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Public Preferences and Willingness to Pay for Invasive Forest Pest Prevention Programs in Urban Areas

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Abstract: Invasive forest pests can cause environmental and economic damage amounting to billions of dollars (US) in lost revenues, restoration and response costs, and the loss of ecosystem services nationwide. Unfortunately, these forest pests do not stay confined to wildland forest areas and can spread into suburban and urban areas, imposing significant costs on local governments, homeowners, and management agencies. In this study, a contingent valuation experiment is used to estimate Florida residents' willingness to pay (WTP) a monthly utility fee that would protect urban forests from invasive pests by implementing a monitoring and prevention program for their early detection and eradication. On average, the respondents are WTP US \$5.44 per month to implement the surveillance program, revealing an aggregate WTP in the order of US \$540 million per year. The results also reveal that respondents are sensitive to the scope of the program, with higher rates of participation and higher WTP for a program that is more effective at preventing forest pest invasions.

Keywords: urban forest; natural forest; invasive species; urban residents; non-market valuation

1. Introduction

Forest pest invasions by non-native pest plants, animals, and pathogens cause environmental and economic damage amounting to billions of dollars (US) in terms of lost ecosystem service and revenues as well as cleanup efforts nationwide. Unfortunately, invasive pests do not stay confined to wildland forest areas and can spread into suburban and urban areas [1]. Some of the impacts of infestations include disturbances of ecosystem processes and habitats [2–5], reductions in the value of residential properties due to increased wildfire risk, risks to human safety due to hazardous dead trees, harm to businesses, and ecosystem degradation [1,6]. These impacts have been exacerbated by the lower aesthetic appeal of dead and dying trees, land use conflicts, hindrances to trail and forest accessibility, lower timber value compared to healthy trees [7], and decreasing biodiversity in the ecosystem [8]. According to Aukema et al. [9], the costs associated with damage caused by forest pests are primarily borne by local governments and homeowners. For local governments, costs arise in the form of treatments for live trees to mitigate infestations, the removal of dead trees, and replanting new

trees. Homeowners shoulder this burden in the form of diminished property values, treatment for pests, and the removal of trees from their landscapes to prevent the proliferation of the pests [9,10].

Pest infestations and invasion risks have the potential to cause harm to native biodiversity and alterations of biogeochemical processes [11]. Many states in the U.S. have been impacted by pest invasions in recent decades with rising world trade flows [12,13]. States with infestations have continued to suffer economic and social losses [14]. For example, Florida has experienced several natural and anthropogenic disturbances over the course of the past century and, along with California and Texas, is one of the only U.S. states in the high-risk cluster for biological invasions [15]. Governments and homeowners in Florida continually attempt to control the exotic redbay ambrosia beetle (*Xyleborus glabratus* Eichhoff) causing laurel wilt disease, which is estimated to potentially cause \$356 million in unabated damages to the avocado industry [16]. Aquatic plants such as the hydrilla (*Hydrilla verticillata* (Linn. f.) Royle) cause an annual loss of \$10 million by impeding waterways, altering nutrient cycles, and preventing the recreational use of Florida lakes and rivers [17,18]. Cogongrass (*Imperata cylindrical* (L.) Beauv.), an invasive perennial grass that can survive disturbance events such as fire, flooding, and drought, results in an annual loss of \$35 million to the state's forestry sector [19]. The arboreal conehead termite (*Nasutitermes corniger* Motschulsky), native to South America and the Caribbean, has become established in South Florida, with estimated costs to homeowners ranging between \$6.9 and \$9.9 million over 10 years [20]. Human health can also be threatened by the introduction of invasive plants in Florida, such as the Melaleuca (*Melaleuca quinquenervia* (Cav.) S.T. Blake) and Pepper-tree (*Schinus terebinthifolius* Raddi), which cause respiratory problems and contact dermatitis [8].

Considerable impacts to residential property values have also been measured in a number of studies and can potentially overshadow other categories of market and non-market impacts [21]. Many studies support findings that show that urban areas with a greater urban forest cover have significantly increased property values [22–24]. The reverse is true, due to the loss of associated ecosystem services, such as wildlife habitats, carbon sequestration, air quality, temperature regulation, energy savings from shading, and increased storm water retention [25–32]. However, if a forest pest outbreak occurs, these services can be reduced or potentially disappear completely, resulting in substantial costs to local governments, management agencies, and homeowners [33].

