THE IMPACT OF INVASIVE UPLAND PLANTS ON THE RECREATIONAL VALUE OF NATURAL AREAS: THE CASE OF WOODED PARKS IN FLORIDA

By

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(To Kisha for understanding when mom was too busy with school)

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LIST OF ABBREVIATIONS

APHIS	Animal and Plant Health Inspection Service
BIPM	Bureau of Invasive Plant Management
CE	Choice Experiment
CV	Contingent Valuation
FACT	Florida Assessment of Coastal Trend
FLDEP	Florida Department of Environmental Protection
FLEPPC	Florida Exotic Plant Pest Council
FLSCORP	Florida Statewide Comprehensive Outdoor Recreation Plan
MAU	Multi-Attribute Utility
MAUM	Multi-Attribute Utility Model
MWTP	Marginal Willingness to Pay
NISC	National Invasive Species Council
OTA	Office of Technology Assessment
RUM	Random Utility Maximization
UF-IRB	University of Florida Institutional Review Board
USDA	United States Department of Agriculture
WAS	Wooded Park Animal Species
WPS	Wooded Park Plant Species
WTA	Willingness to Accept
WTP	Willingness to Pay

Abstract of Thesis Presented to the Graduate School
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Invasive plants can have impacts on the quality and quantity of recreational activities such as hunting, wildlife viewing and hiking because they negatively affect environmental attributes that are important in supporting recreation. This study examined the relationships between invasive plants and recreational values of Florida's wooded parks using a Multi-Attribute Utility Model. Surveys were electronically distributed to Florida residents to examine preferences for these attributes; invasive species, park fee, species diversity and facilities. A conditional logit model predicted the respondents' choice behavior and quantified the relationship between utility derived from recreation and these attributes.

Results indicate that invasive species have a negative impact to recreational utility. Florida residents have a marginal willingness to pay (MWTP) to reduce invasive species of up to $7.15 which is higher than the MWTP to improve facilities or increase species diversity. MWTP to reduce invasive species was even higher with invasive species knowledge ($19.25 for experts). Residents' willingness to pay to control these species ranged from $29.1 to $108.7 million per year with knowledge level differences. Our findings suggest that an invasive species educational program could increase Florida residents' MWTP to control invasive species in natural areas.

CHAPTER 1
INTRODUCTION

Background

Invasive plant species are defined as non-indigenous species with the ability to establish self-sustaining and expanding populations within plant communities and may cause economic or environmental harm (NISC, 2001). The United States' natural ecosystems have been invaded by over 5,000 non-indigenous plant species, which compete with approximately 17,000 native plant species for space and resources. When invasive plants successfully invade natural areas they tend to displace native species and associated wildlife, degrade upland habitats and cause loss of biodiversity (Olson 1999). This is because they possess many weedy characteristics which enable them to spread rapidly and effectively in the new environment.

Some of these non-native plants are responsible for $25 billion in damages to the Unites States' food and horticultural crops and $10 million in losses to natural ecosystems each year (Pimentel, 2002). The annual total cost from damages and controlling invasive plants in the agriculture and horticulture sectors is $34.5 billion and an additional $159.5 million is spent on managing invasive plants in natural systems (Pimentel, 2002). Nationally, invasive species are the second greatest threat to endangered species after habitat destruction and cost the country over $138 billion each year in environmental damages and crop losses (Pimentel, 2002).

While the invasive species problem has become a global and national concern, the state of Florida has been the most affected in the United States (OTA, 1993). The favorable climate, geographical location and environmental conditions that foster the state's high level of plant diversity have consequently made Florida's land susceptible to invasive plant species. To date, more than 1,300 exotic plant species have been introduced and established throughout the state with 124 species destructive to the biological diversity of natural areas (FLEPPC, 2006). In 2005 upland weeds such as the Australian pine, Brazilian pepper and climbing ferns infested over 1.65 million acres of Florida's 11 million acres of public conservation lands (FLDEP, 2005). These plants have also affected millions of acres of Florida's privately owned land.

Non-native invasive plants can also have substantial impact on recreational activities such as hunting, hiking, wildlife viewing and water-based recreation (Eiswerth et al., 2005). Olson (1999) suggests that this is because invasive weeds negatively affect a wide range of environmental attributes that are important in supporting recreation such as plant and animal diversity and abundance. In a study about the economic impacts of weeds on outdoor recreation in the riparian areas of Nevada, Eiswerth et al., (2005) found that non-native weeds had a recreational losses impact over the five years period ranging from $30 million to $40 million.

Recreation in Florida Natural Areas

Florida natural areas play a significant role in the states' economy by providing recreational activities for residents and visitors. Ecotourism recreational activities such as hiking, camping, sightseeing, and wildlife viewing in Florida's natural areas have an estimated economic contribution of $8 billion per year (FLDEP, 2005).

Outdoor recreation is one of the state's main attractions and the Florida's state park system is one of the largest in the country with 159 parks covering 723,852 acres of land and 100 miles of sandy beach (FLDEP, 2006). Florida's state parks offer year-around outdoor activities for all ages. The park system is comprised of beaches, rivers and lakes and wooded parks offering diversified activities in each park. There are some parks like for example, Oleta River state park where visitors can enjoy beach activities, engage in kayaking, mountain biking, camping, swimming, fishing, trail walking, horse riding, wildlife viewing and even hiking, all activities in one place. Over 100 parks offer wooded park activities like hiking, nature trails and horse riding. Over 50 parks offer both river and lake (boating, fishing, and kayaking) activities and wooded park activities while more than 40 parks offer beach activities like swimming, sunning, surfing and wooded park activities.

A good number of visitors come to Florida for the primary purpose of viewing wildlife. According to the Fish and Wildlife Service, approximately 800,000 visitors came to Florida in 1996 primarily for the purpose of viewing wildlife, and over 40 percent of Florida's residents participated in some form of wildlife viewing. In this same year, Florida ranked second in the nation behind Texas for wildlife-related recreation expenditures. In the 2001 Fish and Wildlife survey nearly 4.9 million Florida residents and nonresidents over 16 years of age fished, hunted, or watched wildlife in Florida parks. Over 65% of this total number participated in wildlife-watching activities, including observing, feeding, and photographing. More than half of Florida visitors engage in some type of nature-based activity during their visit, and 19 to 33 percent of all travel and tourism in the southern United States is linked to outdoor recreation (Hodges, 2006).

Between 1995 and 2004, the state park system's economic impact on local economies throughout the state grew from $189 million to over $600 million (FLDEP, 2005) with the annual park attendance growing from 12 to 18.5 million visitors (Figure 1-1). In the last fiscal year, 2005-2006 over 18 million people visited Florida state parks spending over $442 million in the state (FLDEP, 2006). It is expected that in the next five years the need for public outdoor recreation land and parks in Florida will increase greatly as the state's population is growing (FLDEP, 2006).

The demand for wooded park activities like biking, horse riding and wildlife viewing has also been on the rise and expected to continue. The estimated demand for selected wooded park activities are presented in Figure 1-2. On Florida's scenic trails, a growing number of people are undertaking longer day and overnight hikes while horseback riding participation, relative to other forms of outdoor recreation, has been steady (FLSCORP, 2000).

The state has responded to the growing outdoor recreation demand by investing over $3 billion to expand conservation lands and recreational opportunities over the past decade (FLDEP, 2006). The focus has been on making natural areas more accessible to the public through restoration including management and removal of non-native plants.

Upland Invasive Plants in Florida Natural Areas

Upland invasive plants are terrestrial (vs. aquatic) invasive exotic plants. Invasive plants displace native plants and associated wildlife, including endangered species and can alter natural process such as fire and water flow. Exotic plants were brought to the U.S. to be grown for various reasons like food, feed, fiber, and ornamental purposes but some have become invasive and have proven to be a challenge to keep under control. The problem of exotic invasive species in Florida parks has been cited as one of the greatest threats to park resources (Glisson, 1994).

According to the Florida's Recreation and Parks Division, the most troublesome invasive plants in the state parks are Brazilian pepper, Australian pine, Chinese tallow, Cogongrass, Air potato and Japanese climbing fern. Based on the total acres treated in projects dealing with upland weeds management in the state in 2005, the "ten most unwanted" upland invasive exotic plants in Florida are listed in Table 1-1.

Florida Exotic Plant Pest Council (FLEPPC) compiles invasive species lists that are revised every two years. Invasive exotic plants are termed Category I invasive when they are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives. Category II invasive exotics are invasive plants that have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species. They may become category I if they demonstrate ecological damage. The plants on the list of the ten most unwanted in Florida are currently all listed as category I invasive by the FLEPPC. They are scattered everywhere mostly from Central Florida, along the East and West coasts towards South Florida.

Among the list, Australian pine, Brazilian pepper and Malaleuca are the most widely spread in Central and South Florida. These plants, like other invasive species, have a tendency to crowd out native plants and animals. Australian pine invades coastal areas interfering with nesting of endangered sea turtles and American crocodiles. Brazilian pepper grows in dense monocultures and reduces nesting sites for bird, amphibian and reptile populations. It is believed to have displaced some populations of rare listed species, such as the Beach Jacquemontia (*Jacquemontia reclinata)* and Beach Star (*Remirea maritima*) in South Florida (Doren, 2002). Cogongrass invades pinelands, scrub and prairie also threatening rare plants and interfering with fire patterns. In places invaded by Cogongrass, wildfires can be more frequent and intense (FLDEP). Old world climbing fern is naturalized in southern and western Florida, and the Japanese climbing fern is frequently naturalized in north and west Florida.

South Florida's upland environments are the part of the state most heavily invaded by non native species (FLDEP). The reason for South Florida's heavy invasion is said to be high importation activity in the area, highly disturbed landscapes and a climate conducive to growth of subtropical plants.

The plants mentioned above are also restricted by the federal government along with other plants that are known to interfere with agro-ecosystems, native ecosystems, the management of ecosystems, or to cause injury to public health. The USDA Animal and Plant Health Inspection Service (APHIS) runs the Federal noxious weed program designed to prevent the introduction and the spread of newly introduced non-indigenous invasive plants in the United States by excluding, detecting and eradicating introduced weeds that pose the highest risk to agriculture or the environment.

Controlling and management of invasive species in natural areas is one of the state's priorities but this exercise has been costly. Private expenditures for controlling invasive plants in Florida's agriculture and forest industries are estimated at $265 million per year (Lee and Kim, 2005). Overall the state spends $103 million per year on prevention and control of invasive plants (FLDEP, 2006). In 2005 the state exceeded the $6.3 million annual estimate by spending $8.7 million managing just upland invasive exotic species (FLDEP, 2005).

The Upland Plant Management Program responsible for managing invasive exotic plants in the state's public lands is under the Florida Department of Environmental Protection (FLDEP) in the Bureau of Invasive Plant Management (BIPM). The program works in eleven regions within the state to develop strategies to address upland invasive plant management issues locally through regional working groups.

Since the inception of the Upland Program in 1997, BIPM has spent nearly $40 million to bring over 300,000 acres of upland weeds under maintenance control (FLDEP, 2005). Maintenance control is a control method of invasive exotic plants in which control techniques are utilized in a coordinated manner on a continuous basis in order to maintain the plant population at the lowest feasible level. As stated in the FLDEP Agency Strategic Plan, the long-term program goal is to reduce infestations of upland invasive exotic plants on public lands by twenty-five percent by 2010, based on estimated 1995 levels of 1.5 million acres infested with invasive weeds. In 2005 over 22% of affected public land was under maintenance control (FLDEP, 2005). The program treated about 100 different invasive species at 144 publicly managed areas. The control program utilizes a variety of methods including chemical, mechanical, and biological techniques.

Problem Statement

Millions of residents and tourist who participate in outdoor activities derive satisfaction from various attributes of natural areas. The most general attributes specific to the parks include parks sanitation and safety, extent and condition of facilities, the quality of the natural environment and accessible scenic trails for a variety of nature-based recreational activities (e.g., hiking, camping, sightseeing and wildlife viewing).

Invasive plants may have a negative impact on the quality or quantity of outdoor recreational activities. Through altering ecosystems, invasive species can negatively change the supply and composition of environmental amenities that are important for recreation and adversely affect recreational service flows. Plants like the Old World climbing fern (*Lygodium microphyllum*) and Japanese climbing fern (*Lygodium japonicum*), both on the list of the "ten most unwanted" plants in Florida, grow with thick climbing and twining fronds, preventing easy access to natural areas. Likewise, the Air potato (*Dioscorea bulbifera L.*) grows vigorously, twining and forming a dense blanket that engulfs surrounding plants, which can limit access for navigation and recreational activities. The presence of dense twining invasive plants in natural areas may also obstruct wildlife viewing and access to scenic trails making hiking and biking difficult in wooded parks. Some park visitors may be bothered by Catlaw mimosa (*Mimosa pigra L.*) or Tropical soda apple (*Solanum viarum*) due to their hairy stem and prickly nature, respectively.

Studies on the consequences of invasive plants in Florida natural areas have focused on management costs (Lee and Kim, 2005; Doren, 2002; Harding and Thomas, 2003) and ecological impact (Mazzoti, 1981; Gordon, 1998). In order to fully understand how invasive species affect outdoor recreation, it is essential to know how the user's enjoyment and use of natural areas is affected by these exotic species. However, studies that estimate the relationship between recreational utility and invasive species in natural areas do not exist at the national or state level. Given the significance of outdoor recreation in natural areas to the citizens' enjoyment and the state's economy this knowledge could aid in planning statewide programs aiming to control invasive species in Florida. Therefore, this study proposes to examine the relationships between upland invasive plants and the recreational value of Florida natural areas.

Study Objectives

The general objective of this study is to examine the relationship between invasive upland plants and the implicit value of recreational activities in natural areas specifically, in Florida wooded parks. This was achieved through the following objectives:

- **Objective 1:** Quantify the relationship between invasive plants and recreational value in natural areas using a Multi-attribute Utility Model (MAUM);
- **Objective 2:** Determine the relative importance of invasive species in relation to other attributes of a natural recreation experience;
- **Objective 3:** Determine the marginal willingness to pay for fewer invasive species in recreational areas, specifically in Florida wooded parks;

Hypotheses

The basic premise in this study is that invasive plants are undesirable in wooded parks and recreational places such that recreation satisfaction in these areas will be reduced by the presence of invasive species. For this reason natural area users will be willing to pay more for a recreational exercise at a wooded park that has fewer invasive species in outdoor recreation areas.

It is anticipated however that the willingness to pay more for fewer invasive species will not only be due to the effect of invasive plants on recreational utility but also because of the perceived impact of these species on the environment[1]. Therefore, users of natural areas who have a higher level of knowledge of invasive plants and a higher level of environmental consciousness are expected to be willing to pay more for fewer invasive species.

Socioeconomic variables such as income, age, and education are expected to influence individual's perception about the relationship between invasive plants and the recreational value. Furthermore, since Florida regions are affected at different levels by invasive plants, willingness to pay will likely be different between regions and perhaps higher for the most affected region.

[1] It is common for public to express their willingness to pay for passive or non use values. For example people want to pay to make sure blue whales are conserved even if they may not see them in their lifetime.

