ECONOMIC VALUATION OF THE ECOSYSTEM SERVICES (NATURE'S BENEFITS) OF PALM BEACH COUNTY'S NATURAL AREAS MANAGED BY THE DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

FINAL REPORT

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EXECUTIVE SUMMARY

In 2017 Dr. Elizabeth Pienaar and members of her research team conducted an ecosystem services valuation study of the Natural Areas Program in Palm Beach County. The purpose of this study was to determine what value residents of Palm Beach County place on the Natural Areas Program, with specific focus on four ecosystem services: habitat type; outdoor recreation; flood mitigation; and improved water quality. Both a mail-based survey and an online survey were administered to residential property owners in Palm Beach County. A total of 1,371 surveys were returned by county residents.

The majority of survey respondents (53% or higher) indicated that native habitat, flood protection and less water pollution were 'extremely' important to them. On average, respondents stated that outdoor recreation is 'very' important to them. Less than 2% of respondents considered these ecosystem services to be 'not at all' important.

Survey respondents were asked whether they would be willing to pay either increased property taxes ($12 to $120 per year) or increased utility fees ($1 to $10 per month) to continue financing the Natural Areas Program. In total, 1,066 respondents (77.8%) stated that they would vote for an annual payment (either increased property taxes or increased utility fees) to maintain the Natural Areas Program. Across respondents who stated that they would vote in favor of financing for the Natural Areas Program, the majority (55.3%) preferred an increase in property taxes. Fewer of these individuals (33.2%) preferred an increase in utility fees.

The majority of survey respondents (81.3%) placed positive value on the continuation of the Natural Areas Program (an average of $122.05 per year or higher). On average, respondents positively valued both forest and wetlands, two key habitat types that are protected by the Natural Areas Program. The majority of respondents also positively valued dirt and paved trails in terms of the recreational opportunities they provide. Fewer respondents (19%) positively valued kayak ramps, but the value that they derived from kayak ramps was high. Respondents positively valued increased flood protection and improved water quality from flood protection. Based on the economic analysis presented in this report, the value that survey respondents derive from the Natural Areas Program exceeds the annual payment of $12 to $15 per household that is required to maintain this program. There would appear to be sufficient support for the Natural Areas Program to justify a referendum, in order to determine whether the larger voting population in Palm Beach County would vote in favor of dedicated funding for the Natural Areas Program.

INTRODUCTION

The Palm Beach County Natural Areas Program preserves and manages 31,445 acres of native habitat at 36 separate natural areas. These natural areas range in size from 3 to 12,869 acres and represent examples of native sub-tropical ecosystems that covered south Florida prior to habitat conversion for residential, agricultural, industrial and commercial purposes. Pursuant to county referendums that were held in 1991 and 1999, Palm Beach County has invested $150 million to acquire and restore these lands, and to provide limited public use facilities on these lands. The Department of Environmental Resources Management (ERM) is responsible for managing these lands in perpetuity.

As a result of habitat restoration efforts by ERM, the ecological benefits provided by the Palm Beach County Natural Areas Program have increased over time. Native biodiversity on these lands has improved. Several rare species (including both threatened and endangered species) have returned to these areas and their populations have increased. In addition to protecting biodiversity and native habitats, the Natural Areas Program provides a range of ecosystem services to residents of Palm Beach County, including (but not limited to):

- Recreational activities: walking, hiking, bicycling, horseback riding, fishing, canoeing, kayaking, bird watching, photography, and nature appreciation;
- Educational and cultural services;
- Hydrological services: groundwater recharge, water purification, flood mitigation;
- Improved air quality and carbon sequestration;
- Erosion control and soil regeneration;
- Provision of open space;
- Cycling of nutrients; and
- Pollination services and seed dispersal.

In 2017, Dr. Pienaar and members of her research team were contracted by ERM to design and implement a survey in Palm Beach County, in order to measure the value that county residents place on the Natural Areas Program and four ecosystem services provided by this program. The study was designed to attain two key objectives:

1. Provide statistically defensible estimates of the range of values that Palm Beach County residents place on the Natural Areas Program, and four ecosystem services provided by the program; and
2. Determine whether the Natural Areas Program provides sufficient value to Palm Beach County residents to justify continued financing of the program by residents through either a property tax increase or increased utility fees.[1]

The results of the study are also intended to guide management decisions related to the Natural Areas Program. This report presents the results of the research conducted by Dr. Pienaar and her research team.

[1] ERM staff estimated that $12 to $15 per residential property would be required to continue funding the Natural Areas Program.

SURVEY DESIGN

One of the key challenges in designing the survey was to ensure that descriptions of ecosystem services were easy to understand and accurately captured the actual level of services provided by the Natural Areas Program, in order to ensure that value estimates were not inflated. Initially ERM proposed that the survey be designed to value the following ecosystem services: open space; recreational opportunities; flood mitigation; and groundwater recharge. During the survey design process it became clear that two of these ecosystem services (open space and improved water resources) needed to be modified.

The value individuals derive from open space depends on how far they live from that space and the type of habitat protected by the open space. Because survey recipients lived at different distances from each of the natural areas, the distance between survey recipients and the nearest natural area could not be incorporated into how open space was described in the survey. It was also uncertain whether survey recipients would be aware whether they lived in proximity to a natural area that is managed by ERM, or what type of habitat that area protected. Accordingly, Dr. Pienaar (in consultation with ERM) changed this ecosystem service to habitat type. Because the Natural Areas Program protects a variety of habitat types, it was important to determine what value survey respondents placed on the different habitat types. The survey focused on three main habitat types that are protected by the Natural Areas Program: forest, wetlands, and scrub habitat. ERM provided color photos of three different sites to demonstrate what was meant by each of these habitats and to provide examples of habitat protected by the Natural Areas Program. These photos were included in the survey as a visual aid for recipients.

Improved water resources were initially included in the survey. The survey included the following text: "Palm Beach County residents rely on groundwater to provide drinking and irrigation water. About 33% of the water that residents use is groundwater. Natural areas help to secure the county's water resources in two ways:

- Groundwater recharge: natural areas replenish groundwater by trapping rainwater and allowing it to seep down into the ground. Natural areas maintain water quantity.
- Water purification: as water flows through wetlands or seeps down through the sand it is cleaned. Natural areas maintain water quality."

The survey then included questions about how individuals valued groundwater recharge and water purification. Unfortunately, during pre-tests[2] of the survey in Palm Beach County it became apparent that people did not know or understand the term 'groundwater' and so had difficulty understanding the process of groundwater recharge. However, they did understand the concept of reduced water pollution, in large part owing to press about water quality in Lake Okeechobee. Accordingly, Dr. Pienaar (in consultation with ERM) rewrote this ecosystem service as reduced water pollution (i.e. water purification), and used information from government agencies in Palm Beach County and peer-reviewed literature to describe how wetlands reduce the phosphorus and nitrogen contents of water.

[2] The survey was pre-tested with seven specialists in survey design at the University of Florida, the University of California – Davis and the University of Maryland, 25 residents of Palm Beach County, and six members of the general public. These pre-tests were used to ensure that the content of the survey could be easily understood by recipients, in order to ensure data quality. Pre-tests were also used to ensure that questions were clear to recipients.

Further pre-tests demonstrated that people could easily understand this ecosystem service.

Given the number of outdoor recreation activities that are facilitated by the Natural Areas Program, outdoor recreation was described in terms of the recreation infrastructure provided and the activities permitted by this infrastructure. Survey recipients were informed that paved trails allow for walking, bird watching, and nature appreciation, while dirt trails allow for bicycling, horseback riding, hiking and physical fitness. Survey recipients were also informed that kayak ramps allow for canoeing and kayaking on rivers and in the wetlands.

Flood protection was a particularly challenging attribute to describe. Based on information from the Federal Emergency Management Agency (FEMA), survey recipients were informed that over half the county is in a floodplain. Because the average individual does not understand what is meant by a 100-year flood, survey recipients were informed that "There is a 26% chance that properties in floodplains will flood at least once during a 30-year period (the average length of a mortgage). Properties outside the floodplain are also at risk of flooding" – information that was consistent with FEMA documentation. Survey recipients were further informed that natural areas protect people and their properties from floods by absorbing heavy rains and storm water runoff. To avoid overstating the county-wide level of flood protection provided by the Natural Areas Program, Dr. Pienaar calculated what share of the floodplains was protected by the program. Based on this calculation, the upper limit of county-wide flood protection offered by the Natural Areas Program was set at a 2% reduction in flood risk. Pre-tests confirmed that respondents understood this description of flood protection.

SURVEY IMPLEMENTATION

Both mail-based and online surveys were used to collect data from Palm Beach County residents. A total of 5,000 surveys were mailed to residential property owners in Palm Beach County. Survey recipients were identified using property appraisal records from the 2016 tax year. These records included addresses and ownership records for 186,439 condominiums (apartments) and 358,876 single family residences. The mean property value for these residences was $276,131 (first quartile = $113,680, median = $194,357, third quartile = $308,138). Properties were stratified by value and 1,250 addresses were randomly selected for each quartile of property values (1,250 addresses per quartile × 4 quartiles = 5,000 addresses). The first round of the survey was mailed out on March 28, 2017. Reminder postcards were mailed on May 2, 2017, and a second wave of surveys were mailed to non-respondents on May 22, 2017. In total, 845 mailed surveys were returned (16.9% response rate).

