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**The Presence of Hypothetical Bias within Spatial Decay and Charismatic Species: An application of  
Monarch and Viceroy Butterflies**

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## Abstract

Researchers have regularly used stated preference methods to study species valuation and more recently to investigate spatial heterogeneity/distance decay in welfare estimates. Yet, Hypothetical Bias (HB) is an ongoing concern for stated preference methods. In this analysis, we investigate the presence of HB within distance decay in a choice experiment of monarch and viceroy butterflies. Further, monarchs and viceroys are similar except that the former is well known and at-risk, while the latter is unfamiliar but common. This comparison enables the identification of a specific form of value associated with rare species, which we term a charisma effect, and the extent of HB due to the charisma effect. Results show that there is HB and distance decay in value for both butterfly species, but HB in distance decay is only found for monarchs and not for viceroys. We find that a charisma effect for monarchs exists in the hypothetical valuation scenarios, but disappears when the valuation involves real payment. Using our results to modify previous investigations of rare species generates lower, more believable welfare estimates.

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## Introduction

Within environmental economics, observing non-use values is difficult either through markets directly or through revealed preference mechanisms. This has necessitated stated preference methods such as Contingent Valuation or Choice Experiments (CE). However, stated preference methods regularly generate welfare estimates, such as Willingness to Pay (WTP) measures, greater than what one would observe in a non-hypothetical situation, with the difference commonly known as Hypothetical Bias (HB).

A separate vein of research within stated preference approaches that has recently garnered attention is the recognition of spatial heterogeneity of welfare estimates such as distance decay or hotspots. Distance decay is the circumstance in which the value of a species or environmental site decreases as the person's physical distance from species or environmental site increases, all else held constant. Hotspots and patchiness refers to local spatial patterns beyond continuous homogeneity or continuous decay (Johnston and Ramachandran, 2014). A number of studies employing stated preference methods document the presence of spatial decay or patchiness and its potentially large impact on aggregate welfare estimates.

As far as we know, the few studies that consider distance decay focus on iconic species that are available only within a relatively small range of geographical location instead of rare but largely distributed species. Furthermore, no studies examining the existence of geographic impacts on WTP have included an elicitation mechanism involving actual payment, and therefore there has been no assessment of the extent of HB with respect to spatial decay. We investigate the presence of HB in a study of spatial decay using an application of butterflies.

This application of butterflies leads to the second primary contribution of this study. In the United States, monarchs (*Danaus plexippus*) are one of the most well-known butterflies, easily recognizable due to their vibrant orange color pattern. Recently, the monarch population

has plummeted to a fraction of its former size, so much so that its restoration was included as one of three primary goals in the “National Strategy to Promote the Health of Honey Bees and Other Pollinators” (Pollinator Health Task Force, 2015). Further, monarchs are currently under status review for inclusion on the endangered species list (US Fish and Wildlife Service, 2016).

Monarchs could be considered a charismatic species, one that is well known and recognizable by the public and used for broader conservation initiatives. However, Brown and Shogren (1998) suggested that such well-known species generate “suspiciously high” values, such that “less than 2% of all threatened and endangered species represented 1% of the 1995 US GNP,” evidence of HB. Our study design allows us to investigate a potential increase in HB due to charisma, a first for HB on studies of threatened, endangered, or rare (TER) species. We achieve this through comparing the values of monarchs to the viceroy butterfly (*Limenitis archippus*), which is nearly identical in its shape and appearance.

## Background

### **Distance Decay**

Studies on spatial decay were borne out of the need to generate more accurate welfare estimates of resources and amenities by including all relevant populations, especially those outside of the immediate vicinity of a resource. A resource’s total economic value is understated if non-zero values of people from more distance locations are excluded from the analysis, but may be overstated if the value is assumed to be equal to those closest to the resource. Sutherland and Walsh (1985) were among the earliest to document this negative relationship between value and distance, and studies continue to consider distance decay either in use or non-use values (del Saz Salazar and Menéndez, 2007, León, et al., 2016, Schaafsma, et al., 2012).

Rolfe and Windle (2012) outline four principle reasons for declining values over distance: 1) use value declines as people live further away, 2) more or different substitutes

become available as distance increases, 3) less ownership/responsibility for more distant environmental assets in different locations, and 4) lower awareness and knowledge of more distant environmental assets (Hanley, et al., 2003, Pate and Loomis, 1997, Sutherland and Walsh, 1985).

Recently, efforts have shifted from spatial uniformity or simple linear distance decay to whether there is spatial correlation in local areas that affect WTP. Johnston and Ramachandran (2014) found that most attributes did not exhibit global distance decay, but still found significant heterogeneity in WTP at the local level, termed patchiness. Campbell, et al. (2008) and Meyerhoff (2013) both find evidence of local spatial clustering in WTP. Recently, Johnston, et al. (2015) showed the importance of spatial clustering as it relates to the spatial scale under consideration (e.g. gathering responses within 50km versus 500km of a particular site), and that cold and hot spot WTP patterns can change with the spatial scale.

Yet, with the mounting evidence of spatial heterogeneity in WTP, so far, these values are obtained through surveys involving hypothetical valuation questions. In other words, respondents to these surveys do not have to actually pay what they indicated in the survey—a situation that could generate HB. It seems imperative to test the extent of Hypothetical Bias for these same measures.

HB in valuation is the difference between a welfare estimate, usually WTP, that stems from a hypothetical elicitation in which the respondent's decision has no real payment consequence, and a real elicitation, in which payment is binding.<sup>1</sup> Multiple meta-analyses have noted the consistent upward bias and its relevance across a variety of fields and types of goods and services (List and Gallet, 2001, Murphy, et al., 2005). To study this issue, we implement a

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<sup>1</sup>Akin to “payment consequential” as in Herriges et al. (2010).

real and hypothetical Choice Experiment on the willingness to support butterfly conservation in multiple locations involving different distances to the site of conservation. The application on butterflies also yields our second contribution, the charisma effect, as outlined below.