Intervention by local governments is often necessary to mitigate the deleterious effects of forest pest invasion [34]. Mitigation practices can include prevention through reductions in the amount of host materials such as timber, wood products, and live plants that are transported between regions. Monitoring (or surveillance) programs that include the deployment of insect and spore traps as part of a multipronged approach [35] have also been determined to be effective, since the early detection of a non-native species allows for the possibility of eradication of the pest as well as preventative actions to protect trees [36]. While these approaches are costly and require up-front expenditures by federal, state, and local governments and thus taxpayers, they are likely to yield significant returns in the form of lower costs from invasive pest invasions [37].

Consumers' valuations of urban forests and their related ecosystem services have been measured in a number of studies and have revealed insights related to problems including climate protection [38], the protection of ecologically sensitive areas [39–41], forest disease control [42], and biological controls in urban landscapes [43]. However, few studies have focused on the implementation of mitigation strategies that rely on developing a connection between a suitable policy and consumers' valuation of ecosystem services. Soto et al. [44] found that connections between urban forests and policies are important because residents of urban communities are increasingly concerned with tradeoffs associated with the maintenance, planting, and preservation of urban forests. The authors also found that policies enacted by local decision makers in cities or towns have been found to reflect individuals' values in regard to the environment.

Urban forests provide a number of ecosystem services and direct financial benefits to their surrounding populations [45]. Forests near coastal cities, particularly in warm subtropical climates, are particularly vulnerable to the infestation of invasive forest pests due to the presence of airports and ports and the high diversity of trees (native or non-native) in streets, parks, and gardens [46]. In order to protect these urban natural resources, local government agencies need funding from taxpayers to develop and implement programs that provide the early detection of an impending forest pest invasion. The problem is that policymakers need context-specific, science-based information to better understand the level of funding residents are willing to support, specifically for efforts to enact policies that are consistent with residents' preferences. Thus, the objective of this analysis is to estimate Florida residents' willingness to pay (WTP) for a program funded through a utility fee that would protect urban forests from invasive pests, and to assess the levels of potential support for such a program.

2. Methodology

2.1. The Survey and Data

The data used in this analysis were obtained through a survey of residents in the state of Florida in the US. Data collection took place in August 2016 in the form of an online questionnaire. The purpose of the survey was two-fold. First, it was used to determine the preferences and concerns regarding environmental and invasive species issues in Florida. Second, we used a contingent valuation survey approach to determine a utility fee to be paid as a supplement that would allow funds for the protection of ecosystem services, specifically urban forests. A total of 3210 responses were received through an online panel provider, Qualtrics, out of 14,386 invitations sent. With 2486 respondents omitted from data analysis due to a lack of survey attentiveness or people dropping out of the survey, 724 responses remained viable for analysis. The overall completion rate was 23%.

First, the respondents were informed that pest invasions can result in the death of trees—sometimes by the thousands—resulting in expensive removal and replacement costs that are borne by landowners and local governments. The respondents were also told that if pests are detected in a timely manner, trees can usually be treated and saved, and, in addition, that reducing the amount of host material transported between regions could also prevent outbreaks of forest pests. This information led the respondent into a scenario where the state of Florida is considering a program that would deploy thousands of insect and spore traps throughout the state to enhance the early detection of pests. The respondents were also told that experts estimated the effectiveness (percentage chance of invasion reduction) of such a program in percentage terms, with the effectiveness shown to each respondent varying randomly between three levels (50%, 70%, 90%). The respondent was then asked a referendum-style question on a ballot initiative that would raise monthly utility fees to cover the costs of the program. The initial bid offered had four levels (\$3, \$5, \$7, \$9). The respondents were then asked a similar follow-up with the same effectiveness level but a different bid, depending on whether the first question had been answered positively or negatively. There were six bid levels for the follow-up question (\$1, \$3, \$5, \$7, \$9, \$11), with respondents seeing the next higher or lower level as in the initial referendum question, depending on if they answered “yes” or “no” to the first bid.

