Pollinator-friendly Plants: Reasons for and Barriers to Purchase

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SUMMARY. Certain pesticides are coming under scrutiny because of their impact on pollinator insects. Although most consumers express willingness to aid pollinators, the reasons for consumers' preferences or barriers to purchasing pollinator-friendly plants and the types of pollinators that consumers are trying to protect are less understood. Using an online survey of 1200 Connecticut (CT) consumers, of which 841 had home landscapes, we find that 46% of consumers with home landscapes purchased pollinator-friendly plants to attract pollinators to their landscape. Consistent with past research that focused on consumers' preferences for pollinator-friendly plants, the data also reveal that some consumers are willing to pay premiums for plants that contribute to pollinator's health. However, only 17% stated that attracting pollinators was their primary motivation; a finding that suggests labeling alone will likely not motivate consumers to purchase plants. The major barriers to purchasing pollinator-friendly plants included lack of labeling (cited by 28%), followed by high price (28%). Consumers purchasing pollinator-friendly plants were trying to attract butterflies (Lepidoptera) (78%), bees (Apidae) (59%), hummingbirds (Trochilidae) (59%), and other birds (41%). We also find that demographics and purchasing behavior affect barriers and types of pollinators desired. Simply labeling plants has the potential to increase purchasing, but increasing price could be detrimental as many consumers feel pollinator-friendly plants are highly priced. Implications for ornamental horticulture stakeholders are discussed.

Recent pollinator population decline has become a global concern (Gallai et al., 2009; Goulson et al., 2015; Klein et al., 2007). Pollinator insects are important because they contribute substantially to the global economy and food availability (Gallai et al., 2009; Klein et al., 2007). Klein et al. (2007) estimated that 70% of 124 global food crops depend on pollinator insects. Another study by Gallai et al. (2009) discussed that without insect pollination, food crops would not sufficiently meet world consumption needs. In 2005, the annual global value of insect pollination services was €153 billion for human food crops with fruits and vegetables having the highest value at about €102 billion (Gallai et al., 2009). Recent pollinator declines

have resulted in widespread public concern because of the dependence of food crops on insect pollinators. This has generated research on production-related factors (e.g., pesticides, parasites, disease, urbanization, etc.) that negatively impact pollinator health (Blacquière et al., 2012; Fairbrother et al., 2014; Hanley et al., 2015; Pimentel, 2005). However, the studies addressing (noncommercial) end consumers, their interest, and their actions to aid pollinators are much more limited.

Several consumer studies related to pollinator insects focused on willingness-to-pay for conservation programs (Breeze et al., 2015; Diffendorfer et al., 2014; Mwebaze et al., 2010). For example, Mwebaze et al. (2010) found UK households were willing to pay £1.37/week for a hypothetical bee-protection policy, which equates to £1.77 billion/year. Similarly, Breeze et al. (2015) determined consumers were willing to pay a total of £379 million to conserve local produce supplies and wildflower aesthetics for pollinator insects. U.S. consumers were also willing to pay premiums to aid pollinator insects. Diffendorfer et al. (2014) found U.S. consumers were willing to pay a one-time payment of

\$4.78 billion to \$6.64 billion to purchase monarch butterfly (*Danaus plexippus*)-friendly plants and donate to conservation programs. Each of these studies demonstrates that consumers value and want to aid pollinator insects through their gardening practices [such as purchasing monarch butterfly-friendly plants (Diffendorfer et al., 2014)] or through donations to conservation programs (Breeze et al., 2015; Diffendorfer et al., 2014; Mwebaze et al., 2010). However, much less is known about individual-specific actions and preferences related to pollinator insects.

Consumers have specific preferences for and perceptions of horticultural production methods that aid pollinator insects (Getter et al., 2016; Khachatryan and Rihn, 2017; Rihn and Khachatryan, 2016; Wollaeger et al., 2015). Wollaeger et al. (2015) used a nationwide survey to assess U.S. consumer purchase likelihood for floriculture crops grown using different pest management strategies (i.e., traditional, neonicotinoid-free, bee-friendly, biological control). According to their findings, consumers were willing to pay \$0.96 to \$2.10 more for plants grown using bee-friendly production methods when compared with traditional practices. Both the neonicotinoid-free and traditional production methods were perceived negatively. Contrary to common expectations, neonicotinoid-free production was perceived and valued most negatively. Wollaeger et al. (2015) hypothesize the negative perceptions of the neonicotinoid-free production practices were a result from low consumer knowledge. Getter et al. (2016) found similar results with bee-friendly production methods obtaining premiums between \$0.26 and \$1.15 when compared with other eco-friendly production practices (i.e., "grown in a sustainably produced soil/mix," "grown using recycled/recaptured water," "grown using protective neonicotinoid insecticides," or "grown using traditional" practices). Both studies demonstrate consumers' value of practices to aid pollinator insects.