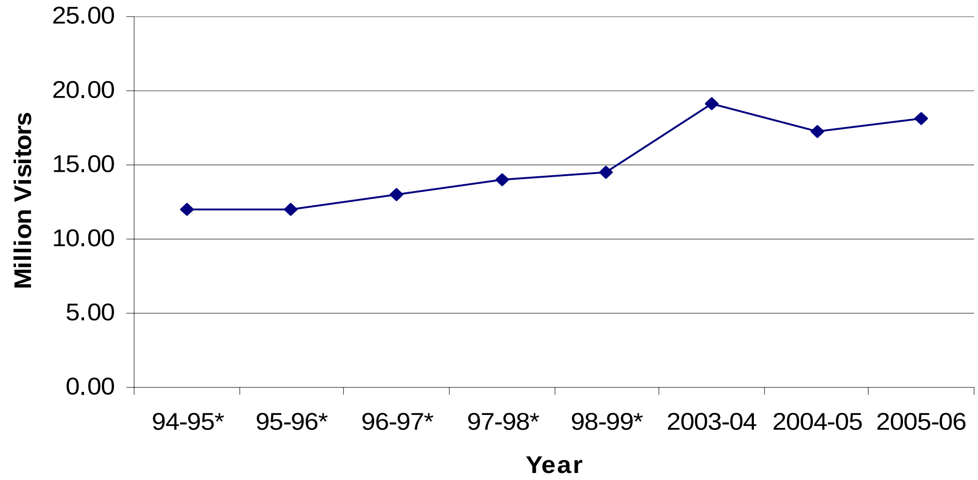

Figure 1-1. Annual attendance at Florida state parks: 1995-2006
Source: *FACT, 2000, FLDEP, 2004-2006

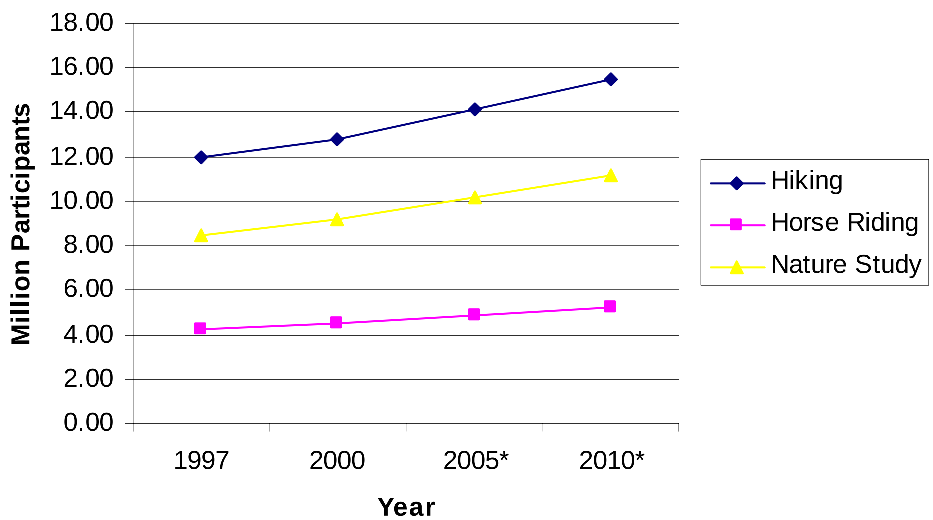

Figure 1-2. Florida's estimated demand for wooded park activities: 1997-2010
Source: FLSCORP 2000

Table 1-1. Ten most unwanted plants in Florida

Common name	Scientific Name	Acres Treated
Australian pine	*Casuarina* species	436
Caesar's weed	*Urena lobata*	749
Old world climbing fern	*Lygodium microphyllum*	3,728
Melaleuca	*Melaleuca quinquenervia*	46,498
Skunk vine	*Paederia foetida*	1,021
Brazilian pepper,	*Schinus terebinthifolius*	7,830
Chinese tallow	*Sapium sebiferum*	667
Japanese climbing fern	*Lygodium japonicum*	771
Cogongrass	*Imperata cylindrica*	1,212
Tropical soda apple	*Solanum viarum*	1,023

Source FLDEP: Upland Exotic Plant Management Program, Annual report FY 2004-2005

CHAPTER 2
LITERATURE REVIEW

Valuation of Non-Market Goods

This study attempts to determine the non-market value of recreation attributes in natural areas with special focus on invasive plants. A non-market good or service is something that is not bought or sold directly, therefore, does not have an observable price (i.e. market value). Non-market values can be categorized as use values and non-use values. The use value of a good is the value to an individual from the active use of the asset like recreational fishing, swimming or bird watching and the non-use values reflect the value to the society or future generation (Letson and Milon, 2002).

Although participation in outdoor recreation through activities like camping and hiking can be categorized as the use value for natural areas and may generate market based economic activity, use of a natural area is often not allocated by markets (Swanson and Loomis, 1996). Therefore the impact of invasive species on natural areas will not fully be captured by market goods and services.

Where there is no price available for non-market goods, it may be possible to use the prices of related market goods or prices from hypothetical markets to estimate the value (Letson and Milon, 2002; Longo, 2007). A number of methods have been devised for valuation of an environmental good or service where market value is not evident. These methods include hedonic price, travel cost, the contingent valuation and the conjoint choice experiment. The hedonic pricing and travel cost method are called revealed preferences because they measure preferences for non-market goods based on observing people's choice behavior on other related goods. For example hedonic pricing method would use the property sales information to assess the monetary value of a cultural tourism attraction. Travel cost method would measure the value of a tourism attraction by using the money spent on that attraction as a proxy of the value that users attach to the place. Contingent valuation (CV) and choice experiment (CE) are referred to as stated preferences because they ask individuals about their preferences through surveys. Typically the CV approach asks people to directly report their willingness to pay (WTP) for a specific good, or their willingness to accept (WTA) compensation for a good rather than inferring them from observed behavior in regular market like in revealed preference methods (Longo, 2007).

In the past, most studies on valuation of non-market environmental goods like natural areas have used CV (Bennet et al., 1997; Tsuge and Washida, 2003; Berrens et al., 2004). This method has also been used in valuing cultural heritage destinations (Alberini et al., 2005). However, CV has been criticized for its weakness in valuing goods when most of the value of the good is derived from non use value. It is believed that the CV provides an incomplete view of the value of the good because this value is multidimensional and may not be easily expressed by qualitative or quantitative scales (Throsby, 2003). Pearce et al. (1994) summarized some of the CV method issues as problems of reliability, bias and validity.

The CE has been successfully used in marketing and transportation research. Following this success, the CE methodology has been increasingly preferred over the CV in valuation of environmental recourses (Holmes et al., 2003). CE has been used to assess public preferences for restoration goals (Milon et al., 1999; MacDonald et al., 2005,) and valuing environmental amenities by Adamowicz and others (1997) who argue that the advantage of CE over CV is that this method could help reduce strategic bias as the attributes change in choice sets.

When a non-market good’s non-use values are impacted, only stated preference models can capture the impact. One such method is the Multi-attribute Utility Model (MAUM) which is a choice experiment type of method (Louviere and Woodworth, 1983; Milon et al., 1999; Louviere et al., 2000). There are two types of MAUM; one is preference based where respondents are asked to rate or rank the provided alternatives and the other is choice based where respondents are asked to choose their preferred alternative from the provided choice package.

Blamey et al. (1997) describe the CE as a technique in which individuals are typically presented with six to ten ‘choice sets’, each containing a base option and several alternatives and asked to indicate their preferred option in each set. Although there is no definitive number of choices to be presented, it is recommended to use not more than eight to avoid respondents being fatigued (Holmes et al., 2003). The respondent chooses from a set of hypothetical “goods or services” that require an evaluation of the trade-offs between attribute levels, with the concept that the choice is based on the individual’s utility maximization. Attributes trade off is presented in the value elicitation process such that reduction in one attribute may be compensated by an increase in another. The MAUM research approach involves prior identification of attributes and levels for building the choices or alternatives to present to the respondent.

Selection of Attributes and Levels

The initial step in developing a choice experiment survey is to determine attributes of the good which has to be valued. The attributes must be relevant to the decision problem and each attribute should reflect independent dimensions to the degree possible to avoid redundancy (Loviere, 1988). The valuation method requires that one of the attribute be the price or cost of the good to the respondent (Longo, 2007).

In previous studies researchers have used focus groups or structured conversation with people who broadly represent the population to be sampled to determine the attributes (Holmes et al., 2003; Milon et al., 1999). When using focus group the researcher would ask the group a series of questions aimed at identifying the important attributes of the good in question as they are considered by the population which is to be surveyed. Some researchers have used information from the existing literature about the subjects to determine desired attributes (Makokha et al., 2006) and some have used both methods depending on the research budget and time constraints.

After identifying attributes the range of each attribute can be determined through the same procedures as the attributes by using the focus groups, subject expert interviews or literature reviews. The levels also have to be realistic and should cover the range over which respondents can have preferences.

When the task of establishing the attributes and levels is completed, presenting all the combinations of the attributes becomes complicated. Sometimes only a sub-set of attributes choice combinations has to be presented. The sub-set of combinations needs to be presented in a statistically representative form to ensure that the maximum amount of information is revealed by the study without bias. A variety of orthogonal factorial experimental design is available to reduce and create a balanced sample of possible attribute combinations.

In a full factorial experimental design, a study with five attributes with three levels each would have 3^5 or 243 possible combination. With a pair wise choice this full factorial design will require more that 120 choice decision which is impractical to manage for both the researcher and the respondent. Researchers have employed software packages for the construction of optimized fractional factorial experimental designs such as SAS "Factex" procedure (SAS institute) to identify subsets of possible combinations of attributes and levels that will best represent attribute preferences with a manageable size (Milon et al., 1999). This technology provides a significant saving in time and resources while allowing the estimation of all the main effects.

Once the experimental design is created, the next step is to construct the choice sets which may consist of two or more alternatives. Most CE surveys present three; two alternatives plus the status quo (Milon et al., 1999; MacDonald et al., 2005; Alberini et al., 2006).The status quo should be included in the choice set if the purpose of the study is to estimate the willingness to pay for a policy option (Longo, 2007). The last step in the development of the experimental design is to choose the number of choice sets to be presented to the respondent and develop the questionnaire. Complexity of CE surveys is said to increase with the number of choices, the number of attributes and levels and the number of alternatives in a choice set (Swait and Adamowicz, 2001). Complicated CE surveys may be tiring to respondents and may lead to poor quality data. When the survey is completed, the study sample size is given by a number of respondents receiving the questionnaire times the number of choice sets presented in the questionnaire.

While each of the mentioned types of MAUM (rank, rate and choice) offers distinct advantages for measuring preferences, the choice based method has the advantage of reflecting an actual consumer behavior (Green and Srinivasan, 1978). With choice models it is possible to partition utility into parts allowing the estimation of the value of individual attributes that make up the good rather than considering the whole good (Adamowicz et al., 1998). In addition, the task of choosing the preferred bundle of attributes levels does not require as much effort by the respondent as do ranking and rating methods (Longo, 2007).

Choice model studies can be achieved with smaller samples relative to contingent valuation. Studies have been completed with less than 110 interviews (Halbrendt et al., 2007; Snowball and Willis, 2006) with most studies being completed with interviews between 250 and 500 (Bateman et al., 2002). Furthermore, providing different choice alternatives to the respondent, which can be accomplished through the attribute based choice modeling methods, is believed to provide richer information for policy maker's at the end of the research.

Estimation of the attribute coefficients in past studies of CE models was done using multinomial logit (MNL), conditional logit or probit models (Siikamäki, 2001; Milon et al., 1999; Makokha et al., 2006). The conditional logit model is useful when the choice probabilities are functions of the choice characteristics (Maddala, 1983), for instance, when the probability that the individual chooses to visit a particular park is affected by the characteristics of that park. The difference between the multinomial logit and conditional logit models is that conditional logit considers the effects of choice characteristics on the determinants of choice probabilities, while MNL makes the choice probabilities dependent on individual characteristics only (Maddala, 1983).

Today, there is an extensive use of choice models, including binary logit/probit, censored probit, conditional logit, finite mixture logit, group logit, random effects and random parameter models, nested logit, mixed logit and multivariate probit. Limdep or Nlogit, Stata, Gauss, and SAS, in that order, are some of the most frequently cited software used in the econometric estimation of choice models (Zapata et al., 2007).

Survey Method

Available literature suggests that CE questionnaire can be administered using different modes: mail, telephone, in person, Internet or a combination. Survey modes differ in cost, time, quality of data, sample control and the quality and amount of information that can be presented to the respondent. Mail surveys have dominated the data collection in CE studies (Adamowicz, 1994; 1998; MacDonald et al., 2005). This survey mode is inexpensive but has a low response rate when compared to telephone and in person interviews and it is limited in the amount of information presented to respondents. Complex scenarios of CE have also been implemented through in person interviews (Milon et al., 1999; Hanley et al., 1998) or computer-based questionnaires (Alberini et al., 2006) but the web survey mode has not been widely used.

Web Surveys

Web surveys have recently been recognized as a valuable instrument for collecting data (Dillman, 2000). The more widespread use of the Internet now makes it possible for more people to access surveys online. As the Internet access widens to include more representation of the adult population, the applications for web-based surveys may increase. The rapid development of web surveys is leading some to argue that soon web surveys will replace traditional methods of survey data collection (Couper, 2000).

Web surveys are presented in two main formats; interactively or passively. Interactive surveys are presented screen-by-screen. When the respondent clicks a button like “next”, it allows the data from the question to be immediately transmitted to the surveyor such that partially completed surveys may be received. Interactive web surveys also allow for customization as subsequent questions may depend on the answer from the previous question. However, this format may create difficulties for respondents to review or change their answers (Couper, 2000).

The passive survey designs involve presenting the entire survey with data transmitted once the respondent completes the survey and submits the answers. Here, survey respondents can easily browse through questions and review their responses before submitting. These types of web surveys are also easy to produce and easy to access with less technical difficulties.

While web surveys may offer some positive opportunities in data collection, its strengths and weaknesses are still being debated. The strengths and weaknesses of web surveys need to be recognized to ensure that they are designed appropriately and results are considered carefully.

Advantages of web surveys

In terms of survey administration, web surveys offer several advantages relative to the telephone and face-to-face interviews. Web surveys have relatively low marginal costs compared to the other two survey modes which involve the time of interviewers and supervisors. Lower marginal costs of distributing web surveys and receiving responses makes it possible to have larger samples for a given research budget. Web-based surveys are self-administered, allowing respondents to complete the survey at their convenience. This process, besides making Internet surveying relatively low cost, reduces data entry requirements and eliminates the possibility of data entry errors (Alvares et al., 2003).

Compared to other survey modes including mail survey, web surveys allow rapid turnaround, allow access to a vast geographically diverse pool of potential respondents, and has the superior capability of providing complex and varied information to respondents (Alvares et al., 2003). Tracking respondents' utilization of information, which is only possible with web surveys can provide basis for assessing the degree of respondent effort devoted to the survey (Berrens, et al., 2004).

Weaknesses of web surveys

Making general statements about large populations based on Internet survey results is currently problematic as this survey mode faces important methodological issues (Alvares et al., 2003). It is widely agreed that the major sources of error in web surveys include sampling, coverage, non- response bias and estimation errors. The nature of the samples that it can provide is questionable because it is difficult to draw representative samples from among Internet users.

Coverage error is the deviation between the sampling frame and the target population. When surveying a large group, the coverage error becomes a major concern because not all population members have Internet access and also there is no list of email addresses for the population.

Non-response bias also occurs in web surveys because some members of the selected sample are unable or unwilling to complete the survey, but this is not unique to Internet surveys. However, the potential problem is said to be severe for web-based surveys due to low response rates (or inability to calculate response rates) and non-random recruitment procedures. In addition, non-response errors for web surveys may be higher because potential respondents may encounter technological difficulties with Internet if they have no basic computer literacy skills. Furthermore, technological hurdles, such as browser incompatibility and slow Internet access will influence whether a potential respondent completes a survey (Couper et al., 2001).

Although coverage error and non-response bias are a concern for web-based surveys, some web surveys have performed better than telephone surveys. On the objective measure of election forecasting in the 2000 presidential election, the Harris Interactive web poll did better than similar telephone surveys at predicting state level presidential votes (Berrens et al., 2003).

In one study to find out if Internet samples produce estimates of willingness-to-pay functions comparable to those from the telephone survey, researches presented the results of parallel telephone and Internet surveys to investigate their comparability. The Internet samples produced relational inferences quite similar to the telephone sample (Berrens et al., 2003). It was concluded that all survey methods involve errors and the appropriate question should not be whether Internet replaces telephone as the mode of survey but rather, under what circumstances the use of Internet surveys is appropriate.

Two trends that are likely to increase the use of Internet surveys in the future are the increasing difficulty of doing valid telephone surveys and the increasing representation of the

Internet users. Internet use in the US and around the globe has been growing rapidly, and is becoming more demographically representative of the population. In 1995, only about 10 percent of U.S households had access to the Internet but in 2003 about 55% of households had access to Internet (U.S Census Bureau, 2005). But still the population of adult Internet users in the U.S has different demographic characteristics than the general population. According to the Census Bureau (2005), it is on average, younger, more educated, has more males, has people in higher income groups, and is disproportionately white or Asian.

An additional advantage of internet surveys is its recent use in splits within the Internet sample to investigate methodological issues. Researchers have used the Internet to find out if the provision of extensive information related to the policy being evaluated when conducting survey could influence the research outcome. The generation of large sample sizes in web surveys permits the investigation of methodological questions within the same survey by comparing the split-sample treatment effect when estimating willingness to pay (Berrens et al., 2004).

