly disagrees with the statement so that a value of three is neutral (“Neither agree nor disagree”). The *p* values reported for the post hoc test of multiple comparisons are Bonferroni adjusted. The number of respondents who answered each question is provided in the column labelled n. Asterisks *** denote 0.1% levels of significance.

Question	Plant Type	Mean $\pm$ 1SD	Median	n	Min–Max	Tukey's HSD Comparison		
						<i>E. purpurea</i>	<i>A. syriaca</i>	Tree
Know how to plant	<i>E. purpurea</i>	3.4 $\pm$ 1.2	4	108	1–5			
	<i>A. syriaca</i>	2.6 $\pm$ 1.1	2	107	1–5	1.65×10^{-10} ***		
	Tree	4 $\pm$ 0.9	4	104	1–5	1.58×10^{-8} ***	$<2 \times 10^{-16}$ ***	
	Wildflowers	3.2 $\pm$ 1.2	3	109	1–5	1	1.51×10^{-8} ***	1.62×10^{-10} ***
Know how to care for	<i>E. purpurea</i>	3.4 $\pm$ 1.2	4	108	1–5			
	<i>A. syriaca</i>	2.7 $\pm$ 1.2	3	108	1–5	4.39×10^{-12} ***		
	Tree	4.1 $\pm$ 0.9	4	105	1–5	7.70×10^{-8} ***	$<2 \times 10^{-16}$ ***	
	Wildflowers	3.3 $\pm$ 1.2	4	109	1–5	1	3.48×10^{-8} ***	1.14×10^{-11} ***
Know where to purchase	<i>E. purpurea</i>	3.5 $\pm$ 1.1	4	108	1–5			
	<i>A. syriaca</i>	2.6 $\pm$ 1.2	2	105	1–5	6.66×10^{-15} ***		
	Wildflowers	3.5 $\pm$ 1.1	4	109	1–5	1	$<2 \times 10^{-16}$ ***	

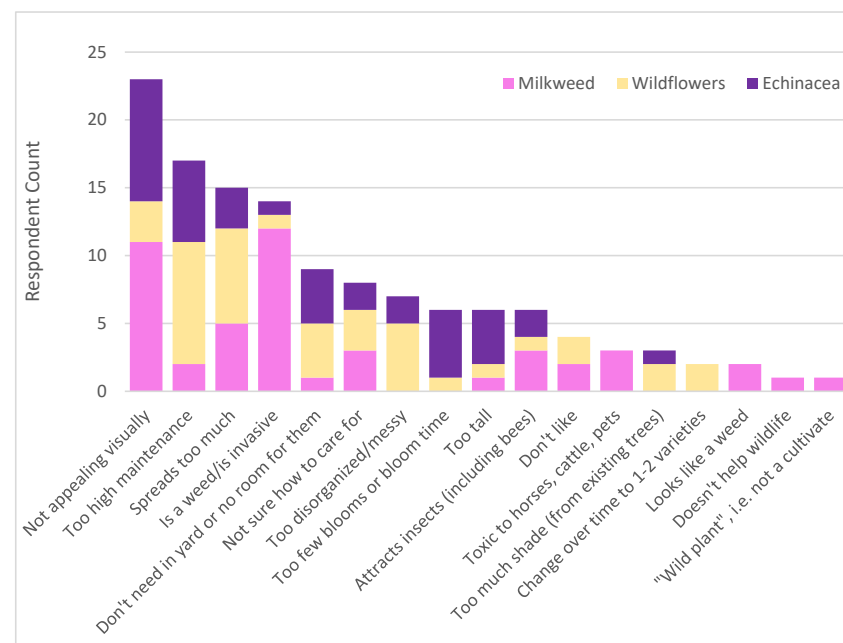


Figure 2. Key barriers to adding the pollinator beneficial plants shown in the survey. Number of times (counts) a respondent stated a particular reason as to why they might not like to add *Asclepias syriaca* (Common Milkweed; pink bars), *Echinacea purpurea* (purple coneflower; purple bars), or wildflowers (multiple *spp.*; orange bars) to their yard. This was an open-ended question on the survey instrument. Out of the 113 respondents to the survey, 48 chose to write at least one reason down in the answer box provided for that purpose for *E. purpurea*, 57 for *A. syriaca*, and 54 for wildflowers.

4. Discussion

The fact that many respondents mentioned they did not care for the plants' visual appearance is expected as these plants do not conform to the traditional aesthetics of yards with neat (weed-free) lawns and ornamental showy flowers, yet the desire for those types of gardens is prevalent across the U.S.A. [26]. Others have found that in the Southwestern United States native landscapes were perceived as unattractive and high maintenance, but "86% [of respondents said they] would use native plants if native plants were attractive" [27]. These results were influenced by education and time spent on horticultural activities. Similarly, in a study of ecological and socioeconomic factors that affect plant richness composition in residential gardens in Minneapolis MN, the most important characteristics for planting decisions were "aesthetics, wildlife, neatness, and food provision" [16].