The survey was also implemented online. Dr. Pienaar allocated her personal research funds to implementing the survey through Qualtrics (https://www.qualtrics.com/). Qualtrics is a company that assists researchers by recruiting respondents to take an online survey, launching the online survey, and collecting data from respondents. Qualtrics recruited an additional 527 residential property owners in Palm Beach County (38% response rate). Qualtrics was instructed to sample residential property owners, based on Census data for Palm Beach County (gender, age, education and income level). It was necessary for Qualtrics to adjust these quotas to meet the minimum requested sample size of 500 residential property owners. However, the inclusion of the

Qualtrics data in the final survey sample ensured that survey respondents were more representative of the Census in terms of demographics (i.e. that lower income and younger respondents were adequately captured in the final sample).

In total, data was collected from 1,371 residential property owners in Palm Beach County. This final sample size exceeded the level needed to allow statistical inference at the 99% confidence level and 4% confidence interval[3].

CHARACTERISTICS OF SURVEY RESPONDENTS

The majority of survey respondents (1,342 property owners, 97.9% of the final sample) lived in Palm Beach County in 2016 (Table 1). On average, survey respondents had lived in Palm Beach County for 11 to 20 years (Table 2). The majority of respondents (1,255 respondents, 91.5%) lived in Palm Beach County fulltime (Table 3), and 1,348 respondents owned residential property in Palm Beach County[4] (Table 4). Only 137 respondents (10%) owned more than one residential property in Palm Beach County (Table 5).

Just over half of respondents were female (716 respondents, 52.2%), and the median age of respondents was 55 to 64 years (Table 6). The median annual household income for respondents (before tax) was $50,000 to $99,999. The median level of education attained by respondents was a Bachelor's degree, although 47.1% of the final sample had an associate degree at most. Based on 2016 Census data, females accounted for 51.7% of the total population in Palm Beach County. Census data indicated that the median age in Palm Beach County was 44.5 years, and the median household income was $56,664 per year. According to Census data, 9.2% of the population of Palm Beach County had received an associate degree, while 21.8% of the population had a Bachelor's degree and 13.2% of the population had a Graduate or professional degree. Although the final survey sample over-represented older and more educated residents of the county, in other respects the final sample was consistent with the Census data.

Table 1. Did you live in Palm Beach County in 2016?

	Mail Survey		Online Survey		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Yes	830	98.3	512	97.2	1,342	97.9
No	0	0.0	15	2.8	15	1.1
No answer	14	1.7	0	0.0	14	1.0
Total	**844**		**527**		**1,371**	

[3] The confidence interval (or margin of error) measures the percentage deviation between the opinions expressed by survey respondents and the opinion of the population of interest. The lower the confidence interval, the lower the probability that the opinions expressed by survey respondents deviate from the opinions of the population of residential property owners in Palm Beach County. The confidence level measures the percentage of the population that falls within the boundaries of the confidence interval.

[4] While 1,342 property owners were residents of Palm Beach County in 2016, a further 6 respondents became residents of Palm Beach County in 2017. As such, the final sample contained 1,348 property owners.

Table 2. How many years have you lived in Palm Beach County?

	Mail Survey		Online Survey		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
5 years or less	94	11.1	91	17.3	185	13.5
6 – 10 years	86	10.2	76	14.4	162	11.8
11 – 20 years	215	25.5	152	28.8	367	26.8
21 – 30 years	188	22.3	110	20.9	298	21.7
Over 30 years	240	28.4	83	15.7	323	23.6
No answer	21	2.5	15	2.8	36	2.6
Total	**844**		**527**		**1,371**	

Table 3. Do you live in Palm Beach County fulltime or only part of the year?

	Mail Survey		Online Survey		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Fulltime	771	91.4	484	91.8	1,255	91.5
Part of the year	51	6.0	28	5.3	79	5.8
No answer	22	2.6	15	2.8	37	2.7
Total	**844**		**527**		**1,371**	

Table 4. Do you own residential property (such as a house or condominium) in Palm Beach County?

	Mail Survey		Online Survey		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Yes	821	97.3	527	100.0	1,348	98.3
No	5	0.6	0	0.0	5	0.4
No answer	18	2.1	0	0.0	18	1.3
Total	**844**		**527**		**1,371**	

Table 5. Do you own more than one residential property in Palm Beach County?

	Mail Survey		Online Survey		Total	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Yes	90	10.7	47	8.9	137	10.0
No	737	87.3	480	91.1	1,217	88.8
No answer	17	2.0	0	0.0	17	1.2
Total	**844**		**527**		**1,371**	

Table 6. Demographic characteristics of respondents

	Mail Survey		Online Survey		Total	
	#	%	#	%	#	%
Gender:						
Male	401	47.5	217	41.2	618	45.1
Female	406	48.1	310	58.8	716	52.2
I prefer not to say	18	2.1	0	0.0	18	1.3
No answer	19	2.3	0	0.0	19	1.4
Age:						
Under 25 years	1	0.1	53	10.1	54	3.9
25 to 34 years	26	3.1	90	17.1	116	8.5
35 to 44 years	71	8.4	70	13.3	141	10.3
45 to 54 years	127	15.0	84	15.9	211	15.4
55 to 64 years	198	23.5	84	15.9	282	20.6
65 to 74 years	213	25.2	106	20.1	319	23.3
75 years or over	188	22.3	40	7.6	228	16.6
No answer	20	2.4	0	0.0	20	1.5
Education:						
Less than 12th grade	4	0.5	9	1.7	13	0.9
High school graduate or GED	60	7.1	93	17.6	153	11.2
Some college/associate or technical degree	221	26.2	146	27.7	367	26.8
Bachelor's degree	264	31.3	182	34.5	446	32.5
Graduate degree	269	31.9	97	18.4	366	26.7
No answer	26	3.1	0	0.0	26	1.9
Household annual income (before tax):						
Less than $25,000	44	5.2	61	11.6	105	7.7
$25,000 to $49,999	110	13.0	105	19.9	215	15.7
$50,000 to $99,999	267	31.6	189	35.9	456	33.3
$100,000 to $199,999	228	27.0	159	30.2	387	28.2
$200,000 or more	112	13.3	13	2.5	125	9.1
No answer	83	9.8	0	0.0	83	6.1

ECOSYSTEM SERVICES PROVIDED BY THE NATURAL AREAS PROGRAM

Before eliciting respondents' willingness to pay to continue financing the Natural Areas Program, they were presented with information about the program and four ecosystem services provided by the Natural Areas Program. Excerpts from the survey are presented in boxes throughout this report:

The Department of Environmental Resources Management manages 31,445 acres of natural areas on behalf of residents of Palm Beach County. These natural areas have been restored to provide habitat for native plants, birds and wildlife. They also provide recreational opportunities, protection against floods, improved water quality, and other benefits (such as improved air quality). These environmental benefits are known as **ecosystem services**.

We will focus on 4 services provided by the Natural Areas Program: habitat; recreation; flood protection; and reduced water pollution.

Ecosystem Service #1: Native Habitat

The Natural Areas Program protects 3 types of native habitat:

Forest

Wetlands

Scrub

When asked if they would like to live next to these different types of habitat, 906 respondents (66.1%) stated that they 'probably' or 'definitely' want to live next to forest (Table 7). Fewer respondents stated that they would like to live next to wetlands or scrub habitat. A total of 588 respondents (42.9%) stated that they 'probably' or 'definitely' want to live next to wetlands, and 557 respondents (40.6%) stated that they 'probably' or 'definitely' want to live next to scrub.