### **Butterflies and Charisma**

Monarchs are one of the most well-known butterflies in the United States, easily recognizable from its vibrant orange color pattern and its annual migration across North America. For a number of reasons, the monarch population has plummeted to a fraction of its observed size since tracking began in the mid-90's (Brower, et al., 2012, Jepsen, et al., 2015). The monarch butterfly was initially placed under status review for inclusion on the endangered species list (Kaufman, 2014) in 2014, with a final decision due in 2019 (US Fish and Wildlife Service, 2016). The Obama administration acknowledged this collapse in its release of the National Strategy to Promote the Health of Honey Bees and Other Pollinators (Pollinator Health Task Force, 2015). One of its primary goals is to “increase the Eastern population of the monarch butterfly to 225 million butterflies occupying an area of approximately 15 acres (6 hectares) in the overwintering grounds in Mexico.”

There are currently over 1,350 animal species<sup>2</sup> listed as endangered or threatened under the Endangered Species Act of 1973, which include some well-known species such as sea turtles, wolves, and bears. Approximately 76 peer-reviewed articles in economics have studied endangered species (Pandit, et al., 2015). Often economists and the public focus on “charismatic species.” Charismatic species are usually a large, easily identifiable species that have widespread

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<sup>2</sup> Statistics generated on 2017-02-08 from <http://ecos.fws.gov/ecp0/reports/box-score-report>

popular appeal and often used by achieve broader environmental goals (Ducarme, et al., 2013).<sup>3</sup> In this study, we define charismatic as being well-known by the public *and* being TER.<sup>4</sup>

Loomis and White (1996) analyzed 18 TER species' economic value collected via stated preference approaches, and a majority of these were oriented towards iconic birds or mammals.<sup>5</sup> Brown and Shogren (1998) later commented that the average value of the 18 species in total was about \$1000 per household, and if it were aggregated across all households, it would represent "1% of the 1995 U.S. Gross National Product, for less than 2% of all threatened and endangered species," values that many would deem "suspiciously high."<sup>6</sup> In reality, the aggregated WTP was \$953, but was made up of studies that reported annual WTP (\$362) as well as lump-sum WTP (\$591) for the various species. Annuitizing the lump-sum values generates an annual WTP of \$47.42<sup>7</sup>, so that a more accurate depiction of annual WTP is \$409.42, rather than the originally quoted \$1000. All the same, this represents WTP equal to \$644 in 2016 dollars, which many may still guess to be an overestimate.

One explanation of these seemingly high estimates could be that charismatic species represent broader support for biodiversity, not just for the species itself. Some portion of these

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<sup>3</sup> Verissimo et al. (2009) even identified which bird species were the strongest candidates to use in public campaigns.

<sup>4</sup> A widely-accepted definition 'charisma' does not seem to exist, and has been a point of controversy for some time (see Metrick and Weitzman, 1996). For instance, Walpole and Leader-Williams (2002) state that a charismatic species does not have to be endangered, but species must have a compromised conservation status in Clucas et al. (2008).

<sup>5</sup> Later expanded by Richardson and Loomis (2009) to 67 observations from 31 studies.

<sup>6</sup> To their credit, Loomis and White specifically state their purpose "is not to provide such aggregate estimates."

<sup>7</sup> Assuming a 5% discount rate and 20-year annuity.



values represent the additional WTP for those particular species' charisma, value beyond the normal economic values such as existence, option, or bequest.

Because valuation of charismatic species often relies on stated preference methods, another explanation of such inflated values is HB. With a few exceptions, underlying explanations of the persistence of HB are rare. Given the exceptionally high WTP estimates documented in previous works, we investigate the extent of additional HB due to charisma. In this case, the monarch butterfly has received a high amount of publicity and national attention to its plight, and could be considered a charismatic species useful to identify HB due to charisma.<sup>8</sup>

An ideal identification strategy would implement a split-sample design in which one group values a charismatic species, and the other values an identical, non-charismatic species. Because charismatic species are often megafauna (large, iconic mammals such as polar bears, lions, whales, etc.), formulating this type of design is extremely difficult using two real species because of the difficulty to identify a non-charismatic counterfactual. For monarchs, this question can be answered because of the existence of the viceroy butterfly. The viceroy and monarch butterfly are visibly nearly identical and have near identical ranges across North America, especially in the region pertaining to the study respondents.<sup>9</sup>

By comparing how individuals value monarchs and viceroys differently, the difference represents the charisma of the monarch. While monarchs, as insects, are not a perfect

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<sup>8</sup> In their review of economic studies of endangered species, Pandit et al. (2015) classify Monarchs as a charismatic species.

<sup>9</sup> The viceroy is slightly smaller and has one subtle difference in wing pattern. This similarity is known as Müllerian mimicry (Ritland and Brower, 1991), when two species mutually benefit from displaying the same warning signal. Focus groups and pre-test of our survey suggest that respondents cannot differentiate these two butterfly species beyond a random guess.

representation of previously studied charismatic species, this difference can provide one explanation of HB within the context of charismatic/TER species. Further, it contributes to the dearth of valuation literature on insects.

In summary, through a choice experiment, our experimental design enables us to address the following questions:

- 1) What is the extent of hypothetical bias for monarch and viceroy butterflies?
- 2) What is the extent of hypothetical bias with respect to distance decay for monarchs and viceroy butterflies?
- 3) As a measure of charisma, what is the additional WTP associated with monarchs compared to viceroys?

We combine the information to generate a rough correction for an estimated real value of the 18 TER species from Loomis and White (1996) as well as other implications.

## Study Design

### **Choice Experiment and Survey Design**

To answer our research questions, we utilized a 2x2 experimental design in conjunction with a CE. As a split-sample design, each participant in our study could be in one of four treatments: a real or hypothetical valuation and valuing either monarch butterflies or viceroy butterflies. The CE was designed with the goal of understanding values of butterfly conservation among participants from the city of Lexington, Kentucky. The CE's attributes and corresponding levels are described in Table 1.

The good presented to respondents was a donation to purchase and install plants that support butterfly conservation. This good was chosen for a number of reasons. The dearth of milkweeds and nectar plants for monarchs along their migration routes and summer breeding grounds is one of the primary theories for the monarch's dramatic decline (Flockhart, et al.,

2015, Pleasants and Oberhauser, 2013).<sup>10</sup> Installing plants for the monarch's benefit is a widely-accepted mechanism to support monarch conservation. Additionally, installing plants has the benefit of being tangible and divisible.