Unfortunately, most of the undesired characteristics of the plants shown in the survey (and other pollinator beneficial plants) seem difficult to counter although some organizations (e.g., the Cincinnati Zoo and Botanical Garden®) do produce plant guides that promote adding plants that would bloom throughout the Spring, Fall, and Summer (<https://cincinnatizoo.org/horticulture/plant-for-pollinators/resources/>). Ostensibly, this is to provide forage for many insect pollinators during their active season, but can also help with a flower garden's appearance over the growing season. Some of the guides also specify plant height, spread, size of flowers typically and thus can help alleviate some residents' concerns as well. Finding ways to keep maintenance needs low for large plantings of these plants (especially weed-free and if possible lower to the ground) seems desired [22]. Perhaps a combination of these plants and groundcover could help counter some of these impediments and while research along those lines has been conducted in orchards, i.e., agricultural settings [28,29], to the best of our knowledge this is an active research need in urban settings (although see [30]).

Correcting the misconceptions surrounding *A. syriaca* with the general public is greatly needed especially since another study found similar concerns in large property owners and farmers of SW Ohio [6]. Indeed, *A. syriaca* is neither a weed nor an invasive plant in this region [31]. It is a native plant that, for full disclosure, can propagate by "sending up new shoots from roots that spread outward from the parent plant. This clonal reproduction allows their populations to expand over time, and plants may spread out of their original area. [. . .] Despite the vegetative growth, many of these species are unlikely to create an ongoing and unmanageable weed problem for roadside managers (or for other land managers, homeowners, and others)" [32]. As to the fears of it being toxic to livestock and pets, this needs to be reframed. Indeed, even the ASPCA's website states that milkweed can be toxic to dogs, cats, and horses and can cause their death [33] with no allusion to the fact that it is highly unpalatable to those species, that it would have to be ingested in large quantities to have those effects, that livestock only eat it if there is nothing else for them to eat, and that toxicity varies by milkweed species [34,35]. With that said, perhaps the survey respondents in this study just did not want to take the chance of accidental large quantity ingestion by pets which of course is understandable, but, for the purposes of this study, rather unsurmountable.

SW Ohioans were in general slightly unwilling to plant the native plants shown in the survey. Surprisingly, there is no difference in the mean stated willingness to plant these pollinator beneficial plants regardless of whether the timing of planting was within the following year or the next time landscaping changes were made, or whether assistance with cost, labor, or the provision of online resources were offered. This is especially true for *A. syriaca* as, collectively, respondents moderately disagreed that they were willing to plant it. Overall, these findings are rather problematic as they may indicate that the aesthetic and other considerations previously mentioned are paramount in these residents' minds and since milkweeds *spp.* are the host plants for the monarch butterfly no substitutes can be used in this case. It also may mean that for the organizations that currently provide such incentives to interested homeowners, they are reaching a population that was already

going to make the changes to their landscape regardless of the assistance. If this is the case, in the long term, it may be more difficult to find willing homeowners. We do not imply that initiatives that provide these types of incentives should be halted especially since they are one known effective strategy to help change behavior [36]; however, it seems wise to find other mechanisms by which to entice residents to put these plants and other pollinator beneficial plants in their yards. One example of an approach that worked for native plants in Dunedin (New Zealand), was to use biodiversity assessments and dialog with homeowners as it led to an increase in knowledge and positive shift in attitude towards native plant species [37]. After participating in the program, one quarter of participants incorporated native plants in their yard and 13% stated it was to improve biodiversity [37]. Another mechanism would include passing policies aimed at improving conservation efforts for pollinators, which is greatly needed [38,39], including in urban areas [40]. It is critical that these policies be enforced [41] and integrate the “perspective of farmers and local communities on the need to conserve pollinators, alongside scientific understanding” [42].

Other than for *A. syriaca*, reported knowledge of how to plant, care for or purchase the plants shown in the survey is strong although, for wildflowers and trees, survey respondents were significantly less certain of their abilities to plant these species compared to caring for them or purchasing them. Educational materials, including demonstrations, videos, and hands-on workshops might be valuable in this regard. Reported knowledge of purchasing, planting, and caring for *A. syriaca* is significantly lower than for the other plants shown in the survey and should be addressed if the vision of 1.3 billion new stems is to be achieved [8]. Whether or not these plants or seeds are widely available at nurseries and other retailers is a separate but important barrier to overcome [16,43–45].

Reported knowledge of how to plant and care for trees is high. Given the mistakes homeowners are known to make when it comes to tree planting and care [46,47] this is a bit alarming. It might be beneficial to educate homeowners about the needs of trees and it also may be an opportunity. Some trees provide abundant resources for pollinators [48–50] and given their general acceptability to residents, the fact they are easier to maintain, that their aesthetic value is generally high, that the area underneath can be mowed around and not take up large portions of a yard’s surface area, and that they provide many other ecosystem services, promoting pollinator beneficial tree plantings could be a straightforward way to provide floral resources for many pollinators and nesting resource for some. Of course, this proposed solution would not serve the monarch butterfly populations (*Danaus plexippus*).

Limitations and Future Research Needs

It is probable that the individuals who took the time to respond to this survey may have more affinity to gardening than non-respondents. Despite all the measures we took to increase response rate, 43% of selected households did not return a completed survey. Given that individuals who like gardening and view it as a hobby are associated with more wildlife supporting yards [22] the mean responses to the questions about intentions to plant the native plant species shown in the survey and the plant and gardening knowledge responses may be higher than they would be for the general population and this should be considered while interpreting the results presented herein.