Consumer awareness of production methods that aid pollinators also influence behavior toward ornamental plants (Rihn and Khachatryan, 2016). Rihn and Khachatryan (2016) assess how consumers' awareness of

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neonicotinoids was related to pollinator-related knowledge and pollinator promotion preferences. About, 24% of the U.S. population was aware of neonicotinoid insecticides. Those who were familiar with the term were more knowledgeable about neonicotinoids and pollinators/pollinator-related topics in general. Neonicotinoid aware consumers were more likely to purchase products labeled as “neonic-free” than individuals who were not aware of neonicotinoids. Awareness also influenced point-of-sale promotion preferences with aware individuals preferring “bee-safe” and “neonic-free” more than those who were unaware. However, despite this increased preference for that terminology, “neonic-free” was not the preferred phrasing for either aware or not aware consumers. Instead, they preferred “pollinator-friendly,” “pollinator-safe,” “plants for pollinators,” and “bee-friendly.” Regarding purchase likelihood, neonicotinoid aware consumers were more likely to purchase a “neonic-free” plant than not aware consumers. Nevertheless, other promotional labels had more impact.

Considering the findings in recent empirical investigations, consumers value pollinator insect conservation programs (Breeze et al., 2015; Diffendorfer et al., 2014; Mwebaze et al., 2010) and horticultural products grown using pollinator-friendly insect management programs (Getter et al., 2016; Khachatryan and Rihn, 2017; Rihn and Khachatryan, 2016; Wollaeger et al., 2015). However, the underlying reasons for their preferences or barriers to purchasing pollinator-friendly plants and the types of pollinators consumers are trying to protect have not been studied. This study addresses this knowledge gap using an online survey of 1200 CT consumers. Notably, we investigate the demographic characteristics and purchasing behaviors that drive preferences for purchasing pollinator-friendly plants at different types of retailers. Furthermore, we evaluate the types of pollinators that respondents are willing to attract and aid. Finally, we take a brief look at the barriers to purchasing pollinator-friendly plants.

Data and methods

An online survey was implemented during the Summer/Fall

2016. The survey covered a host of topics, including perceptions and use of pollinators, genetically modified organisms, and local and organic products. The survey sample constituted of CT residents using Lightspeed Global Market Insight, Inc. (GMI) (Lightspeed Research, Warren, NJ) panel database. CT was chosen given the funding agency's interest in the CT market. Potential respondents were randomly invited from GMI's panel database and those choosing to participate were directed to the survey. The overall completion rate for the survey was ≈83%. However, the total number of respondents varied by question given that not all questions were asked of each respondent. For instance, pollinator usage questions were directed at respondents that had purchased a pollinator plant. On the other hand, the pollinator barrier question was posed to all respondents.

The sample was relatively representative of the CT population. However, our sample's median household income and age are similar to that of the CT population (Table 1). The CT median age is 40 years (U.S. Census Bureau, 2015), whereas our sample's median age was 46 years. Considering the U.S. Census, median age for CT includes persons less than 18 years of age and our survey only includes respondents more than 18 years of age; our sample is most likely closer to the CT median population than the 6-year difference provided. Median CT household income is \$70,000 (U.S. Census Bureau, 2011), which is comparable with our sample's median household income of \$75,000.

To understand the potential drivers of pollinator purchasing at mass merchandiser/home improvement centers and nursery/greenhouse garden centers, we used a two-limit

Table 1. Descriptive statistics of the sample of Connecticut survey respondents who had a home landscape as found by a 2016 survey of Connecticut residents.

Variables ^a	Mean	SD
Median age (years)	46.0	—
Ethnicity: Caucasian	86%	34%
Gender: male	27%	45%
Political leaning		
Republican	24%	43%
Independent	38%	49%
Other (not democrat)	9%	28%
Urbanicity		
Suburban	66%	47%
Urban	10%	28%
Adults in household (no.)	2.30	1.04
Children in household (no.)	0.59	0.98
Household income (median)	75,000	—
Education level		
Some college/2-year degree	35%	47%
Bachelors	28%	45%
Graduate degree	18%	39%
Environmental information source trust ^b		
University	70%	29%
Industry association	45%	30%
Federal government	48%	30%
Nonprofit	64%	29%
Mass merchandiser	43%	27%
Activist group	64%	31%
Landscape plants pollinator-friendly (%)	45%	25%
Pollinator plant neighbor comparison		
Less than	19%	39%
More than	35%	48%
Observations (no.) ^c	855	

^aThe base variables included ethnicity = non-Caucasian, political leaning = democrat, urbanicity = rural, education = high school/general educational development (GED) or less, neighbor comparison = equal.