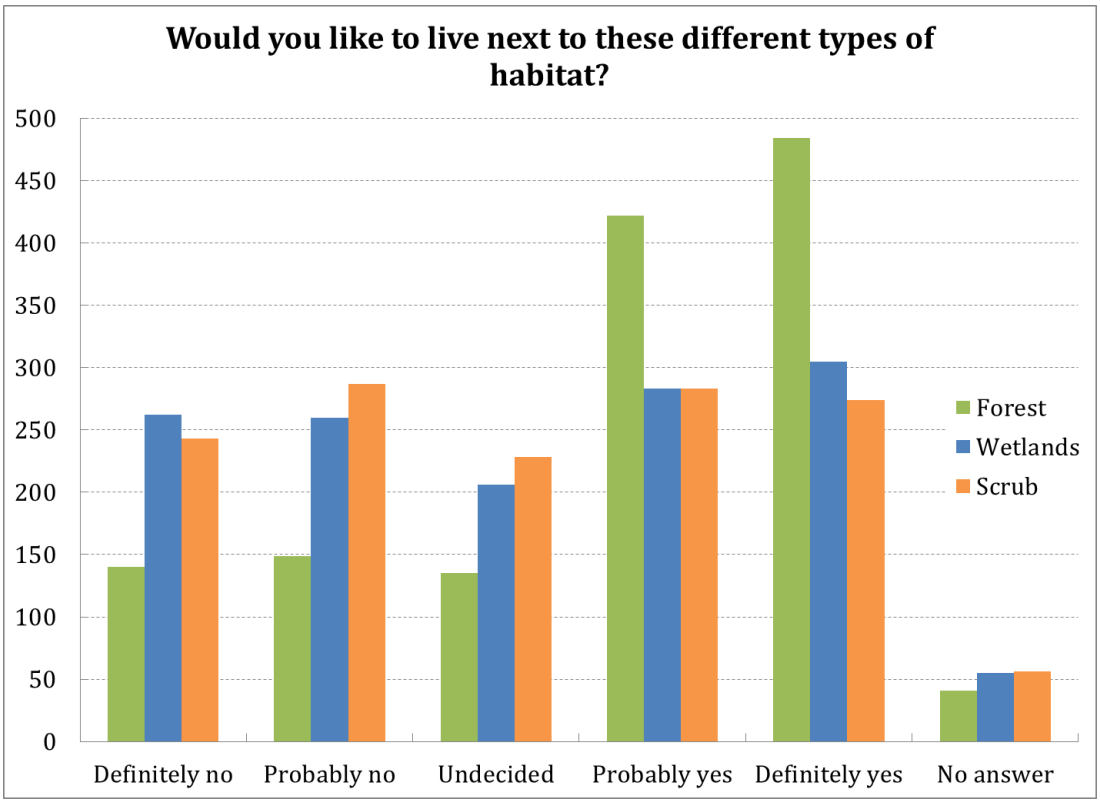


Table 7. Would you like to live next to these different types of habitat?

	Forest		Wetlands		Scrub	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Definitely no	140	10.2	262	19.1	243	17.7
Probably no	149	10.9	260	19.0	287	20.9
Undecided	135	9.8	206	15.0	228	16.6
Probably yes	422	30.8	283	20.6	283	20.6
Definitely yes	484	35.3	305	22.2	274	20.0
No answer	41	3.0	55	4.0	56	4.1

Ecosystem Service #2: Opportunities for Outdoor Recreation

The County's natural areas provide the following opportunities for recreation:

- **paved trails** for walking, bird watching, and nature appreciation
- **dirt trails** for bicycling, horseback riding, hiking, and physical fitness
- **kayak ramps** that allow visitors to canoe and kayak on rivers and in the wetlands

When asked if they had visited a natural area in Palm Beach County in the past year, 950 respondents (69.3%) answered yes (Table 8). To better understand respondents' recreation behavior, they were also asked to indicate how often they (or members of their household) engage in outdoor recreational activities that are facilitated by the Natural Areas Program. Hiking and walking were the most common outdoor recreational activities in which respondents and their household members engaged (Table 9). On average, respondents walked outdoors or hiked every month.

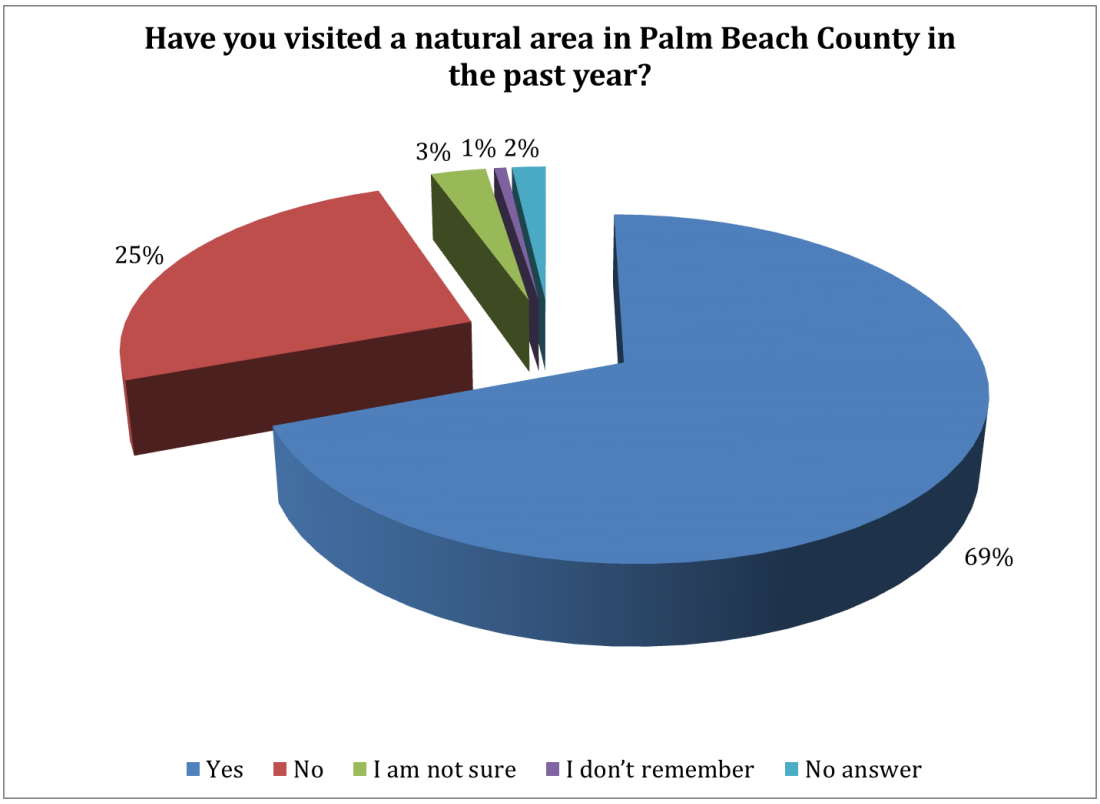


Table 8. Have you visited a natural area in Palm Beach County in the past year?

	Number	Percent
Yes	950	69.3
No	346	25.2
I am not sure	41	3.0
I don't remember	9	0.7
No answer	25	1.8

On average, how often do you, or members of your household, engage in outdoor recreation?

Table 9. On average, how often do you, or members of your household, engage in outdoor recreation?

	Never		Sometimes		Every month		Every week		Daily	
	#	%	#	%	#	%	#	%	#	%
Hiking/walking	122	8.9	474	34.6	169	12.3	294	21.4	269	19.6
Kayaking/canoeing	685	50.0	423	30.9	101	7.4	31	2.3	5	0.4
Bicycling	416	30.3	433	31.6	161	11.7	199	14.5	59	4.3
Riding horses	990	72.2	191	13.9	20	1.5	17	1.2	18	1.3
Fishing	607	44.3	431	31.4	112	8.2	96	7.0	17	1.2
Bird watching	494	36.0	436	31.8	89	6.5	114	8.3	145	10.6

Ecosystem Service #3: Flood Protection

Over half of Palm Beach County is in a floodplain. There is a 26% chance that properties in floodplains will flood at least once during a 30-year period (the average length of a mortgage). Properties outside the floodplain are also at risk of flooding. Natural areas help to protect people and their properties from floods by absorbing heavy rains and storm water runoff.

When asked if they pay flood insurance in Palm Beach County, a total of 580 respondents (42.3%) stated that they do pay flood insurance (Table 10).

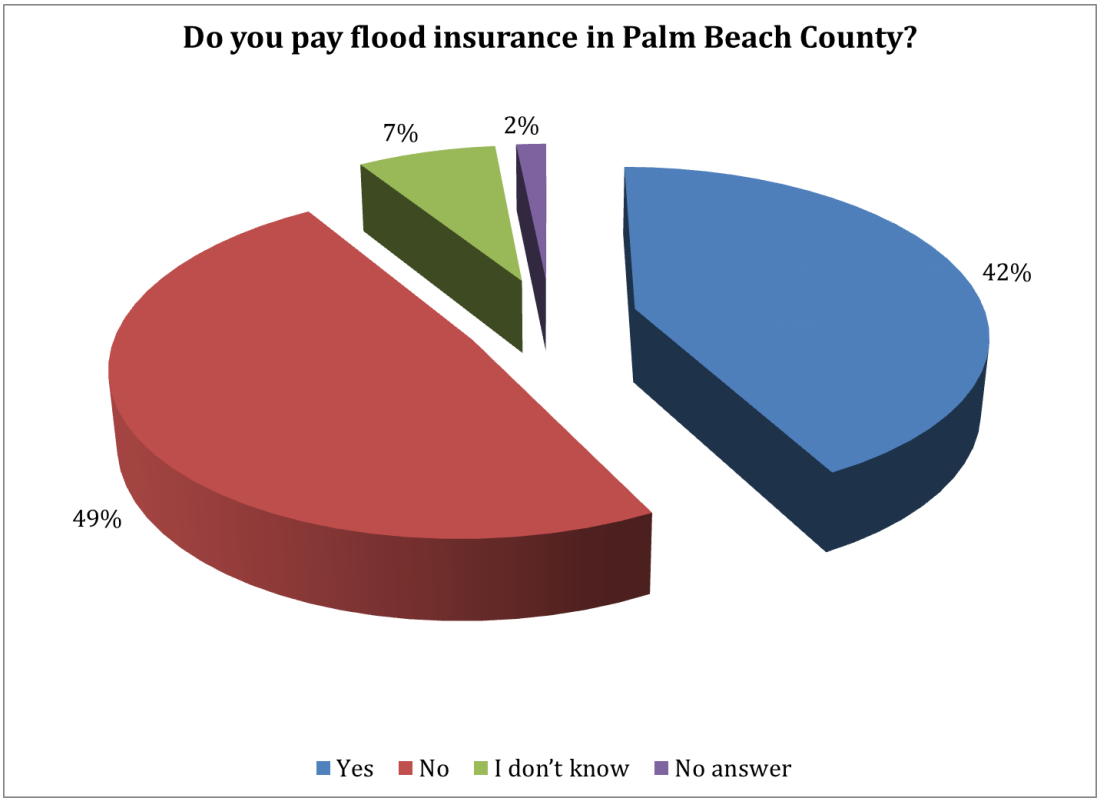


Table 10. Do you pay flood insurance in Palm Beach County?