Participants were told that all donations go towards the purchase and installation of plant seedlings, each at a cost of \$1. The cost information was obtained and confirmed through checking multiple nurseries in or around the city. Similar to Ready, et al. (2010), this means the good is quasi-public, additional benefit to butterflies is only provided if the respondent donates, mitigating free-riding behavior. Given this information, a donation towards the installation of additional plants that support butterflies was chosen as the most credible good.<sup>11</sup> Upon multiple focus group and a pilot testing exercise, the potential donation between \$1 and \$10 is deemed reasonable.

Three non-payment vehicle attributes were part of the CE for installing plants: the location, site accessibility, and designation as a Waystation. The three locations, Paducah (McCracken County), Elizabethtown (Hardin County), Lexington (Fayette County), were deliberately chosen. All three are among the largest of Kentucky's statistical areas. Their separation is rather linear, avoiding the potential of directional effects as observed in Schaafsma, et al. (2012). The driving time, between Paducah and Elizabethtown and between Elizabethtown and Lexington is 2.5 and 1.5 hours, respectively. By keeping the benefit of donations within the state, it reduces the chance of potential geopolitical threshold effects which can be confound the

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<sup>10</sup> Inamine et al. (2016) demonstrate that this belief is not held universally by all entomologists.

<sup>11</sup> Other mechanisms may be possible. For example, one alternative is to donate to support monarch overwintering sites in Mexico. This has the disadvantage of being more abstract, create potential free-riding, generate potential geopolitical distortions, and most importantly, is inapplicable to viceroy butterflies.

with potential distance decay effects (Johnston and Duke, 2009, Rolfe and Windle, 2012, Van Bueren and Bennett, 2004). Distance was stressed to respondents in a number of ways. In the CE instructions, respondents saw a map of Kentucky highlighting each of the 3 locations to visually reinforce the distance of Elizabethtown and Paducah from Lexington as well as the estimated drive time to each from Lexington. These locations for installing plants that support butterfly conservation is the primary mechanism for testing for distance decay and will be explained in detail below.

The next attribute is the accessibility of each butterfly restoration site, such that a respondent could or could not physically visit and/or see a site. This is similar to Johnston and Ramachandran (2014). Access could be considered a measure of the respondent's option value.

Lastly, each location could become a certified Monarch Waystation, which included the installation of a corresponding sign, and described as supporting the conservation of many butterfly species.<sup>12</sup>

Respondents were informed that the Waystation certification and sign installation occur after a habitat is created, which means that the benefits to butterflies is independent of whether a habitat is a certified Waystation. Conversely, the designation and sign increase each a habitat's outreach and educational ability to the public. Each respondent answered six choice sets, with an example choice set featured in Figure 1.<sup>13</sup>

Figure 1 also shows that the CE used a repeated binary choice format, a first alternative with varying attribute levels, and a second opt-out alternative that provided no support for

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<sup>12</sup>To be truthful, respondents were informed there was no viceroy-specific Waystation program, but that Waystations promote butterfly conservation of many species, with listed some examples of other species.

<sup>13</sup> Image of the Waystation was used with permission from Monarch Watch.

butterfly conservation nor any payment by the respondent. This binary elicitation mechanism was chosen because a single binary choice can be incentive-compatible (Carson, et al., 2014, Vossler, et al., 2012) under certain conditions. These conditions are that respondents care about the outcome, that payment is enforceable, elicitation is a yes/no vote for a single project, and that likelihood of provision increases with proportion of yes votes.<sup>14</sup>

Further, Vossler, et al. (2012) show that with some additional conditions, a sequence of binary choices can still maintain incentive-compatibility. These are: that only one of the series of binary choice sets will be implemented, that provision in each choice set is independent of decisions in other choice sets, and that the characteristics in the choice set exactly correspond to the policy implemented and no other policy.

Some of these assertions may be rather strong in a field survey setting, but we will describe steps taken below to make such assertions more plausible. Correspondingly, we avoid a multinomial CE to circumvent the considerable doubt of its incentive-compatibility, formalized by the Gibbard-Satterwaithe theorem. The CE's design allow for tests of distance decay for values of monarch and viceroy butterflies.

To implement the CE, we use a full factorial design, using 36 two-alternative choice sets. Each respondent participated in one of six groups of choice sets, and each group contained six choice sets. After completing their choice sets, respondents assigned to a treatment requiring actual payment rolled a 6-sided die to determine which of the choice sets would be binding. If their answer in the binding choice set was to donate, the respondent immediately placed the

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<sup>14</sup> A single dichotomous-choice elicitation can be considered a specific form of a voting-style elicitation such that it is a referendum determined by one person, in which the person's vote entirely determines provision (Answering no means no provision nor payment with 100% certainty, and answering yes means provision and payment occurs with 100% certainty).

corresponding amount in a secured lock-box. Afterwards, they continued the survey until completion.

With respect to identifying differences in the value of monarch and viceroy butterflies, respondents read a brief description of only one butterfly species.<sup>15</sup> To ensure reading comprehension, each respondent answered several True-False questions on whether their butterfly's range included the entire state of Kentucky and whether their butterfly was considered a vulnerable species. Further, if respondents provided an incorrect answer, a brief message reminded respondents of the correct answer. This approach of reminding respondents improves respondent cognition of the range and status of each butterfly species. This design coupled with the similarity of the viceroy and monarch butterflies means any difference in values between the two species will likely be attributed to the charisma of the monarch butterfly, both in hypothetical and real valuations as well as associated HB. Beyond the CE, the survey included a variety of other questions such as attitude towards conservation, knowledge and interest in butterflies, as well as standard demographic queries. Our central hypotheses are:

#### Hypothetical Bias (H1)

H1<sub>0</sub>: hypothetical WTP is less than or equal to real WTP for both monarch and viceroy butterflies;

H1<sub>A</sub>: hypothetical WTP is greater than real WTP for at least one of the butterfly species, i.e. the presence of HB.

