Support for Native, Solitary Pollinator Conservation among the Public versus Beekeepers

Abstract

Most public and private attention regarding pollinator decline is focused on common honey bees (*Apis mellifera*), which is not native to North America and may compete for resources with native pollinators. Yet many other insect species provide use and non-use values that cannot be replaced by honey bees but have faced even more precipitous dieoffs. However, little is known about public support for native pollinators. Using data collected from the general public and beekeepers, we find that since honey bees are often used as a flagship species for pollinator conservation, public valuation of native pollinator species is not strong. However, beekeepers have significantly higher willingness to pay to conserve native pollinator species. Significant heterogeneity also exists between the general public and beekeepers in terms of the cause they may support native pollinators.

Keywords: Beekeepers, General Public, Honey Bees, Native Solitary Pollinators, Valuation

JEL Code: Q29

Pollination is a key ecosystem service necessary for maintaining ecosystem health as well as for agriculture (Klein, et al., 2007). In North America, populations of multiple insect pollinators have decreased substantially (Cameron, et al., 2011), following a global trend of decreased insect biomass by roughly 75% in a three-decade period (Hallmann, et al., 2017, Lister and Garcia, 2018). This decline is most evident with the addition of the first bee species- the Rusty Patched Bumble Bee (*Bombus affinis*) - to the USFWS endangered species list, with an 87% population decline in two decades (US Fish and Wildlife Service (USFWS), 2018). Honey bees (*Apis melifera*) have also decreased substantially, stemming from a number of reasons such as parasites, pesticides, and land development (Goulson, et al., 2015), which can cause significant loss to food production. For example in the US, virtually all California's million acres of almond production relied on commercial honey bee pollination services, utilizing roughly 1.5 million hives, over half of all commercial hives in the US (USDA2017a, 2017b).

Consequently, the public's awareness of and support to reverse the decline of honey bees and other pollinators has risen (Wilson, et al., 2017). A number of private initiatives and organizations have been initiated to protect pollinators including the Xerces Society, the National Wildlife Federation, and the North American Pollinator Protection Campaign. In addition, government agencies have also responded. The USDA's Conservation Reserve Program (CRP) initiated the Pollinator Habitat Initiative (CP-42) in 2008, with financial compensation for land previous in crop production. The EPA and USDA under the Obama Administration jointly proposed three goals in their National Strategy to Promote the Health of Honey Bees and Other Pollinators (Vilsack and McCarthy, 2015): decrease honey bee mortality, increase monarch butterflies, and increase pollinator habitat acreage.

However, most current conservation policy practices do not differentiate native pollinators from honey bees, which is a non-native species to North America. Thus, even if the total pollinator population is preserved, increases in honey bee populations may not be coupled with corresponding increases in native pollinator conservation (Pleasants, 1980).

Honey bees are a flagship species, well known and able to facilitate broader knowledge and financial support for conservation of other species (Andelman and Fagan, 2000, Guiney and Oberhauser, 2009, Walpole and Leader-Williams, 2002). As a result, the public is generally familiar with and motivated to support *Apis mellifera*, but know little else about the diversity or status of other bee species (Royal Mail, 2015, Wilson, et al., 2017). Conversely, honey bees may detract from native pollinator species since honey bees often directly compete for the same resources and can vector disease to native pollinators (Cane and Tepedino, 2017, Fürst, et al., 2014, Thomson, 2004). Native bees also perform pollination services to crop and non-crop plants that may not be provided by honey bees (Klein, et al., 2007, Winfree, et al., 2007).

Given their importance to agriculture, honey bees are typically viewed as more similar to domesticated livestock among ecologists (Colla and MacIvor, 2011, Geldmann and González-Varo, 2018), private goods much like hogs and cattle, than to wildlife. Virtually all other insect pollinator species are more akin to common goods, and therefore are in particular need of public policy for their protection.

However, it is unclear how the general public's perceptions and the current conservation policies may incorporate these important distinctions. Furthermore, since honey bees to some extent represent the conflict between agricultural and nature, it can be suspected that beekeepers may not support conservation of other types of native pollinators as much as the general public. Nevertheless, since all pollinators are sharing the similar threat of species population reduction, experience with honey bees, particularly hobby beekeeping may induce additional willingness to engage in conservation for native pollinators. This leads to the central objectives of this analysis:

(1) Determine the Willingness to Pay (WTP) among the general public to support native, solitary pollinator species distinct from honey bees.