^bTrust was measured on a 0–100 point scale where 0 = “distrust,” 50 = “neither trust or distrust,” and 100 = “trust.”

^cA total of 1,200 consumers took the survey, but 841 were asked questions about pollinator-friendly plants given the other survey respondents did not have a home landscape.

tobit model developed by Rossett and Nelson (1975). A pollinator-friendly plant purchasing value was obtained by asking survey respondents what percentage of their plant purchases at a mass merchandiser/home improvement center (and nursery/greenhouse garden center) are pollinator-friendly plants. Of note, it could be the case that some misreporting (under- or overestimating of purchases) may occur, although the extent of any misreporting is unknown. In this context, respondents are limited to a lower (0) and upper limit (100). The two-limit model can be formulated as

$$y_i^* = \beta'x_i + \varepsilon_i \quad (i = 1, \dots, n)$$

$$y_i = \begin{cases} 0 & \text{if } y_i^* \leq 0 \\ y_i^* & \text{if } 0 < y_i^* < 100 \\ 100 & \text{if } y_i^* \geq 100 \end{cases} \quad (i = 1, \dots, n)$$

where the latent variable y_i^* is not observed for values less than 0% and greater than 100%, x is a matrix of explanatory variables (Tables 1–6), β is a coefficient vector, and ε represents an independently and normally distributed error term with zero mean and variance σ^2 . Explanatory variables included age, household income, number of adults and children within the household, education level, and urbanicity. We also included political leaning (e.g., Republican, Democrat, etc.) and amount of trust in different sources of environmental information (e.g., universities, industry associations, nonprofits). Trust in source of environmental information was measured via a 0–100 point scale where 0 = “distrust,” 50 = “neither trust or distrust,” and 100 = “trust.” We report the conditional marginal effects (calculated as the average marginal effect) which are interpretable similar to that of an ordinary least squares regression coefficient. For categorical variables, it is a change in the dependent variable given a move from the base explanatory variable (e.g., female to male). For continuous variables, it is a change in the dependent variable given a one-unit change in the independent variable.

We use a set of binary logit models to assess which variables may explain which pollinators consumers are wanting to attract. The dependent variable was coded as “zero” when the pollinator was not selected and

Table 2. Production practices for survey respondents with a home landscape from a 2016 survey of Connecticut residents as compared by pollinator inclusion within the home landscape.

	Respondent had some pollinators in home landscape	Respondent had no pollinators in home landscape	
	Mean (SD)		
Organic production practices	23% (42%)	0% —	***
Integrated pest management	8% (27%)	0% —	***
Reduced pesticide use	48% (50%)	21% (42%)	***
Observations (no.) ^z	770	28	

^zA total of 1,200 consumers took the survey; however, the production practice question was only asked of respondents indicating they had a home landscape.

***represents significance at the $P \leq 0.01$ level using a chi-square test.

“one” when it was selected. For instance, for a respondent who indicated that bees were a pollinator they wanted to attract, the bee variable value was scored a one. The binary logit probability can be formulated as

$$P(Y = 1|X) = \frac{e^{x'\beta}}{1 + e^{x'\beta}};$$

where P is the respondent’s probability of choosing the pollinator, x is a set of explanatory variables (Tables 1–6), and β is a coefficient vector (Greene, 2003). We report log odds which are the odds of being in one of the groups.

Results and discussion

PRODUCTION PRACTICES. To better understand pollinator plant purchasing, an initial objective is to determine if respondents are implementing what could be thought of as pollinator-friendly practices. Based on Table 2, about half of respondents who indicated they had pollinator-friendly plants in their home landscape state that they have reduced pesticide use in their home landscape. In comparison, significantly fewer (21%) respondents with no pollinator-friendly plants in their home landscape had reduced pesticide use in their landscape. Furthermore, 23% of respondents with pollinator-friendly plants in their landscape had moved to organic production practices, whereas only 0% of respondents with no pollinator-friendly plants had moved to organic production practices.

PURCHASING. As can be seen in Table 3, half of respondents cited attracting pollinators as a reason they

Table 3. Connecticut survey respondents with pollinator-friendly plants in their home landscape purchased pollinator-friendly plants based on the results from a 2016 survey of 1,200 Connecticut residents.