We solely surveyed residents of single-family homes in suburban and peri-urban southwestern Ohio (USA). More research is needed to uncover whether these findings are universal across geographies, vary by yard size, structure, and classification (e.g., urban, versus suburban, versus exurban). An interesting area of research would be to examine whether different typologies of residents exist with regard to adding native plants to private yards as that could help tailor education and outreach programs for different constituents. Additionally, we examine people’s intention to add native plantings to their yards but there exists a gap between intention and behavior [51]. Conducting experiments to ascertain the width of that gap is greatly needed, although see Champine et al. [52] for such a study in Fort Collins, Colorado, USA and Knapp et al. [53] for empirical data on this gap in the

United Kingdom. Lastly, if efforts to add pollinator-beneficial plants in yards are wildly successful, it will be important to know whether (and in what proportion) residents might take measures to control stinging insects in their yard. While insect pollinator knowledge and appreciation has increased over time [54], a study of residents in a county in SW Ohio found that approximately 5% of residents surveyed specified they would not like to see these plants in their yards because the plants attracted bees [55]. To the best of our knowledge, whether this sentiment translates to actively trying to eradicate these insects from one's yard is unknown but should be examined closely.

5. Conclusions

The objectives of this study were to uncover impediments to adding different types of pollinator-beneficial plants to private yards, as well as ascertain which incentives to plant these native plants might be most persuasive, and finally determine if there were procedural knowledge gaps in how to plant, care for, or where to purchase these pollinator beneficial plants. Unfortunately, getting residents of single-family homes to voluntarily add *A. syriaca* (common milkweed) to private yards in quantities that are needed to support a thriving monarch butterfly population may prove to be difficult given SW Ohio residents seem to dislike the appearance of the plant, its mode of propagation, and have some preconceived notions as well as somewhat erroneous concerns about the plant itself (e.g., invasiveness). Focusing instead on planting large areas of milkweed (*Asclepias* spp.) along roadsides, on agricultural and government land, and exploring payments for ecosystem services options might be necessary.

Overall, SW Ohio residents' intent to add the pollinator-beneficial plants shown in the survey to the yards of single-family homes is not high and, surprisingly, does not differ when incentives are offered; even when help with costs, labor, or the provision of online resources are proposed. Finding other ways to entice homeowners to plant native plants is necessary, especially given the gap between strong behavioral intentions to plant native plants and their actual addition to yards [52]. Experimenting with different approaches to elicit this pro-environmental behavior is needed, such as the one described in van Heezik et al. [37].

Procedural knowledge, i.e., knowledge of how to plant and care for *A. syriaca*, *E. purpurea*, and wildflowers is significantly lower than for trees. More education and outreach in this regard may be warranted. However, education and outreach materials and programs should consider ways to increase the visual appeal of the plantings (by for example providing "cues to care" [19]) and decrease maintenance needs (especially compared to the mindlessness and ease of taking care of turfgrass). Convenience is important when attempting to convince someone to adopt a pro-environmental behavior [36], especially planting wildlife friendly yards [22].

The results of this research could be used to design more effective education and outreach programs for Midwesterners, keeping in mind that the incentives proposed in this study are unlikely to substantially change the intent to plant these pollinator-beneficial plants. Other mechanisms (e.g., through policy and/or payment for ecosystem services) will most likely be needed to markedly increase the area of private yards devoted to native plants in general but milkweeds in particular in suburban/rural Southwest Ohio (USA).

Author Contributions: Conceptualization, A.D.; methodology, A.D. and J.S.; software, A.D.; validation, A.D.; formal analysis, A.D.; investigation, A.D. and J.S.; resources, A.D.; data curation, J.S.; writing—original draft preparation, A.D. and J.S.; writing—review and editing, A.D. and J.S.; visualization, A.D.; supervision, A.D.; project administration, A.D.; funding acquisition, A.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This research was approved through Miami University's Institutional Review Board (IRB). Our project reference number is 03270e.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Anonymized survey responses can be requested by emailing the corresponding author.

Acknowledgments: The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the United States Air Force Academy, the Air Force, the Department of Defense, or the U.S. Government (PA#: USAFA-DF-2022-911). We are extremely grateful to the survey participants for taking the time to complete the survey. We are also thankful for funding from Miami University to complete this study. Without these elements this research would not be possible. Lastly, we want to extend a huge thank you to Debbi White, the departmental assistant for the Geography Department at Miami University for overseeing the stuffing of the survey packets and helping us navigate reimbursements for the field work. Her competence and can-do attitude as well as incessant hard work is immensely appreciated.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

M Your Landscaping Preferences!

Completing the survey is easy:

1. **Keep the \$2 bill and marker** as a small token of appreciation.
2. **Fill out the survey.** This survey should be filled out by an adult (18 years or older) who makes most of the landscaping choices at this address.
3. **Fold it in half, place it in the prepaid envelope and mail it back to us!**
Please remember to include the map (but keep the marker).

This survey should be filled out by the person in this household who makes most of the landscaping and gardening decisions and is over 18 years old.

For the purposes of this research the front yard is defined as the section of your yard between the main road and the house, while the backyard is the section from the house to the property line furthest from the main road. The main road is the road that meets the driveway.

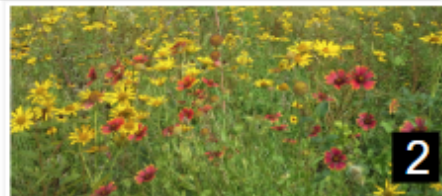
Please note that the plant selections shown in this survey will all grow in our region given our climatic conditions.