CHAPTER 3
THE MULTI-ATTRIBUTE UTILITY MODEL

This chapter summarizes the theoretical and methodological concepts used in the study. The Multi-attribute Utility Model (MAUM) is used to determine the relationship between invasive species and the recreational value in Florida natural areas. MAUM is a choice modeling method based on the random utility maximization (RUM) theory. The model finds its origins with Lancaster (1966) who built the conceptual framework for conjoint analysis by clarifying that utility is gained from the attributes of a good rather than the good itself. For example, the actual source of the individual's utility when engaged in recreation at a state park are the park attributes like facilities and activities provided at the park and the variety of animals and plant species available to see at the park among other things. If an individual is presented with a number of alternatives to choose from, it is assumed that utility is linear in parameters such that:

$$U_j = \sum_{k=1} \beta_k x_{jk} + \varepsilon_j \qquad (3\text{-}1)$$

where U_j is the indirect utility associated with alternative j, βk is the preference parameter associated with attribute k, x_{jk} is the attribute k in choice j and ε is the random error term.

In a multi-attribute choice setting, a person compares the attributes of the alternatives and would select the alternative that provides the maximum utility. Suppose an individual was faced with a pair wise attribute setting to choose alternative A or B. If an individual choose A with its set of attributes over B, then to that individual utility from choice A, is greater than utility from choice B; in symbolic terms:

$$U(X_A) > U(X_B) \qquad (3\text{-}2)$$

RUM models assume that utility is the sum of the deterministic component v(.) and a random component ε, such that:

$$U(X) = v(X) + \varepsilon \qquad (3\text{-}3)$$

The error term is introduced for estimation purposes and it is assumed that it comes from omissions of explanatory variables, random preferences and errors in measuring the dependent variable. The error term in the model allows probabilistic statements to be made about the choice behavior. Assumptions made on how the error term is distributed result in different choice models.

In a pair wise choice setting for any given respondent *i*, the probability that the respondent will choose X_A over X_B equals the probability that the difference between the deterministic components exceeds the difference between the random components.

$$P(A) = P[vi(X_A) - vi(X_B) > (\varepsilon i_B - \varepsilon i_A)] \qquad (3\text{-}4)$$

From the above foundation, we use attributes which are the basic components of an individual's indirect utility or preference function. Since the attributes are built with levels, a preference function relates the level of each attribute to utility as independent dummy variable making a part worth utility model. So as the respondents make their choices between the alternatives, the utility associated with changes in levels of specific attributes can be estimated. The additive linear function produces the main effects of the model and the effects indicates how utility is affected by the level of the attribute when it is separated from all other attributes.

From the utility function in equation 3-1, the choice behaviors for a respondent from any set of choices are predicted with the conditional logit model (McFadden, 1974) and the preference parameters in the equation are estimated. With the conditional logit model the probability values are estimated under the assumptions that ε is independently and normally distributed[2].

[2] When the choice sets has more than two alternatives, it also assumes that the ratio of probabilities between any two alternatives is unaffected by other alternatives in the choice set.

For each set of alternatives, the probability that an individual chooses A over the other alternatives is expressed as:

$$P(A) = \frac{e^{(\beta' X_{iA})}}{\sum_j e^{(\beta' X_{ij})}} \tag{3-5}$$

For a pair of alternatives A and B the probability that an individual chooses A over B is expressed as a logit function:

$$\log\left[\frac{\pi_A(x_{iA})}{\pi_B(x_{iB})}\right] = \beta'(x_{iA} - x_{iB}) \tag{3-6}$$

where X_{iA} is the vector of values of the attributes in the choice A and X_{iB} is the vector of values of the attributes in the choice B.

The other dimension to the model is to evaluate if socioeconomic characteristics like age, income and education influence the attribute weights or preference variation within the population. In choice models, these variables are not examined directly because they do not vary across alternatives (Holmes et al., 2003). In order to account for their differences on preferences, socioeconomic characteristics are incorporated in the model through interaction terms with the attribute level variables:

$$U_{ij} = \beta' X_{ij} + \alpha'_j S_i + \varepsilon_{ij} \tag{3-7}$$

where U_{ij} is the indirect utility for an individual i associated with alternative j, S_i are individuals socioeconomic variables interacted with attribute level j's; X_{ij} is the vector of values of the attributes in the j^{th} alternative, $\beta'$and α_j are vectors of coefficients to be estimated. The random utility model estimates the probability that utility of the i^{th} individual derived from the j^{th} alternative is greater than the utility from the other alternatives. From equation (3-5), with the social economic variables, the probability that the i^{th} individual makes the j^{th} choice will be estimated as:

$$P_{ij} = \frac{e^{(\beta' X_{ij} + \alpha'_j S_i)}}{\sum_{k=1}^{j} e^{(\beta' X_{ik} + \alpha'_k S_i)}} \tag{3-8}$$

With the utility function defined, we can model the choice as the relative differences in utility (Darby, 2006). The difference between choice A and choice B with the social economic variables included is:

$$dU^i{}_{AB} = \beta\Delta X + \alpha\Delta S + \varepsilon_{AB} \tag{3-9}$$

where $dU^i{}_{AB}$ is the utility difference between choice A and choice B; $\Delta S = Si\ (x_{jA} - x_{jB})$; $\Delta x = (x_{jA} - x_{jB})$; and $\varepsilon_{AB} = (e_{iA} - e_{iB})$.

Since each alternative has the price or cost as one of the attribute, the marginal willingness to pay for each attribute can be defined as:

$$MWTP_k = -\frac{\beta_k}{\beta_p} \tag{3-10}$$

Where $MWTP_k$ is the marginal willingness to pay for the attribute k, β_k is the preference parameter for the attribute k and β_p is the price or cost parameter.

CHAPTER 4
DATA COLLECTION AND RESEARCH METHODS

Surveys

This chapter summarizes the survey design and the Multi-attribute Utility (MAU) survey development procedure. Since this study was part of a broader study which was to determine the effect of invasive plants in both aquatic and upland parks, initial preparations and development of the MAU survey was generalized to include three types of parks. The park types were ocean and beach, river and lakes, and wooded parks. After the MAU survey instrument was developed, the surveys were administered separately for each of the three park types. Data analysis was also conducted by park type and this part of the study is only dealing with wooded parks. We used interactive online surveys to gather the data from Florida residents.

The study started in fall of 2006 with a survey of Florida state park managers. Then based on park managers' responses, two groups of Florida residents were surveyed to determine natural areas relevant recreational attributes and the level of knowledge regarding invasive species in the state. Finally the MAU survey was developed using the information from these three surveys as well as from literature review and expert interviews. The Florida residents' questionnaires for the two preliminary surveys were designed using Survey Monkey software package and sent through emails with Expedite Marketing Survey Company.

Before being administered, the questionnaires were reviewed and approved by the University of Florida Institutional Review Board (UF-IRB) for compliance with ethical standards for human subject research. The surveys included a short statement on the purpose of the questionnaire, the importance of providing information, completing instructions, confidentiality guarantee and contact information in case the respondents had any questions.

The knowledge assessment survey was sent to 40,000 and the recreational attribute survey was sent to 80,000 Florida residents. Response rates for the two surveys were less than 1%. The invasive species knowledge survey had a 0.82% while the attribute survey had a 0.37% response rate. Despite low response rates, the number of responses received was sufficient to make the required analysis. The details for each of the mentioned surveys are presented below.

Park Managers' Survey

First, questions were sent through email to 159 Florida state park managers asking for important recreational attributes and the situation of invasive species in Florida parks. Specifically, managers were asked the type of their park (wooded, ocean and beach or river and lake) and what were the valuable characteristics of the park. If they had any invasive plants problems they were asked to name the species. Managers were also asked to indicate any complaint that park visitors had related to park attributes and if any were related to invasive plants. In order to determine the park priorities indirectly, park managers were asked if they had $200,000 to spend, how they would spend it to improve the park. Managers were also asked if they felt that invasive species had impaired natural areas or diminished its recreational use. This survey revealed that park visitors care most about the following attributes:

- To be able to see native plants in the park
- To be able to see a variety of animals in the park
- Visitors are bothered by congestion in the parks (if there are too many visitors)
- Park visitors care about services and facilities availability and condition
- Cost for the trip
- Distance from home

From this survey it was indicated that the most important upland invasive species in the parks are Brazilian pepper (*Schinus terebinthifolius)*, Cogongrass (*Imperata cylindrica)*, Australian pine (*Casuarina* species), Chinese tallow (*Sapium sebiferum)* and Japanese climbing fern (*Lygodium japonicum)*. Since the MAU survey was to be developed for both the upland and aquatic recreational parks, invasive aquatic plants were also mentioned. They included Hydrilla (*Hydrilla verticillata)* and Water Hyacinth (*Eichhornia crassipes)*.

Park managers also revealed that generally invasive species do not seem to affect the satisfaction of park visitors and some visitors even like invasive species like Australian pine for shade. According to park managers only few people who are educated about invasive species are concerned about these species. Park Managers know about the environmental impact of invasive plants on natural areas but control of these species is not their priority. If given some extra funds, most managers' priority was to improve park facilities arguing that the state government is already taking care of invasive species in their respective parks.

The six recreational attributes identified from this survey were used in constructing the attribute selection for the Florida residents' surveys. The type of invasive species reported in the parks and the managers' indication of low knowledge of invasive plants among Florida residents were used in the development of an invasive species knowledge assessment.

Florida Residents: Invasive Species Knowledge Survey

Based on the invasive plants information above, a survey was created to determine the level of awareness and knowledge for invasive species among Florida residents. With the study objective focusing on invasive species and recreation, the level of knowledge of invasive species is crucial in designing the background information for the MAU survey and Model.

In the survey, respondents were asked how they characterize their knowledge on invasive species on a 1-5 Likert scale where 1= None, 2= Little, 3=Modest 4= Well versed and 5= Expert. Out of 319 respondents, a total of 146 (46%) could be classified as having no knowledge, 132 (41%) had moderate knowledge and 41 (13%) were very knowledgeable about invasive species.

In order to determine whether residents had the actual knowledge on invasive species, a simple test was given to respondents. For respondents who said they had the knowledge, a twelve plant quiz with pictures and names was administered and they were asked to identify which plants were invasive.

The knowledge level was analyzed using a scoring method. Scoring was based on the correct answers out of twelve questions. Those scoring ≥ 8 were categorized as experts. Scores 6 and 7 were grouped in moderate knowledge and scores ≤5 were grouped into the no knowledge category. A total of 254 respondents participated in the test. From the results, 161 (63.4%) had no knowledge on invasive species, 64 (25.2%) had moderate knowledge on invasive species and only 29 (11.4%) were very knowledgeable about invasive plants. By combining the number of people with moderate knowledge with the number of those very knowledgeable about invasive species, we arrived at the conclusion that 36.6% of Florida residents have knowledge on invasive species. Results on invasive species knowledge among Florida residents are presented in Figure 4-1. From the test we determined that the actual knowledge respondents had was different from what the respondents said they knew. For respondents who said they were well versed or experts on invasive species, there was not much difference between what they said and the test score results (13% vs.11.4%). There was, however a big difference for the moderate knowledge group (41% vs. 25.2%) and the no knowledge group (46% vs. 63.4%) with respect to what they said and the test results.

In three separate questions respondents were also asked to indicate whether they felt that invasive species had affected natural areas, their enjoyment in outdoor recreation, or if these species may influence the choice of destination for outdoor recreation. The answers in each of the three questions was to choose from Yes, No or Not sure. Results for the perception of invasive species in the three aspects are presented in Figure 4-2. Overwhelmingly, 82% of the respondents were aware that invasive species affected natural areas and the environment but less than 30% indicated that the presence of these species in a park would interfere with their outdoor activity enjoyment or influence their choice on which park to visit. This observation could be related to park managers' indication that visitors are not bothered by invasive plants when participating in park recreational activities.

The last section of the survey gathered demographic information about the respondent. In addition, respondents were asked to what extent they were environmentally conscious on a 1-5 Likert scale where 1= Not at all, 3= Moderately conscious and 5= Extremely conscious. Over 50% of the respondents said they were moderately environmentally conscious.

Florida Residents: Attributes Selection Survey

The main objective for this survey was to determine important recreational attributes for Florida natural area users. In the survey, respondents were asked which nature related outdoor activities they participated in during the past twelve months. The activities choices included bird watching, backpacking, camping, hunting walking, hiking and many more. These activities and the level of participation for the respondents are presented in Figure 4-3. According to the survey, most people participated in walking, hiking and running, followed by swimming in the ocean then nature watching or observation.

Respondents were also asked their reasons to participate in outdoor recreation from a list of suggested reasons in order to find features which contribute to utility in outdoor recreation. The suggested reasons are listed on Table 4-1 as they were ranked by the respondents. The top reason was to experience nature, followed by exercise and enjoying with friends and families.

In order to make the MAU survey manageable not all park attributes could be included in the model, so we had to select the most important. Respondents graded the importance of six recreational attributes when visiting wooded parks. The attributes graded in this survey were determined through park manager's survey results. They included park fees, facilities' condition, congestion at the parks, animal and plant species diversity and travel distance to the park.

Results are shown in Figure 4-4 revealing that the three most important attributes in Florida upland natural areas recreation were: Plant Species diversity, Animal Species diversity and Facilities condition. However, all the six presented attributes were important as each one of them was chosen by over 50% of the respondents.

An indirect evaluation of important attributes of outdoor recreation was included by asking respondents how should the state government invest more or make some improvement in Florida parks. Again, results from this question reflected that important attributes were animal and plant species diversity and facilities (Figure 4-5).

Building the Multi-Attribute Utility Survey

As mentioned before, choice Modeling or Multi-attribute Utility Model development required the identification of relevant attributes and levels. This was the reason for the above preliminary surveys. From the knowledge survey, it was determined that only 36.6% of Florida residents have knowledge about invasive species. From the attribute selection survey, the three most important attributes were animal species diversity, native plant species diversity and facilities condition. In addition to these three attributes, the extent of invasive species in the parks and park fees were included as attributes. The fee attribute was added for the purpose of determining implicit prices or marginal willingness to pay for the attributes. The invasive species attribute was added because the main purpose of the study was to determine its relationship with outdoor recreational utility.

Park facilities condition was defined to include parking lots, boat docks and ramps, picnic tables, restroom, showers among other things. Diversity of animal species was defined to include wild birds, animals and fish. Fees included fees for admission, parking, camping among others. Presence of invasive species was defined as all non-native plants known to disrupt ecosystem process. Diversity of native plants was defined to include all the plants which are indigenous to Florida.

After deciding on the attributes, levels were determined for each attribute. Levels for plant and animal species diversity were low, moderate and high. Levels for facilities were minimal, adequate, and excellent. The levels for the invasive species were none, few and dispersed, numerous and dense. The fee levels were $0 (free), $10, and $20. The levels were determined from the survey information both from park managers and residents. For example, park managers indicated that invasive species in most parks are few and dispersed and over 53% residents indicated that they spent less than $10 on park fees for each visit at a wooded park. Park fees were also reviewed from the Florida Division of Recreation and Parks web site for the 159 state parks. From this information the levels were created to provide distinct variations in order to identify the preference parameters.

Combinations of attributes and levels were to be grouped by selecting one level from each attribute and combining across attributes. We had five attributes at three levels each resulting in $3^5 = 243$ profiles. As already mentioned in chapter two, survey with this many profiles would be complicated for both the respondents and the researcher. Therefore, the study was limited to four attributes with three levels each, which form $3^4 = 81$ profiles. In order to confine the attributes to only four, two surveys were developed to separate the plant and animal species attributes. The rest of the attributes were the same in each of the two surveys. The other reason for separating animal and plant species diversity is that these two attributes could be highly correlated. If two correlated attributes are treated as independent in a choice experiment, respondents might become confused and fail to answer the questions (Holmes et al., 2003). So it is advised to select attributes that represent separate dimensions of valuation problem. Eighty one profiles were reduced by using a fractional factorial design, selecting a sample of attribute levels from a full factorial design using SAS Factex procedure. The samples for the MAU questions for both the plant (WPS) and animal species (WAS) surveys are shown in Figure 4-6. A choice of the park included four attributes at one of the three levels in each attribute. In the end, each of the animal and plant species diversity surveys had seven choice questions each composed by two park options.

It is believed that choice alternatives should include the “neither” or the “status quo” option because in most real world choice situations individuals are not in a” forced choice situation” (Holmes et al., 2003; Blamey et al., 1997). However, this study presents one of the circumstances when these options are considered not to be realistic choices. This is because our research is interested in the trade-off of attributes mainly in invasive species as an attribute in outdoor recreation and how the trade-off is made between the invasive species and other recreational attributes (Snowball and Willis, 2006; Alberini et al., 2003). As previously mentioned, we are not attempting to analyze policy options or estimate welfare changes due to policy changes. The estimation of statewide willingness to pay to control invasive species will be a component of this study only for the purpose of assessing the attribute trade-offs. The willingness to pay to reduce invasive plants in natural areas will be compared to the willingness to pay to improve other park attributes. This information will provide an insight on the value that respondents place on each attribute.