	Mean	SD
Attract pollinators	47%	50%
Plant a variety of plant types	50%	50%
Like the way they look	49%	50%
Some other reason	9%	28%
Observations (no.) ^z	749	

^zA total of 1,200 consumers took the survey; however, the production practice question was only asked of respondents indicating they had a home landscape.

use pollinator-friendly plants. Planting a variety of plants and liking the look of pollinator-friendly plants were also cited by half the respondents. This implies that focusing only on the pollinator attraction characteristic of pollinator-friendly plants may not optimize the effect of marketing messages that resonate for many buyers. Given these findings, retailers need to focus on marketing not only the plant’s ability to attract pollinators, but also focus on the plant’s appearance in the landscape as well as promoting a variety of pollinator plants.

With respect to attracting pollinators, butterflies are the primary pollinator that 78% of pollinator-friendly buyer respondents seek to attract (Table 4). Bees and hummingbirds are the second most identified pollinator with 60% and 59%, respectively. Birds rank fourth with bats (Chiroptera) and other pollinators rounding out the list with 11% each.

Table 4. Types of pollinators
Connecticut survey respondents are trying to attract based on responses from a 2016 survey of 1,200 Connecticut residents.

	Mean	SD
Bees	59%	49%
Hummingbirds	59%	49%
Butterflies	76%	43%
Birds (excluding hummingbirds)	41%	49%
Bats	11%	31%
Other	11%	31%
Observations (no.) ^z	749	

^zA total of 1,200 consumers took the survey; however, the production practice question was only asked of respondents indicating they had a home landscape.

In this vein, consumers perceive that they are purchasing a large amount of pollinator-friendly plants from mass merchandiser/home improvement centers and nursery/greenhouse garden centers (Table 5). For instance, 42% of consumers perceive their plant purchases at a mass merchandiser/home improvement center were pollinator-friendly plants. However, 54% of plants purchased at a nursery/greenhouse garden center were perceived as pollinator-friendly. This percentage is lower than that of local and native, but in-line with the percentage purchased that were perceived to be organic. Our findings that a relatively large number of respondents indicate they are reducing pesticide use in their landscape (Table 2) in conjunction with the relatively large percentage of pollinator-friendly plants respondents indicate their purchasing (Table 5) is consistent with the findings of Khachatryan and Rihn (2017). Khachatryan and Rihn (2017) found that consumers perceive reducing pesticides is a good way to increase pollinator health.

Also of interest, we find that consumers perceive they are purchasing more local, native, pollinator-friendly, and organic plants at nursery/greenhouse garden centers compared with home improvement center/mass merchandisers. The reason for this is not known. A plausible explanation could be that nursery/greenhouse garden centers are more specialized in marketing plants as local, organic, native, or pollinator-friendly. However, an equally valid reason could be that consumers are more likely to assume

Table 5. Perceived percentage of plant types purchased by Connecticut survey respondents who purchased plants in the last 3 years at varying retail outlets based on responses from a 2016 survey of 1,200 Connecticut residents.^z

	Home improvement center/mass merchandiser		Nursery/greenhouse garden center	
	Mean	SD	Mean	SD
Local	49%	29%	69%	28%
Native	47%	28%	64%	29%
Pollinator-friendly	42%	28%	54%	30%
Organic	39%	30%	53%	32%
Observations (no.) ^y	841		844	

^zThe question was as follows, "When shopping at a home improvement center/mass merchandiser (nursery/greenhouse garden center), what percentage of your plant purchases are..." where respondents clicking on a 0–100 point scale the amount of purchases that were local, native, pollinator-friendly, and organic.

^yA total of 1,200 consumers took the survey; however, the production practice question was only asked of respondents indicating they had a home landscape.

(either correctly or incorrectly) that plants are local, organic, native, or pollinator-friendly at a nursery/greenhouse garden center compared with plants purchased at a home improvement center/mass merchandiser. This could be the result of varying definitions both real and perceived for these terms. For instance, there is no definitive definition for pollinator-friendly. Respondents may be thinking of a plant that attracts pollinators, a plant that does not harm a pollinator, or a plant that is neonicotinoid-free. The reason for the perception that more local, organic, native, or pollinator-friendly purchased at nursery/greenhouse garden centers would dictate how firms should react. If nursery/greenhouse garden centers are better at marketing their plants or offering plants not offered by home improvement center/mass merchandiser then this is a niche that should be catered too. However, if respondents only perceived increased purchasing of these plant types at nursery/greenhouse garden centers, then this creates issues for both types of retailers. Home improvement center/mass merchandisers may be investing in products with specific production practices or offering plants that are local, organic, etc., but consumers are not noticing. Nursery/greenhouse garden centers may be selling plants that are being afforded attributes they may not have. If consumers are incorrectly perceiving they are purchasing these types of plants and they are not, then nursery/greenhouse garden centers, as well as home improvement centers/mass merchandisers, need to better educate their clientele so that consumers do not

Table 6. Barriers to purchasing more pollinator-friendly plants by Connecticut survey respondents who have pollinator-friendly plants in their home landscapes based on responses from a 2016 survey of 1,200 Connecticut residents.