#### Distance Decay (H2)

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<sup>15</sup> Note that the description did *not* include a picture of the specific butterfly. Specifically, focus groups and pilot testing revealed that even though respondents read a description and saw a picture of a viceroy, they frequently associated the picture with a monarch butterfly anyway. To avoid confusion between the two butterflies, we choose not provide a picture of either butterfly.

H2<sub>0</sub>: WTP for a Lexington site is less than or equal to the WTP for an Elizabethtown site, and/or WTP for an Elizabethtown site is less than or equal to the WTP for a Paducah site, and/or WTP for a Lexington site is less than or equal to the WTP for a Paducah site, regardless of whether the treatment is real, hypothetical, monarch, or viceroy;

H2<sub>A</sub>: Distance decay holds between at least some of the three locations and in one of the treatments.

#### Distance Decay HB (H3)

H3<sub>0</sub>: Conditional on evidence to support HB (H1<sub>A</sub>), the extent of HB is equal for all three locations regardless of butterfly species;

H3<sub>A</sub>: HB is not equal across locations for at least one butterfly species.

#### Charisma (H4)

H4<sub>0</sub>: WTP for monarchs is less than or equal to that of viceroys for both the real and the hypothetical comparisons and regardless of locations;

H4<sub>A</sub>: WTP for monarchs exceeds WTP for viceroys in at least one of the treatments in one of the locations.

#### Charisma HB (H5)

H5<sub>0</sub>: Conditional on evidence to support HB (H1<sub>A</sub>) and charisma (H4<sub>A</sub>), the extent of HB for monarchs is less than or equal to that for viceroys;

H5<sub>A</sub>: HB for monarch butterflies is greater than HB for viceroy butterflies.

## Field Survey Implementation

We implement a field survey using the CE and experimental design described above. All respondents were from the single metropolitan community, Lexington, in the state of Kentucky.

This has the inherent benefit of mitigating differences in value due to proximity to the resource.

Similarly, because of both species ubiquity throughout the state, our analysis and sample focuses

almost exclusively on distance decay and avoids spatial cold or hotspots (Johnston and Ramachandran, 2014) when sampling over a larger scale.

Prior to launch, the survey went through multiple rounds of refinement based on four focus groups as well as a pilot survey. Surveys were completed on an internet-connected tablet, which allowed for treatment randomization and enhanced audio-visual communication with respondents. Specifically, after reading a description of their respective butterfly species, respondents watched a one-minute video for the CE instructions.

It is typical to provide text-based instructions, but focus group feedback demonstrated that communication via video instructions along with an example choice set in the video improved respondent comprehension when completing the CE choice sets. Respondents assigned to the real payment treatment group watched a slightly longer video in order to explain how the roll of a die would be used to determine the binding choice set. Additionally, a true-false question appeared immediately after the video with a statement to reaffirm that the respondent understood they would be expected to pay based on the roll of the die.

Surveys were collected during May, June, and July of 2016 on 51 occasions at 35 unique locations or events and occurred at least twice every day of the week at various times (e.g. morning, afternoon, and evening) throughout Lexington. Collection occurred as early as 8am to as late as 9pm, but responses tend to come from weekday afternoons/evenings and weekends. While each of the survey collection sites were outdoors, which is common for an environmental and resource valuation study, they did not necessarily focus on outdoor enthusiasts. For example, surveys were collected at a county fair, at a movie in the park, at playgrounds, at sports events, and at jazz festivals. This makes it possible for the sample to be qualitatively similar to the



general Lexington population, though we do not claim it is representative of the broader US population.

During each occasion, the same equipment and promotional material was used to provide a consistent visual presentation. To reduce interviewer bias, one survey enumerator was present at all events as well as an assistant enumerator, which rotated among five other individuals.

Once a potential respondent agreed to participate, they were seated in front of a tablet to begin the process. Prior to starting the survey itself, each respondent completed a separate exercise to earn \$10. This is to allow the respondents to treat the money as earned instead of windfall/house money, the latter of which may distort WTP (Clark, 2002, Loureiro, et al., 2003). To match the potential \$1, \$5, and \$10 payments in the real CE, both hypothetical and real respondents received five \$1 bills and one \$5 bill. To mitigate protests, real respondents were notified at the beginning the survey that they would have a chance, but not obligated, to make a real donation during the survey.

## Model Specification

Discrete choice models are based upon Random Utility Theory, which describes a person's utility from a particular good being composed of observable and unobservable components (McFadden, 1973). Equation 1 shows that individual  $i$  derives utility from selecting alternative  $j$  in choice set  $t$  with observable attributes  $X_{ijt}$  and the payment variable  $c_{ijt}$  and an unobservable component,  $\varepsilon$ :

$$U_{ijt} = -(\alpha_i/k_i) c_{ijt} + (\beta_i/k_i)' X_{ijt} + \varepsilon_{ijt} \quad (1)$$

Among the coefficients to be estimated,  $\alpha$  represents the effect of change in price while the vector for  $\beta$  yields the estimated effect of various attributes on their choice. The coefficients

are indexed by  $i$  to show that the effect of attributes varies across individuals, one of the primary advantages of conducting a mixed logit model based on (1).

The above specifications represent a model in parameter space. In typical parameter space models, the scale parameter,  $k_i$ , is inherent to but not separately identifiable in the model, and is assumed to be fixed, such that the unobservable component's variance is equal across respondents (i.e. homoscedasticity). This issue of scale has two important implications: 1) comparing coefficient estimates across samples is inappropriate due to scale differences, and 2) that the variability in unobserved utility is the same for all respondents, which can potentially bias other coefficient estimates in the model.<sup>16</sup> If  $\lambda_i = (\alpha_i/k_i)$  and  $h_i = (\beta_i/k_i)$ , then WTP,  $\omega_i$ , is simply  $h_i/\lambda_i$ , which eliminates the scale issue.