The respondents were also asked a series of questions concerning environmental impacts and invasive species. They were first asked about their level of concern for water pollution and invasive species in Florida (Likert scale). Similarly, the participants were also asked: (1) if they think that climate change is resulting in more extreme weather events, and this was followed by a question asking if they believe climate change is caused by human activity or natural changes in the environment, or both; (2) if they recycle; (3) if they are willing to change their lifestyle to reduce environmental damage; and (4) how important outdoor recreation is to them, as well as the types of outdoor recreation activities they have engaged in the past 12 months. Additionally, we elicited information regarding political

preferences—namely, we asked, “who do you agree with more about what the government should and should not do (Republicans, Democrats, Independents, or somebody else)?”

2.2. Analytical Approach

For the second part of the survey instrument, a double-bounded contingent valuation approach was used to also estimate the respondents' WTP a utility fee in United States Dollars, \$ hereafter, to implement a program to protect trees in urban and near-urban areas by preventing and monitoring the introduction of forest pests. This analytical approach has been used in a variety of other studies involving non-market valuation for issues such as safer drinking water [47,48], green energy [49–51], damage from oil spills [52], and forest resource restoration [53].

Each survey participant was presented with a short introduction paragraph which briefly summarized the problem with invasive species and resulting damage to trees in forests and urban areas. The respondents were asked whether they would vote for, against, or not vote on a monthly utility fee with varying levels of effectiveness rates. The effectiveness rates represent the percentage chance of invasion reduction that experts estimate a prevention and monitoring program would provide, and were introduced in order to test for sensitivity to scope in the contingent valuation experiment [54]. To assess the sensitivity of efficacy, we included three levels of forest pest prevention (50%, 70%, and 90%).

Following the standard practices of double-bounded contingent valuation (e.g., [55]), the respondents were shown two sequential bid questions—an initial bid (i.e., first bid), followed by a second bid that is lower or higher depending on the response to the initial bid. That is, the respondents were shown an initial monthly utility fee, f_i , of \$3, \$5, or \$7, and then asked to vote on the utility fee at a randomly provided invasion reduction level. If the initial fee that they were shown was voted for, then they were subsequently shown a second ballot initiative in which the monthly utility fee, f_u , was higher by \$2.00 (i.e., \$5, \$7, \$9) at the same invasion reduction level as the initial bid. If, conversely, the respondent “votes against” the utility fee, then the respondent was subsequently shown a second ballot initiative in which the monthly utility fee, f_d , was lower by \$2.00 (i.e., \$1, \$3, \$5) at the same invasion reduction level as the initial bid. The data from each of the individual choice tasks are comprised of two utility fee values, f_i followed by f_u or f_d , and two bid outcomes (“Yes, Yes,” “Yes, No,” “No, Yes,” or “No, No”). Figure 1 shows a flow diagram of the decisions being made by each respondent. When the respondent answers “yes” to the first bid and “yes” to the second bid, then $f_u < WTP < \infty$. When the respondent answers “yes” to the first bid and “no” to the second bid, then $f_i < WTP < f_u$. When the respondent answers “no” to the first bid and “yes” to the second bid, then $f_d < WTP < f_i$. When the respondent answers “no” to the first bid and “no” to the second bid, then $0 < WTP < f_d$.

The referendum format [56]—the double-bounded contingent valuation approach used in this analysis—is an improvement upon the single-bounded approach, where each respondent is only asked if they would vote for or against the initial bid and goes no further in eliciting information from the respondent [57]. Since a second bid was used to provide a boundary for the WTP values, more information was available than in the simpler format with only a single question—an advantage of traditional contingent valuation [55].

If we let c_1 and c_2 represent dichotomous variables for each response given by the respondent for the first and second question, respectively, then, for example, the probability that a respondent answers “yes” to the first question and “no” to the second question can be expressed as $\Pr(c_{1i} = 1, c_{2i} = 0 | d_i) = \Pr(\text{yes}, \text{no} | x)$. The WTP is estimated as the linear function $WTP_i(x_i, u_i) = x_i\beta + u_i$, where x_i is a vector of explanatory variables, β is a vector of parameters, and u_i is an error term that is assumed to be normally distributed with the mean, 0, and standard deviation σ^2 . Estimations for β and σ are directly obtained using a maximum likelihood function [57]. All the double-bound contingent valuation estimates using the data collected in the choice tasks were performed in STATA Version 14 using the doubleb command [57].