First Question ↓

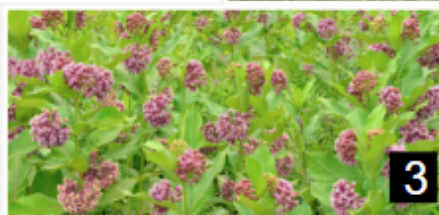
A. Of the three options shown below, which one (if any) do you think is the MOST beautiful? Please check ONE.



1



2



3

- ☐ 1. Purple coneflower
☐ 3. Common Milkweed

- ☐ 2. Wildflower prairie
☐ I do not think any of these landscapes are beautiful



B. These are purple coneflowers (*Echinacea purpurea*)



Bloom: June to August

Height: 2 to 5 feet; **Spread:** 2 to 5 feet

Do you already have this plant in your yard?

Please check ONE.

- ☐ Yes, it was here when I moved in
- ☐ Yes, I planted it here
- ☐ No
- ☐ I don't know

Please write possible reasons you might like to see purple coneflowers in your yard:

Please write possible reasons you might not like to see purple coneflowers in your yard:

Please Check the most appropriate box:	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I know how to plant coneflowers	☐	☐	☐	☐	☐
I know how to care for coneflowers	☐	☐	☐	☐	☐
I know where to purchase coneflowers or its seeds	☐	☐	☐	☐	☐
I will add (or add more) coneflowers to my yard in the next year	☐	☐	☐	☐	☐
I will add (or add more) coneflowers to my yard the next time I make changes to my landscape	☐	☐	☐	☐	☐
I would likely add coneflowers if I received help with the cost of seed for this plant	☐	☐	☐	☐	☐
I would likely add coneflowers if I received online resources regarding plant purchase, planting, and care	☐	☐	☐	☐	☐
I would likely add coneflowers if I received help with the labor (i.e. tilling and planting)	☐	☐	☐	☐	☐



C. These are wildflowers (multiple species of plants)



Bloom time: May to September

Height: varies but usually between 2-4 feet

Multiple plants that bloom at different times so that there is continuous and varied color.

Do you already have wildflowers in your yard?

- ☐ Yes, it was here when I moved in
- ☐ Yes, I planted it here
- ☐ No
- ☐ I don't know

Please write possible reasons you might like to see wildflowers in your yard:

Please write possible reasons you might not like to see wildflowers in your yard:

Please Check the most appropriate box:	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I know how to plant wildflowers	☐	☐	☐	☐	☐
I know how to care for wildflowers	☐	☐	☐	☐	☐
I know where to purchase wildflowers or their seeds	☐	☐	☐	☐	☐
I will add (or add more) wildflowers to my yard in the next year	☐	☐	☐	☐	☐
I will add (or add more) wildflowers to my yard the next time I make changes to my landscape	☐	☐	☐	☐	☐
I would likely add wildflowers if I received help with the cost of seed for these plants	☐	☐	☐	☐	☐
I would likely add wildflowers if I received online resources regarding plant purchase, planting, and care	☐	☐	☐	☐	☐
I would likely add wildflowers if I received help with the labor (i.e. tilling and planting)	☐	☐	☐	☐	☐



D. This is common milkweed (*Asclepias syriaca*)



Bloom Time: June to August

Height: 2.00 to 3.00 feet; **Spread:** 0.75 to 1.00 feet

Do you already have this plant in your yard?

Please check ONE.

- ☐ Yes, it was here when I moved in
- ☐ Yes, I planted it here
- ☐ No
- ☐ I don't know

Please write possible reasons you might like to see common milkweed (*Asclepias syriaca*) in your yard:

Please write possible reasons you might not like to see common milkweed (*Asclepias syriaca*) in your yard:

Please Check the most appropriate box:	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I know how to plant milkweed	☐	☐	☐	☐	☐
I know how to care for milkweed	☐	☐	☐	☐	☐
I know where to purchase milkweed or its seeds	☐	☐	☐	☐	☐
I will add (or add more) milkweed to my yard in the next year	☐	☐	☐	☐	☐
I will add (or add more) milkweed to my yard the next time I make changes to my landscape	☐	☐	☐	☐	☐
I would likely add milkweed if I received help with the cost of seed for this plant	☐	☐	☐	☐	☐
I would likely add milkweed if I received online resources regarding plant purchase, planting, and care	☐	☐	☐	☐	☐
I would likely add milkweed if I received help with the labor (i.e. tilling and planting)	☐	☐	☐	☐	☐



E. Map Instructions

Please use the map of this property which was provided in your packet

If you **WOULD NOT** consider planting any of the plants shown previously in the survey within the next year, please check this box ☐ **and SKIP to section F**

If you **WOULD** consider planting the plants shown previously **WITHIN THE NEXT YEAR**, please complete the following 4 steps:

- 1) Draw the area or areas where you might plant one of the three plant choices shown in the survey with the pen we provided on the map we provided.
- 2) Label each area with:

- ☐ "PC" if you intend to plant purple coneflowers
- ☐ "CW" if you intend to plant common milkweed
- ☐ "WP" if you intend to plant wildflower prairie.

If the label will not fit in the area you drew please write the letters next to the area with an arrow pointing to it.