Furthermore, in Florida there are 159 state parks, over 7,700 big lakes, 2,276 miles of shoreline, over 663 miles of beaches (FLDEP, 2006). It will be unrealistic to generalize the state of rivers and lakes, ocean and beaches and wooded parks to create a status quo option.

The survey instrument (Appendix A) had three sections: (1) the first section presented the MAU choices after eliminating respondents who were not Florida residents; (2) the next section asked questions about attitudes and personal experience with invasive species; (3) the last section asked questions to elicit some demographic information.

The MAU survey included a brief description of the study, potential problems with specific invasive plants from the biological/ecosystem perspective and photos depicting invasive plants in natural areas (Australian pine, Brazilian pepper). Because it was determined that more than 60% of Florida residents had no knowledge on invasive species, this information was necessary to ensure common interpretation and understanding of the subject among the respondents. The survey also included park pictures and the activities a respondent could find at the park. For The MAU section, we asked the respondents to assume that each of the two park choices are (1) the only alternatives (2) the same distance from the respondents home and (3) both parks offer the same described activities and facilities. The attributes were defined in details to make sure they were well understood by the respondents.

Before sending the survey to respondents, it was pre-tested through a series of trials among 242 UF students and four academic staff to identify any problems with the length, content and if it will be easily understood by the respondents. Appropriate corrections were made accordingly following the given comments or suggestions.

Based on the available literature that choice analysis studies can be conducted with relatively small samples (Snowball and Willis, 2006; Bateman et al., 2002), it was decided that a sample size of at least 400 complete responses for each survey would be sufficient. The surveys were electronically distributed at www.surveymonkey.com to Florida residents in May 2007 through a marketing company (www.zoomerang.com) that had a good reputation with web surveys. For each survey, 6,655 emails were sent to solicit participant. With this company, responses were even higher than anticipated as each survey had over 700 responses only a few days after the survey was launched. The survey hosting company provided results for each respondent in a database which could be accessed anytime for analysis.

Preference parameters α and β in the model equations were estimated with the conditional logit model for the samples separately. The study estimated the basic models first for both plant and animal species diversity surveys. By basic models we mean that the estimations were made for the attributes without the social characteristics interactions. These models were specified with and without the intercept parameters to test if there was an order bias in respondents' choice between alternative parks (Milon et al., 1999).

After estimating the basic models, the study estimated the demographic characteristics and invasive species attitude variables as they interact with the defined recreational attributes. Using the estimated parameters, Marginal Willingness to Pay (MWTP) and the relative weights of the four attributes were determined. MWTP for the attributes were also calculated for the three Florida regions: North, Central and South Florida.

We also conducted a brief analysis of the combined data for the animal and plant species diversity only with recreational attributes (without social interactions). This was done to compare if the results for the separated models had any relationship with the results when the two models were combined. We estimated the preference parameters, the MWTP for the attributes and determined the relative weights of the attributes for combined data.

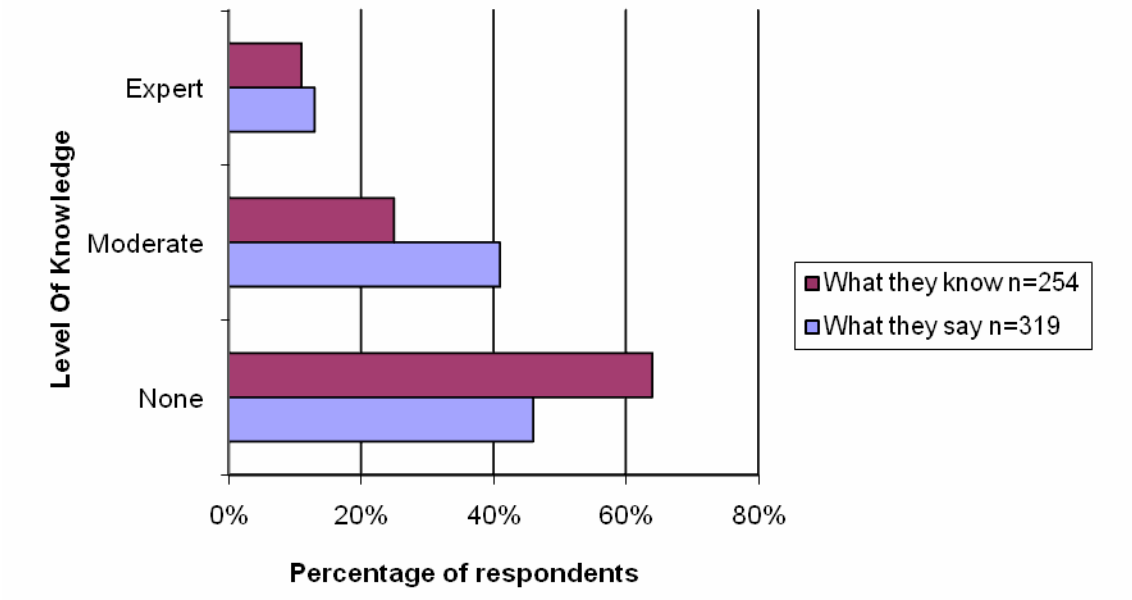

Figure 4-1. Level of invasive species knowledge in Florida

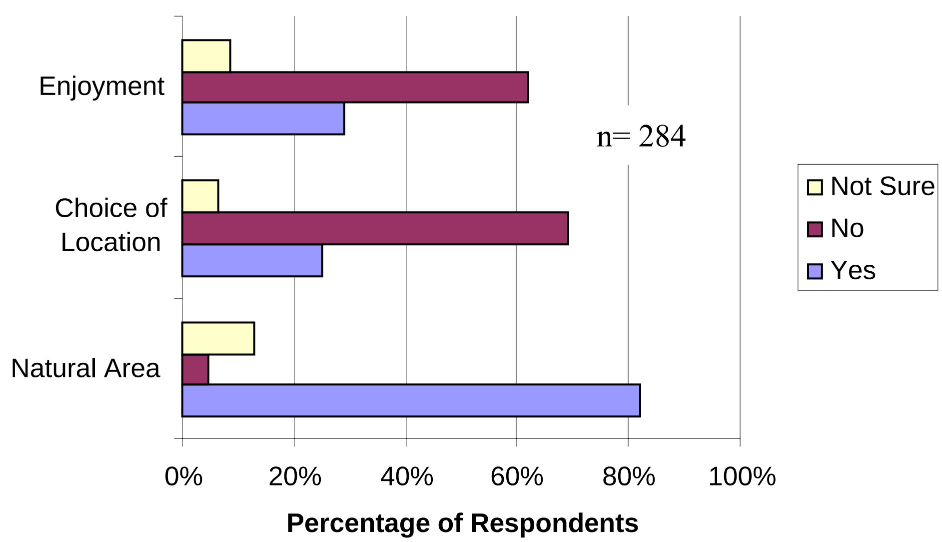

Figure 4-2. Perceived impact of invasive species on enjoyment and other aspects-(preliminary)

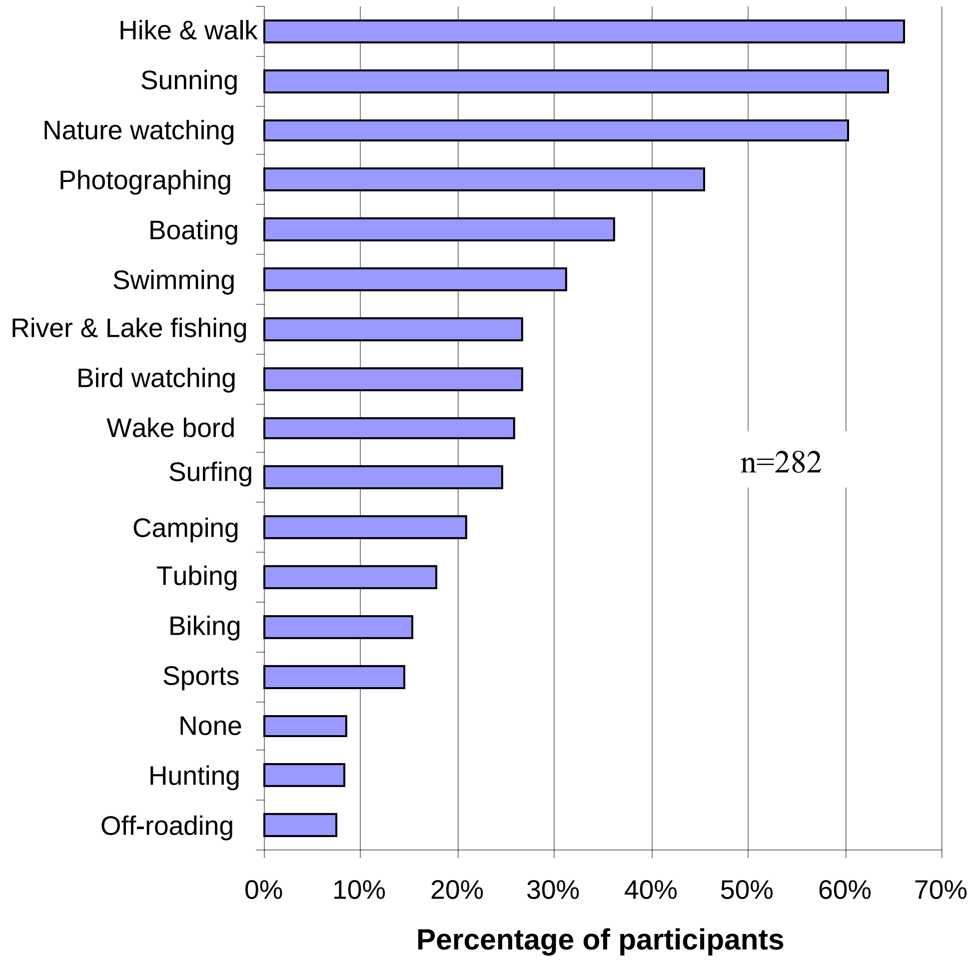

Figure 4-3. Natural areas outdoor activities participation

Table 4-1. Reasons for participating in outdoor recreational activities

Reason n=240	Response %
To enjoy and experience nature	87.50%
To spend time with family	55.00%
To meet friends	41.20%
To be with people with similar interests	24.60%
To get exercise and improve health	74.60%
To meet new people	12.10%
To share knowledge and skills	18.30%
To be engaged in thrill situations	13.80%
Other	8.30%

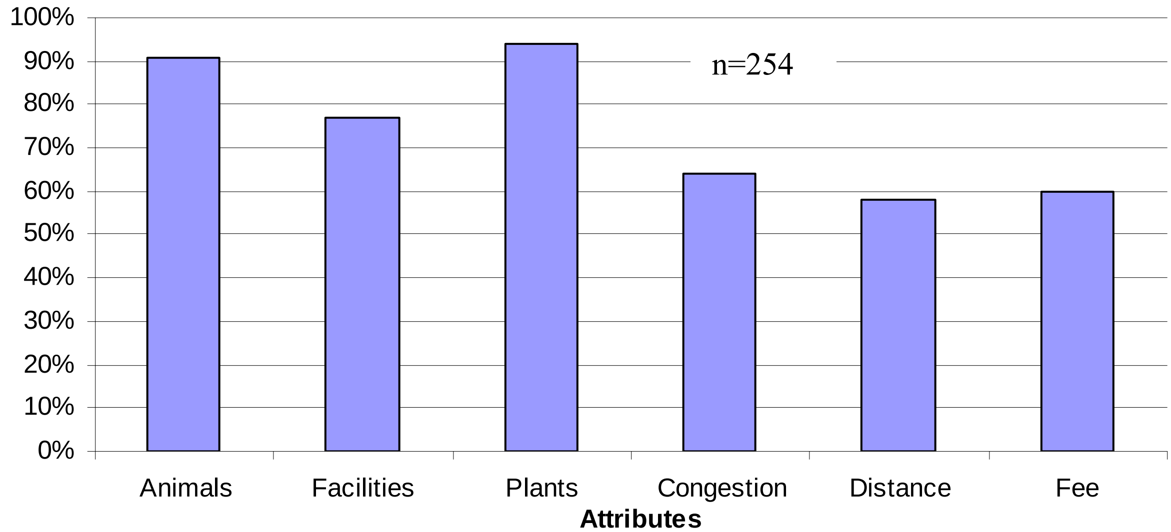

Figure 4-4. Outdoor recreation attributes selection

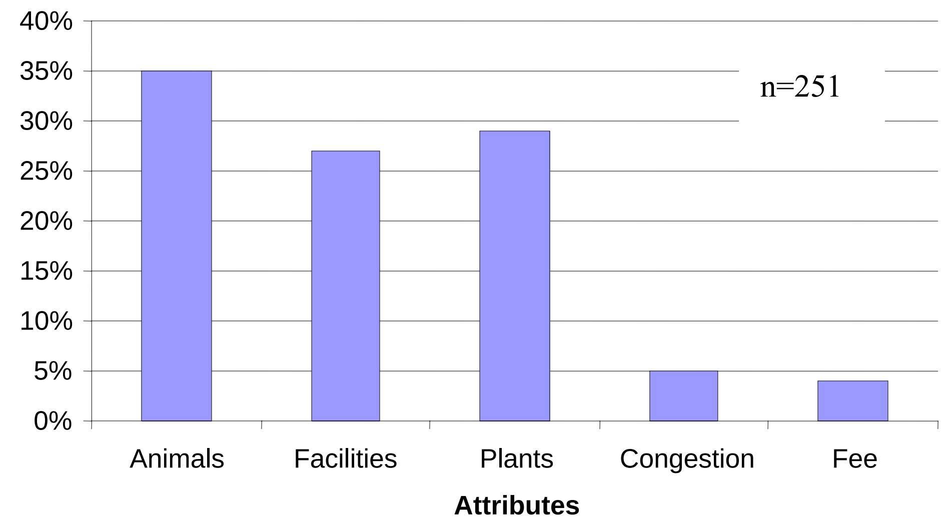

Figure 4-5. Suggested park attributes for the state to improve

	PARK A	PARK B
Facilities condition	Minimal	Adequate
Native plant diversity	Moderate	High
Presence of invasive species	Few and dispersed	Numerous and dense
Fees	$10	$20

A

Which of the two parks do you prefer?

❐ Park A ❐ Park B

	PARK A	PARK B
Facilities condition	Minimal	Excellent
Animal species diversity	Low	High
Presence of invasive species	None	Few and dispersed
Fees	Free	$20

B

Which of the two parks do you prefer?

❐ Park A ❐ Park B

Figure 4-6. Example of the MAUM questions A) plant species B) animal species

CHAPTER 5
SURVEY RESULTS

Introduction

The primary purpose of the survey was to determine the implicit value of invasive plants on the value of outdoor recreation. The survey also aimed to collect general demographic and invasive species attitude information to better understand the factors influencing choice preferences and the WTP to reduce invasive species in natural areas.

The two surveys differentiated by animal and plant species diversity had the same format. The animal species sample (WAS) had 640 respondents and the plant species sample (WPS) had 648 respondents. These complete responses were about 89% for each survey after leaving out the incomplete responses. About 10% of the respondents skipped the MAU questionnaire and 12% skipped the demographic questionnaire with most of them skipping the household income question (13.5%). The surveys had high response rates for an Internet survey, which was 8.49% for animal species and 8.69% for plant species. Responses mean the number of people in each sample and we have observations which refer to the total number of choice experiments completed. Since we had seven choice pairs for each survey we multiply the number of responses by seven leading to a total of 4480 observations for animal species and 4536 for plant species survey.

Respondents' Profiles

Overall, the surveys had over 55% respondents from Central Florida, about 24% from South Florida and only 20% from North Florida. Social economic and demographic profile of respondents differed from Florida state demographics (Table 5-1). A comparison of these characteristics with the 2000 US census revealed some potential non-coverage bias[3]. Relatively,

[3] Non coverage bias is the deviation between the sampling frame and the population.

the preliminary surveys samples represented the state's demographic characteristics better than the main survey except for education and the high income groups.

Selected characteristics of the sample population compared to the state profiles are presented in Figure 5-1 to 5-5. In relation to location, one would think that because we used Internet survey the samples would be skewed towards more urban residents. Surprisingly, the samples were skewed in a different direction with more people from suburban and rural areas above the state representation (Figure 5-1). In both samples 55% of respondents were from sub urban population.