	Number	Percent
Yes	580	42.3
No	667	48.7
I don't know	102	7.4
No answer	22	1.6

Ecosystem Service #4: Reduced Water Pollution

Wetlands help to improve water quality. Research shows that wetlands remove up to 68% of nitrogen and 43% of phosphorus from water that runs off agricultural lands. This purification process helps to protect human health and reduce the costs to residents of water treatment.

When asked to indicate how important the four ecosystem services that were presented in the survey were to them, the majority of respondents indicated that native habitat, flood protection and less water pollution were 'extremely' important to them. The largest share of respondents (65.5%) stated that reduced water pollution is extremely important to them (Table 11). On average, respondents stated that outdoor recreation is 'very' important to them. Less than 2% of respondents considered these ecosystem services to be 'not at all' important.

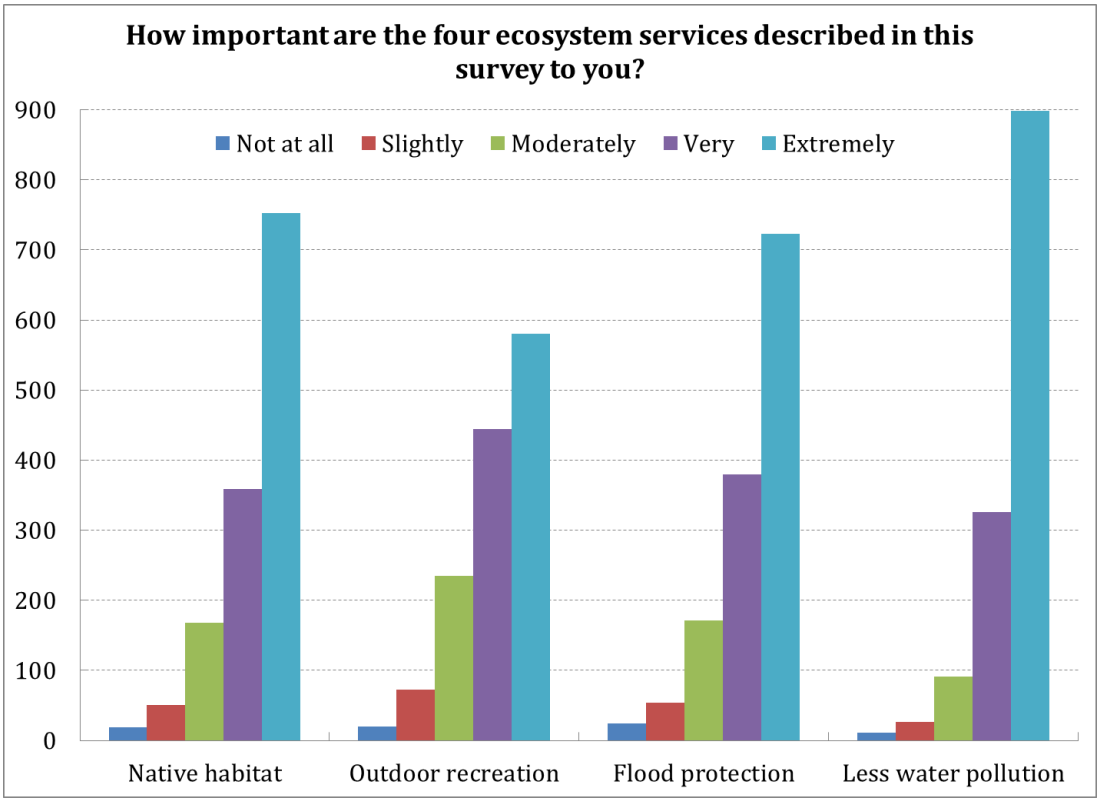


Table 11. How important are the four ecosystem services described in this survey to you?

	Native habitat		Outdoor recreation		Flood protection		Less water pollution	
	#	%	#	%	#	%	#	%
Not at all	19	1.4	20	1.5	24	1.8	11	0.8
Slightly	51	3.7	73	5.3	54	3.9	26	1.9
Moderately	168	12.3	235	17.1	171	12.5	91	6.6
Very	359	26.2	444	32.4	380	27.7	326	23.8
Extremely	753	54.9	580	42.3	723	52.7	898	65.5
No answer	21	1.5	19	1.4	19	1.4	19	1.4

FUNDING THE NATURAL AREAS PROGRAM

Prior to asking respondents whether they would be willing to vote for a tax to continue financing the Natural Areas Program, respondents were informed why funding for the program is required, and how those funds would be spent:

Funding the Natural Area Program

Past funding: Palm Beach County used two bonds to purchase and restore natural areas. A 1991 bond raised $100 million to purchase environmentally sensitive lands. A 1999 bond raised $50 million to acquire land for the Natural Areas Program. In total, 67% of county voters voted in favor of both bonds.

Current spending on natural areas: The County spends approximately $6.4 million per year to maintain the natural areas. These funds pay for:

- revegetation and removal of invasive plants
- maintaining recreation infrastructure, parking lots, fences, and signs
- providing educational materials for visitors
- monitoring the habitat, plants and animals in the natural areas to maintain ecosystem health

The bond money that was used to acquire and restore the natural areas has been fully spent. A dedicated source of money is required to maintain the Natural Areas Program.

To ascertain whether respondents were familiar with the two bond referenda, we asked them whether they had voted for either bond. A total of 415 respondents (30.3%) stated that they voted for either the 1991 or 1999 bond that was used to finance the Natural Areas Program (Table 12). A further 486 respondents (35.4%) were not voters in Palm Beach County at the time of these two referenda.

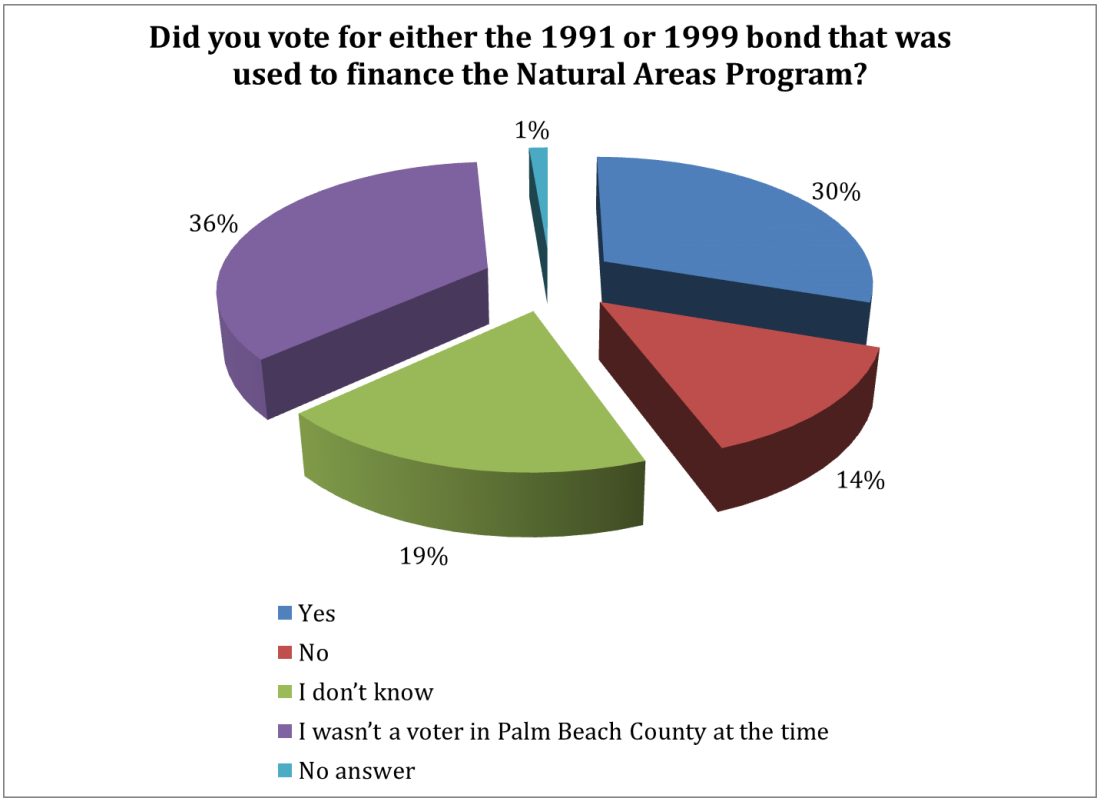


Table 12. Did you vote for either the 1991 or 1999 bond that was used to finance the Natural Areas Program?