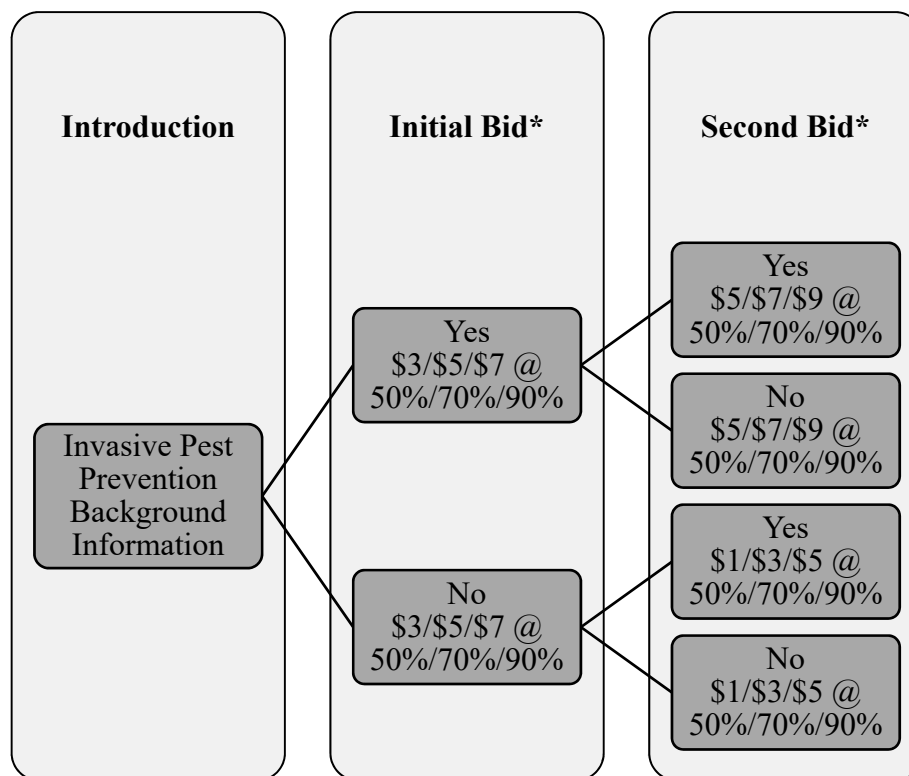


Figure 1. Double-bounded contingent valuation flow diagram (note: * non-voters were omitted).

3. Results

3.1. Summary Statistics and Public Preferences

Tables 1–3 report the summary statistics for the demographics, perceptions, and other influencing factors thought to drive WTP; Table 4 explains how these data were coded for econometric model estimations. Table 1 shows the summary statistics of the respondent demographics. About two thirds of the respondents were male. Over 70% of the respondents were 54 years old or younger, with the largest age group being between 18 and 24 years. Approximately 41% of the respondents indicated an educational level of associate/technical degree, bachelor's degree, or graduate degree. A majority of the respondents identified as white/Caucasian. The second largest group was black or African American, with a response rate of 15%. Overall, the demographics of the surveyed respondents fall within the line of the 2015 American Community Survey with the exception of gender. The sample is more representative of males than of females.

Table 1. Summary statistics of the respondents.

Demographic		Response Rate (%)	2015 American Community Survey (%)
Gender	Female	64	48
	Male	36	52
Age	18–24 years	27	14
	25–34 years	17	17
	35–44 years	15	16
	45–54 years	12	17
	55–64 years	13	16
	65 years and over	16	19
Household's Annual Income	Less than \$25,000	30	26
	\$25,000–\$49,000	28	27
	\$50,000–\$99,999	27	29
	\$100,000–199,999	11	15
	\$200,000 or More	4	4
Education	Less than 12th grade	10	13
	High school graduate or GED	23	28
	Some college	26	23
	Associate or technical degree	11	13
	Bachelor's degree	20	15
	Graduate degree	10	8
Ethnicity	White/Caucasian	67	76
	Black or African American	15	16
	American Indian or Alaska Native	1	0
	Asian	4	3
	Native Hawaiian or Other Pacific Islander	0	0
	From multiple races	6	3
	Other	7	2

Table 2. Perceptions concerning key environmental and invasive species issues in Florida.