- 3) Mark with an **X** any/all locations where you will plant trees **WITHIN THE NEXT YEAR**

- 4) Please answer the following questions:

- Were there any areas that you would consider planting but that were too small to represent on the map. ☐ Yes ☐ No
- The area(s) I drew on the map is/are currently covered in (please check all that apply):
☐ Pasture ☐ Lawn ☐ Trees ☐ Honeysuckle ☐ Weeds ☐ Crops
☐ Flower beds ☐ Hay ☐ Other (please specify): _____

F. Your Current Landscaping Practices

Which of the following are present on this property?

- ☐ Lawn ☐ Pasture/Hay ☐ Trees ☐ Shrubs ☐ Vegetable plot
☐ Hard surface (e.g. driveway, patio, decking, gravel) ☐ Flower beds
☐ Row crops ☐ Other (please state): _____

How many trees have you planted since you've lived on this property: _____ trees planted

How many trees have you removed since you've lived on this property: _____ trees removed

Do you keep bees or let someone keep bees on this property? ☐ Yes ☐ No

In the summer months, how much time do you spend mowing on average each week?
 _____ hours per week on average in summer spent mowing

Excluding mowing, in the summer months, how much time do you spend gardening, weeding, and/or doing other yard work each week on average?
 _____ hours per week on average in summer

Who takes care of your mowing?

- ☐ Self ☐ Other person living in household ☐ A person (or company) you hire
☐ I/We do not have any lawn ☐ Other _____

Who takes care of your landscaping?

- ☐ Self ☐ Person living in household ☐ A person (or company) you hire
☐ I/We do not have any landscaping needs ☐ Other _____

Is your lawn mostly under tree cover, i.e. full shade? ☐ Yes ☐ No

Please check the most appropriate box	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I would be willing to mow my lawn every two weeks regardless of rainfall	☐	☐	☐	☐	☐
I would be willing to allow white clover to grow in my front yard	☐	☐	☐	☐	☐
I would be willing to allow white clover to grow in my backyard	☐	☐	☐	☐	☐
I would be willing to allow dandelions to grow in my front yard	☐	☐	☐	☐	☐
I would be willing to allow dandelions to grow in my backyard	☐	☐	☐	☐	☐
I want my front yard to look neat and tidy	☐	☐	☐	☐	☐
I want my backyard to look neat and tidy	☐	☐	☐	☐	☐
I know how to plant trees	☐	☐	☐	☐	☐
I know how to take care of trees	☐	☐	☐	☐	☐
I think my yard is a reflection of me	☐	☐	☐	☐	☐
I enjoy mowing	☐	☐	☐	☐	☐
I enjoy gardening	☐	☐	☐	☐	☐
I enjoy planting trees	☐	☐	☐	☐	☐
I enjoy caring for trees	☐	☐	☐	☐	☐
I enjoy being outside	☐	☐	☐	☐	☐



G. Parcel Characteristics

Do you own a parcel that shares a property line with this property? ☐ Yes ☐ No

Do you own a zero turn radius mower? ☐ Yes ☐ No

Do you have a pond on the property? ☐ Yes ☐ No

Which of the following would you like to see more of on your property (check all that apply)?

☐ Bats ☐ Bees ☐ Beetles ☐ Birds ☐ Butterflies ☐ Deer
☐ Foxes ☐ Moths ☐ Spiders ☐ Squirrels ☐ Other: _____

Is anyone in your household allergic to bee stings? ☐ Yes ☐ No ☐ I Don't know

Do you have any pets that spend time in your yard? ☐ Yes ☐ No ☐ I Don't know

Do you have white clover in your front yard? ☐ Yes ☐ No ☐ I Don't know

Do you have white clover in your backyard? ☐ Yes ☐ No ☐ I Don't know

Do you have dandelions in your front yard? ☐ Yes ☐ No ☐ I Don't know

Do you have dandelions in your backyard? ☐ Yes ☐ No ☐ I Don't know

In the last year, have you or someone else applied chemicals to control weeds or unwanted plants in the outdoor areas of your home?

☐ Yes ☐ No ☐ I don't know



If yes, to which part(s) of your yard have you or someone else applied chemicals to in order to control weeds or unwanted plants (check all that apply):

☐ Lawn ☐ Flower Beds ☐ Vegetable Garden ☐ Pasture
☐ Other (please specify): _____

In the last year, have you or someone else applied chemicals to control insects or other pests in the outdoor areas of your home?

☐ Yes ☐ No ☐ I don't know



If yes, to what part(s) of your yard have you or someone else applied chemicals in order to control insects or other pests (check all that apply):

☐ Lawn ☐ Flower Beds ☐ Vegetable Garden ☐ Pasture
☐ Other (please specify): _____

In the last year, have you or someone else applied fertilizer on this property?

☐ Yes ☐ No ☐ I don't know



If yes, what part(s) of your yard have you or someone else applied fertilizer to (check all that apply):

☐ Lawn ☐ Flower Beds ☐ Vegetable Garden ☐ Potted Plants
☐ Other (please specify): _____

Is this property a working farm? ☐ Yes ☐ No ☐ I Don't know

Do you keep livestock on this property? ☐ Yes ☐ No ☐ I Don't know

Do you keep horses on this property? ☐ Yes ☐ No ☐ I Don't know

Do you own a tractor? ☐ Yes ☐ No ☐ I Don't know

Do you grow hay on this property? ☐ Yes ☐ No ☐ I Don't know

Last page next!

BACKGROUND INFORMATION.

This section is for statistical purposes only.

As a reminder, all survey responses will be strictly confidential.

How many years have you lived in your current home? _____ years

Is some or all the land on this property under a conservation easement? ☐ Yes ☐ No

What year was your house built (approximately)?