(2) Measure if beekeepers have different perceptions and WTP for native, solitary pollinators to the general public.

Conclusions from our analysis are crucial to policymakers to improve their instruments to offer the best support for not only honey bees but also other pollinator species. We answer these questions by estimating and comparing WTP for solitary pollinator conservation among beekeepers versus the general population using data collected in the state of Louisiana. In addition, we compare hobby beekeeping with other outdoor recreational activities to discern whether hobby beekeeping leads to substantially greater WTP relative to other mechanisms for increasing environmental cognizance.

Literature Review

Even as some species face massive die-offs and have received increased public attention, the existence value of insects is rarely quantified, especially prior to the 2010s. As suggested by meta-analyses (Loomis and White, 1996, Richardson and Loomis, 2009) almost all of the threatened, endangered, and rare species featured in valuation studies were mammals, birds, or sea life, many of which are charismatic megafauna, species favored by the public on the basis of size and conservation status, typically including large birds and mammals.

Instead, valuation for insects is most often done for ecosystem services such as pollination services or waste processing (Gallai, et al., 2009, Losey and Vaughan, 2006), use value for human consumption (Verbeke, 2015), as well as ecosystem dis-services such as crop destruction (Zhang, et al., 2007). Recently, beekeeping and pollination services have been studied more closely as an agricultural input and industry (Ferrier, et al., 2018, Goodrich, 2017). Few studies have considered other non-use values of insects such as existence values.

Not all individuals enjoy thinking of insects, including bees (Schönfelder and Bogner 2017). It may be a factor leading to the lack of valuation research and public attention to insects, which may further contribute to their population decline (Pitt and Shockley, 2014). While insects are hardly megafauna, some are still arguably charismatic or flagship species. Flagship species are often used as symbols to increase public awareness or financial support for conservation (Simberloff, 1998, Walpole and Leader-Williams, 2002). A prime example is a type of pollinator, monarch butterfly (*Danaus plexippus*). The monarch has received public attention, with over 22,000 monarch waystations (mini-habitats specifically designed to provide resources for monarchs), a nationwide tagging program, and organized conservation efforts by a multitude of local and national organizations. Diffendorfer, et al. (2014) estimated a one-time WTP of $4.8-6.6 billion to support Monarch butterfly conservation.

Few studies of WTP for use or non-use values of insect pollinators other than monarch butterflies exist (Khachatryan, et al., 2017, Mwebaze, et al., 2018). These studies are quite general in species conservation they are valuing. For example, Mwebeze et al. (2018) elicited WTP for a bee protection policy ‘to maintain bee populations at the current level,’ generating approximately £43 per household per year (Mwebaze, et al., 2018). Khachatryan, et al. (2017) and Wollaeger, et al. (2015) found positive WTP for a ‘pollinator-friendly’ and ‘bee-friendly’ attribute, respectively, for potential purchases of houseplants.

The concern on these non-use pollinator valuations is their generality. Because of their widespread attention, honey bees are likely at the forefront of the respondents' minds as they respond to these elicitations, even though they are neither native nor wildlife. Yet consumers desire to attract other orders of insects beyond bees (Campbell, et al., 2017). A challenge is then on how to disentangle the conservation effort for honey bees and other pollinators.

One way to differentiate honey bees from other pollinators is via bee hotels/houses (hereafter 'hotels'). These bee hotels are typically used by solitary bee species, which are the majority of roughly 4,000 native bee species to North American, that require different types of nesting sites than honey bees. Honey bees are a social insect species, living in colonies of 30-50 thousand bees, so typically reside in Langstroth hives and do not benefit from bee hotels. Using the natural separation of bee hotels enables this paper's investigation of values of bee species distinct from honey bees and the impact of beekeeping experience on willingness to support native pollinators.