	Number	Percent
Yes	415	30.3
No	193	14.1
I don't know	259	18.9
I wasn't a voter in Palm Beach County at the time	486	35.4
No answer	18	1.3

The survey was designed to determine both how much value respondents derive from the Natural Areas Program (see the next section of this report), and how they would prefer the program to be financed. Two options were presented to respondents for financing the Natural Areas Program:

1. a property tax increase (between $12 and $120 per year); and
2. increased utility fees (between $1 and $10 per month).

A total of 925 respondents (67.5%) stated that they would vote for a property tax increase to finance the Natural Areas Program, while 857 respondents (62.5%) agreed that they would vote for increased utility fees (Table 13). Based on these two questions, 1,066 respondents (77.8%) stated that they would vote for an annual payment (either increased property taxes or increased utility fees) to maintain the Natural Areas Program. Across respondents who stated that they would vote in favor of financing for the Natural Areas

Program, the majority (55.3%) preferred an increase in property taxes.[5] Fewer of these individuals (33.2%) preferred an increase in utility fees. Only 89 respondents (8.3%) preferred neither a property tax increase nor a utility fee increase.

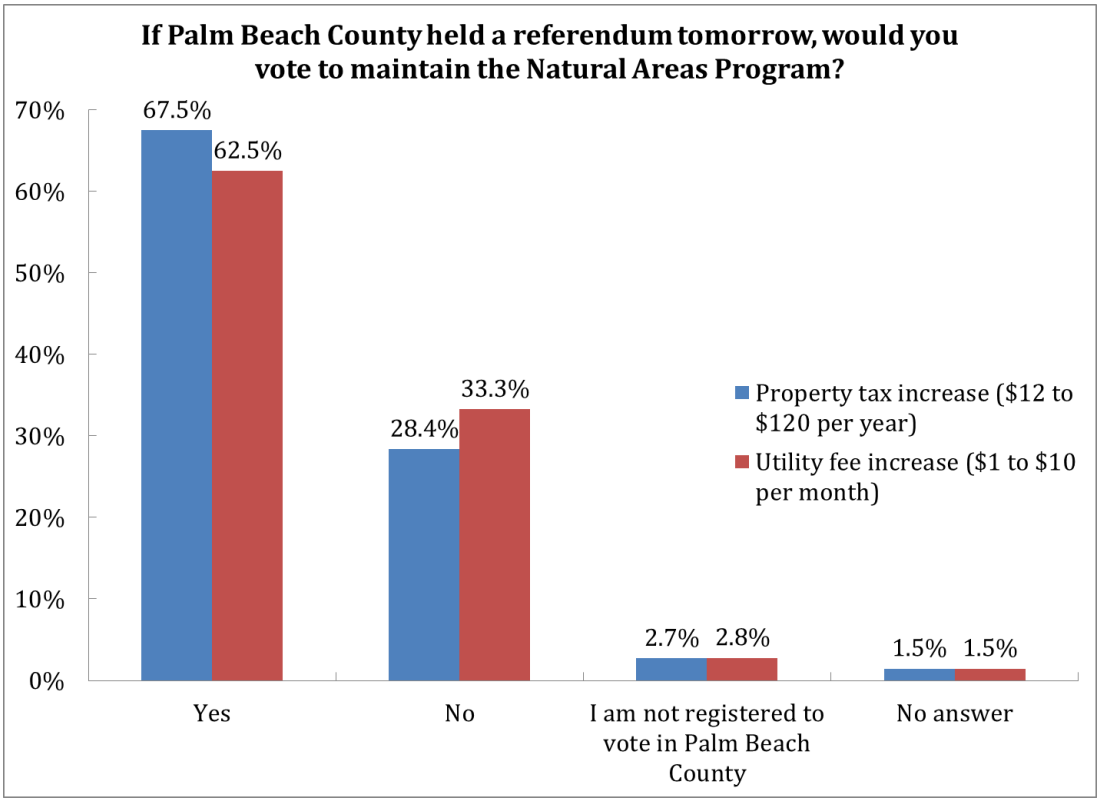
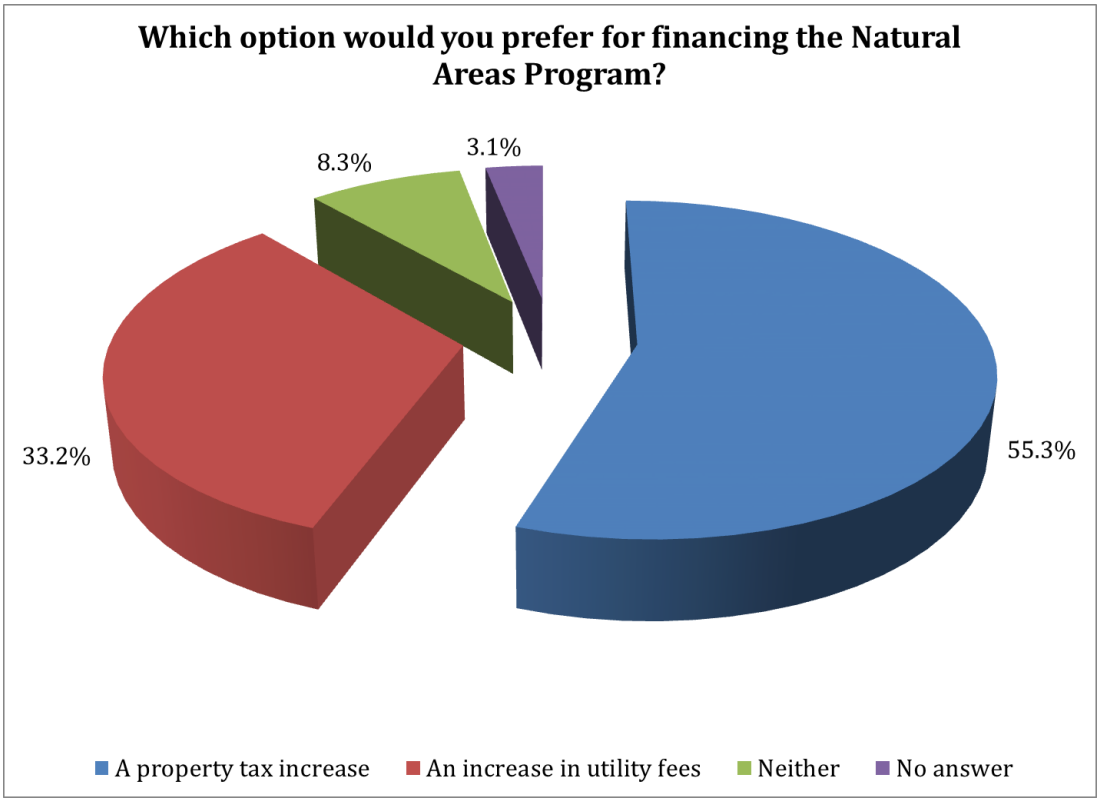


Table 13. If Palm Beach County held a referendum tomorrow, would you vote to maintain the Natural Areas Program?

	Property tax		Utility fees	
	Number	**Percent**	**Number**	**Percent**
Yes	925	67.5	857	62.5
No	389	28.4	456	33.3
I am not registered to vote in the county	37	2.7	38	2.8
No answer	20	1.5	20	1.5

[5] A total of 1,066 respondents stated that they would vote in favor of a property tax increase and/or an increase in utility fees to maintain the Natural Areas Program. Of these 1,066 respondents, a total of 590 respondents (55.3%) preferred a property tax increase to provide the necessary funding to maintain the Natural Areas Program. In contrast, 354 respondents (33.2%) preferred a utility fee increase.



RESPONDENTS' PREFERENCES RELATED TO THE NATURAL AREAS PROGRAM

In order to measure the value that respondents derived from the Natural Areas Program and the ecosystem services provided by the program, they were presented with stated preference choice experiment (SPCE) questions[6]. These questions were designed to measure the value that respondents placed on three ecosystem services: native habitat, recreational opportunities, and flood protection.

Respondents were shown three different programs that included different levels of the three ecosystem services, and an annual tax that the respondent would be expected to pay to finance the Natural Areas Program (see the text box below). Alternatively, the respondent could choose not to continue funding the Natural Areas Program, referred to as the 'opt-out' scenario.

To reduce cognitive load[7] associated with the SPCE questions the survey contained a separate question related to the value that respondents place on reduced water pollution. To further reduce respondents' cognitive load, three versions of the survey were created,

[6] Stated preference choice experiments are used by economists to conduct environmental valuation. These questions are designed to measure the value that people place on specific attributes of an environmental good (e.g. the ecosystem services provided by protected areas). These questions are also used to measure what individuals or households would be willing to pay to maintain environmental quality or ecosystem services.