☐ <1900 ☐ 1901-1940 ☐ 1941-1960 ☐ 1961-1980 ☐ 1981-2000 ☐ 2001-2010 ☐ 2010-2019

Does your neighborhood have a Homeowners Association? ☐ Yes ☐ No ☐ I don't know

Do you rent or own your home? ☐ Rent ☐ Own

How many people live in your home (including you) that are age 18 or older? _____ people

How many people live in your home that are younger than age 18? _____ people

What is the employment status of the main earner in your household?

☐ Full-time ☐ Part-time ☐ Not working ☐ Retired ☐ Student

What is the highest level of education you have completed?

☐ Less than High School ☐ High School/GED ☐ Certificate Program
☐ Associates Degree ☐ Some College ☐ 4-year College Degree
☐ Graduate Degree ☐ Prefer not to answer

In what year were you born? _____

Are you married or in a domestic partnership? ☐ Yes ☐ No ☐ Prefer not to answer

What is your gender? ☐ Male ☐ Female ☐ Non Binary ☐ Prefer not to answer

How do you identify your race/ethnicity?

☐ White ☐ Hispanic ☐ African American ☐ American Indian
☐ Asian/Pacific Islander ☐ Other ☐ Prefer not to answer

What was your total household income last year, before taxes? Please check ONE answer

☐ Less than \$25,000 ☐ \$50,001 up to \$100,000 ☐ More than \$150,001
☐ \$25,001 up to \$50,000 ☐ \$100,001 up to \$150,000 ☐ Prefer not to answer

Do you have any final comments you would like to share with us?

If resources mentioned throughout this survey become available, and you would like us to share them with you, please provide your email address: _____

Thank you greatly for completing our survey! Please remember to include the map along with the survey in the prepaid return envelope.

If you misplaced the return envelope we provided to send this survey back to us, please mail it to Dr. Amelie Davis, Dept. of Geography, Miami University, 250 S. Patterson Ave, Oxford OH, 45056.

References

1. Haberl, H.; Erb, K.-H.; Krausmann, F. Human appropriation of net primary production: Patterns, trends, and planetary boundaries. *Annu. Rev. Environ. Resour.* **2014**, *39*, 363–391. [[CrossRef](#)]
2. Aronson, M.F.J.; La Sorte, F.A.; Nilon, C.H.; Katti, M.; Goddard, M.A.; Lepczyk, C.A.; Warren, P.S.; Williams, N.S.G.; Clilliers, S.; Clarkson, B. A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proc. R. Soc. B Biol. Sci.* **2014**, *281*, 20133330. [[CrossRef](#)] [[PubMed](#)]
3. Lerman, S.B.; Warren, P.S. The conservation value of residential yards: Linking birds and people. *Ecol. Appl.* **2011**, *21*, 1327–1339. [[CrossRef](#)] [[PubMed](#)]