Methods

In order to estimate WTP for solitary bee conservation, a survey of the general public and beekeepers was conducted using a dichotomous choice elicitation. The surveys began with sections unique to each of the relevant samples, all of which made up about the first half of each survey. Section 1 of the beekeeper survey focused on their practices and their concerns and methods of maintaining honey bee health. Section 1 of the general public survey centered on preferences and purchasing habits of honey, followed by demographics. Section 2 was common across samples, querying for knowledge of honey bees, honey bee identification, and knowledge and opinions towards other pollinators. Section 3 was also presented in all surveys, containing all valuation-related questions.

To reduce the potential for differences due to informational/knowledge differences, all participants received an information treatment related to honey bees and native pollinators. The information was intentionally kept brief to minimize the chance of skipping the information. Focus group participants and debfriefings with pilot survey respondents indicated the information was reviewed. The information was provided in section 3 of the survey just prior to the bee hotel elicitation as the following:

"Fast Facts:

- While honey bees are important to US agriculture, pollinating $15 billion in US crops each year, they are not native to North America.
- Native pollinators to North America are also important contributors to crop pollination.
- USDA research has shown a significant decline for both native pollinators and honey bees throughout the US."

The elicitation itself was posed as a single-bounded dichotomous choice question as in Figure 1. This elicitation method is incentive compatible (Carson, et al., 2014). Respondents saw a price of either $10, $20, or $30, matching prices commonly seen in various physical and online retailers for similarly sized bee hotels.

[Figure 1 about here]

One potential shortcoming that may affect the efficacy of this strategy for solitary bee conservation is that relatively little information exists related to the connection between the installation of bee hotels and their ability to increase native bee populations as well as for which species (Barthell, et al., 1998, MacIvor and Packer, 2015). While other conservation strategies such as restoring land in agricultural production to native grasslands and prairie are shown to be effective (Morandin, et al., 2016, Ponisio, et al., 2016), they suffer from low adoption. Furthermore, based on focus group discussions, after reviewing the bee hotel description, respondents expressed belief that the survey's pictured bee hotel is related to native pollinator conservation.

An ongoing concern with stated preference elicitation is Hypothetical Bias (HB), describing the difference between a stated hypothetical decision and an actual decision in real life (List and Gallet, 2001, Penn and Hu, 2018). Several steps were taken to ameliorate this issue in our survey. Prior to the WTP question on bee hotels, respondents received a short Cheap Talk reminding them of their budget and to answer as if it were a real purchase, which has been shown to systematically reduce economic values (Penn and Hu, 2018). Secondly, respondents who answered yes in the elicitation answered a two-level qualitative certainty follow-up question, answering either "Definitely Sure" or "Probably Sure," which has been shown to be effective at reducing HB as well (Blomquist, et al., 2009). All respondents who answered 'Probably Sure' are recoded to no responses in the certainty-adjusted models, decreasing the proportion of yes responses and the corresponding WTP. The two techniques have been shown to be complementary in reducing HB (Penn and Hu, 2018, Whitehead and Cherry, 2007).

Another important element of incentive-compatible elicitation is consequentiality. An agent must care about the outcome and believe their choice has an influence on the outcome to be considered consequential. To implement this, we follow ex-post consequentiality approach (Interis and Petrolia, 2014), asking respondents the extent to which they believe installing a bee hotel/bee house can help solitary bee conservation on a 5-point Likert scale. Respondents who answered at the lowest level “1-Not at all” are excluded as inconsequential.[1] Relatedly, those who said no in the elicitation also received a follow-up question to screen for protestors.

Data Collection and Model Approach

To conduct this analysis, two separate surveys targeting on different types of respondents were implemented in fall 2018, each receiving prior IRB approval.

The beekeepers survey was conducted in-person at the annual Fall Field Day (October 27, 2018) held at the USDA-Agricultural Research Service Honey Bee Breeding, Genetics and Physiology Laboratory in Baton Rouge, LA, co-sponsored by the Louisiana Beekeepers Association (LBA), and at the LBA’s annual convention (December 7, 2018) in Sulphur, LA, roughly 140 miles apart.[2] These events attract beekeepers from the state and region of many levels including beginners with little to no experience, experienced hobbyists, as well as commercial beekeepers.