Respondents were overwhelmingly female, with 66% females in animal species survey and 64% in plant species compared to the state statistics which is 51% female (Figure 5-2). Majority of the respondents were also mature people between age 46 and 65 who accounted for over 50% of respondents compared to about 11% of people under 35 years old (Figure 5-3).

About 30% had an annual taxable household income between $35,000 and $60, 000. A total 6% had less than $15,000. The survey was an exact representation of people with over $150,000 taxable income in the state which is 4% of the population (Figure 5-4).

The samples had more highly educated people (Bachelors degree and above about 40% respondents) compared to the state (22%). The population with at least some college classes was well represented compared to people with high school education and college degrees (Fig 5-5).

Invasive Species Knowledge

Respondents were asked to indicate how much knowledge they had on invasive species prior to our survey. This knowledge assessment results revealed the results close to the preliminary survey (11% vs. 13%) for people who said they were experts on invasive species (Figure 5-6). The moderate knowledge group results in this survey were higher and the no knowledge group number was lower compared to the preliminary survey results on knowledge.

Respondents were asked to give their opinion as to whether invasive species have effect on the parks and would affect their choice, enjoyment and frequency of visit to parks. This was done on a Likert scale of 1-5, where Strongly agree=1, Undecided=3, and Strongly disagree =5. Results for the two samples were almost the same with less than 30% (cumulative of strongly agree and somewhat agree) of the respondents agreeing to the effects. On the same cumulative basis, over 15% respondents said that invasive species could benefit Florida parks (Figure 5-7).

Respondents were asked to indicate whether they have taken any action in response to invasive species threat. Examples of actions against invasive species were defined to the respondent .They included helping to remove invasive species from natural areas, travel farther to visit an alternative location with fewer invasive species and donating money or supplies to help remove invasive plants in natural areas. Less than 16% of residents in the state have taken some action against invasive species (Figure 5-8). For the respondents who had taken action, over 50% participated in removing invasive plants in natural areas and some respondents said that they have participated in removing invasive species in their communities. Some communities have organized volunteer sessions to combat invasive plants. Here in Gainesville, one such event is organized annually and this year it took place on January 27. Over 1200 volunteers gathered to collect the exotic invasive plant, Air potato, (*Dioscorea bulbifera*) which is threatening native plants in the area (The alligator 01/29/2007).

Respondents were also asked how frequently they have participated in nature related outdoor activities in the last twelve months (Figure 5-9). Although more than 35% of the respondents did not visit the park at all, over 15% visited the state parks at least once a year. Cumulatively, over 65% of the respondents visited Florida state parks last year. On average, survey respondents visited the park at least once a month (11.11 times a year).

Table 5-1. Demographic profiles for surveys compared to Florida profiles

	Preliminary Surveys		Main Surveys		
Survey	Knowledge	Attributes	WAS	WPS	Florida[Φ]
Urban	49%	47.2%	27.2%	28.0%	47.0%
Suburban	41.7%	44.1%	55.5%	55.0%	44.0%
Rural	9.3%	8.7%	17.3%	17.0%	9.0%
Male	55.3%	49.0%	34.5%	36.0%	48.8%
Female	44.7%	51.0%	65.5%	64.0%	51.2%
18 - 25 years	15.3%	13.2%	2.0%	1.2%	7.8%
26 - 35 years	14.3%	12.4%	9.7%	11.2%	16.9%
36 - 45 years	19.6%	18.8%	20.0%	19.0%	20.1%
46 - 55 years	29.9%	24.1%	25.2%	27.3%	16.8%
56 - 65 years	15.6%	17.3%	25.3%	24.8%	12.6%
More than 65 years	5.0%	14.3%	17.8%	16.5%	25.9%
High School or less	4.0%	18.1%	32.5%	39.1%	48.9%
Associate or some college	25.7%	17.0%	26.1%	27.6%	28.8%
Bachelor's degree	18.3%	22.4%	24.2%	19.8%	14.3%
Advanced degree beyond bachelor's	52.0%	42.7%	17.2%	13.5%	8.0%
Less than $14,999	15.1%	22.8%	6.1%	5.9%	16.3%
$15,000 - $34,999	14.1%	13.1%	18.9%	21.5%	28.7%
$35,000 - $59,999	13.7%	11.0%	29.2%	31.5%	24.8%
$60,000 - $74,999	12.3%	10.1%	13.3%	14.0%	11.1%
$75,000 - $99,999	13.0%	12.7%	17.0%	13.8%	8.7%
$100,000 - $149,999	12.0%	10.5%	11.4%	9.4%	6.3%
More than $150,000	19.7%	19.8%	4.1%	3.9%	4.1%

[Φ]US Census 2000

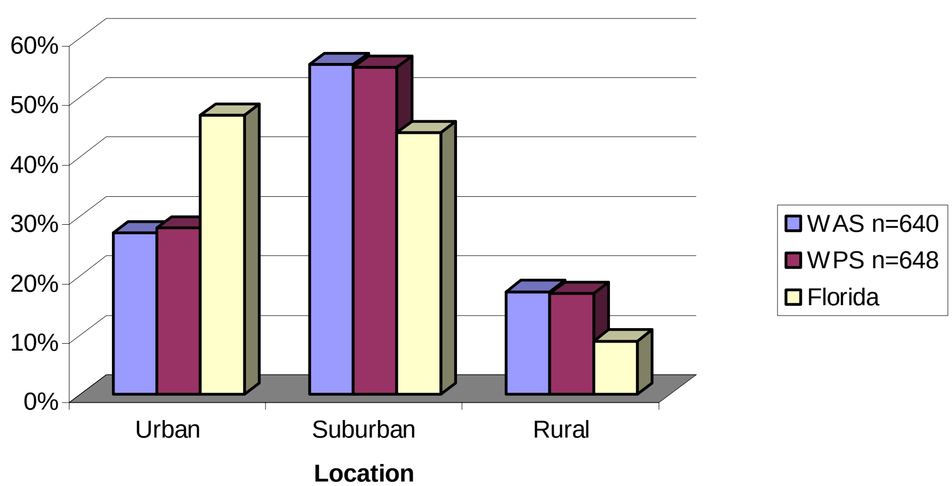

Figure 5-1. Location profiles of samples and Florida residents

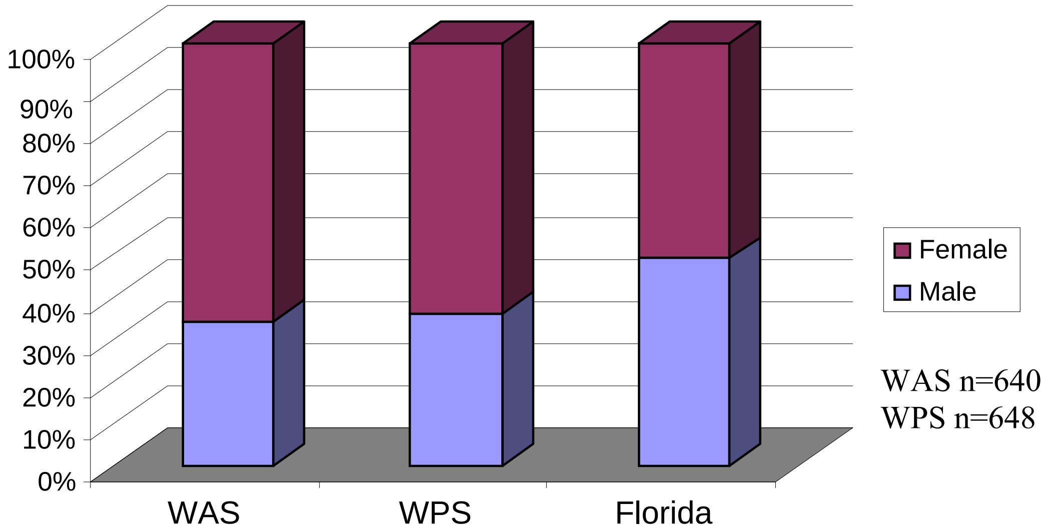

Figure 5-2. Gender profiles of samples and Florida residents

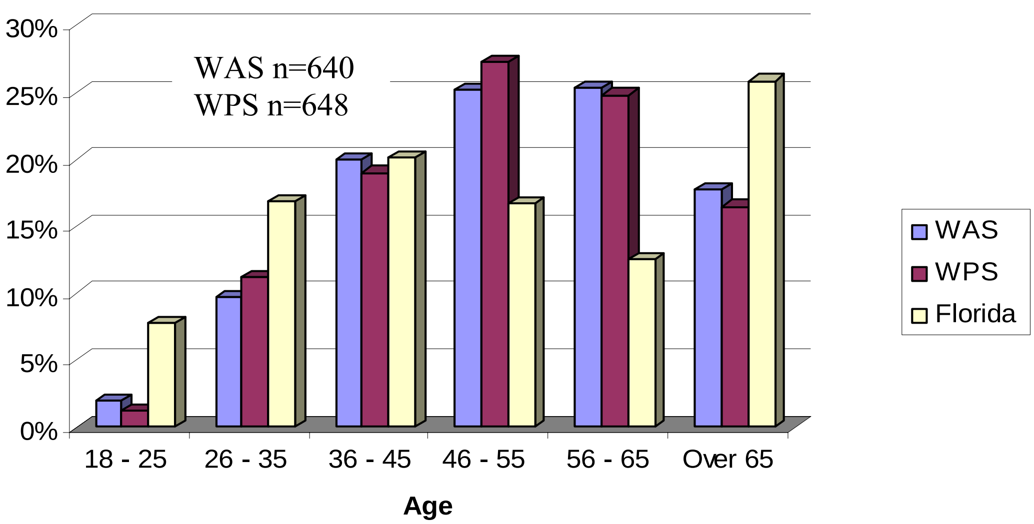

Figure 5-3. Age profiles of samples and Florida residents

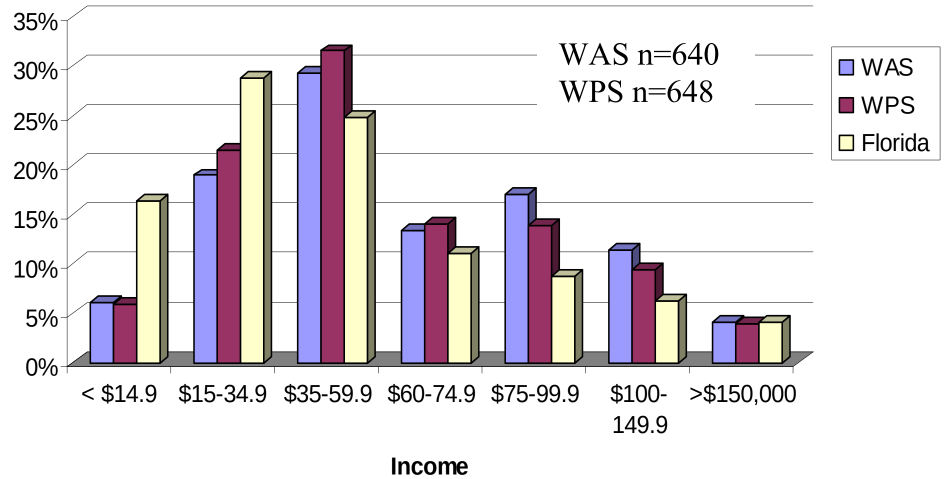

Figure 5-4. Income profiles of samples and Florida residents

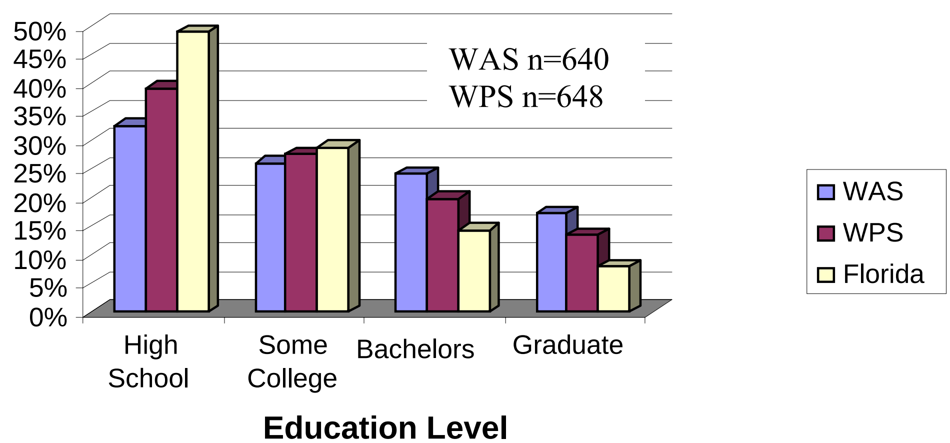

Figure 5-5. Education profiles of samples and Florida residents

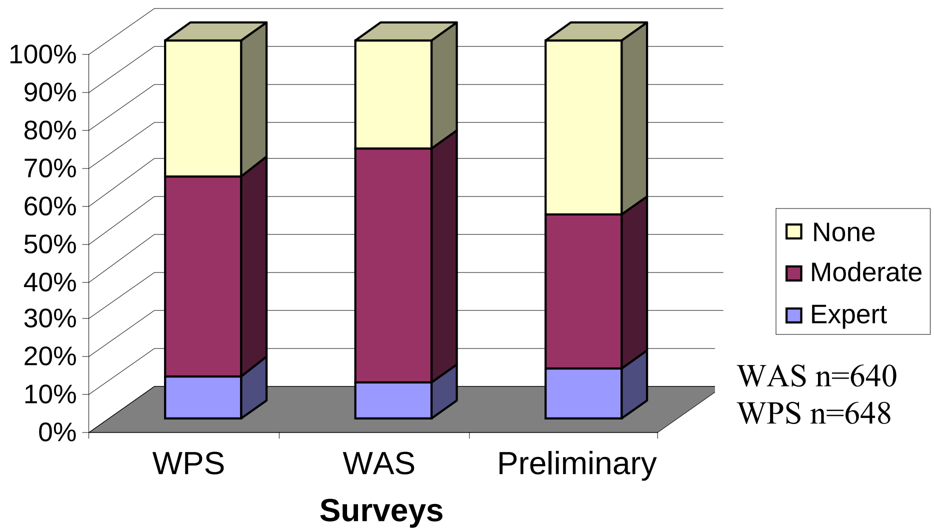

Figure 5-6. Comparison of knowledge of invasive species in three surveys

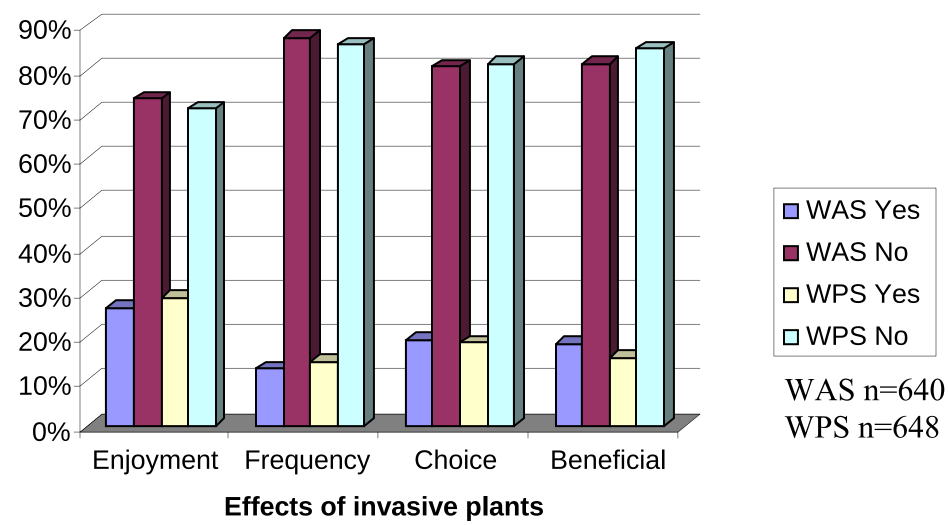

Figure 5-7. Perceived impact of invasive species on enjoyment and other aspects-(main)