Barrier	Mean	SD
High price	28%	45%
Lack the products I want	20%	40%
Quality issues	12%	32%
Not labeled	34%	48%
Lack of unique plants	17%	38%
Do not carry	16%	37%
Marketing gimmick	7%	25%
Other	20%	40%
Observations (no.) ^z	855	

^zA total of 1,200 consumers took the survey; however, the production practice question was only asked of respondents indicating they had a home landscape.

lose trust if they find out they are incorrect in their assumptions.

BARRIERS TO PURCHASING. "Not labeling pollinator-friendly plants" was the most cited reason for not purchasing more pollinator-friendly plants (Table 6). About one-third (34%) of respondents identified labeling as a reason for not purchasing more pollinator-friendly plants. Seven percent of respondents in our survey perceived pollinator-friendly plants as a marketing gimmick. "Higher prices" was cited by 28% of respondents as limiting their pollinator plant purchasing. This implies that 72% of respondents did not find higher prices as a limiting barrier. However, before charging higher prices, retailers need to consider the amount of effort and resources they will be using to brand or differentiate the pollinator-friendly label. Retailers who are able to brand

Table 7. Tobit conditional marginal effects for percent pollinator-friendly plant purchases by retailer type based on responses from a 2016 survey of 1,200 Connecticut residents.

	Mass merchandiser/home improvement center		Nursery/greenhouse garden center	
	Conditional marginal effects ^z			
Variables	Coefficient	P value	Coefficient	P value
Age (years)	−0.17	0.004	−0.10	0.071
Ethnicity: Caucasian	−4.97	0.026	−6.15	0.008
Gender: male	1.56	0.405	−1.43	0.424
Political leaning				
Republican	2.41	0.299	0.83	0.731
Independent	−2.95	0.138	−1.00	0.623
Other (not democrat)	0.77	0.822	−4.11	0.238
Urbanicity				
Suburban	0.53	0.783	0.10	0.960
Urban	0.01	0.998	3.19	0.342
Adults in household (no.)	−0.38	0.650	0.13	0.867
Children in household (no.)	0.32	0.691	0.38	0.643
Household income	0.00	0.795	0.00	0.347
Education level				
Some college/2-year degree	−2.84	0.247	−0.26	0.917
Bachelors	−2.81	0.272	−3.91	0.122
Graduate degree	−5.15	0.075	−4.29	0.135
Environmental information source trust				
University	−0.02	0.541	0.07	0.018
Industry association	0.06	0.040	−0.01	0.865
Federal government	0.03	0.283	−0.01	0.864
Nonprofit	−0.01	0.781	0.02	0.547
Mass merchandiser	0.06	0.078	0.02	0.505
Activist group	0.02	0.569	−0.01	0.746
Landscape plants pollinator-friendly (%)	0.19	0.000	0.17	0.000
Pollinator plant neighbor comparison				
Less than	−1.04	0.645	−1.13	0.615
More than	0.20	0.917	−2.11	0.278
Current landscaping practices				
Organic	5.11	0.009	9.71	0.000
Integrated pest management	−2.54	0.386	3.58	0.198
Reduced pesticide use	−0.02	0.991	0.44	0.797
Reasons to purchase				
Attract pollinators	5.85	0.001	5.74	0.002
Like to plant variety	1.70	0.322	1.44	0.399
Like look of pollinators	−0.83	0.632	−1.20	0.488
Other	3.31	0.351	−1.24	0.716
Barriers to purchase more				
High price	1.00	0.609	−2.02	0.320
Lack the products I want	2.65	0.163	2.11	0.298
Quality issues	8.41	0.001	4.73	0.068
Not labeled	−4.14	0.028	−1.37	0.460
Lack of unique plants	−0.88	0.662	1.53	0.457
Do not carry	2.09	0.334	−0.59	0.774
Marketing gimmick	−3.78	0.221	−4.64	0.154
Other	−7.42	0.006	−4.24	0.100
Overall model fit				
Sigma ^y	26.7		30.9	
Sigma confidence interval ^y	(24.9, 28.6)		(28.6, 33.2)	
Left censored ^y	13%		9%	
Right censored ^y	2%		9%	
Observations (no.) ^x	516		512	
Log pseudo likelihood ^y	−2,157.3		−2,146.6	

(Continued on next page)

Table 7. (*Continued*) Tobit conditional marginal effects for percent pollinator-friendly plant purchases by retailer type based on responses from a 2016 survey of 1,200 Connecticut residents.