The primary and advertised purpose of the beekeeper survey was to understand beekeepers’ practices and opinion related to their bees, especially *Varroa* mite management as well as other issues related to honey bee health. The survey was provided as both a QR code linking to an online Qualtrics link available on provided tablets or respondents’ phones. For participating, participants received a test kit for *Varroa* mite (*Varroa destructor*), an attractive incentive among beekeepers since Varroa is cited as the most common stressor of colony health (US Department of Agriculture (USDA), 2017b) as well as being entered into a drawing for a number of door prizes.

[1] To be precise, this question addresses ‘policy consequentiality’ but ignores ‘payment consequentiality’ (Herriges et al. (2010). The effect of excluding these inconsequential respondents led to a slight increase in WTP, similar to other such ex post consequentiality analyses (Interis and Petrolia, 2014).
[2] Attempts were made to solicit participation using online distribution, but received minimal participation.

To be consistent with the in-person beekeeper sample, the general public sample was also collected as an in-person survey through random intercept in the summer of 2018. Potential respondents were queried on their participation in a survey on their food preferences and its connection to the environment. Responses were collected at various public-oriented area events and parks in Baton Rouge, LA. Each participant received a half-pound bottle of honey for participating. As self-selected honey consumers, these general public respondents do not reflect the average Louisiana consumer or respondent. To maintain data quality, attention-check questions were included in each of the surveys using a synonym matching game as in Howard, et al. (2017). Because the answer to the first synonym was provided in the question's instructions, and those who incorrectly answered the first synonym question were excluded from the analysis.[3]

To model the single-bounded dichotomous choice data on WTP for bee hotels, we rely on the parametric approach following Cameron (1988), using logistic regression to control for observable respondent characteristics as in equation (1).

$$Prob_j[Yes = 1] = 1/\left(1 + \exp\left(-(\boldsymbol{\alpha z_j} + \beta t_j)\right)\right) \quad (1)$$

It shows that the dependent variable, the probability whether respondent *j* states yes or no to purchasing a bee hotel, is a function of the vector of respondent characteristics ***z*** and the bid price *t*, with **α** and β as parameters to be estimated using maximum likelihood. The data collected through the two surveys are modeled as one dataset along with indicators for the relevant samples, with the general public sample as the reference group. Additional characteristics are considered, which feature demographic characteristics as well as respondents' knowledge of and

[3] The attention check question excluded zero respondents in the beekeeping sample and 10 respondents in the general public sample.

attitudes towards bees and pollinators. These variables will be explained in detail in the next section. The median WTP is derived as equation (2), using the vector of independent variable coefficients $\hat{\boldsymbol{\alpha}}$ and each corresponding variable measured at sample mean over the bid coefficient $\hat{\beta}$:

$$WTP = -\left(\frac{\hat{\alpha}}{\hat{\beta}}\right)'\bar{\mathbf{z}} \tag{2}$$

We include four model specifications. Model 1 is for the main effects based on the raw yes and no responses in the dichotomous choice elicitation and Model 3 utilizes the certainty-adjusted yes and no responses. Models 2 and 4 are equivalent to 1 and 3, respectively, but include interactions of the beekeeper sample with the Likert questions to distinguish how beekeepers attitudes' may affect WTP differently than the general population. All models were run in Stata 15.1.

Results

After removing inattentive and incomplete responses, 138 respondents from the beekeeping sample and 265 respondents from the Baton Rouge general public honey consumers sample are used in the analysis. Table 1 provides a summary of the demographic characteristics of the two survey samples as well as the Baton Rouge and Louisiana general population. Beekeepers are dissimilar to both the Baton Rouge and Lousiana general population. Compared to the Baton Rouge or Louisiana population statistics, beekeepers tend to be older, more well-educated, male, and white. While relatively little information is publicly available, these characteristics seem to match historical norms of beekeepers (Daberkow, et al., 2009). Due to concerns of privacy, relatively little information was allowed to be collected from beekeepers. This includes not being permitted to collect income information. One additional caveat is that self-selection may occur since beekeepers who attend formal beekeeping events as approached to conduct the current survey may be dissimilar from other beekeepers. As far as we know, no state demographics of beekeepers are publicly available. We have no specific expectation as to the direction of the effect of these variables on the probability of saying yes.