Environmental Issue		Response Rate (%)
Water Pollution Concern	Extremely	33
	Very	28
	Moderately	28
	Slightly	7
	Not at all	4
Invasive Species Concern	Extremely	23
	Very	27
	Moderately	35
	Slightly	9
	Not at all	6
Climate Change	Yes, this is happening	74
	No, is not happening	11
	Don't know	15
Cause of Climate Change	Human activity	48
	Natural changes in the environment	10
	Both equally of the above	40
	Don't know	3
Recycle	Always	36
	Most of the time	37
	About half the time	14
	Once in a while	9
	Never	4

Table 3. Personal influencing factors.

Personal Preferences		Response Rate (%)
Lifestyle Change	Extremely willing	26
	Very willing	37
	Moderately willing	30
	Slightly willing	6
	Not at all willing	2
Outdoor Recreation	Very important	38
	Somewhat important	47
	Not at all important	14
	Don't know	1
Activities	Wildlife viewing	10
	Hiking or walking outdoors	14
	Horseback riding	2
	Camping	5
	Visiting historical or archaeological sites	6
	Geocaching	1
	Canoeing or kayaking	4
	Hunting	2
	Sport shooting	2
	Off-road vehicle driving	2
	Fishing	8
	Beach activities	15
	Bicycling	8
	Swimming in public pools	9
	Golf	3
	Outdoor team sports	4
	Other	4
Political Agreement	Republicans	24
	Democrats	42
	Independents	26
	Other	8

Table 4. Variables and Coded Values.

Variable	Coding	Definition
Program Effectiveness	1	50%
	2	70%
	3	90%
Household Income	1	Less than \$25,000
	2	\$25,000–\$49,999
	3	\$50,000–\$99,999
	4	\$100,000–\$199,999
	5	\$200,000 or more
Education	1	Less than 12th grade
	2	High school graduate or GED
	3	Some college
	4	Associate or technical degree
	5	Bachelor's degree
Children	6	Graduate degree
	1	None
	2	1 child
	3	2 children
	4	3 children
	5	4 children
Invasive Species	6	More than 4 children
	1	Extremely concerned
	2	Very concerned
	3	Moderately concerned
	4	Slightly concerned
Change Lifestyle	5	Not at all concerned
	1	Extremely willing
	2	Very willing
	3	Moderately willing
	4	Slightly willing
	5	Not at all willing

The information collected to understand the respondents' perceptions of environmental issues shows that about 6 out of 10 respondents indicated that they were "extremely" or "very" concerned with water pollution (Table 2). With respect to invasive species, 50% were "extremely" or "very" concerned. Nearly three quarters of the respondents believed that the world's climate is undergoing a change that is causing more extreme weather patterns and a rise in sea levels, while the remaining respondents "don't know" (15%) or indicated "no" (11%). About 48% of the respondents believed this is solely due to "human activity," 10% believe it is due to "natural changes in the environment," 40% believe it is being caused by both, and the remaining respondents replied "don't know." Approximately 27% of the respondents indicated that they recycled less than half the time or not at all. The other 73% always recycle or recycle most of the time.

The majority of Florida residents sampled indicated that they were "very" or "extremely" willing to change their lifestyle to reduce the damage they cause to the environment (Table 3). About 38% of the respondents also found outdoor recreation personally "very" important. Nearly half of the respondents in the sample declared outdoor activities to be "somewhat" important. The remainder indicated that outdoor recreation was not important or didn't know. The top three activities selected they were when asked if the respondent personally participated in any outdoor activities were "beach activities" (15%), "hiking or walking outdoors" (14%), and "wildlife viewing" (10%). A large proportion of the respondents indicated they agreed most with the Democrats about what the government should or should not do.

3.2. Willingness To Pay

Initially, an estimation of the respondents' WTP was estimated to serve as the base model for comparison. It also aids in the estimation procedure by serving as a seed starting point for follow-up estimations. Without controlling for demographics or environmental preferences, the Florida residents were found to be WTP \$5.44, on average, as a monthly utility fee to support the implementation of a program to detect forest pests before they became a problem and monitor the introduction of forest pests. A naïve constant-only model found a mean WTP of \$5.50. Indeed, the mean WTP was highly robust regardless of the model specification. See Table 5, which reports WTP estimates, including the confidence interval estimates of WTP at the 95% significance level. Figure 2 shows the breakdown of respondent percentages as they completed the choice task in the questionnaire. In the initial bid, 68% of the respondents would vote favorably towards a ballot initiative in support of the invasive pest prevention and early response program, and 32% would vote to reject the ballot. Of the former, roughly 51% voted in favor of an even higher bid, whereas ~26% of the respondents rejected both the initial and second bids. These results suggest that the respondents were diverse in their perspectives on forest pest prevention and alleviate concerns about bias in the response pool.