4. Burghardt, K.T.; Tallamy, D.W.; Shriver, W.G. Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes. *Conserv. Biol.* **2009**, *23*, 219–224. [CrossRef] [PubMed]
5. Lowenstein, D.M.; Matteson, K.C.; Xiao, I.; Silva, A.M.; Minor, E.S. Humans, bees, and pollination services in the city: The case of Chicago, IL (USA). *Biodivers. Conserv.* **2014**, *23*, 2857–2874. [CrossRef]
6. Davis, A.Y.; Lonsdorf, E.V.; Shierk, C.R.; Matteson, K.C.; Taylor, J.R.; Lovell, S.T.; Minor, E.S. Enhancing pollination supply in an urban ecosystem through landscape modifications. *Landscape Urban Plan.* **2017**, *162*, 157–166. [CrossRef]
7. Derby Lewis, A.; Bouman, M.J.; Winter, A.M.; Hasle, E.A.; Stotz, D.F.; Johnston, M.K.; Klinger, K.R.; Rosenthal, A.; Czarnecki, C.A. Does Nature Need Cities? Pollinators Reveal a Role for Cities in Wildlife Conservation. *Front. Ecol. Evol.* **2019**, *7*, 220. [CrossRef]
8. Thogmartin, W.E.; López-Hoffman, L.; Rohweder, J.; Diffendorfer, J.; Drum, R.; Semmens, D.; Black, S.; Caldwell, I.; Cotter, D.; Drobney, P.; et al. Restoring monarch butterfly habitat in the Midwestern US: ‘all hands on deck’. *Environ. Res. Lett.* **2017**, *12*, 074005. [CrossRef]
9. Cook, E.M.; Hall, S.; Larson, K.L. Residential landscapes as social-ecological systems: A synthesis of multi-scalar interactions between people and their home environment. *Urban Ecosyst.* **2012**, *15*, 19–52. [CrossRef]
10. Chowdhury, R.R.; Larson, K.; Grove, M.; Polsky, C.; Cook, E.; Onsted, J.; Ogden, L. A Multi-Scalar Approach to Theorizing Socio-Ecological Dynamics of Urban Residential Landscapes. *Cities Environ.* **2011**, *4*, 6. [CrossRef]
11. Kollmuss, A.; Agyeman, J. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res.* **2002**, *8*, 239–260. [CrossRef]
12. Schultz, P.W. Knowledge, information, and household recycling: Examining the knowledge-deficit model of behavior change. In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*; National Academy Press: Washington, DC, USA, 2002.
13. Nassauer, J.I.; Wang, Z.; Dayrell, E. What will the neighbors think? Cultural norms and ecological design. *Landscape Urban Plan.* **2009**, *92*, 282–292. [CrossRef]
14. Wheeler, M.M.; Larson, K.L.; Bergman, D.; Hall, S.J. Environmental attitudes predict native plant abundance in residential yards. *Landscape Urban Plan.* **2022**, *224*, 104443. [CrossRef]
15. McKenzie-Mohr, D. *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing*; New Society Publishers: Gabriola Island, BC, Canada, 2011.
16. Cavender-Bares, J.; Cubino, J.P.; Pearse, W.D.; Hobbie, S.E.; Lange, A.J.; Knapp, S.; Nelson, K.C. Horticultural availability and homeowner preferences drive plant diversity and composition in urban yards. *Ecol. Appl.* **2020**, *30*, e02082. [CrossRef] [PubMed]
17. Kendal, D.; Williams, K.J.; Williams, N.S. Plant traits link people’s plant preferences to the composition of their gardens. *Landscape Urban Plan.* **2012**, *105*, 34–42. [CrossRef]
18. Li, J.; Nassauer, J.I. Cues to care: A systematic analytical review. *Landscape Urban Plan.* **2020**, *201*, 103821. [CrossRef]
19. Nassauer, J.I. Messy ecosystems, orderly frames. *Landscape J.* **1995**, *14*, 161–170. [CrossRef]
20. Uren, H.V.; Dzidic, P.L.; Bishop, B.J. Exploring social and cultural norms to promote ecologically sensitive residential garden design. *Landscape Urban Plan.* **2015**, *137*, 76–84. [CrossRef]
21. Luck, G.W.; Smallbone, L.T.; O’Brien, R. Socio-Economics and Vegetation Change in Urban Ecosystems: Patterns in Space and Time. *Ecosystems* **2009**, *12*, 604–620. [CrossRef]
22. Larson, K.L.; Lerman, S.B.; Nelson, K.C.; Narango, D.L.; Wheeler, M.M.; Groffman, P.M.; Hall, S.J.; Grove, J.M. Examining the potential to expand wildlife-supporting residential yards and gardens. *Landscape Urban Plan.* **2022**, *222*, 104396. [CrossRef]
23. Herzog, T.R.; Herbert, E.J.; Kaplan, R.; Crooks, C. Cultural and developmental comparisons of landscape perceptions and preferences. *Environ. Behav.* **2000**, *32*, 323–346. [CrossRef]
24. Marco, A.; Barthelemy, C.; Dutoit, T.; Bertaudière-Montes, V. Bridging Human and Natural Sciences for a Better Understanding of Urban Floral Patterns: The Role of Planting Practices in Mediterranean Gardens. *Ecol. Soc.* **2010**, *15*. [CrossRef]
25. Bates, D.; Mächler, M.; Bolker, B.; Walker, S. Fitting Linear Mixed-Effects Models Using lme4. *J. Stat. Softw.* **2015**, *67*, 48. [CrossRef]
26. Larson, K.L.; Nelson, K.C.; Samples, S.R.; Hall, S.J.; Bettez, N.; Cavender-Bares, J.; Groffman, P.M.; Grove, M.; Heffernan, J.B.; Hobbie, S.E.; et al. Ecosystem services in managing residential landscapes: Priorities, value dimensions, and cross-regional patterns. *Urban Ecosyst.* **2016**, *19*, 95–113. [CrossRef]
27. Lockett, L.; Montague, T.; McKenney, C.; Auld, D. Assessing Public Opinion on Water Conservation and Water Conserving Landscapes in the Semiarid Southwestern United States. *HortTechnology* **2002**, *12*, 392–396. [CrossRef]
28. Karamaouna, F.; Kati, V.; Volakakis, N.; Varikou, K.; Garantonakis, N.; Economou, L.; Birouraki, A.; Markellou, E.; Liberopoulou, S.; Edwards, M. Ground cover management with mixtures of flowering plants to enhance insect pollinators and natural enemies of pests in olive groves. *Agric. Ecosyst. Environ.* **2019**, *274*, 76–89. [CrossRef]
29. Saunders, M.E.; Luck, G.W.; Mayfield, M.M. Almond orchards with living ground cover host more wild insect pollinators. *J. Insect Conserv.* **2013**, *17*, 1011–1025. [CrossRef]
30. Masierowska, M.; Stawiarz, E.; Rozwałka, R. Perennial ground cover plants as floral resources for urban pollinators: A case of Geranium species. *Urban For. Urban Green.* **2018**, *32*, 185–194. [CrossRef]
31. Spreading Milkweed, not Myths | U.S. Fish & Wildlife Service. *FWS.gov*. 23 June 2021. Available online: <https://www.fws.gov/story/spreading-milkweed-not-myths> (accessed on 12 December 2022).