We address these parameter-space issues by modelling choices in WTP-space as in equation 2. Train and Weeks (2005) demonstrate its equivalence to parameter-space.

$$U_{ijt} = -\lambda_i [c_{ijt} + \omega'_i X_{ijt}] + \varepsilon_{ijt} \quad (2)$$

Equation 3 reflects WTP-space in our application, with  $\omega_i$  already reflecting WTP estimates per attribute, and  $\delta_i$  representing the change in WTP for the various treatment groups (Hypothetical-Viceroy, Real-Monarch, and Hypothetical-Monarch), relative to the reference group made up of Real-Viceroy respondents.

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<sup>16</sup> Train and Weeks (2005) mention other disadvantages of parameter-space models are that the price coefficient is usually fixed across respondents, implying a constant marginal utility of income. If a distribution is assumed, then the associated WTP, usually the ratio of a normally-distributed attribute coefficient to a log-normally-distributed payment vehicle coefficient, has undefined moments. Secondly, assuming independent parameter-space estimates of attributes implies correlated WTP across attributes.

$$\begin{aligned}
U_{ijt} = & -\lambda_i(\textit{Donation Amount}_{ijt} + \omega_1\textit{OptOut} + \omega_2\textit{Elizabethtown}_{ijt} \\
& + \omega_3\textit{Lexington}_{ijt} + \omega_4\textit{Public}_{ijt} + \omega_5\textit{Waystation}_{ijt}) \\
& + \delta_1(\textit{OptOut} * \textit{Treat}) + \delta_2(\textit{Elizabethtown} * \textit{Treat}) \quad (3) \\
& + \delta_3(\textit{Lexington} * \textit{Treat}) + \delta_4(\textit{Public} * \textit{Treat}) + \delta_5(\textit{Sign} \\
& * \textit{Treat}) + e_{ijt}
\end{aligned}$$

By having coefficients directly represent WTP, the issue of scale is removed. As seen in equation 3, it allows for data from different treatments to be pooled and directly test for differences by including interaction terms. Further, modelling in WTP space allows for scale heterogeneity across respondents, which is represented by the standard deviation of the payment vehicle.<sup>17</sup> Lastly, WTP-space assumes a distribution of WTP itself, such that the ratio is assumed to be normally distributed, rather than the problems of assuming a distribution for the numerator and denominator (see Carson and Czajkowski (2013)).

Formal comparisons of WTP space and parameter space remain relatively sparse. Nevertheless, several cases show that WTP space models produce more reasonable estimates of the distribution of WTP versus parameter space models (Hole and Kolstad, 2012, Scarpa, et al., 2008, Train and Weeks, 2005).

The opt-out constant represents a choice not to donate in a particular situation. It usually represents the disutility of being unable to consume the offered good with the base level of the various attributes. In our case, this is the installation of plants in Paducah, KY in a private location without the waystation designation (presumably the least valuable alternative possible).

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<sup>17</sup> Allowing for scale heterogeneity is also possible in parameter-space by using generalized multinomial logit (gmnl) models (Fiebig et al. 2010). In fact, Greene and Hensher (2010) show that WTP Space is a special case of gmnl.

We utilize a mixed logit model assuming that WTP for Opt-Out, Elizabethtown, Lexington, and Public are heterogeneous following a normal distribution while the Waystation attribute remains fixed. The Waystation attribute is specified with a non-random WTP measure because in various trial analyses, the standard deviation of this WTP measure is always insignificant. We use 250 Halton draws in WTP space. We rely on the delta method for a number of post-estimation comparisons of model results.

## Results

In total, 789 useable responses were collected in the field survey. Select socioeconomic characteristics of the sample respondents, both per treatment and collectively, are presented in Table 2.

First, based on demographic information, no significant differences exist in demographic characteristics across the four treatment groups. While the treatments are statistically similar, taken together, the sample is not perfectly representative of the community. It resembles the community reasonably with respect to age and gender, but dissimilar with respect to children and educational levels.

Across all treatments, a total of 141 respondents chose not to donate in all six of their choice sets. A follow-up question revealed that 55 were (34 from hypothetical and 21 from real) protest respondents, allowing for an analysis based on a total of 734 respondents.

### **Model Results**

Mixed logit WTP-space model results including treatment interactions are presented in Table 3. We first focus on the results of the baseline, Real-Viceroy respondents. Individual coefficient estimates follow expectations. Scenarios with higher requested donations are significantly less likely to be chosen, and publicly accessible locations are more likely to be chosen. We do not find evidence that the Waystation designation and associated sign as being

significant in affecting respondent choice. Lastly, we observe some evidence of distance decay in that the WTP for viceroy conservation is greater in Elizabethtown and Lexington, discussed in more detail below. Since the focus of this study is on HB and distance decay, in the following discussion, we base our interpretation on conservation sites located on private land (variable Public = 0) without a monarch Waystation designation or sign (variable Waystation = 0).

While it may seem peculiar to observe a significant and positive WTP for the opt-out alternative, this result is unsurprising in the current context. Because the donation is ultimately for the installation of plants for a non-endangered butterfly species in a distant location (not a representation of the species itself), it is reasonable to expect that, for many people, the utility of keeping their money for other activities would exceed the utility of a donation. In this case, viceroy respondents receive positive utility equal to \$4.81 to avoid making a donation. Equivalently, the dollar value of disutility from forcing a respondent to support viceroys is \$ -4.81. Since monarchs are well known and potentially endangered, we would expect and find that the disutility to support plants for its conservation to be smaller, equal to \$3.28 (\$4.81-\$1.53) in the Real-Monarch treatment and \$.08 (\$4.81-\$4.73) in the Hypothetical-Monarch treatment with the latter being insignificant from zero.

From the results of the standard deviations, we observe significant differences across individuals for each of the attributes. The significance of the donation amount means that there is significant scale heterogeneity across respondents. Furthermore, the standard deviations are roughly twice as large as their corresponding point estimates of WTP. This suggests an extremely wide range of values associated with butterfly conservation.

To begin our comparison across treatments, we first consider the extent of HB for viceroys and monarchs. If HB exists, WTP to opt out in hypothetical treatments will be closer to

0, indicating of smaller penchant to opt-out, all else equal. Because the coefficient of opt-out in Hypothetical-Viceroy is not significant, we cannot reject the null hypothesis,  $H_{10}$ , that there is no HB in the opt-out for real versus hypothetical viceroy respondents.