[Table 1 about here]

In addition to the demographic characteristics, other relevant aspects describe the sample of beekeepers. The majority (56.5%) maintain 1-4 colonies and another 22.5% maintain 5-10 colonies. With respect to beekeeping experience, 29.0% have less than one year of experience, and 30.4% have 1-3 years of experience. Lastly, the three most frequently cited reasons for keeping bees were 'personal enjoyment' 'honey for personal use' and 'to help the environment.' This suggests that the sample is composed primarily of hobby beekeepers and not commercial beekeepers.

To continue, it is important to establish to what extent knowledge and attitudes may be different across the samples. All groups were asked to identify a honey bee in a lineup of six similar looking insects and shortly thereafter to identify, in a multiple choice question, which among six other types of creatures were pollinators (moths, wasps, spiders, dragonflies, flies, and beetles; all but dragonflies and spiders are pollinators). In addition to the six options, respondents could also state they were unsure for either question. Results appear in Table 2. As expected, beekeepers had the highest proportion (94.2%) of correct responses in identifying the honey bee and 67.5% of the general public respondents correctly answered. With respect to being able to identify other pollinators, beekeepers have the smallest percentage of stating being unsure. In comparing the samples' respondents who did identify other pollinators, beekeepers had 3.86 correct responses (out of 6), significantly more than the general public sample (3.31).

[Table 2 about here]

A separate set of Likert-style questions also measured respondents' knowledge of and attitudes towards honey bees as well as other pollinators, as seen in Table 3 along with an anticipated effect sign of each variable: either '(+)' or '(-)' on the probability of willing to pay for a bee hotel. If there is no expectation, '(/)' is used. All knowledge and attitude variables are measured on a 5 point Likert scale, where 1 is Strongly Agree and 5 is Strongly Disagree. For example, an increase in the reported value of the variable *Biodiversity* corresponds to the person more strongly disagreeing with the statement that 'Insect biodiversity is important,' so should have a negative effect on the probability of saying yes to purchasing a bee hotel.[4]

[Table 3 about here]

For many of the statements, beekeepers are similar to the other samples. They generally believe that honey bees are important food production, to the environment, and know that honey bee population has been in decline. Beekeepers are significantly more likely to know that honey bees are not native to North America and be more uncertain towards the statement that the US produces a majority of its own honey, when in fact most honey is imported (ERS, 2018). Lastly, all groups tend to agree with the statement that honey bees are more similar to wildlife than to livestock, counter to ecologists (Colla and MacIvor, 2011, Geldmann and González-Varo, 2018). With respect to their connection to other insects, beekeepers agree significantly more that honey bees are more important to them because of honey production, but also care more about insect biodiversity, and demonstrate more awareness by acknowledging that bees can spread illness to other insects.

[4] These queries on knowledge and attitude were conducted prior to the "fast facts" and the WTP elicitation in the survey. As a result, we do not expect the information in the "fast facts" may affect the answers to these questions.

These results show that beekeepers are generally more knowledgeable about facts of honey bees and honey production as well as other pollinators. Together with the facts that both samples appeared care about other pollinators beyond honey bees, if honey bees may act as a flagship species for other pollinators, it is important to differentiate and quantify the support to the other pollinator species. Although little difference appears to exist between the general public and beekeepers in terms of their response to the single attitude question regarding the other pollinators, given the many differences across these groups identified in Table 3, it is crucial to further compare whether beekeepers may value native pollinators differently.

Model Estimation Results

Turning to the elicitation to support solitary bees, Table 4 presents the percentage of respondents who stated they were willing to purchase a bee hotel, both with and without a certainty calibration, as well as the associated Turnbull lower bound of WTP (Haab and McConnell, 2002). The results largely follow expectation in each of the samples, namely that the proportion of yeses decreases as price increases, and that the proportion of yeses drops considerably with the certainty correction. A comparison of the Turnbull lower bound estimates of WTP show that beekeepers appear to have significantly higher WTP relative to honey consumers regardless of certainty.

[Table 4 about here]

Results of the econometric analysis following equation (1) are shown in Table 5. These models reflect preferred specification after some preliminary analysis exploring different characterizations for beekeeping experience as well as its related interactions (e.g., ordinal versus the current dummy variable approach). The likelihood of purchasing a bee hotel is found generally unrelated to the reported demographic characteristics, which are subsequently dropped with little effect on remaining coefficient estimates. As well, certain variables from Table 3 with (/) predictions (Surivival, Imports, and US Food) demonstrated no evidence of statistical significance in any model specification and therefore are excluded from analysis.