32. Hopwood, J. "Roadsides as Habitat for Pollinators: Are Milkweeds Really Weeds? Xerces Society for Invertebrates. 2018. Available online: https://xerces.org/sites/default/files/2018-05/15-057_01_XercesSoc_Pollinators%2BRoadsides_Are-Milkweeds-Really-Weeds_web.pdf (accessed on 12 December 2022).
33. Milkweed. ASPCA. Available online: <https://www.aspc.org/pet-care/animal-poison-control/toxic-and-non-toxic-plants/milkweed> (accessed on 12 December 2022).
34. Milkweed (*Asclepias* spp.): USDA ARS. Available online: <https://www.ars.usda.gov/pacific-west-area/logan-ut/poisonous-plant-research/docs/milkweed-asclepias-spp/> (accessed on 12 December 2022).
35. Nelson, M.; Alfuth, D. Ornamental Plants Toxic to Animals: Milkweed. University of Wisconsin-Madison Extension. 2021. Available online: <https://hort.extension.wisc.edu/files/2021/03/Milkweed.pdf> (accessed on 12 December 2021).
36. Schultz, P.W. Strategies for Promoting Proenvironmental Behavior. *Eur. Psychol.* **2014**, *19*, 107–117. [CrossRef]
37. Van Heezik, Y.M.; Dickinson, K.J.M.; Freeman, C. Closing the Gap: Communicating to Change Gardening Practices in Support of Native Biodiversity in Urban Private Gardens. *Ecol. Soc.* **2012**, *17*. [CrossRef]
38. Hall, D.M.; Steiner, R. Insect pollinator conservation policy innovations at subnational levels: Lessons for lawmakers. *Environ. Sci. Policy* **2019**, *93*, 118–128. [CrossRef]
39. Dicks, L.V.; Viana, B.; Bommarco, R.; Brosi, B.; Arizmendi, M.D.C.; Cunningham, S.A.; Galetto, L.; Hill, R.; Lopes, A.V.; Pires, C.; et al. Ten policies for pollinators. *Science* **2016**, *354*, 975–976. [CrossRef] [PubMed]
40. Hipólito, J.; Coutinho, J.; Mahlmann, T.; Santana, T.B.R.; Magnusson, W.E. Legislation and pollination: Recommendations for policymakers and scientists. *Perspect. Ecol. Conserv.* **2021**, *19*, 1–9. [CrossRef]
41. Senapathi, D.; Goddard, M.A.; Kunin, W.E.; Baldock, K.C.R. Landscape impacts on pollinator communities in temperate systems: Evidence and knowledge gaps. *Funct. Ecol.* **2017**, *31*, 26–37. [CrossRef]
42. Gemmill-Herren, B.; A Garibaldi, L.; Kremen, C.; Ngo, H.T. Building effective policies to conserve pollinators: Translating knowledge into policy. *Curr. Opin. Insect Sci.* **2021**, *46*, 64–71. [CrossRef]
43. Coombs, G.; Gilchrist, D.; Watson, P. An assessment of the native and invasive horticultural plants sold in the mid-Atlantic region. *Nativ. Plants J.* **2020**, *21*, 74–82. [CrossRef]
44. Hooper, V.H.; Endter-Wada, J.; Johnson, C.W. Theory and Practice Related to Native Plants: A Case Study of Utah Landscape Professionals. *Landsc. J.* **2008**, *27*, 127–141. [CrossRef]
45. White, A.; Fant, J.B.; Havens, K.; Skinner, M.; Kramer, A.T. Restoring species diversity: Assessing capacity in the U.S. native plant industry. *Restor. Ecol.* **2018**, *26*, 605–611. [CrossRef]
46. Conway, T.M. Tending their urban forest: Residents' motivations for tree planting and removal. *Urban For. Urban Green.* **2016**, *17*, 23–32. [CrossRef]
47. Kuhns, M.R.; Reiter, D.K. Tree care and topping beliefs, knowledge, and practices in Six Western US Cities. *J. Arboric.* **2009**, *35*, 122.
48. Hausmann, S.L.; Petermann, J.S.; Rolff, J. Wild bees as pollinators of city trees. *Insect Conserv. Divers.* **2016**, *9*, 97–107. [CrossRef]
49. Mach, B.M.; Potter, D.A. Quantifying bee assemblages and attractiveness of flowering woody landscape plants for urban pollinator conservation. *PLoS ONE* **2018**, *13*, e0208428. [CrossRef]
50. Somme, L.; Moquet, L.; Quinet, M.; Vanderplanck, M.; Michez, D.; Lognay, G.; Jacquemart, A.-L. Food in a row: Urban trees offer valuable floral resources to pollinating insects. *Urban Ecosyst.* **2016**, *19*, 1149–1161. [CrossRef]
51. Ajzen, I. The theory of planned behavior: Frequently asked questions. *Hum. Behav. Emerg. Technol.* **2020**, *2*, 314–324. [CrossRef]
52. Champine, V.M.; Jones, M.S.; Lischka, S.; Vaske, J.J.; Niemiec, R.M. Understanding individual and diffusion behaviors related to native plant gardening. *J. Environ. Psychol.* **2022**, *81*, 101798. [CrossRef]
53. Knapp, J.L.; Phillips, B.B.; Clements, J.; Shaw, R.F.; Osborne, J.L. Socio-psychological factors, beyond knowledge, predict people's engagement in pollinator conservation. *People Nat.* **2021**, *3*, 204–220. [CrossRef]
54. Hall, D.M.; Martins, D.J. Human dimensions of insect pollinator conservation. *Curr. Opin. Insect Sci.* **2020**, *38*, 107–114. [CrossRef]
55. Davis, A.; Herron, O.; Dumyahn, S. Uncovering the potential for exurban properties and small working farms in the Midwestern United States to provide food and refuge for pollinators. *Urban Ecosyst.* **2021**, *24*, 1047–1060. [CrossRef]

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