To determine HB for monarchs, we observe that the opt-out WTP for Real-Monarch ( $\$3.28 = \$4.81 - \$1.53$ ) is significantly greater than Hypothetical-Monarch ( $\$.08 = \$4.81 - \$4.73$ ) ( $p = .04$ ). This means there is evidence of HB for monarchs, supporting  $H_{1A}$ . Therefore, for the baseline location (i.e., Paducah), we have evidence of HB for monarchs, but not for viceroys.

Next, we consider distance decay. If distance decay exists, then we would expect that the coefficients of Elizabethtown and Lexington to be positive, with Lexington being larger in magnitude compared to Elizabethtown. In the Real-Viceroy treatment, compared to the reference location of Paducah, Lexington is statistically significant, with respondent WTP equal to \$4.36, but Elizabethtown is not significantly different. This supports  $H_{2A}$  for Real-Viceroy, there is distance decay, but rather than a linear decay, it is a sharp decline with relatively little value outside of Lexington.

We reach similar conclusions in support of  $H_{2A}$  for the Real-Monarch treatment. Since neither the Elizabethtown nor Lexington interaction coefficients are significant, the combined effect is still that Lexington conservation sites are associated with a larger value than sites in the other two locations. This again implies a similar distance decay pattern as for Real-Viceroy.

In order to test  $H_3$ , we examine WTP for the hypothetical treatments of monarch and viceroy at each location. Coupling this with real WTP information can let us determine HB in each location. Recall that the opt-out of Hypothetical-Viceroy was not significantly different to that of Real-Viceroy, suggesting no HB in the opt-out for viceroys. Once location is included, we find marginal evidence that WTP is higher for Hypothetical-Viceroy in Lexington. This implies

that there is some evidence of HB for viceroys in Lexington, but because the Hypothetical-Viceroy interactions for opt-out (representing Paducah) and Elizabethtown are not significant, there is no evidence to suggest HB with respect to distance decay for viceroys, supporting H3<sub>0</sub>. For monarchs, the significance of the opt-out for Hypothetical-Monarch is especially important. It indicates that, even while the WTP for Elizabethtown and Lexington are not significantly different from each other in the two monarch treatments, hypothetical WTP values exceeds real WTP in all three locations, which in turn means there is HB even in locations that are more distant. This is evidence of H3<sub>A</sub> for monarchs.

Figure 2 displays the WTP for in each location for all four treatments using all estimated location coefficients, regardless of statistical significance. To facilitate comprehension, we use the negative of the opt-out coefficients, again representing the value if forced to donate. This makes it clear that outside of Lexington, the WTP to support butterfly conservation is less than or equal to 0. In Lexington, only Hypothetical-Monarch and Hypothetical-Viceroy are significantly greater than 0 (both p-values < .01).

Another important comparison is to identify whether there is a premium for charisma received by monarchs relative to viceroy butterflies (H4), and if HB affects this premium (H5). If there is charisma, we would expect the WTP to opt-out to be closer to 0 for monarchs, in other words, the disutility of a forced donation should be smaller for monarchs.

Establishing the value of charisma can occur based on two comparisons of monarchs and viceroys, either real or hypothetical WTP. Based on the non-significance of the Real-Monarch opt-out coefficient compared to that of the Real-Viceroy, we observe no real charisma premium for monarchs and no evidence to reject H4<sub>0</sub>. In the second comparison of hypothetical treatments, we find evidence of a charisma premium for monarchs compared to viceroys. The

hypothetical WTP to opt-out for monarchs is \$.08 (\$4.81-\$4.73), while the hypothetical WTP to opt-out for viceroys equals \$4.63 (\$4.81-\$1.18), and the two are significantly different ( $p < .001$ ), which supports H4<sub>A</sub>.

These results provide at least initial evidence that charisma has a considerable effect on hypothetical WTP, but not on real WTP, therefore, HB may be more pronounced for a charismatic species versus their non-charismatic counterparts. This finding particularly calls into question of the previous analysis of the value of charismatic species based on hypothetical surveys. Using the results from Table 3 to test H5 on the difference in HB for monarchs and viceroys. We find a significant difference ( $p = .031$ ) in the HB of viceroys (\$4.63/\$4.81) to the HB of monarchs (\$.08/\$3.28) in Paducah. We attribute this difference in HB to the charisma effect, evidence to support H5<sub>A</sub>. A similar analysis can be completed for Elizabethtown or Lexington, but in both cases, there was no significant difference ( $p = .165$  and  $p = .211$ , respectively).

Given the evidence of additional HB for monarchs, and using hypothetical and real WTP for monarchs and viceroys, we have enough information to calculate the extent of HB for the charismatic species and how much of the HB is due to charisma, as seen in Table 4. In this calculation, we use the WTP estimates based on Lexington, while not significant, this approach facilitates interpretation and is most appropriate due its proximity to the respondents. A similar conclusion is reached using WTP in Paducah of the four treatments (also reported in Table 4).

In this case, we take the negative of the opt-out constant because making a donation to Lexington inherently means that the respondent faces the disutility of the opt-out combined with the utility of donating to Lexington. We observe that the difference between hypothetical and real WTP for viceroys and monarchs is \$2.84 and \$4.17, respectively. This means that monarchs



have about \$1.33 more HB, or about 31.9% of the \$4.17 difference between hypothetical and real WTP for monarchs.

Based on our estimates for charismatic species, it may be appropriate to reduce the total value of TER in Loomis and White (1996). We observe that the difference between hypothetical and real WTP for monarch conservation in Lexington is \$4.17, or approximately 83.1% of hypothetical WTP. If we apply this reduction to the \$409 for the 18 species from Loomis and White (1996) calculated earlier, the estimated real WTP decreases by \$301 to \$69  $((1 - .831) * 409)$ . In 2016 dollars, this is a correction from \$644 to \$109. While this a rough estimate, an average of \$6 per species is unlikely to draw the attention of economists as “suspiciously high.” Further, because of our previous model results, we estimate that 31.9% of the \$301 reduction is due to HB from charisma (\$95.89) and the remaining 68.1% (\$204.70) is from typical HB. For comparison, an even larger proportion (94.4%) of HB for monarchs in Paducah is attributable to the charisma effect.