[Table 5 about here]

Models 1 and 2 are based on survey participant raw responses to the bee hotel WTP question while Models 3 and 4 are based on certainty calibrated response where uncertain responses are recoded as no responses. Compared to the baseline Model 1, Model 2 includes additional variables reflecting the interactions between beekeeping experience and respondent knowledge and attitude variables. A similar distinction is characterized by Model 3 and 4. In the modeling process, initially both dummy variables indicating one to three years of beekeeping experience and greater than or equal to three years of experience are used to create the interactions. However, such an approach produces strong multicollinearity thus only one dummy variable indicating whether a respondent has ever had beekeeping experience is used to generate the interactions. Likelihood ratio tests demonstrate usefulness of the additional interactions of knowledge and attitudes with the beekeeper indicators in the certainty calibrated Model (4) (p-value=0.031), but not in Model 2 based on raw response data (p-value=0.160).

As expected, the price of the offered bee hotel is significant and negative across all models. Beekeepers are significantly more likely to purchase a bee hotel compared to the general public but this effect is only significant in the certainty calibrated models. For the rest of the variables in Table 5, we first interpret the main effects, which represent those who do not have beekeeping experience. Variable *Correct Honey Bee* is insignificant in all models suggesting respondent WTP for bee hotel is not related to whether they could correctly identify honey bees.

Variable *Native* is significant and positive in the extended models (Model 2 and 4), consistent with expectation. It suggests that the general public respondents who recognize that honey bees are not native to North America are more willing to support native pollinators. Variable *Disease* is significant in the certainty calibrated models, suggesting that respondents who believe honey bees may transmit disease and parasites to native pollinators are less likely to purchase a bee hotel, an unexpected result. Variable *Wildlife* is only marginally significant in Model 4 and has an unexpected sign, which contrasts to variable *Environment* in the same model and has the expected sign. As suggested by the significant and positive sign of variable *Other Pollinators* in Models 3 and 4, when respondents are concerned about other pollinators, they are more likely to pay for a bee hotel. Variable *Honey Production* also has the expected sign although it is only marginally significant in Model 1. Finally, *Biodiversity* is highly significant in all four models and has the expected sign: respondents who believe biodiversity is important for pollinators are more likely to support the purchase of a bee hotel.

The interacted variables reflect willingness to purchase bee hotels by beekeepers relative to the general public. As shown by Model 4, beekeepers who believe honey bees are not native to North America are much less likely to pay for a bee hotel than the general public who have the same knowledge. Beekeepers who believe honey bees may transmit disease and parasites to other pollinators are more receptive to purchasing a bee hotel than their general public counterparts. Beekeepers thinking honey bees are important for the environment are less likely to pay for a bee hotel compared to the general public but they are more likely to purchase a bee hotel than the general public when both groups believe honey production is important. Finally, as suggested by Model 2, beekeepers have reduced WTP for bee hotels compared to the general public when the two groups have the same level of perception on the importance of insect biodiversity.

Table 6 encapsulates the differences between beekeepers and the general public by calculating the underlying WTP based on equation (2). We further differentiate beekeepers based on their experience as well as WTP estimates according to whether the raw data or the certainty calibration was applied. The general directions of WTP measures are consistent with those in Table 4. Some evidence indicates that the general public are willing to pay for a bee hotel at a positive amount suggesting their support of native pollinators. However, this may be an artefact of HB. Shown by the insignificant certainty calibrated WTP, the general public do not appear to have significant values attached to native pollinators. With some variations, the central trend shows that beekeepers are willing to pay more for bee hotels thus are more likely to support native pollinators than the general public. Interestingly, among beekeepers, the experience with beekeeping does not appear to affect WTP indicated by the overlapping WTP confidence intervals.