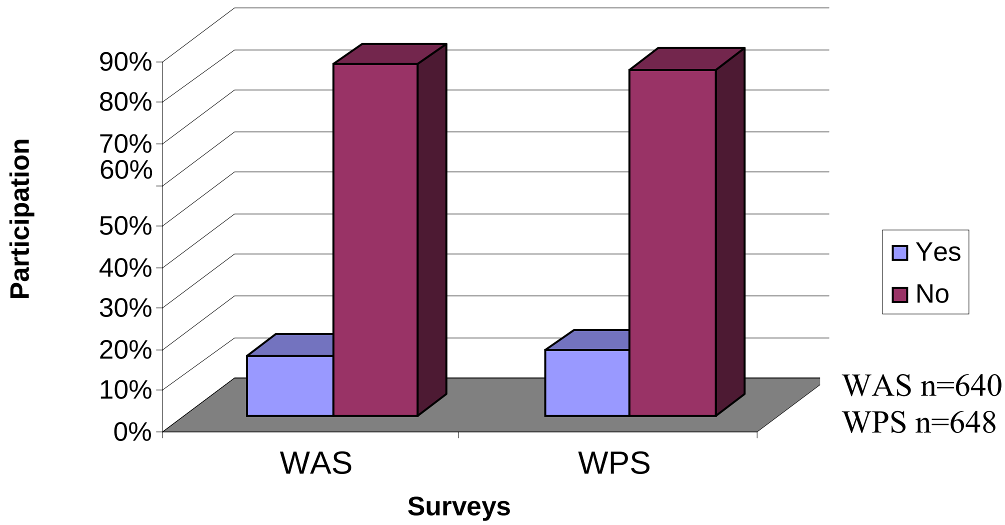

Figure 5-8. Respondents taking action against invasive species

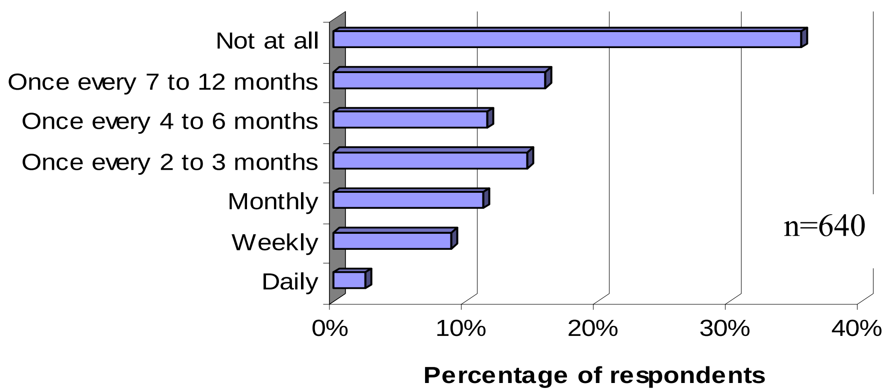

Figure 5-9. Park visit frequencies

CHAPTER 6
MODEL SPECIFICATION AND EMPIRICAL RESULTS

Model Variables

This chapter presents the empirical results estimated using the conditional logit models as described in chapter 3. In the model the dependent variable is the respondents choice which takes a value of Y=1 if park A is chosen and Y=0 otherwise. The independent variables include the park attributes and fee and the respondents' socioeconomic and invasive species attitude characteristics as presented in Tables 6-1 and 6-2. Socioeconomic variables and invasive species attitude variables are together referred to as individual specific variables. Invasive species attitude variables include knowledge of invasive species, if affected or have taken action against invasive species and if the respondent think that invasive species could be beneficial.

Non-Response Errors Testing

Since we used internet as the mode of data collection, we believe that problems like non response errors which are common when data is collected on the web, may exist. We checked for the presence of non-response bias by testing for statistical significance between the distribution of demographic characteristics in sub-samples of the early and late respondents (Armstrong and Overton, 1997). The early respondents are the first fifty and the late respondents are the last fifty. We conducted a chi-square distribution of age, income, education, gender and location for early and late responses to determine whether the characteristics of early survey occur in the same proportion as those who answered later. Late comers are thought to resemble-non respondents so a statistically significant difference between the sub samples will give an indication for non response bias, which would need to be corrected. Results from these sub-samples are presented in Table 6-3. The chi square test indicated no statistical difference between the early and late respondents sub-samples at the 95% confidence level, therefore, no evidence that non-response bias exists. The ratio of males to females for the early and late sub-samples was statistically significant at 99% confidence level in the plant species model. The early respondent group had 40% male while the late respondent group had only 26% males.

Hypothesized Signs on Parameters

The other specification requirements of the model are hypothesized relationships between the independent variables and the probability of choosing a certain park alternative. Based on general economic theory, we hypothesize a negative sign to the fee parameter. It is expected that as fee increases the probability of choosing a particular park would decrease. While invasive species can provide some positive utility to some individuals, such as in their own yards, this study sought to aid managers in making decisions regarding ongoing and planned control and mitigation programs. As such, this study focused on the negative impacts of invasive species. For this reason it was assumed that invasive plants have negative impact on utility. We hypothesize that respondents will be more likely to choose parks with less invasive plants giving a hypothesized negative sign to the invasive species attribute. Therefore, the negative coefficient indicates a willingness to pay to reduce invasive species. We also hypothesize a positive sign to facilities, plant and animal species diversity. The interaction variables were not assigned specific signs. In summary, the models specification for plant species follows:

$$Y = \beta_0 + \beta_1 \Delta fa + \beta_2 \Delta ps - \beta_3 \Delta is - \beta_4 \Delta fe \pm \alpha_j S_i \tag{6-1}$$

The model specification for animal species:

$$Y = \beta_0 + \beta_1 \Delta fa + \beta_2 \Delta as - \beta_3 \Delta is - \beta_4 \Delta fe \pm \alpha_j S_i \tag{6-2}$$

where Y is the respondents choice, β_i and α_j are preference parameters to be estimated, S_i represent the individual specific variable interacted with alternative specific attribute X_i (fa, as, ps, is and fe). The signs on parameters in the specified models indicate the hypothesized sign.

Parameters are estimated with the maximum likelihood procedure for logit model with the STATA statistical package version 9.

Statistically Significant Individual Specific Variables

Part of the process of selecting a model is to compile the individual estimated coefficients. A good model will include estimated coefficients that are statistically different from zero (McDonald et al., 2005). For this reason individual specific variables which play a role in preference variability had to be determined. Socioeconomic and invasive species attitude variables were interacted with park attributes and the parameters were estimated. Table 6-4 shows the results of test of significance for these variables when interacted with park attributes in the plant species model. Variables that were tested and found not significant display an "ns" and if the interaction was not tested it is indicated by a double dash. The coefficients for the interaction terms which were found significant in this process are indicated by asterisks (*) for significance at the 5% confidence level.

In order to maintain consistency, the same model was used for each of the sub-samples. The same process was completed for the animal species survey and interestingly, the interaction terms had relatively similar results as the plant species sample (Table 6-5). A complete list of parameter estimates for the attributes, social economic and invasive species attitude variables is presented in Table 6-7.

Generally, for both models, the socioeconomic variables were not significant. The invasive species attribute when interacted with species attitude characteristics were significant and therefore, included in the final model. The interaction with invasive species resulted into Knowledge*Invasive species where knowledge was classified as Expert=1, Moderate = 2 and None =3; Affected*Invasive species where affected =1 and not affected = 0. Taken action*Invasive species where action =1 and no action =0; Benefit*Invasive species where benefit =1 and no benefit = 0.

Specification

Returning to the theoretical model described in chapter 3 and the four parks attributes, the utility functions for the two surveys are:

$$U_{WPS} = \beta_0 + \beta_1 fa + \beta_2 ps + \beta_3 is + \beta_4 fe + \varepsilon \qquad (6\text{-}3)$$

$$U_{WAS} = \beta_0 + \beta_1 fa + \beta_2 as + \beta_3 is + \beta_4 fe + \varepsilon \qquad (6\text{-}4)$$

For each survey the utility difference between choices with invasive species attitude included:

$$dU^i_{AB} = \beta\Delta X + \alpha\Delta S + \varepsilon_{AB} \qquad (6\text{-}5)$$

where dU^i_{AB} = the utility difference between choice A and choice B; $\Delta S = Si\,(x_{jA} - x_{jB})$; $\Delta x = (x_{jA} - x_{jB})$; and $\varepsilon_{AB} = (e_{iA} - e_{iB})$. Δx can be defined as changes in attribute levels as follows:

ΔFacilities = $fa_A - fa_B$ (fa ranging from 0-2)

ΔNative Plant diversity = $ps_A - ps_B$ (ps ranging from 0-2)

ΔAnimal species diversity = $as_A - as_B$ (as ranging from 0-2)

ΔInvasive species = $is_A - is_B$ (is ranging from 0-2)

ΔFee = $fe_A - fe_B$ (fe ranging from \$0-\$20)

where A and B represents park choices for example fa =0 if park A has minimal facilities and fa=1 if the facilities were adequate as shown in Table 6-1. An Example of ΔS will be $S_i(is_A - is_B)$ for change in invasive species level as it interacts with one of the invasive species attitude variables from the respondent for example invasive species knowledge. The determined utility difference goes into the logit function for the estimation of preference parameters.

Results

Overall Model Fit

The estimated models based on the animal and plant species samples are presented in Table 6-6. The focus is on the probability of choosing an option with the underlying theory that maximum individual's utility will determine which option they choose. The probability of choosing an option is a function of facilities condition, species diversity (both with positive relationship), invasive species and fee (both with negative relationship).

In models of choice, R^2 for good models ranges from 0.2 to 0.4 (Louviere et al., 2000). From the likelihood ratio index (Pseudo R^2 or McFadden's R^2), both models do not appear to fit the data well as the McFadden's R^2 was 0.0346 for the WPS model and 0.0226 for the WAS model. However, for large numbers of observations, a model can fail goodness of fit test but still be adequate for practical purposes and it is possible to focus on estimation rather than hypothesis testing (Agresti, 1996). So the analysis was conducted on this basis because we had about 4500 observations for each sample. The plant species model relatively has a higher prediction rate. This might be an indication that there is less preference variability within the respondents about plant specie diversity in natural areas than it is for animal species.

Attribute Variables

The parameter estimates for the variables in the two empirical models are included in Table 6-7. The conditional logit models indicate that each of the attribute parameter estimates were significant with the hypothesized sign. Fee and invasive species had negative signs and facilities and species diversity had positive signs. The intercept was not significant so the results interpreted are from the models repeated without a constant.

Comparison of the parameter estimates across the models allows us to draw conclusions about the relative importance of these attributes for the two samples. For both samples the invasive species variable shows a negative coefficient that is larger in magnitude than any other attribute. This indicates that in choosing a park, respondents were more sensitive to changes in invasive species in natural areas than any other factor in the models.

Probabilities and Marginal Effects for the Models

The sensitivity for choice preference can be further explained by the marginal effects of the attributes to the probabilities. Using the plant species results as an example, we calculated the probabilities of choosing park A for the seven choices which were presented to the respondents. The choice with the highest level of invasive plants and fee had the lowest probability while the choice with the lowest level of invasive plants but free has the highest probability as shown in Table 6-8.

It is recommended that parameter estimates from choice models should be transformed to yield estimates of the marginal effect, that is, the change in predicted probability associated with changes in the explanatory variables (Green, 2003). The marginal effects are nonlinear functions of the parameter estimates and the levels of the explanatory variables, so they cannot generally be inferred directly from the parameter estimates. The marginal effect in this study as they compare to the actual parameter estimates are presented in Table 6-9.

The plant species model shows a marginal effect of -0.127 for invasive species compared to 0.079 plant species diversity. In the animal species model, the marginal effect of invasive species is -0.114 compared to 0.094 for animal species diversity. These attributes were valued more than facilities and fee. Based on estimated coefficients and marginal effects, overall fee was the least important attribute in impacting the probabilities but it plays an important role in determining the willingness to pay as will be reflected in the next section.

Marginal Willingness to Pay Measures

Willingness to pay was another goal of this study and its correct interpretation from the choice experiment could benefit the state in planning invasive species management programs. However, the CE in this study presented the respondent with hypothetical choice sets without the "Neither" or "status quo" option. This forced choice exercise is said to limit the usefulness of the CE methodology as we can only estimate the marginal price of the attribute but not the net willingness to pay for different choices (Longo, 2007). Therefore, the MWTP for attributes in this study are simply the implicit prices and the choices are only ranked by using the utility scores.

The study had four attributes in each survey and the MWTP or the implicit prices were determined for each attribute for the two surveys. The implicit price of the attribute was made on the basis of "ceteris paribus"[4] assumptions. By factoring out the marginal utility of money (Holmes et al., 2003), the coefficients for the attributes can be translated into the implicit prices for attribute (Table 6-10) as follows:

$$\text{Implicit Price} = -\frac{\beta_{attribute}}{\beta_{fee}} \qquad (6\text{-}6)$$

The marginal utility of money is simply the negative of the fee coefficient. Since we assumed linear relationship in attribute levels, with three levels of invasive species, a change from numerous and dense to few and dispersed in the WPS survey is valued at \$6.85 which is the same value for moving from few and dispersed to none.

[4] With all the other attributes remaining at the mean levels.

The implicit price was the highest for invasive species in both models followed by species diversity (Figure 6-1). Implicit prices were slightly higher for all the attributes in the animal species model. Facilities implicit prices ($4.49 for WAS and $4.13 for WPS) were the lowest.

Marginal willingness to pay and individual specific variables

Although demographic characteristics per see (gender, education, age, income) overall did not cause variations in choice preferences when interacted with attributes, some special characteristics of the respondent had effects on estimated parameters and MWTP for the invasive species attribute. These characteristics included knowledge of invasive species, if the person has been personally affected or participated in taking action against invasive plants. People with these characteristics were willing to pay more to reduce invasive species. On the other hand, respondents who claimed that invasive plants were beneficial for the natural areas were willing to pay less compared to those who did not think these plants were beneficial (Table 6-11).

Marginal willingness to pay by regions

The MWTP or implicit price for invasive species was further analyzed by regions for North, Central and South Florida. We asked each respondent to indicate which County they reside. Using the results from this question we grouped the 68 state counties in their respective regions and generated MWTP estimates for attributes by regions. South Florida had the highest implicit prices for all the attributes in both the samples (Table 6-12). For the WAS sample, South Florida was followed by North Florida and Central Florida last (Figure 6-2B). For the WPS sample, South Florida had the highest price for invasive plants but Central and North Florida switched places. In the WPS there are no visible variations between regions for the implicit prices for facilities and plant species diversity but the price difference for invasive species is very evident (Figure 6-2A). This implies that South Florida region have a relatively higher willingness to pay to reduce invasive species than the other two regions. In addition, within regions in the

WPS sample respondents appeared to value species diversity and facilities about the same. Respondents in three regions were practically similar in their preferences. They all had invasive species with the highest implicit price, followed by species diversity and then facilities.

Relative Weighting of Attributes

The importance of each of the model attributes had to be expressed in relation to all the other attributes in the model and how they impact recreational utility. The normalized weights for attributes were calculated for this purpose (Figure 6-3 A and B)[5]. Respondents gave negative weights to fee and invasive species and positive weights for facilities and species diversity. From these weights the most important attribute is the fee followed by invasive species. By looking at Figure 6-3A, the weights for plant species and facilities in the WPS model look the same. Since native plant species diversity and facilities condition have the same mean level, a test statistic was conducted for this sample and we failed to reject the null hypothesis that $\beta_1 = \beta_2$. β_1 and β_2 represents the attribute coefficients for facilities condition and native plant diversity, respectively. The same test was applied to the WAS sample for facilities and animal species diversity attributes but this time we rejected the null hypothesis. Therefore, the ranking for the attributes based on the relative weights in both models, fee is the most important followed by invasive species. Native plant species are tied with facilities in the WPS model while animal species diversity is ranked number three followed by facilities in the WAS model.

Choices Ranking by Utility Scores

As previously mentioned ranking in this study could only be done by utility score, not the net willingness to pay. The most preferred attribute levels were excellent facilities, high diversity in plant and animal species, no invasive plants and free. The least preferred combination of

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[5] The normalized weight were computed by multiplying each attribute coefficient with its mean level and then multiplying the product times ten (Milon et al., 1999)

attribute levels was the minimal facilities, low diversity in plant and animal species, numerous and dense invasive species at a $20 fee. Park choices according to utility for all 81 possible alternatives were calculated. The choices with positive derived utility for both the plants and animal species samples are presented in Appendix B. Utility scores are 1.33 and 1.246 for the most preferred and -2.194 and -2.498 for the least preferred for the animal and plant species samples, respectively. The largest contributor to the utility in the alternative is fee as reflected by high utility for the alternatives which were free. This is clearly presented in Table 6-13 by changing just one attribute level in a park choice and calculating the change in utility as a result of the level change. For example in the WPS model, a change in fee from free to $10 will reduce the utility by 0.74 units while a change in invasive species from none to few and dispersed will reduce the utility by 0.51 units.