As an additional check, we present the WTP per attribute for each treatment based on mixed-logit parameter space in Table 5. These results are based on the Krinsky-Robb approach using 5,000 permutations. Results are largely consistent in terms of sign, significance, and magnitude of the parameters.

## Conclusions

We investigate the extent of HB with respect to distance decay and charismatic species through a valuation of butterfly conservation. Based on this analysis, we find a number of results.

First, there is distance decay in WTP for both monarch and viceroy conservation; people prefer to support conservation in their own community compared to a more distant one. Given the ubiquity of monarchs and viceroys throughout the state, the sense of ownership to the

resource seems the most probable of Rolfe and Windle's (2012) four principal reasons for distance decay.

Second, when we compare hypothetical and real WTP across locations, we observe HB in distance decay for monarchs, but no such HB in distance decay for viceroys. There is still some evidence of HB for viceroy though because hypothetical WTP is greater than real WTP in Lexington.

Third, we find that WTP for monarchs exceeds viceroys in the hypothetical treatment, but not in the real treatment, it suggests there is a hypothetical charisma effect. On the other hand, WTP is equal to support monarchs and viceroys in the real treatments, indicating that the two species are valued equally and no evidence of a real charisma effect. Because the two butterflies are so similar, this means there is additional HB for monarchs compared to viceroys, evidence that the additional HB is due to a charisma effect.

Interestingly, many conservation organization use charismatic species as 'flagship species' as a way to improve fundraising and campaign effectiveness (Ducarme, et al., 2013). Our results show that, at least with respect to monarch butterflies, only hypothetical donations are likely to see a flagship premium, and the real benefits of a flagship species are much lower than what may be presumed. Equivalently, in most previous studies that used hypothetical survey to elicit public WTP for symbolic species, the suggested WTP may due to HB as well as charisma effect. If one uses a real WTP eliciting technique, it may reduce typical HB as well as HB from the charisma effect.

Some qualifications of the research design exist. First, our results of distance decay use locations within one state for a species that is nationally present. Similarly, our design varies the location where the conservation effort occurs while the respondent's location remains fixed.

Most distant decay valuation studies do the opposite, focusing on a resource at a fixed location and sampling respondents at varying locations.

Additionally, monarch butterflies, even if categorized as a charismatic species, are charismatic insects, which are not equivalent to charismatic mammals. Our finding that WTP reduction of \$831 for the 18 species in Loomis and White, \$265 (31.9%) of it stems from the charisma effect may be an underestimate. Compared to insects, mammals are relatively ‘more charismatic’, so would likely have a larger proportion of their inflated WTP due to the charismatic effect.

The question remains, why are charismatic species more likely to have HB? One explanation of HB in the context of species conservation that may be especially important is social desirability bias. Because of a charismatic species’ ubiquity, people generally know that the “correct” answer in society is to show support, financial or otherwise, easily achieved in a purely hypothetical survey.

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Figure 1: Example Choice Set



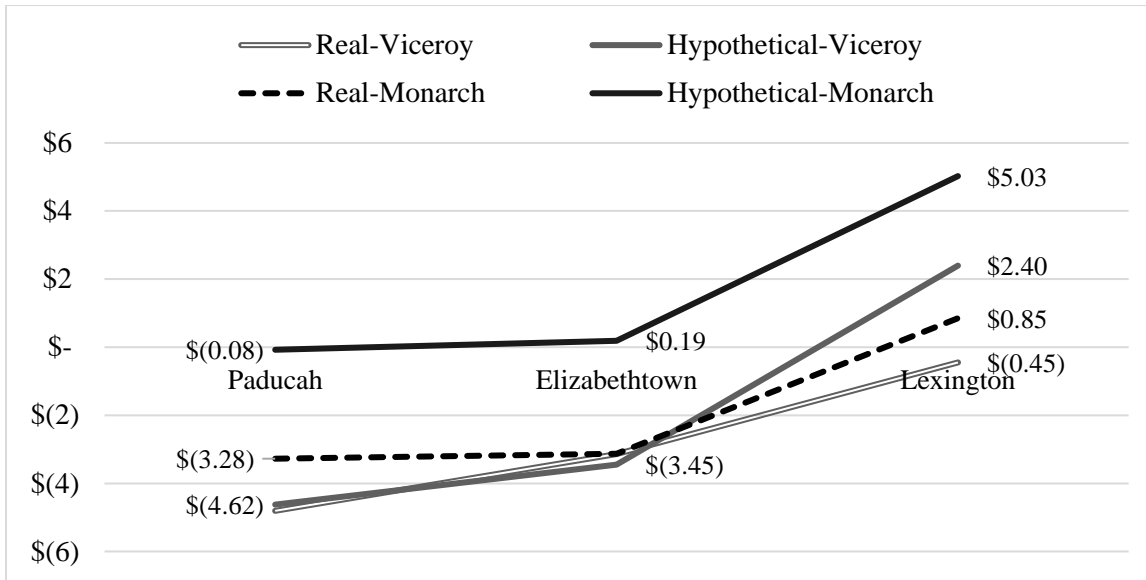
<b><u>Option A</u></b>	<b><u>Option B</u></b>
\$5 donation	\$0 donation
	
<b>Paducah Public</b>	<b>No additional contribution to butterfly conservation</b>
	

Figure 2: WTP at each location per treatment group





**Table 1: CE Attributes and Levels**

<b><u>Attribute</u></b>	<b><u>Description</u></b>	<b><u>Levels</u></b>
<b>Location</b>	Potential sites in Kentucky to install butterfly plants	1. Lexington (Fayette County) 2. Elizabethtown (Hardin County): 85 miles away from Lexington (1.5 hour drive) 3. Paducah (McCracken County): 350 miles away from Lexington (4 hour drive)
<b>Accessibility</b>	Public's ability to visit site	1. Closed: habitat inaccessible nor viewable by the public, such as a private farmland 2. Open: habitat accessible and viewable by the public, such as public parks
<b>Waystation</b>	Inclusion in national waystation program	1. Certified: Waystation is certified and Waystation Sign is installed. 2. Not Certified: Habitat is not a certified Waystation nor is a Waystation Sign installed.
<b>Donation</b>	Amount of money to support butterfly plants	\$1, \$5, \$10