By accounting for demographic variables, the WTP changes only slightly. While demographic factors such as household annual income, education, and number of children in the household are statistically significant, the WTP for the average respondent was \$5.49 for the monthly utility fee. Household income, education, number of children, and program effectiveness were found to influence the WTP for the monthly utility fee positively, consistent with other studies [58]. Program effectiveness had the greatest impact on the WTP, at nearly \$8 on average, indicating that the respondents were sensitive to scope. Among the demographic factors, household annual income had the greatest impact on the WTP, at \$1.17 to \$1.25, depending on the model specification. The number of children and education level came in second and third, respectively.

Table 5. Double-bound contingent valuation estimations.

	Constant Only		Effectiveness		Demographics		Environment Opinions	
	Coef. (Std. Err.)	95% C.I.	Coef. (Std. Err.)	95% C.I.	Coef. (Std. Err.)	95% C.I.	Coef. (Std. Err.)	95% C.I.
Constant	\$5.50 (0.41)	[\$4.70, \$6.30]	\$0.05 (1.84)	[\$−3.55, \$3.65]	−\$6.55 (2.31)	[−\$11.08, −\$2.03]	\$5.16 (2.48)	[\$0.30, \$10.02]
Effectiveness			\$7.78 (2.54)	[\$2.80, \$12.76]	\$7.93 (2.50)	[\$3.03, \$12.83]	\$6.62 (2.40)	[\$1.92, \$11.31]
Household Income					\$1.17 (0.41)	[\$0.37, \$1.97]	\$1.25 (0.39)	[\$0.48, \$2.02]
Education					\$0.64 (0.29)	[\$0.07, \$1.20]	\$0.48 (0.28)	[−\$0.06, \$1.02]
Children					\$1.01 (0.4428)	[\$0.15, \$1.88]	\$0.56 (0.43)	[−\$0.28, \$1.39]
Invasive Species							−\$2.63 (0.41)	[−\$3.43, −\$1.83]
Change Lifestyle							−\$1.46 (0.44)	[−\$2.32, −\$0.60]
Mean WTP (US \$)	\$5.50	[\$4.70, \$6.30]	\$5.44	[\$1.96, \$8.93]	\$5.49	[\$4.71, \$6.27]	\$5.44	[\$4.69, \$6.20]