[7] 'Cognitive load' is a term that was developed by researchers who specialize in cognitive psychology. Cognitive load refers to the amount of mental effort used during problem solving, e.g. when answering survey questions.

each of which contained four SPCE questions. Each survey version was administered to one third of survey recipients.

Respondents were provided with clear instructions on how to answer the SPCE questions. These instructions were extensively pre-tested to ensure that they were clear to respondents, in order to ensure data quality:

Your Preferences Related to the Natural Areas Program

We will now ask you four questions about your preferences related to the county's natural areas and whether you would pay to maintain the Natural Areas Program.

This EXAMPLE QUESTION shows you how to fill in the four questions that you will find on the next page:

Step 1: Decide if you like any of the programs

Please consider the following three programs:

	PROGRAM 1	PROGRAM 2	PROGRAM 3
Protected habitat	Forest	Scrub	Wetland
Recreation opportunity	Kayak ramps	Paved trails	Dirt trails
Flood risk	1% reduction	2% reduction	No reduction
Annual tax	$30	$15	$100

If a referendum was held tomorrow, would you vote for one of the above programs? *Circle **ONE** number.*

1 **YES** on Program 1
2 **YES** on Program 2
3 **YES** on Program 3
4 I would vote **NO** on paying for the natural areas program

Step 2: Decide if you would vote for one of the programs above. Circle **ONE** response

If you choose not to vote for any of the options then you are choosing not to maintain the Natural Areas Program.

If you vote for one of the programs, then you are providing information about which ecosystem services are important to you, and how much you would pay to maintain the Natural Areas Program.

Paved trails allow for walking, photography, birdwatching, and nature appreciation. **Dirt trails** allow for bicycling, horseback riding, and hiking.

Motorized vehicles (such as ATVs or motorbikes) are not allowed inside the natural areas.

No reduction in flood risk means that the probability that properties in the flood plain will flood at least once every 30 years remains 26%. A **1% reduction** in flood risk means that the risk of flooding falls to 25%.

The number and percent of respondents who stated that they would vote for each of the programs included in the SPCE questions are presented in Table 14 (the most frequently chosen program for each SPCE question is highlighted). Between 437 and 482 respondents were presented with each survey version (survey versions A, B or C which contained different SPCE questions). The majority of respondents (between 72.3% and 83.1% of respondents for each SPCE question) voted for one of the programs presented. Only 11.4% to 21.5% of respondents stated that they would not vote for one of the programs included in the SPCE questions, i.e. that they would choose not to maintain the Natural Areas Program. The majority of respondents (68.4%) either agreed or strongly agreed that their responses to the SPCE questions accurately reflected their preferences for the Natural Areas Program, which reinforced the validity of the results presented below.

Table 14. Respondents' choice of program

Program	Protected habitat	Recreation opportunity	Flood risk	Annual tax	Selected	
					#	%
1	Wetland	Kayak ramps	1% reduction	$30	111	25.4
2	Scrub	Dirt trails	No reduction	$100	32	7.3
3	Forest	Paved trails	2% reduction	$15	220	50.3
None					50	11.4
No answer					24	5.5
1	Wetland	Kayak ramps	No reduction	$15	133	30.4
2	Forest	Dirt trails	1% reduction	$60	136	31.1
3	Scrub	Paved trails	2% reduction	$100	63	14.4
None					83	19.0
No answer					22	5.0
1	Forest	Kayak ramps	2% reduction	$30	173	39.6
2	Scrub	Dirt trails	No reduction	$60	48	11.0
3	Wetland	Paved trails	1% reduction	$100	95	21.7
None					92	21.1
No answer					29	6.6
1	Scrub	Dirt trails	1% reduction	$15	100	22.9
2	Wetland	Paved trails	2% reduction	$30	183	41.9
3	Forest	Kayak ramps	No reduction	$60	59	13.5
None					72	16.5
No answer					23	5.3
1	Wetland	Kayak ramps	No reduction	$15	142	31.4
2	Scrub	Dirt trails	2% reduction	$30	116	25.7
3	Forest	Paved trails	1% reduction	$60	101	22.3
None					71	15.7
No answer					22	4.9
1	Scrub	Dirt trails	1% reduction	$30	103	22.8
2	Wetland	Paved trails	No reduction	$15	193	42.7
3	Forest	Kayak ramps	2% reduction	$100	65	14.4
None					71	15.7
No answer					20	4.4

Program	Protected habitat	Recreation opportunity	Flood risk	Annual tax	Selected	
1	Scrub	Paved trails	No reduction	$100	57	12.6
2	Wetland	Dirt trails	2% reduction	$60	152	33.6
3	Forest	Kayak ramps	1% reduction	$15	130	28.8
None					84	18.6
No answer					29	6.4
1	Wetland	Dirt trails	1% reduction	$100	88	19.5
2	Forest	Kayak ramps	No reduction	$30	127	28.1
3	Scrub	Paved trails	2% reduction	$60	116	25.7
None					97	21.5
No answer					24	5.3
1	Scrub	Paved trails	1% reduction	$15	175	36.3
2	Forest	Dirt trails	No reduction	$100	88	18.3
3	Wetland	Kayak ramps	2% reduction	$60	126	26.1
None					69	14.3
No answer					24	5.0
1	Wetland	Kayak ramps	1% reduction	$30	126	26.1
2	Scrub	Paved trails	No reduction	$60	68	14.1
3	Forest	Dirt trails	2% reduction	$15	192	39.8
None					72	14.9
No answer					24	5.0
1	Wetland	Dirt trails	No reduction	$30	172	35.7%
2	Forest	Kayak ramps	2% reduction	$100	73	15.1%
3	Scrub	Paved trails	1% reduction	$60	105	21.8%
None					101	21.0%
No answer					31	6.4%
1	Wetland	Kayak ramps	1% reduction	$100	83	17.2
2	Scrub	Dirt trails	2% reduction	$15	172	35.7
3	Forest	Paved trails	No reduction	$30	117	24.3
None					84	17.4
No answer					26	5.4

Statistical analysis of the responses to the SPCE questions was conducted to determine what value respondents placed on each of the ecosystem services and on the Natural Areas Program as a whole. Because residents of Palm Beach County are not identical in terms of their preferences, demographic characteristics or economic welfare, this analysis explicitly accounted for heterogeneity across respondents. Two common, rigorous statistical approaches to modeling respondent heterogeneity were used during data analysis:

1. random parameters logistic regression, and
2. latent class analysis.

These two statistical models account for heterogeneity differently. Details on how these specific models account for respondent heterogeneity are provided in the appendix to this paper.

Random Parameters Logit

Based on the random parameters logit (RPL) model, we found that respondents derived an average of $122.25 per year in value from the Natural Areas Program (Table 15). This is the value that respondents would lose each year if the Natural Areas Program was discontinued. Further analysis showed that respondents derived positive value from the protection of wetlands and forest habitats by the Natural Areas Program. According to the RPL model, respondents derived an average of $7.87 per year in value from the protection of wetlands, and $5.35 per year in value from the protection of forest. The only habitat that respondents did not derive positive value from was scrub. Respondents also positively valued dirt trails (average value of $1.79 per year), paved trails (average value of $7.54 per year) and kayak ramps (average value of $5.68 per year). Respondents valued a reduction in flood risk associated with the protection of natural areas (average of $2.58 per year for a 1% reduction in flood risk, and $7.27 per year for a 2% reduction in flood risk).

Latent Class Analysis

The latent class analysis provided further insights into how respondents value the Natural Areas Program and the ecosystem services it protects. In contrast to the RPL approach which treats the sample of respondents as a single group with a range of preferences, this estimation procedure segments individuals into groups (which display similar preferences).[8] By segmenting respondents into groups, latent class analysis can be used to better understand which groups derive greatest value from the Natural Areas Program and which groups derive less value from the program. Latent class analysis can also be used to determine what percentage of respondents would benefit from maintaining the Natural Areas Program, and securing specific ecosystem services. Palm Beach County respondents sorted into 3 groups.

Segment 1 was the majority group, accounting for 62.3% of all respondents. This majority group derived an average of $445.64 per year in value from maintaining the Natural Areas program, i.e. this group placed high value on maintaining the program. This group also positively valued the protection of forest (average value of $34.47 per year). The majority group positively valued dirt and paved trails ($74.29 per year in value from dirt trails, and $85.54 per year in value from paved trails). Finally, the majority group positively valued reduced flood risks associated with the Natural Areas Program ($55.24 per year for a 2% reduction in flood risk).

Segment 2 accounted for 18.7% of respondents. This group did not positively value the Natural Areas Program as a whole. However, the group placed positive value on both dirt and paved trails ($22.65 per year for dirt trails, $34.88 per year for paved trails), i.e. this group primarily valued the recreational opportunities offered by the Natural Areas Program.

[8] These segments were determined by the statistical software, based on how individuals responded to the survey questions.