Table 2: Select Sample Characteristics (all entries are percentage measures)

Variable	Population <sup>1</sup>	Total Sample	Real Monarch	Hypo Monarch	Real Viceroy	Hypo Viceroy
N <sup>2</sup>		734	147	223	147	217
18-24	18.6	17.3	15.1	19.3	15.7	18.0
25-34	19.4	28.5	31.5	31.8	27.2	24.0
35-44	16.8	23.5	20.6	19.3	26.5	27.7
45-54	16.0	14.7	16.4	15.3	13.6	13.8
55-64	14.6	10.8	11.0	11.7	10.2	10.1
65+	14.7	5.2	5.5	2.7	6.8	6.5
Chi-2(15)=13.6, p-value=.56 <sup>3</sup>						
Male	48.6	43.3	46.9	39.9	40.4	46.3
Female	51.4	56.7	53.1	60.1	59.6	53.7
Chi-2 (3)= 3.1, p-value=.37						
Education						
High school or less	30.0	21.1	21.8	20.4	27.2	17.1
Some college	27.4	24.8	22.5	23.1	27.9	25.9
Bachelor's degree	23.6	27.9	27.9	29.0	23.1	30.1
Graduate/professional	17.0	26.3	27.9	27.6	21.8	26.9
Chi-2 (9)=8.7, p-value=.47						
White	75.6	71.5	70.1	73.1	70.8	71.4
Black/African American	14.4	14.2	13.6	13.9	12.9	15.7
Asian	3.6	2.9	4.1	1.8	1.4	4.2
Chi-2 (6)=4.4, p-value=.62						
Having minors at home	28.9	46.1	43.8	48.9	48.3	43.3
Chi-2 (3)=2.0, p-value=.58						
Single, never married	38.8	33.1	30.6	35.9	34	31.3
Married	41.1	53.4	53.1	50.7	50.3	58.5
Chi-2 (3)=2.1, p-value=.54						
Median Income	\$47968	\$42,500*				

<sup>1</sup> Based on 2015 ACS 1-year

<sup>2</sup> Based on sample of non-protest respondents

<sup>3</sup> Chi-square tests are used to test for differences across the four treatment groups

\*Value calculated using midpoint of responses

Table 3: WTP-Space Model Results for Butterfly Valuation<sup>1</sup>

N=734	<b>Baseline for Real- Viceroy WTP</b>	<b>Baseline plus Hypothetical- Viceroy WTP</b>	<b>Baseline plus Real-Monarch WTP</b>	<b>Baseline plus Hypothetical- Monarch WTP</b>
<b>Ln(Donation)</b>	-0.77*** (0.17)			
<b><u>Mean WTP</u></b>				
<b>Opt-Out</b>	4.81*** (1.33)	-0.18 (1.55)	-1.53 (1.83)	-4.73*** (1.65)
<b>Elizabethtown</b>	1.67 (1.12)	-0.5 (1.43)	-1.53 (1.51)	-1.4 (1.38)
<b>Lexington</b>	4.36*** (1.22)	2.66* (1.55)	-0.23 (1.7)	0.74 (1.48)
<b>Public</b>	1.76** (0.84)	1.77 (1.08)	1.43 (1.16)	1.85* (1.07)
<b>Waystation</b>	-1.40 (0.94)	2.12* (1.15)	1.54 (1.25)	1.84 (1.14)
<b><u>Standard Dev.</u></b>				
<b>Ln(Donation)</b>	0.72*** (0.23)			
<b>Opt-Out</b>	9.71*** (0.64)			
<b>Elizabethtown</b>	3.81*** (0.73)			
<b>Lexington</b>	7.3*** (0.65)			
<b>Public</b>	4.46*** (0.53)			

<sup>1</sup> Standard errors reported in parentheses; \*\*\*, \*\*, and \* indicate statistical significance at the p-value <.01, <.05, and <.1, respectively.

Table 4: Estimated WTP among respondents for butterfly conservation based on results of Table 3

	<b>Real</b>	<b>Hypothetical</b>	<b>Difference</b>	<b>Difference as a % of Hypothetical WTP</b>
<b>Lexington-Viceroy</b>	-\$0.45	\$2.40	\$2.84	NA <sup>1</sup>
<b>Lexington-Monarch</b>	\$0.85	\$5.03	\$4.17	83.1%
		Difference=	\$1.33 (31.9% of \$4.17)	
<b>Paducah-Viceroy</b>	-4.81	-4.63	\$0.18	NA
<b>Paducah-Monarch</b>	-3.28	-.08	\$3.20	NA
		Difference=	\$3.02 (94.4% of \$3.20)	

<sup>1</sup> NA indicates that this number is uninterpretable in the conventional sense of Hypothetical Bias for WTP

Table 5: Mixed Logit Parameter Space WTP for Viceroy and Monarch Butterflies<sup>1</sup>

	<b>Real- Viceroy WTP</b>	<b>Hypothetical- Viceroy WTP</b>	<b>Real- Monarch WTP</b>	<b>Hypothetical- Monarch WTP</b>	<b>Poe Test<sup>2</sup></b>
<b>Opt-Out</b>	1.25	1.63	.71	.03	C,D
<b>Elizabethtown<sup>NS</sup></b>	1.05	1.07	-.14	-.04	
<b>Lexington</b>	4.71	7.53	2.95	5.48	A,B
<b>Public</b>	2.07	3.84	2.27	4.23	A,B
<b>Waystation</b>	-1.23	.82	-.20	.49	A

<sup>1</sup>Based on mixed-logit parameter-space model results.

<sup>2</sup>A, B, C, and D indicates a significant difference ( $p < .1$ ) in WTP between real and hypothetical Viceroy, real and hypothetical monarch, real viceroy and real monarch, and hypothetical viceroy and hypothetical monarch, respectively.

<sup>NS</sup> Indicates underlying parameter estimates were not significant.