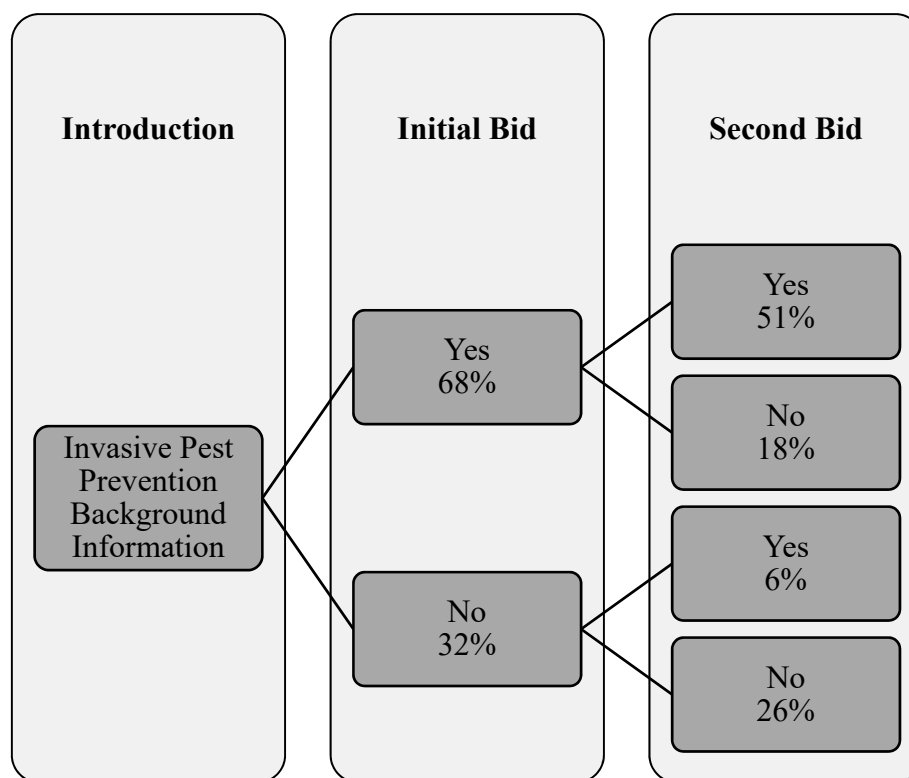


Figure 2. Response rates for the initial and second bids.

With the inclusion of environmental perceptions, the WTP remains very stable at \$5.44 for an average monthly utility. Program effectiveness, as measured by the percentage change in reduction in invasive pests by the implementation of the program, is still the main determinant of the WTP even when including several demographic and attitudinal factors. The environmental opinion factor regarding concern about invasive species in Florida also heavily impacts the average WTP. The more concerned a resident is about invasive species, the more they are WTP for the implementation of a prevention and monitoring program. The same can be said for the resident's willingness to change their lifestyle, where the higher the willingness to change behavior, the greater the WTP. The ranking of impact on the WTP in this model remains the same as in the previous model with demographics. However, the variable representing the number of children in the household is not statistically significant. In both the demographic and environmental opinion models, the effectiveness of the program is an important aspect that consumers are mindful of and has the greatest impact on WTP.

4. Discussion

Forests and urban ecosystems both can act as hotspots of biological invasions that cause significant economic and ecological damage [59]. Both wildland and urban forest ecosystems are clearly presenting a new suite of challenges relating to the understanding and management of biological invasions. However, stakeholders in cities often have strongly divergent views on non-native species (invasive or not) for a wide range of reasons—esthetic, culinary, or diverse cultural reasons [60]. It is, therefore, essential to understand the people's perception and preferences for invasive forest pest species prevention in both urban and wildland areas. The results from this study indicate that the prevention of invasive forest pests is important to residents of the state of Florida, and, on average, they are willing to pay a small monthly fee to ensure that a program to protect the state's forests through the early detection of forest pests is implemented. While the monthly sum that each household is willing to pay is relatively small (~\$5.44), the aggregation of WTP across all Florida households would result in a substantial sum. In 2019, the state of Florida was estimated to have a total of 8,427,696 households [61],

and therefore a simple extrapolation yields a total estimated WTP of \$45.8 million per month to reduce the likelihood of forest pest invasions. Aggregated at the annual level, Floridians are willing to pay a substantial \$550 million to reduce the chances that forest pest invasions occur. It is important to note that our models did not account for urban versus rural residents' WTP for controlling invasive species in urban areas, which could differ significantly. However, Florida is a heavily urbanized state, with 96.6% of its population (20.8 mn of 21.48 mn total) living in urban areas [62]. Given that, even if assuming the WTP = 0 for rural residents, the overall estimate of the annual WTP is robust (\$547 million).

When considered along with the avoided societal costs from invasive species, these results suggest that the policy intervention is economically feasible. It is unlikely that a prevention and monitoring program in Florida, such as the one outlined in the contingent valuation experiment, would cost as much as \$550 million per year. Invasive species in urban areas can negatively affect ecosystem services [63], act as vectors of human and animal diseases [64,65], and increase wildfire risk [66]. McLean et al. [67] showed that small urban centers can act as source areas for invasions into peri-urban and natural/rural areas. Therefore, the cost of the surveillance and prevention of invasive pest in wildland and urban areas would be much lower than the cost of overcoming the consequences after invasion (e.g., Adams and Lee 2012 [68]).