Table 15. Value that respondents place on the Natural Areas Program and the ecosystem services provided by the program

	Random Parameters Logit		Latent Class Model					
			Segment 1		Segment 2		Segment 3	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Value of Natural Areas Program	122.25	83.81:150.69	445.64	335.99:555.28	-11.01	-37.88:15.87	122.05	60.45:183.66
Native habitat:								
Forest	5.35	2.57:8.12	34.47	16.90:52.03	13.00	-4.95:30.96	65.13	19.05:111.20
Wetlands	7.87	4.86:10.89	15.38	-4.83:35.59	21.73	2.16:41.30	93.22	59.49:126.94
Scrub	-13.22	-19.01:-7.43	-49.85	-87.63:-12.08	-34.74	-72.26:2.79	-158.34	-238.2:-78.54
Recreation opportunity:								
Dirt trails	1.79	-1.21:4.78	74.29	42.92:105.66	22.65	-1.15:46.46	-65.06	-99.28:-30.84
Paved trails	7.54	4.83:10.25	85.54	53.55:117.53	34.88	11.84:57.91	-31.53	-47.88:-15.18
Kayak ramps	5.68	2.60:8.76	-35.69	-41.47:-29.90	-0.14	-14.64:14.35	189.87	126.41:253.33
Flood risk:								
No reduction	-9.85	-14.67:-5.03	-65.77	-102.00:-29.54	-4.83	-41.67:32.02	-48.94	-107.70:9.82
1% reduction	2.58	0.31:4.85	10.53	-5.94:27.01	8.02	-11.15:27.19	42.03	6.76:77.30
2% reduction	7.27	4.72:9.82	55.24	35.48:74.99	-3.20	-20.87:14.48	6.91	-16.59:30.40

CI: confidence interval. The 95% confidence interval provides the upper and lower bound estimates of the value that survey respondents placed on the Natural Areas Program and each of the ecosystem services. The mean value is the average value that respondents placed on the Natural Areas Program and the ecosystem services provided by this program.
Segment 1 accounts for 62.3% of respondents.
Segment 2 accounts for 18.7% of respondents.
Segment 3 accounts for 19% of respondents.

Segment 3 accounted for 19% of respondents, and was the only group that positively valued kayak ramps. This group derived an average of $122.05 per year in value from maintaining the Natural Areas Program. This group also valued the protection of wetlands at $93.22 per year and the provision of kayak ramps at $189.87 per year. In contrast to the other two groups, this group did not positively value dirt or paved trails.

The latent class analysis shows that although different groups of Palm Beach County residents value the Natural Areas Program and the ecosystem services it provides differently, they still derive value from the program. This analysis also demonstrates that the majority of respondents (81.3% of respondents who sorted into Segments 1 and 3) place positive value on the continuation of the Natural Areas Program, over and above the specific ecosystem services that were the focus of the survey.

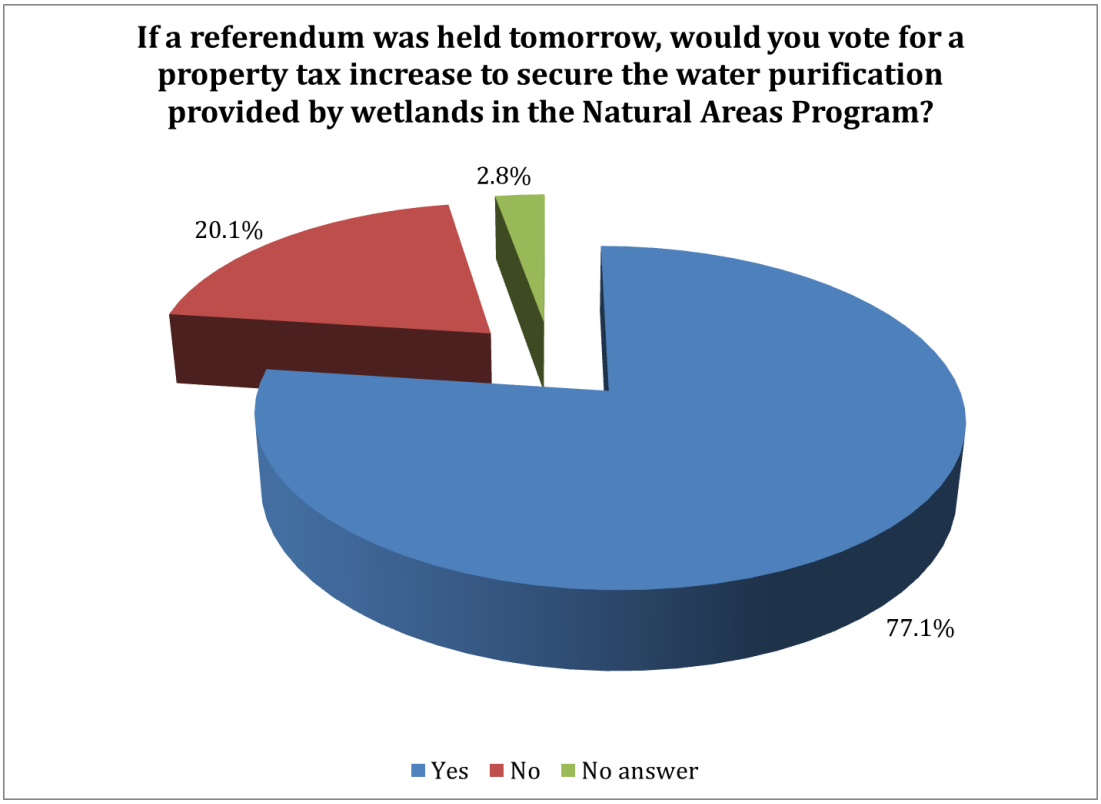
Value of Reduced Water Pollution

In addition to the SPCE questions, respondents were asked the following question: "Wetlands improve water quality by removing up to 68% of nitrogen and 43% of phosphorus from water that runs off agricultural lands. If a referendum was held tomorrow, would you vote for a property tax increase to secure the water purification provided by wetlands in the Natural Areas Program?" A total of 1,057 respondents (77.1%) agreed that they would vote for a tax to secure reduced water pollution (Table 16). Respondents who were willing to vote for an increase in property taxes to secure water quality improvements from wetlands were asked to indicate the amount they would pay. The amount they were willing to pay ranged from $1 per year to $300 per year. Based on responses to both these questions, the average amount that respondents were willing to pay to maintain water quality improvements was $27.96 per year (standard deviation of $26.41)[9].

Table 16. If a referendum was held tomorrow, would you vote for a property tax increase to secure the water purification provided by wetlands in the Natural Areas Program?

	Number	Percent
Yes	1,057	77.1
No	276	20.1
No answer	38	2.8

[9] The standard deviation measures how widely values are dispersed from the average value (or mean). Because respondents placed a wide array of values on improvements in water quality, the standard deviation is relatively large.



Reasons Why Respondents Were Not Willing to Pay Towards Maintaining the Natural Areas Program

In total 125 respondents (9.1%) stated that they would not pay to maintain the Natural Areas Program or secure any of the four ecosystem services described in the survey. The most common reason that these individuals gave for why they would not vote to maintain the Natural Areas Program was that they should not have to pay more taxes (96 respondents, 7%). Other reasons why respondents were not willing to vote in favor of a tax to pay for the Natural Areas Program were:

- they do not trust the government to run the Natural Areas Program (42 respondents, 3.1%);
- the costs of the Natural Areas Program are too high (21 respondents, 1.5%);
- it is not their responsibility to pay for the Natural Areas Program (17 respondents, 1.2%);
- they are not planning to stay in Palm Beach County (7 respondents, 0.5%); and
- protecting natural areas is not important to them (6 respondents, 0.4%).

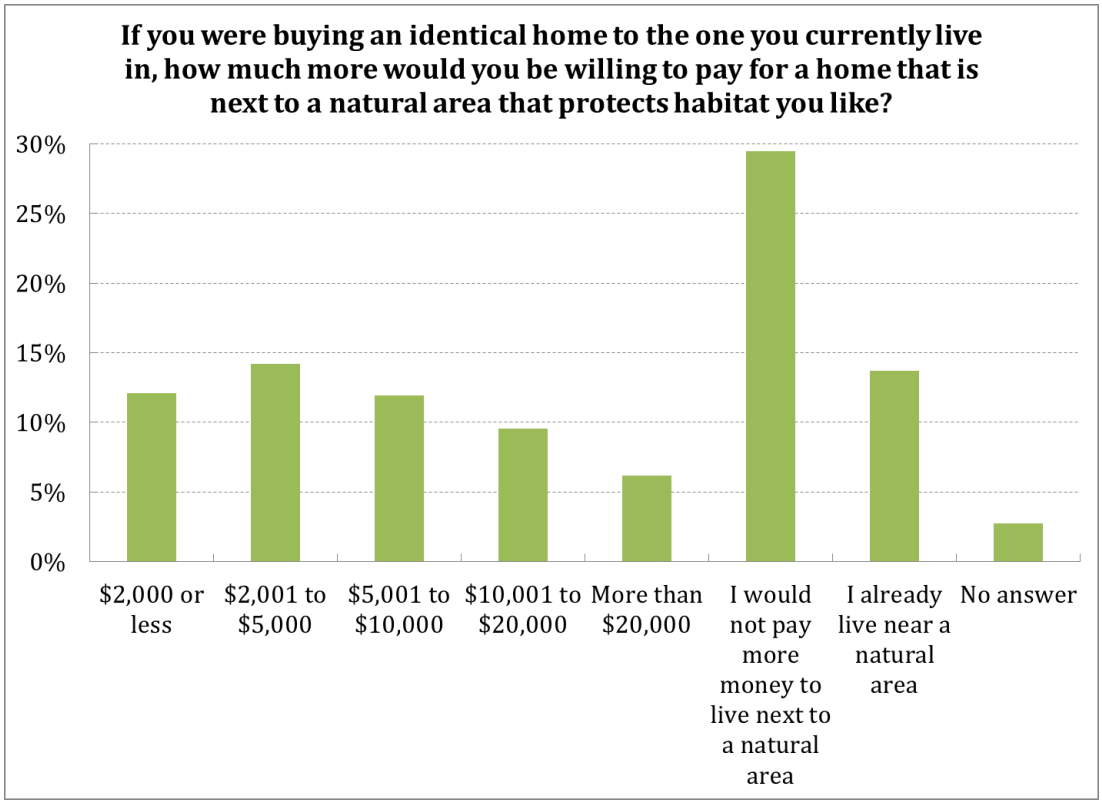
Willingness to Pay to Live Next to a Natural Area