[Table 6 about here]

Discussion and Implications

Despite the abundant use and non-use values pollinators provide, their population in North America has suffered sharp declines in recent decades. Honey bees, although not native to North America, are important both in their ability to support and to detract from pollinator conservation. On the one hand, honey bees are a flagship, drawing attention to the plight of pollinators to the general public. On the other hand, they also compete for resources with other pollinators and are sometimes considered more similar to livestock than wildlife, therefore in less need of conservation efforts. Often being overshadowed by honey bees, conservation effort as well as public perceptions on native pollinator conservation is not clearly defined. To better guide conservation and policy, this analysis seeks to first study the value of native pollinators and based on it, whether or not beekeeping is in fact related to greater support in terms of economic values for non-honey bee species.

Our results show that although pollinators are generally regarded as important and valuable by the scientific community, the general public do not have strong values associated with non-honey bee species, consistent with our speculation that public support for pollinators may be concentrated on honey bees but not on the less known species. On the other hand, honey beekeepers do appear to value other pollinators significantly more than the general public. As a result, our findings support the notion that regardless the possible competition between honey bees and the other pollinator species, beekeeping is related to conservation of all pollinator species. Furthermore, although the length of beekeeping experience does not affect willingness to support pollinator species other than honey bees, significant differences exist between the WTP of beekeepers and the general public through their different knowledge level of pollinators and attitude toward pollinator conservation.

Results of this study call for continued public support and education for pollinator conservation, particularly for native species. The current public support for pollinator conservation appears to have been drawn to honey bees. For native pollinator species to survive, education needs to reach to a broader audience. While beekeepers might be more aware and willing to contribute to overall pollinator conservation, other means to raise public awareness is needed.

Figure 1: Elicitation

"About 30% of native bee pollinators in North America are solitary bees, such as carpenter bees and mason bees, which need a different kind of home versus honey bees. One way to support solitary bees is to install a permanent nesting habitat, known as a 'bee hotel/bee house.' They are about the same size as a birdhouse and can be installed in a yard or porch such as the one pictured below.

Would you be willing to buy and install one such bee hotel for $X?"

Table 1: Summary Statistics of Sample Respondents

	Beekeepers Sample	General Public Sample	Baton Rouge Pop[1]	State Pop[1]
N	138	265		
Age				
18 - 34	8.0	54.5	43.5	32.0
35 - 64	63.0	39.6	40.0	50.0
65 or older	29.0	6.0	16.5	18.0
Gender				
Female	37.0	62.7	52.5	51.1
Male	63.0	37.3	47.7	48.9
Education				
High School or less	16.7	10.1	38.1	50.2
Some College	30.4	29.1	34.9	28.9
4-year or more	52.9	60.8	27.0	20.9
Race				
White	94.2	57.1	38.6	62.6
Black	2.20	29.5	54.8	32.2
Asian	0.0	6.3	3.6	1.7
Race-Other	3.6	7.1	2.9	3.5
Beekeeping				
<3 years experience	59.4	0.0		
≥3 years experience	40.6	0.0		
In Beekeeping Club	71.0	0.0		

[1]Based on the American Community Survey

Table 2: Identification of Honey Bees and Other Pollinators

	Beekeepers Sample	General Public Sample
Honey Bee Question		
Correct Identification	94.2%	67.2%*
Unsure	0%	5.28%*
Pollinator Question		
Correct Identification[#]	3.86	3.31*
Unsure	14.5%	34.7%*

* indicates significant differences (2-tailed p-value<.05) between the beekeepers and general public samples.

The highest possible score is six in which the respondent selects the four pollinators, moths, wasps, flies, and beetles, but does not select spiders nor dragonflies, which are not pollinators.

Table 3: Knowledge and Attitudes towards honey bees and other pollinators

	Beekeeper Sample	**General Public Sample**
Knowledge (1-Definitely Agree, 5-Definitely Disagree)		
Native: Honey bees are a native species to North America. (+)	4.02	2.62*
Survival: The rate of honey bee colony survival from year to year has *increased* in the past 10 years. (/)	3.47	3.45
Imports: The US produces a large majority of its own honey rather than from imports. (/)	2.95	2.55*
Disease: Honey bees can transmit disease and parasites to native pollinators. (-)	2.70	3.22*
Attitude (1-Definitely Agree, 5-Definitely Disagree)		
Wildlife: Honey bees are more similar to wildlife than to livestock. (-)	2.28	2.35
US Food: Honey bees are important to US food production. (/)	1.17	1.42*
Environment: Honey bees are important to the environment. (-)	1.14	1.25
Other Pollinators: Excluding honey bees, I'm *not* concerned about other pollinators. (+)	4.18	4.03
Honey Production: Honey bees are more important to me than native pollinators because of honey production. (+)	2.67	2.98*
Biodiversity: Insect biodiversity is important. (-)	1.47	1.95*

* indicates significant differences (2-tailed p-value<.05) between the Beekeepers and Baton Rouge samples.