Results for the Combined Model

Since there was not much differences in the estimated coefficients and MWTP for the two samples, at the end of the analysis we decided to combine the WAS and WPS samples to get the results for one model. The MAU survey for the animal species had no native plants attribute and vice versa for the plant species survey. We made an assumption that for each survey the missing attribute was the same in the two alternatives. For example, in WPS when a respondent is presented with a choice set of park A and park B the animal species level is the same in both parks. Therefore, asA-asB =0 for the plant species sample and psA-psB =0 for the animal species sample. We estimated the model only for the attributes and the results are presented in Table 6-14. For the attributes which were in WAS and WPS, their estimated coefficients and MWTP were between the values for the separated model. For example, the MWTP to reduce invasive species in the combined model was $6.99 which is between $6.85 and $7.15, the values of MWTP in WPS and WAS, respectively. The ranking of the attributes based on relative weights turned out exactly as they were when the models were separated (Figure 6-4). Fee is the highest ranked followed by invasive species, then animal species diversity. Native plant species and facilities received the same weight.

Hypotheses Testing

The basic hypothesis in this study is that invasive plants are undesirable and are considered unsightly in parks and recreational places such that recreation satisfaction in these areas will be reduced by the presence of invasive species. For this reason natural area users will be willing to pay to reduce invasive species in outdoor recreation areas. We fail to reject this hypothesis. Invasive species had a statistically significant negative coefficient indicating a willingness to pay to reduce invasive species. The MWTP to reduce invasive species was $6.85 and $7.15 per person for the plants and animal species samples, respectively.

It was anticipated that the willingness to pay for invasive species will not only be because of the effect of invasive plants on recreational utility but also because of the perceived impact of these species on the environment. We fail to reject this hypothesis. Our estimates suggest that invasive species attitude characteristics like the level of knowledge of invasive species and whether people had taken action against invasive species has an impact on MWTP. For example people with higher knowledge on invasive plants were willing to pay more to reduce invasive species than people with less knowledge.

Some socioeconomic variables such as income, age, and education were expected to be significant determinants of the impact of invasive plants on the recreational value. We reject this hypothesis. Socio-economic characteristics had no statistically significant impact on park preferences and MWTP when interacted with the invasive species attribute.

It was also anticipated that since Florida regions are affected at different levels by invasive plants, willingness to pay will likely be different between regions and perhaps higher for the most affected region. We fail to reject this hypothesis. MWTP for invasive species differed significantly between regions and South Florida which is the most affected region had the highest MWTP to reduce invasive species in natural areas.

Table 6-1. Basic models independent variables

Attribute	Levels	Scores	Variable
	Minimal	0	
Facilities Condition	Adequate	1	Fa
	Excellent	2	
	Low	0	
Native Plants Diversity	Moderate	1	Ps
	High	2	
	Low	0	
Animal Species Diversity	Moderate	1	As
	High	2	
	None	0	
Presence of Invasive Species	Few & dispersed	1	Is
	Numerous &dense	2	
	$0	0	
Fee	$10	10	Fe
	$20	20	

Table 6-2. Socioeconomic and invasive species attitude variables

Variable	Type	Meaning	Response/categories
Age	Continuous	Age of the respondent (years)	1-6 (six categories)
Gen	Categorical	Gender	1,2 (male, female)
Edu	Categorical	Attained level of Education	1-4 (four categories)
Emp	Categorical	Employment status	1-5 (five categories)
Inco	Continuous	Annual Gross household income	1-7 (seven categories)
Env	Categorical	Membership in Environmental org.	1,2 (yes, no)
Loc	Categorical	Location where respondent live	1,2,3 (urban, suburban, rural)
Reg	Categorical	Region in Florida	1,2,3 (Central, South, North)
Mar	Categorical	Marital status	1-4 (four categories)
Act	Categorical	Took action against Invasive plants	1,0 (yes, no)
Ben	Categorical	Invasive plants are beneficial	1,0 (yes, no)
K	Categorical	Knowledge of invasive plants	1,2,3 (expert, moderate, none)
Aff	Categorical	Affected by invasive plants	1,0 (yes, no)

Table 6-3. χ^2 Tests statistics of first 50 and last 50 respondent characteristics

		Location(df=2)	Gender(df=1) $^{\eta}$	Education(df=3)	Income(df=4)	Age (df=3)
WPS	χ^2	4.964	7.040***	1.974	0.616	1.896
	p-value	0.084	0.008	0.579	0.961	0.593
WAS	χ^2	0.891	1.630	1.827	6.163	5.055
	p-value	0.641	0.202	0.608	0.188	0.168

η Yates chi-square test used instead of the Pearson chi-square when df = 1.
*** Significant at the 99% level of confidence

Table 6-4. Significance test for attribute interaction with individual specific variables-WPS

Variable	Fee	Plant Sp.	Facilities	Invasive Sp.
Knowledge	*	ns	ns	*
Income	*	ns	*	ns
Education	ns	ns	ns	ns
Affected	*	ns	ns	*
Benefit	ns	ns	ns	*
Action	ns	ns	ns	*
Location	ns	ns	ns	ns
Gender	ns	ns	ns	ns
Age	*	ns	ns	ns
Marital status	--	--	--	ns
Environment	--	ns	ns	ns
Employment	--	--	--	--

* Significant at 5% confidence level

Table 6-5. Significance test for attribute interaction with individual specific variables-WAS

Variable	Fee	Animal Sp.	Facilities	Invasive Sp.
Knowledge	ns	ns	ns	*
Income	*	*	*	ns
Education	ns	ns	ns	ns
Affected	*	ns	ns	*
Benefit	ns	*	ns	*
Action	ns	N*	ns	*
Location	ns	ns	ns	ns
Gender	ns	ns	ns	ns
Age	*	ns	ns	ns
Marital status	ns	ns	--	ns
Environment	ns	ns	ns	ns
Employment	ns	ns	*	ns

* Significant at 5% confidence level

Table 6-6. Overall fit for the multi-attribute models

	WPS	WAS
No. of Observations	4536	4480
Likelihood function value	-2994	-3027
Pseudo R^2	0.0346	0.0226
Sensitivity (actual 1s correctly predicted)	66.2%	64.3%
Specificity (actual 0s correctly predicted)	53.6%	51%

Table 6-7. Coefficient estimate for the multi-attribute models

Plant Species Model (WPS)			Animal Species Model (WAS)		
Variable	Coefficient	Std. Error	Variable	Coefficient	Std. Error
Facilities	0.306*	0.038	Facilities	0.287*	0.038
Native Plant Species	0.308*	0.038	Animal Species Diversity	0.379*	0.039
Invasive Species	-0.497*	0.040	Invasive Species	-0.458*	0.040
Fee	-0.074*	0.006	Fee	-0.064*	0.006
constant	0.031	0.034	constant	-0.002	0.034
Facilities	0.307*	0.038	Facilities	0.287*	0.038
Native Plant Species	0.316*	0.037	Animal Species Diversity	0.378*	0.038
Invasive Species	-0.509*	0.038	Invasive Species	-0.457*	0.038
Fee	-0.074*	0.006	Fee	-0.064*	0.006
age*fa	-0.005	0.015	age*fa	0.028	0.014
age*ps	0.022	0.043	age*as	-0.009	0.015
age*Is	-0.089	0.016	age*Is	-0.087	0.016
age*fe	0.004	0.002	age*fe	0.008	0.002
gen*fa	0.016	0.039	gen*fa	0.039	0.039
gen*ps	0.022	0.043	gen*as	-0.022	0.043
gen*Is	-0.002	0.042	gen*Is	-0.104	0.042
gen*fe	0.002	0.005	gen*fe	0.011	0.005
edu*fa	0.007	0.017	edu*fa	-0.006	0.016
edu*ps	0.025	0.019	edu*as	0.009	0.018
edu*Is	0.022	0.019	edu*Is	0.001	0.018
edu*fe	0.000	0.002	edu*fe	-0.001	0.002
inco*fa	0.040*	0.012	inco*fa	0.065*	0.012
inco*ps	0.021	0.013	inco*as	0.053*	0.013
inco*Is	-0.003	0.013	inco*Is	-0.014	0.013
inco*fe	0.005*	0.001	inco*fe	0.009*	0.001
env*fa	-0.139	0.081	env*fa	0.172	0.078
env*ps	-0.079	0.090	env*as	0.165	0.085
env*Is	0.124	0.091	env*Is	0.153	0.086
env*fe	0.002	0.005	env*fe	0.016	0.009
loc*fa	0.002	0.028	loc*fa	0.010	0.028
loc*ps	0.012	0.031	loc*as	-0.013	0.031
loc*Is	-0.031	0.031	loc*Is	-0.053	0.031
loc*fe	0.001	0.003	loc*fe	0.005	0.003
ac*fa	0.033	0.051	ac*fa	-0.090	0.052

Table 6-7. Continued

Plant Species Model (WPS)			Animal Species Model (WAS)		
Variable	Coefficient	Std. Error	Variable	Coefficient	Std. Error
ac*ps	-0.066	0.056	ac*as	-0.217*	0.058
ac*Is	-0.169*	0.057	**ac*Is**	-0.424*	0.061
ac*fe	0.010	0.006	ac*fe	0.004	0.006
aff*fa	0.085*	0.040	aff*fa	0.068	0.039
aff*ps	-0.023	0.044	aff*as	-0.064	0.043
aff*Is	-0.237*	0.044	**aff*Is**	-0.359*	0.044
aff*fe	0.023*	0.005	aff*fe	0.029	0.005
ben*fa	-0.043	0.052	ben*fa	0.057	0.047
ben*ps	0.090	0.057	ben*as	0.221*	0.052
ben*Is	0.120*	0.056	**ben*Is**	0.242*	0.052
ben*fe	-0.008	0.006	ben*fe	0.003	0.006
k*fa	-0.021	0.029	k*fa	-0.009	0.004
k*ps	0.019	0.032	k*as	-0.008	0.035
k*Is	0.168	0.032	**k*Is**	0.123*	0.035
k*fe	-0.013		k*fe	-0.016	0.031
Central Florida			mar*fa	-0.024	0.025
Facilities	0.289*	0.050	mar*as	-0.058	0.028
Native Plant Species	0.306*	0.049	mar*Is	-0.056	0.028
Invasive Species	-0.509*	0.050	mar*fe	0.000	0.003
Fee	-0.072*	0.008			
			Central Florida		
South Florida			Facilities	0.260*	0.051
Facilities	0.287*	0.076	Animal Species Diversity	0.380*	0.051
Native Plant Species	0.279*	0.076	Invasive Species	-0.444*	0.051
Invasive Species	-0.454*	0.076	Fee	-0.066*	0.008
Fee	-0.059*	0.012			
North Florida			South Florida		
Facilities	0.397*	0.089	Facilities	0.279*	0.076
Native Plant Species	0.402*	0.087	Animal Species Diversity	0.355*	0.078
Invasive Species	-0.592*	0.088	Invasive Species	-0.390*	0.077
Fee	-0.102*	0.015	Fee	-0.048*	0.012
			North Florida		
			Facilities	0.374*	0.085
			Animal Species Diversity	0.408*	0.085
			Invasive Species	-0.583*	0.086
			Fee	-0.079*	0.014

*Indicates Significance at the 0.05 level

Bold Indicates Variables in the Final Model

Table 6-8. Probabilities for park choices-WPS

CHOICE	FA	PS	IS	FE	P(Yi=A)
PARK A	Minimal	Moderate	Few and dispersed	$10	0.653
PARK B	Adequate	High	Numerous and dense	$20	
PARK A	Minimal	Low	None	Free	0.679
PARK B	Excellent	High	Few and dispersed	$20	
PARK A	Excellent	High	None	$20	0.615
PARK B	Adequate	Low	Numerous and dense	Free	
PARK A	Minimal	High	Few and dispersed	$10	0.484
PARK B	Excellent	Moderate	None	$20	
PARK A	Adequate	Moderate	None	$10	0.414
PARK B	Excellent	High	Numerous and dense	Free	
PARK A	Excellent	Moderate	Few	$10	0.516
PARK B	Minimal	High	Numerous and dense	Free	
PARK A	Excellent	High	Numerous and dense	$20	0.374
PARK B	Minimal	Low	None	$10	

Table 6-9. Marginal effects for the models

	Animal Species (WAS)		Plant Species (WPS)	
Parameter	Coefficient	Marginal Effects	Coefficient	Marginal effects
Facilities	0.287	0.071	0.307	0.076
Species Diversity	0.378	0.094	0.316	0.079
Invasive Species	-0.457	-0.114	-0.509	-0.127
Fee	-0.064	-0.016	-0.074	-0.019

Table 6-10. Comparison of implicit prices estimates for recreational attributes

	Animal Species(WAS)	Plant Species (WPS)
Marginal utility of money	$0.064	$0.074
Invasive Species	$(7.15)	$(6.85)
Facilities	$4.49	$4.13
Diversity	$5.92	$4.25

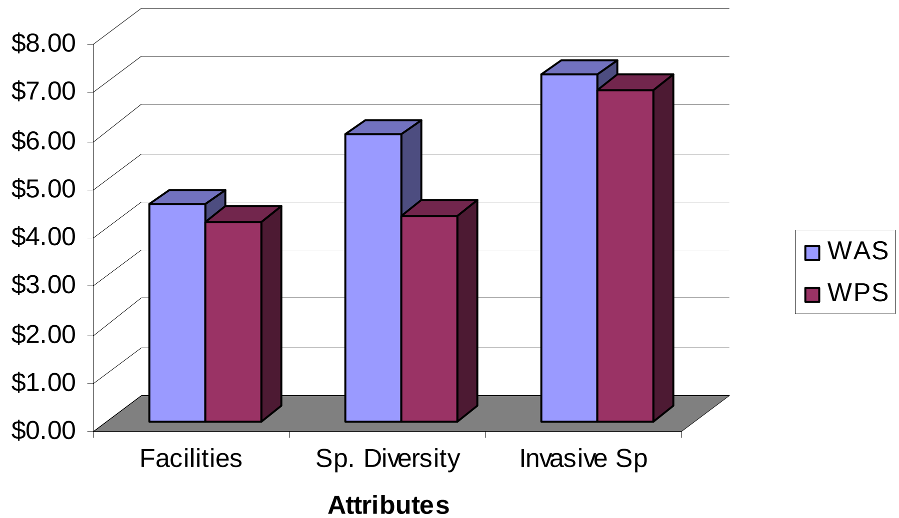


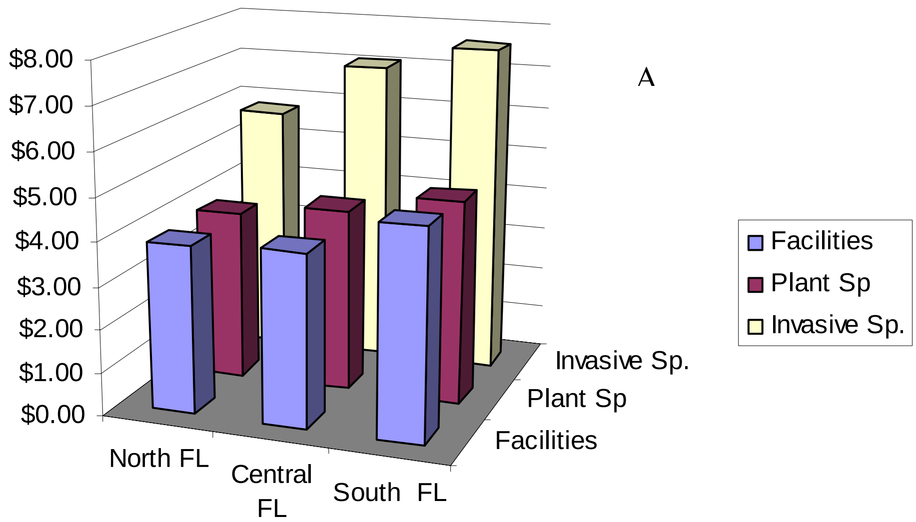
Figure 6-1. Implicit prices for recreational attributes

Table 6-11. Implicit prices to reduce invasive species with attitude variables

Variable	WAS	WPS
Knowledge		
Expert	9.43	9.63
Moderate	7.52	7.39
None	5.60	5.15
Affected		
Yes	10.86	9.00
No	5.35	5.84
Actions		
Yes	12.76	8.76
No	6.22	6.49
Benefits		
Yes	4.09	5.48
No	7.84	7.09