Variables	Mass merchandiser/home improvement center		Nursery/greenhouse garden center	
	Conditional marginal effects ^z			
	Coefficient	P value	Coefficient	P value
$P > F^y$	0.000		0.000	
Pseudo R^{2y}	0.04		0.04	

^zConditional marginal effects are calculated at as the average marginal effects and are interpreted similar to ordinary least squares regression coefficients. For categorical variables it is a change in the dependent variable given a move from the based explanatory variable (e.g., female to male). For continuous variables it is a change in the dependent variable given a one-unit change in the independent variable. Significance ($P \leq 0.050$) indicated in bold font.

^yLog pseudo likelihood = log likelihood of model; $P > F$ = probability associated with the F -test of the overall model fit; Pseudo R^2 = amount of variance explained by model (must be treated with caution as this is not the same as an ordinary least square regression R^2 , left and right censored = number of observations that had 0% and 100% pollinator-friendly plant purchases, and sigma = estimated standard error of the model.

^xA total of 1,200 consumers took the survey; however, the tobit model only used respondents that had had pollinator-friendly plants in their home landscape and completed all explanatory variable questions.

the pollinator-friendly label as a positive, value-added component to the plant may be able to create a more inelastic demand curve, thereby creating more revenue via higher prices (Palma et al., 2012). However, retailers who are not able to create increased label value may be blunting sales volume by charging premiums. Given recent findings that ornamental plant demand is elastic (Hovhannisyan and Khachatryan, 2017), increasing prices would result in lower revenue overall with an elastic demand curve. Thereby, pricing needs to be considered in conjunction with efforts to promote the pollinator-friendly plant label.

TWO-LIMIT TOBIT MODEL: POLLINATOR PURCHASING. Using the two-limit tobit model, we gain a better understanding of the drivers of pollinator-friendly plant purchasing which comprises a large percentage of plant purchasing. In the mass merchandiser/home improvement center model, we find that older consumers are less likely to purchase pollinator-friendly plants (Table 7). Furthermore, Caucasian consumers are less likely to purchase pollinator-friendly plants. However, respondents who trust industry associations and mass merchandisers are more likely to purchase pollinator-friendly plants. Respondents who use organic production practices in their landscapes, want to attract more pollinators, and consider quality issues as a barrier to purchasing more pollinator-friendly plants are more likely to purchase pollinator-friendly plants.

With respect to the nursery/greenhouse garden center model, greater age and Caucasian ethnicity are correlated with reduced pollinator-friendly plant purchases. Trust in

university environmental information is significant in increasing pollinator-friendly plant purchases. Respondents that use organic landscaping practices and want to attract pollinators are more apt to purchase more pollinator-friendly plants. Interestingly, trust in industry associations is not a significant driver for pollinator plant purchasing at a nursery/greenhouse garden center.

There are several important takeaways observed through the mass merchandiser/home improvement centers nursery/greenhouse garden center models. First, older consumers were less likely to purchase pollinator-friendly plants. Whether this tendency is driven by a lack of ecological knowledge is a potential issue for many retailers as the primary consumer group of these plants is expected to be older (Baldwin, 2015; Butterfield, 2004; Dennis and Behe, 2007). Targeting pollinator-friendly plants to older consumers may result in advertising that does not resonate with this group, thereby leading to decreased sales. However, retailers may experience increased benefits by targeting pollinator-friendly plants to younger clientele or to new customers. Second, the source of environmental information will play a significant role in shaping some consumer's purchasing of pollinator-friendly plants. A caveat to these results is that this study only surveyed residents of CT so extrapolating the aforementioned recommendations should keep this in mind.

BINARY LOGIT MODELS: POLLINATOR ATTRACTION. Retailers who can effectively convey which plants are pollinator-friendly are better positioned to drive sales. As such, keeping plants in stock that attract

specific types of pollinators can be an effective strategy given that consumers want to attract different pollinators. For instance, respondents who want to attract bees rely heavily on the source of environmental information (Table 8). As trust and credibility increases for university and nonprofit sources, a respondent's odds of wanting to attract bees increases. Thereby, a retailer selling plants that attract bees could tout university and nonprofit information, while staying away from information provided by industry associations and activist groups. This response trend is also evident for hummingbirds and butterflies. Retailers selling hummingbird-attracting plants should promote information generated by nonprofit groups, whereas butterfly attracting plants' promotional messages should highlight university-sourced information.

Considering demographic characteristics of the sample, males were less likely to purchase plants that attract hummingbirds and butterflies. On the other hand, respondents in suburban and urban areas were less likely than rural respondents to want pollinator plants that attract hummingbirds. Older consumers were more likely to want pollinator-friendly plants that attract birds (excluding hummingbirds). As can be seen by the demographic results, retailers need to be wary of developing blanket marketing strategies and would benefit by providing a more "individualized" message that is more meaningful to different consumers.