As a final question, respondents were asked "If you were buying an identical home to the one you currently live in, how much more would you be willing to pay for a home that is next to a natural area that protects habitat you like?" Although 404 respondents (29.5%) stated that they would not pay more money to live next to a natural area, 741 respondents (54%) indicated that they would pay more for a house that is located next to a

preferred habitat type (Table 17). The largest share of these individuals was willing to pay an additional $2,001 to $5,000 for a house next to a natural area.

Table 17. If you were buying an identical home to the one you currently live in, how much more would you be willing to pay for a home that is next to a natural area that protects habitat you like?

	Number	Percent
$2,000 or less	166	12.1
$2,001 to $5,000	195	14.2
$5,001 to $10,000	164	12.0
$10,001 to $20,000	131	9.6
More than $20,000	85	6.2
I would not pay more money to live next to a natural area	404	29.5
I already live near a natural area	188	13.7
No answer	38	2.8



CONCLUSIONS

Based on the survey data collected, the following inferences may be drawn:

1. Taking respondent heterogeneity into account, the majority of individuals value the Natural Areas Program, and the ecosystem services this program provides, above the annual $12 to $15 payment per residential property required to maintain the program.

2. A greater share of respondents preferred a property tax increase over an increase in utility fees, in order to finance the Natural Areas Program.
3. There would appear to be sufficient support for the Natural Areas Program to justify a referendum, in order to determine whether the larger voting population in Palm Beach County would vote in favor of dedicated funding for the Natural Areas Program.
4. Education and outreach efforts by Palm Beach County should highlight the ecological importance of scrub habitat.

Additional economic valuations of the other ecosystem services provided by Natural Areas (e.g., air purification, erosion control, aquifer recharge, carbon sequestration, improved aesthetics, health benefits, etc.) may demonstrate additional value that residents of Palm Beach County derive from the Natural Areas Program. However, it is beyond the scope of this study to infer what those values might be.

APPENDIX: STATISTICAL ESTIMATION TECHNIQUES

Multinomial Logit (MNL) Model

Initially, we analyzed the SPCE data using the standard multinomial logit model (MNL), the foundation for the analysis of discrete choice modeling. Respondents' choices were modeled using a random utility maximization framework (McFadden, 1973). We specified the latent utility (U) that respondent *i* derives from each natural area program (or choice profile) *j* as the sum of a systematic, known component (V) and a random component (ε):

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

Assuming linear utility, V_{ij} takes the form

$$V_{ij} = \mathbf{X}_{ij}^{'}\boldsymbol{\beta} = \beta_1 \cdot \text{Habitat}_{ij} + \beta_2 \cdot \text{Recreation}_{ij} + \beta_3 \cdot \text{Flood}_{ij}$$

where $\boldsymbol{X_{ij}}$ is a vector of the attribute levels (type of habitat conserved, Habitat; outdoor recreation opportunity, Recreation; change in flood risk, Flood) for profile *j*, and $\boldsymbol{\beta}$ is the vector of attribute coefficients. Assuming that individuals maximize utility, individual *i* will choose program *j* if the utility associated with program *j* exceeds the utility derived from other programs (including discontinuing the Natural Areas Program), i.e.

$$U_{ij} \geq \max\{U_{i1}.....U_{ik}\}, \text{ k≠j}$$

Finally, assuming that error terms follow a type I extreme value distribution, the probability that individual *i* will select program *j* is given by:

$$\Pr(\text{individual } i \text{ chooses program } j) = \frac{\exp\left(\mathbf{X}_{ij}^{'}\boldsymbol{\beta}\right)}{\sum_{j \neq k} \exp\left(\mathbf{X}_{ij}^{'}\boldsymbol{\beta}\right)}$$

The multinomial logit model makes a number of restrictive assumptions that are unlikely to hold in reality, in particular the assumption of homogeneity of preferences across individuals. In order to model preference heterogeneity, we used both random parameters and latent class models to analyze the SPCE data.

Random Parameter Logit (RPL) Model

The random parameter logit (RPL) model is a generalization of the MNL model, but it does not exhibit independence of irrelevant alternatives, and the model explicitly incorporates unobserved heterogeneity across respondents (Carlsson et al., 2003; Train, 1998). In common with the MNL model, the latent utility function incorporates both a systematic, known component (V) and a random component (ε), and V is linear in program attributes:

$$V_{ij} = \mathbf{X}_{ij}^{'}\boldsymbol{\beta}.$$

However, the coefficient vector $\boldsymbol{\beta}$ varies across respondents with density $f(\boldsymbol{\beta}|\boldsymbol{\theta})$, where $\boldsymbol{\theta}$ is a vector of the true parameters of the preference distribution. Assuming that the error terms follow a type I extreme value distribution, the conditional probability that individual *i* will select alternative *j* in choice situation *t* is:

$$P_i(jt \mid \beta_i) = \exp\left(\mathbf{X}_{ij}^{'}\boldsymbol{\beta}\right) \sum k \notin \mathbf{A}_j \exp\left(\mathbf{X}_{kj}^{'}\boldsymbol{\beta}\right), \; k \neq i$$

where **A** is the choice set. Accordingly, the conditional probability of observing any given sequence of choices is given by:

$$S_i(\beta_i) = \prod_t \Pr(k(i,t)t \mid \beta_i)$$

and the unconditional probability that individual *i* makes a sequence of choices is the integral of the conditional probability over all values of β:

$$\Pr_i(\theta) = \int S_i(\beta) f(\beta \mid \theta) \mathrm{d}\beta = \int \frac{\exp(\mathbf{X}_{ij}'\boldsymbol{\beta})}{\sum_k \exp(\mathbf{X}_{kj}'\boldsymbol{\beta})} f(\beta \mid \theta) \mathrm{d}\beta .$$

In the RPL model, the coefficients **β** vary across individuals, but are constant across each individual's choices, i.e. we assume stable preferences for each individual. Because the model allows for preference heterogeneity, the vector of random parameters **β** has a mean and variance – which captures heterogeneity across respondents.

Latent Class Model (LCM)

The latent class model (LCM) posits that respondents' choices between programs depends on the observable attributes of the program, observable attributes of respondents, and latent, unobservable heterogeneity in respondents' preferences. The LCM captures heterogeneity of preferences through discrete parameter variation (Greene & Hensher, 2003; Swait, 1994). Following Greene and Hensher (2003), respondents are sorted into Q classes, such that:

$$\Pr(\text{choice } j \text{ by individual } i \text{ in choice situation } t \mid \text{class } q) = \frac{\exp(\mathbf{X}_{it,j}'\boldsymbol{\beta}_q)}{\sum_{j=1}^{J_i} \exp(\mathbf{X}_{it,j}'\boldsymbol{\beta}_q)} = F(i,t,j \mid q)$$

which may be rewritten as:

$$P_{it|q} = F(i,t,j \mid q)$$

Assuming that the T_i choice events are independent within each class *q*, individual *i*'s contribution to the likelihood is given by the joint probability:

$$P_{i|q} = \prod_{t=1}^{T_i} P_{it|q}$$

If H_{iq} is the prior probability that individual *i* belongs to class *q* then the multinomial logit takes the form:

$$H_{iq} = \frac{\exp(\mathbf{z}_i'\theta_q)}{\sum_{q=1}^{Q} \exp(\mathbf{z}_i'\theta_q)}, \; q = 1,\ldots Q; \; \theta_Q = 0$$

where $\boldsymbol{z}_i$ are the observable characteristics associated with class membership, and the Q^{th} parameter vector is normalized to zero, in order to ensure identification of the model. The latent class model specification is determined by maximizing the log likelihood function:

$$\ln L = \sum_i \ln P_i = \sum_i \ln\left[\sum_q H_{iq}\left(\prod_t P_{it|q}\right)\right].$$

We used respondent characteristics (e.g. demographics, importance respondents placed on ecosystem services) to allow for discrete segmentation based on homogeneous preferences within segments (Boxall & Adamowicz, 2002).

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