Table 4: Turnbull WTP

	Beekeepers %Yes, %CertainYes*	**General Public %Yes, %CertainYes**
$10	72.0, 58.0	67.1, 41.2
$20	66.7, 55.6	51.7, 27.0
$30	64.7, 44.1	42.9, 24.2
Turnbull lower bound (Variance)	20.34, 15.77 (1.49, 1.67)	16.16, 9.23 (0.81, 0.71)

* %Yes and %CertainYes represent the percentage of respondents indicated they would purchase the bee hotel using raw responses and using the certainty follow-up to recode responses, respectively.

Table 5: Model results for purchasing a bee hotel

	1. Base Model	2. Extended Model	3. Certainty Calibrated Base Model	4. Certainty Calibrated Extended Model
Intercept	0.689 (0.786)	0.514 (0.973)	-1.626* (0.838)	-2.238* (1.168)
Price	-0.040*** (0.014)	-0.041*** (0.014)	-0.032** (0.014)	-0.038** (0.015)
Beekeeper <3 years experience	0.410 (0.333)	1.473 (1.578)	0.84*** (0.317)	2.259 (1.67)
Beekeeper ≥3 years experience	-0.227 (0.385)	1.059 (1.626)	0.693* (0.368)	2.301 (1.722)
Correct Honey Bee	0.134 (0.274)	0.113 (0.302)	0.427 (0.301)	0.374 (0.336)
Native	0.121 (0.098)	0.285** (0.142)	0.014 (0.094)	0.235* (0.135)
Disease	-0.022 (0.118)	-0.043 (0.161)	0.205* (0.115)	0.449*** (0.168)
Widlife	0.018 (0.106)	0.104 (0.149)	0.084 (0.103)	0.259* (0.152)
Environment	-0.131 (0.174)	-0.338 (0.247)	-0.104 (0.185)	-0.58* (0.321)
Other Pollinators	0.167 (0.110)	0.219 (0.142)	0.249** (0.117)	0.311* (0.166)
Honey Production	0.189* (0.104)	0.214 (0.136)	0.073 (0.100)	-0.113 (0.134)
Biodiversity	-0.597*** (0.129)	-0.78*** (0.164)	-0.484*** (0.140)	-0.602*** (0.185)
BK*Correct Honey Bee		-0.051 (0.903)		0.185 (0.892)
BK*Native		-0.333 (0.214)		-0.389* (0.202)
BK*Disease		-0.114 (0.246)		-0.551** (0.243)
BK*Wildlife		-0.182 (0.214)		-0.321 (0.21)
BK*Environment		0.412 (0.399)		0.86* (0.462)
BK*Other Pollinators		-0.135 (0.233)		-0.159 (0.24)
BK*Honey Production		-0.077 (0.220)		0.365* (0.211)
BK*Biodiversity		0.573** (0.283)		0.404 (0.296)
Number of obs.	403	403	403	403
Log-likelihood	-231.76	-225.03	-228.13	-222.80
AIC	507.692	500.428	511.526	498.059

Table 6: Willingness to Pay

	Raw WTP (Based on Model 2 in Table 5)	Certainty Calibrated WTP (Based on Model 4 in Table 5)
Beekeepers with 1-3 years experience	$42.71 (72.33 13.09)*	$23.17 (45.53 2.81)
Beekeepers with ≥3 years experience	$32.62 (58.27 6.97)	$24.28 (45.07 3.49)
General Public	25.77 (48.85 2.69)	-$4.63 (0.06 -9.32)

*Confidence intervals are reported in parentheses and are based on the delta method.

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Appendix

- **Instrument for General Public Survey**
- **Instrument for Beekeeper Survey**