Conclusions

This study examined a number of issues associated with pollinator-friendly

Table 8. Log odds from the logit model for attracting various types of pollinators using data from a 2016 survey of Connecticut residents.^z

Variables	Bees		Hummingbirds		Butterflies		Birds (excluding hummingbirds)		Bats		Other	
	Coefficient	P value	Coefficient	P value	Coefficient	P value	Coefficient	P value	Coefficient	P value	Coefficient	P value
Age (years)	0.009	0.234	-0.001	0.863	0.005	0.564	0.014	0.065	-0.019	0.110	-0.017	0.182
Ethnicity: Caucasian	-0.244	0.484	-0.071	0.807	-0.086	0.833	0.157	0.659	0.520	0.398	-0.332	0.501
Gender: male	0.292	0.247	-0.580	0.015	-1.060	0.000	0.082	0.747	-0.464	0.275	0.207	0.600
Political leaning												
Republican	-0.220	0.457	-0.119	0.713	0.511	0.173	0.216	0.493	-0.391	0.444	-0.333	0.517
Independent	0.097	0.708	0.207	0.440	0.568	0.069	0.141	0.592	0.403	0.293	-0.198	0.637
Other (not democrat)	-0.329	0.429	-0.699	0.109	0.176	0.735	0.131	0.781	-0.451	0.467	0.503	0.409
Urbanicity												
Suburban	0.035	0.892	-0.902	0.001	0.393	0.166	0.197	0.441	-0.479	0.178	-0.068	0.865
Urban	-0.121	0.769	-1.905	0.000	0.227	0.659	0.378	0.379	-0.228	0.713	-0.099	0.873
Adults in household (no.)	-0.038	0.713	0.224	0.060	0.078	0.543	0.359	0.001	0.254	0.116	-0.296	0.118
Children in household (no.)	-0.176	0.136	-0.133	0.267	-0.068	0.605	-0.247	0.035	-0.148	0.437	-0.148	0.445
Household income	0.000	0.283	-0.000	0.383	-0.000	0.442	-0.000	0.968	0.000	0.125	0.000	0.851
Education level												
Some college/2-year degree	0.088	0.773	-0.086	0.785	0.447	0.227	-0.019	0.954	0.621	0.187	-0.470	0.336
Bachelors	-0.117	0.714	-0.203	0.552	0.261	0.479	-0.383	0.269	0.124	0.807	0.012	0.981
Graduate degree	0.349	0.358	-0.471	0.220	0.316	0.460	-0.242	0.525	-0.173	0.796	0.584	0.266
Environmental information source trust												
University	0.008	0.050	0.000	0.957	0.009	0.086	0.003	0.484	0.003	0.665	0.002	0.729
Industry association	-0.012	0.001	-0.006	0.143	-0.008	0.097	0.002	0.555	-0.007	0.277	0.005	0.473
Federal government	-0.001	0.823	-0.003	0.382	-0.012	0.008	-0.008	0.059	0.003	0.601	-0.008	0.262
Nonprofit	0.009	0.027	0.007	0.067	0.001	0.884	0.005	0.231	-0.006	0.271	-0.003	0.575
Mass merchandiser	-0.003	0.476	-0.004	0.320	0.000	0.986	-0.002	0.595	0.005	0.512	0.006	0.359
Activist group	-0.009	0.020	-0.002	0.560	0.006	0.135	-0.005	0.170	-0.007	0.201	-0.013	0.023
Landscape plants	0.009	0.061	-0.004	0.386	-0.005	0.337	0.010	0.030	0.001	0.871	0.014	0.071
pollinator-friendly (%)												
Pollinator plant neighbor comparison												
Less than	0.369	0.229	-0.081	0.780	-0.449	0.175	0.388	0.205	0.261	0.612	-0.053	0.912
More than	0.732	0.003	0.247	0.345	0.533	0.117	0.044	0.860	0.766	0.037	0.101	0.776
Current landscaping practices												
Organic	0.455	0.102	-0.143	0.597	-0.115	0.738	0.145	0.612	0.849	0.022	0.491	0.214
Integrated pest management	-0.492	0.187	0.008	0.983	-0.109	0.834	-0.070	0.866	-0.053	0.915	0.112	0.834
Reduced pesticide use	0.258	0.230	-0.002	0.993	0.087	0.742	0.701	0.001	0.389	0.236	-0.174	0.583
Reasons to purchase												
Attract pollinators	1.421	0.000	1.149	0.000	0.883	0.007	0.779	0.002	0.575	0.114	0.136	0.691
Like to plant variety	0.679	0.004	0.841	0.000	0.788	0.008	0.195	0.367	0.169	0.613	-0.219	0.536
Like look of pollinators	-0.013	0.955	0.967	0.000	0.944	0.002	0.926	0.000	0.182	0.579	-0.197	0.582
Other	0.530	0.224	0.054	0.912	-0.354	0.556	0.695	0.118	0.536	0.392	0.961	0.091
Barriers to purchase more												
High price	0.468	0.082	0.338	0.215	0.110	0.726	0.235	0.390	-0.211	0.621	0.942	0.009
Lack the products I want	0.212	0.493	0.229	0.425	-0.414	0.254	0.196	0.449	-0.190	0.609	0.250	0.538