Forest invasive pest management in wildland and urban areas present a diverse suite of challenges because of the diversity of public perceptions about the impacts of invasive species in urban areas and the range of different stakeholder interests [69,70]. Given the multitude of stakeholders in cities, conflicts over the management of invasive species can create intense and complex obstacles in appropriate policy interventions [70,71]. The design, implementation, and management of surveillance programs is a complex and costly endeavor [72]; the estimated WTP should greatly benefit the policy makers in designing pest prevention programs in Florida. Thus, it is clear that to some extent—at least in Florida—the life experience of survey participants may significantly condition their responses in assigning high/low values (e.g., the high WTP is partially the result of an educated public that can understand the connection between sampling programs and the prevention of negative and costly outcomes, such as forest pest invasions). This could indicate that consumers care about protecting the environment: not necessarily for future generations (e.g., bequest values) but because of Florida's environment itself (e.g., existence values). Urban ecosystems are novel plant and faunal assemblages with altered biogeochemical cycles relative to less disturbed wildland ecosystems [73]. Hence, this information is crucial in determining trade-offs between the services and disservices of non-native plants, which often causes conflicts over whether to manage for the former or the latter [74].

Our findings suggest that residents in urban areas, especially those with a higher education and economic status, would support measures that protect their urban forests from invasive species infestations. This is consistent with findings that show public support for conservation policies and programs generally—for example, in Northern European cities, where forest conservation is driven demographically by a strong demand for both urban living and access to nature [75]. This finding has implications for policy design, specifically around “who should pay?”, including sensitivity to equity concerns and to the relative tax burdens on the poor [76].

An interesting question raised by the high WTP elicited by Floridians is: are they valuing the prevention program as a policy intervention (e.g., [40]), or are they expressing an aversion to the costs of forest pest invasions? In reality, the prevention of a forest pest invasion will be less costly than the ensuing outbreak [77]. Although we did not assess this, it is possible that individuals who have experienced the large-scale damage caused by a widespread biological invasion are likely to assign high values to these events, as it is the costs of prior outbreaks that serve as frames of reference. Conversely, it is possible that individuals who have not experienced these types of outbreaks in the past would be more likely to assign low values, as the cost of the surveillance program would serve as a frame of reference (e.g., [78]). While the survey included a question regarding concern for biological invasions, most if not all Floridians can be expected to be familiar with invasive species and their

impacts. Future research replicating this experiment across other regions facing different invasion pressures would provide clearer insights on this point.

The contingent valuation method and stated preference methods in general have been criticized for their potential biases [79,80]. One of the potential limitations of the method include the possibility of protest bids, which may introduce bias. To minimize the effect of this bias and the problem of excessive zero bids or improbably large bids, open-ended questions were avoided [81] in the survey. Furthermore, the US National Oceanic & Atmospheric Administration's Blue Ribbon Panel on Contingent Valuation (Arrow [56]) recommends providing respondents with the option to indicate that they "would not vote," a recommendation that was implemented in the survey. Another recommendation involves asking follow-up questions, which is generally preferable to single-question contingent valuation [82], as the single-question format can introduce bias in estimates by introducing feelings of guilt or displeasure [55]. While our survey was designed with bias concerns in mind, the largest effect in our results was seen with respect to concern about invasive species (see Section 3.2). Without a diversity of responses on that item, it would not have been statistically significant. That result is encouraging, and alleviates some concern about a major bias issue. Indeed, 26% of respondents rejected both the first and second bids, so it would not be accurate to say that only the Florida residents interested in forest pest prevention provided full responses. However, we recognize the influence that bias can have on WTP and urge caution when interpreting the results. In the context of policy design, this WTP information can be very useful, but decisions made on economic criteria alone may fail along broader social goals (e.g., environmental and social), or may fail to meet the political or administrative criteria needed for policy success.

Another potential limitation of the method is the insensitivity of scope, where the respondents' WTP does not change when the level or amount of the service provided changes [54]. However, the survey included several values of program effectiveness, and our results indicate that respondents are sensitive to the program's scope, with a higher program effectiveness associated with a higher WTP. Therefore, the results of this study provide important insight into environmental protection policies.

5. Conclusions

Protecting Florida's forests in wildland, wildland-urban interface, and urban areas is an important issue when dealing with invasive species, especially due the immense economic and ecosystem consequences. All consumers, regardless of whether or not they own land or property, are prone to the adverse effects of these consequences and are generally willing to pay for prevention measures. With respect to a monitoring and prevention program for invasive forest pests, consumers in Florida would support this program via monthly utility fee assessment. A number of demographic factors affect this amount, which includes household income, education, and whether a family has children. The expected effectiveness of the invasive species program, concern regarding invasive species, and propensity to change personal lifestyles also have an impact on the WTP for the program. For further research, a different approach using relatively recent advancements in choice behavior analysis through the use of choice experiments can be employed.

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