(Continued on next page)

Table 8. (Continued) Log odds from the logit model for attracting various types of pollinators using data from a 2016 survey of Connecticut residents.^z

Variables	Bees		Hummingbirds		Butterflies		Birds (excluding hummingbirds)		Bats		Other	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Quality issues	-0.033	0.927	-0.183	0.646	-0.351	0.430	0.440	0.303	-0.195	0.736	1.126	0.011
Not labeled	0.080	0.750	0.751	0.004	1.117	0.001	0.536	0.031	-0.360	0.261	-0.011	0.977
Lack of unique plants	-0.142	0.652	0.162	0.593	1.179	0.005	0.143	0.620	0.541	0.139	0.461	0.312
Do not carry	0.226	0.458	0.145	0.637	0.386	0.285	1.024	0.000	0.274	0.461	0.344	0.447
Marketing gimmick	0.214	0.594	0.275	0.478	0.263	0.544	0.720	0.067	-0.664	0.306	- 1.590	0.012
Other	0.395	0.245	0.608	0.101	0.941	0.031	0.795	0.018	-0.331	0.446	0.497	0.311
Constant	- 1.968	0.026	-0.046	0.952	-1.115	0.279	- 4.683	0.000	- 3.288	0.006	-1.105	0.310
Log pseudo likelihood ^y	-283.6		-285.0		-217.2		-291.9		-154.2		-142.7	
P > chi-square critical value ^y	0.000		0.000		0.000		0.000		0.000		0.000	
Pseudo R ^{2y}	0.193		0.183		0.211		0.162		0.163		0.178	
Observations (no.) ^x	522		522		522		522		522		522	

^zLog odds are the odds of being in one of the groups. Significance ($P \leq 0.050$) indicated in bold font.^yLog pseudo likelihood = log likelihood of model; $P > \chi^2$ = probability associated with the chi-square test of the overall model fit; Pseudo R² = amount of variance explained by model (must be treated with caution as this is not the same as an ordinary least square regression R²).^xA total of 1,200 consumers took the survey; however, the tobit model only used respondents that had pollinator-friendly plants in their home landscape.

plants. First, pollinator-friendly plants make up a substantial portion of plant purchases, yet the wide belief that purchasing these plants to attract pollinators is inaccurate for half of consumers. Many consumers are purchasing these products because of the desire for a variety of plants and the way pollinator-friendly plants look. Retailers need to use this information within their marketing campaigns to address many consumers' reasons for purchasing.

Retailers should also pay close attention to their clientele because demographics and sources identified as primarily background play a role in driving pollinator-friendly plant purchases. Notably, age and gender influences who purchases these plants and, thereby, should be accounted for in marketing campaigns. Highlighting information sources, such as universities for nursery/greenhouse garden centers and industry association information for mass merchandiser/home improvement centers, could enhance the messaging associated with purchasing pollinator-friendly plants. Furthermore, realizing that the type of pollinator being attracted is driven by demographics and trust in the source of information. Retailers in non-rural areas should focus less on plants designed to attract pollinators, whereas retailers with older clientele are more likely to have customers wanting plants that attract birds (excluding hummingbirds). As with plant purchasing, information source trust is important in facilitating consumers wanting to attract certain pollinators. Notably, retailers should use information sources valued by consumers in their messaging/advertising. For instance, citing university information will appeal to consumers who want to attract bees.

Finally, retailers face a conundrum as research has shown consumers are willing to pay a price premium for pollinator-friendly attributes. However, higher prices was identified by 28% of our respondents as a barrier to purchasing more pollinator-friendly plants. Understanding there is a trade-off with higher prices is essential. Higher prices may increase the margin for pollinator-friendly plants, but it

may also decrease sales as a lower price might allow for increased volume at a lower margin. At the very least, retailers who want to increase pollinator-friendly plant sales should label these plants as lack of labeling was the number one barrier to purchasing pollinator-friendly plants.

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