Table 6-12. Regional marginal willingness to pay for the attributes

	Animal Species Model (WAS)			Plant Species Model (WPS)		
	North FL	Central FL	South FL	North FL	Central FL	South FL
Facilities	$4.76	$3.93	$5.83	$3.88	$3.99	$4.83
Sp.Diversity	$5.19	$5.75	$7.40	$3.93	$4.24	$4.69
Invasive Sp.	$(7.42)	$ (6.72)	$ (8.15)	$ (5.78)	$ (7.05)	$ (7.63)



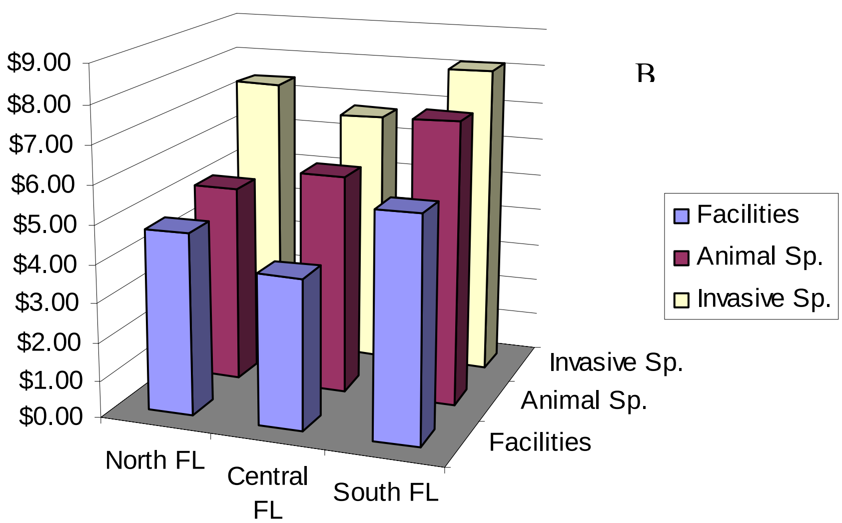


Figure 6-2. Regional marginal willingness to pay A) plant species B) animal species

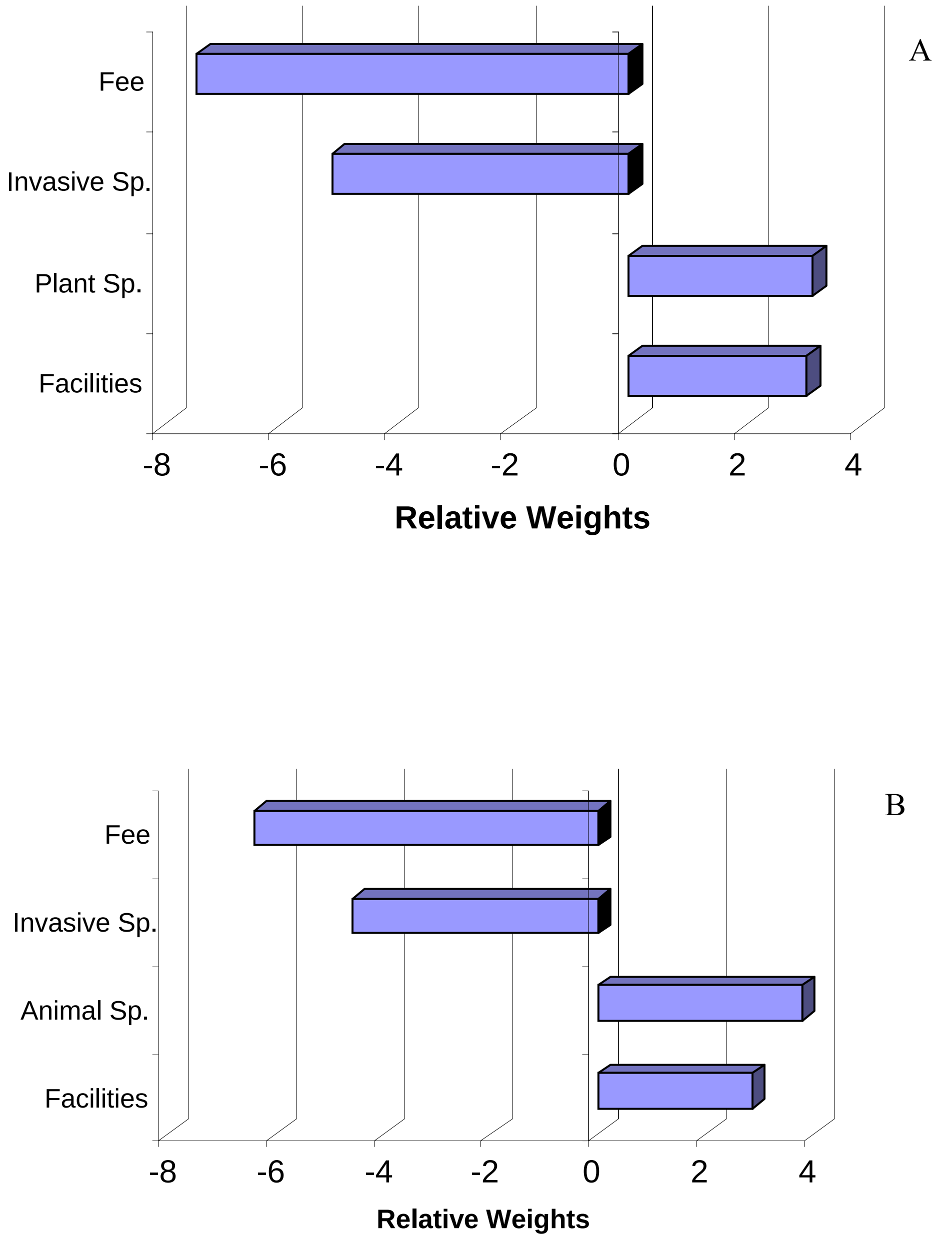


Figure 6-3. Relative weights of attributes A) plant species B) animal species

Table 6-13. Impact of change in attribute level on the total utility

Choices	Facilities	Diversity	Invasive species	Fee	Utility	Δ Attribute	Δ Utility
			Animal Species				
1	Excellent	High	None	Free	1.33	Facilities	0.287
2	Adequate	High	None	Free	1.043		
1	Excellent	High	None	Free	1.33	Diversity	0.378
2	Excellent	Moderate	None	Free	0.952		
1	Excellent	High	None	Free	1.33	Invasive Sp.	0.457
2	Excellent	High	Few and dispersed	Free	0.873		
1	Excellent	High	None	Free	1.33	Fee	0.64
2	Excellent	High	None	$10	0.69		
			Plant Species				
1	Excellent	High	None	Free	1.246	Facilities	0.307
2	Adequate	High	None	Free	0.939		
1	Excellent	High	None	Free	1.246	Diversity	0.316
2	Excellent	Moderate	None	Free	0.93		
1	Excellent	High	None	Free	1.246	Invasive Sp.	0.509
2	Excellent	High	Few and dispersed	Free	0.737		
1	Excellent	High	None	Free	1.246	Fee	0.74
2	Excellent	High	None	$10	0.506		

Table 6-14. Coefficient estimates for the attributes (combined model)

Variable	Coefficient	Std.Err	MWTP	Rank
Facilities	0.297	0.027	$4.30	4
Animal Species Diversity	0.410	0.030	$5.94	3
Native Plant Species	0.284	0.030	$4.11	4
Invasive Species	-0.483	0.027	($-6.99)	2
Fee	-0.069	0.004		1

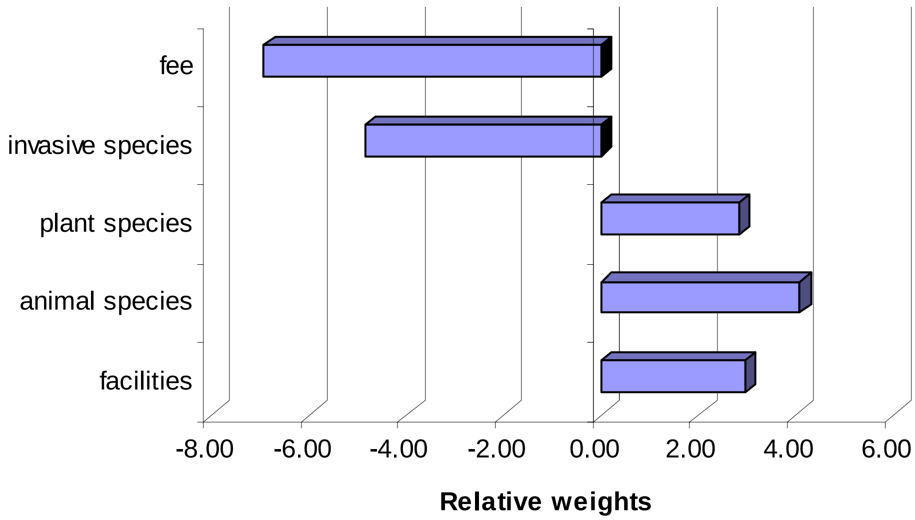


Figure 6-4. Relative weights of the attributes for the combined model

CHAPTER 7
INTERPRETATION OF THE RESULTS FOR INVASIVE PLANT MANAGEMENT

Invasive Species and Outdoor Recreation

Regarding the invasive species attribute, based on respondents' interviews, our results are consistent with some studies that while Florida residents know that invasive plants have a negative impact to natural areas, the plants do not seem to affect people's enjoyment in outdoor recreation (Wirth and White, 2006; Finn, 2006). Our preliminary surveys while searching for attributes also indicated that people do not care about invasive species when engaged in outdoor recreation in natural areas. However, a study by Adams and Lee (2006) found that the presence of hydrilla in Florida lakes had a negative influence on angler's decisions to use certain lakes. But there is no indication of this happening with recreation in wooded parks.

Surprisingly, in our study both the animal and the plant species models found high invasive species sensitivity in choosing a wooded park for recreation. One explanation is that no previous work has measured the effect of invasive plants in recreation using a survey based methodology and analysis. The other studies were not designed to capture the choice behavior of the respondent as in this study. These past studies analyzed the relationship between park enjoyment and the presence of invasive species based on what people said and not on how they behaved in choosing a park with different levels of invasive species.

Estimations of Willingness to Pay to Reduce Invasive Species

Based on the determined implicit price for the invasive species attribute, the statewide willingness to pay to control invasive species in state parks was estimated. The attribute levels for invasive plants were "None," "Few and Dispersed," and "Numerous and Dense." As respondents chose their preferred park, they revealed their average willingness to pay for each attribute. This included the willingness to pay to reduce invasive species from "Numerous and

Dense" to "Few and Dispersed" and from "Few and Dispersed" to "None." Given a known current condition of state parks with respect to invasive plants, and with the assumption we made that the average value associated with each level changes is the same, we estimated the total willingness to pay to implement an invasive plant control policy that achieves reductions along these levels.

From an online survey with the park managers to determine the current conditions of invasive plants in state parks, we can presume that the levels of invasive species in the majority of Florida state parks are currently "Few and Dispersed"; there were 4% responses indicating no presence of invasive species, 50% indicated few and dispersed, 33% indicated an obvious presence and 13% of the park managers indicated (in an open ended question) that the invasive species problem is being taken care of in their respective parks. Florida has various types of parks; wooded, ocean and beach and river and lakes. From the 159 state parks, 116 parks offer hiking, nature trails, biking and horse trails activities and we considered them to be "wooded parks".

We applied the MWTP estimates using the "Few and Dispersed" level as the status quo and calculated the range of WTP to prevent invasive species from becoming "Numerous and Dense" for wooded parks for the entire state. We applied the MWTP measures with the annual estimated park attendance for the fiscal year 2005-2006 (FLDEP, 2006); the state parks received about 18.2 million visitors last year with the 116 wooded parks taking 16.1 million visitors. The number of visitors per year has been fluctuating around 18 million for Florida state parks with the local visitors estimated at 35% of total park visitors (FLDEP, 2004). For the "low" estimate, we multiplied the invasive species MWTP by 35% of annual park attendance; which was 5.6

million visitors for the wooded parks. For the “high” estimate, we multiply MWTP by the total annual park attendance; which was 16.1 million visitors for the wooded parks.

The total amount that Florida residents would be willing to pay to keep invasive plants from becoming “Numerous and Dense” in Florida wooded parks amounts to $38.7 million per year in the WPS sample. With the application of the MWTP estimates to 100% of 2005/2006 wooded park attendance for high WTP estimates, we arrive at $110.48 million per year (Table 7-1). Since the MWTP measures for the WAS survey was relatively higher, the estimates ranges from $40.4 to $115.3 per year for this model.

We compared the WTP ranges for the plant species model with ranges of WTP for the other attributes in the same model. Using the same calculation method, the WTP to improve facilities from adequate to the excellent level ranged from $23.3 to $66.6 million per year while the WTP to improve native plants diversity from the moderate to high level ranged from $23.9 to $68.5 million per year. For the animal species model, the annual statewide WTP ranged from $25.3 to $72.4 million to improve facilities and $33.4 to $95.5 million dollars to improve animal species diversity. Taking care of the invasive species has the highest range of total WTP than to improve the other two park attributes.

Since the money could be collected through an increased park entrance fee, we assume that non-Florida residents have the same MWTP as Florida residents and interpret these amounts as the ranges of annual WTP by state park visitors to prevent invasive species from becoming “Numerous and Dense” and to improve facilities and species diversity in the wooded parks.

Also, since Florida‘s regions are affected at different levels by invasive plants and not all the state parks have invasive plants, it will be practical to estimate the willingness to pay based on this reality. From the status quo determination with the park managers, we can assume that

4% of the state parks have no invasive plants, 63% (50% + 13%) of the parks have few and dispersed invasive plants and 33% have numerous and dense invasive plants. The MWTP also differed between regions, ranging from $5.78 to $7.63 for invasive species in the WPS sample. The Florida recreation and park system is divided in five districts which can be classified into the three regions of the state as follows: the Northwest and Northeast districts as “North Florida”, the Central district as “Central Florida” and the Southwest and Southeast districts as “South Florida” (Appendix C).

The MWTP from each level of invasive species was calculated by multiplying last years park attendance for the regions with the regional invasive species implicit price and the percentage of parks assumed for each level of invasive plants. South Florida, with the second largest number of parks but the highest attendance and highest MWTP has the willingness to pay of $20.8 million per year to improve its parks from “Numerous and Dense” invasive species to the “Few and Dispersed”. North Florida, with the highest number of parks but low MWTP has only $9.2 million WTP per year to achieve the same improvement. The remaining values by region are in Table 7-2.

Marginal Willingness to Pay and the Invasive Species Attitude

A study using data collected from the National Survey on Recreation and the Environment reported that 96.7% of the respondents supported user fees or a combination of user fees and taxes to fund the services (Bowker et al.,1 999). However, the implementation of an additional park fee for the purpose of invasive management should be considered carefully. Although people have indicated some willingness to pay to reduce invasive plants through an increased park usage fee, the amounts they are willing to pay are very low even less than one dollar per visit. An example of low willingness to pay to reduce invasive species in outdoor recreation areas in Florida from Finn (2006) is presented in Table 7-3. On average people were willing to pay less than $4 per visit to reduce *Malaleuca* in recreational areas. Compared to these figures our estimate for invasive plants MWTP is relatively high.

An important observation is that although the overall MWTP for invasive species was up to over $7 dollars for this study, the ranking of park preferences based on utility gives a different outcome. In both samples, the top preferences that gave the respondent utility greater than "zero," over 84% of the choices are "free" and only one park was chosen for the $20 fee. This might be an indication that the increase in park fee may not be received positively by Florida state park users.

In this study the respondent's invasive species attitude had an impact on the MWTP to reduce invasive plants. These characteristics included the level of knowledge of invasive species, if the respondent was affected by invasive species and people who have taken action against invasive plants. Thus the state could improve the awareness and knowledge of invasive species among Florida residents to increase the MWTP values. There have been some indications that Florida residents have interest in receiving information on invasive species (Wirth and White, 2006).

As we calculated the statewide WTP to control invasive plants, we calculated the statewide WTP changes for a change in knowledge level. We had three levels of knowledge; none, moderate and expert. Since it was determined that 60% of Florida residents have no knowledge of invasive species, it could be reasonable for the state to implement an educational campaign that could give Florida residents at least the moderate level of knowledge and raise the awareness of the impact of invasive plants. The marginal willingness to pay to reduce invasive species in WPS was $5.15 and $7.39 for the "none" and "moderate" knowledge, respectively. The different MWTP were multiplied with the 2006 annual park attendance of local visitors to determine the change of WPT with the change in invasive species knowledge level. From the WPS model, an educational program that could increase the knowledge from "none" to "moderate" level would increase statewide WTP by $12.6 million per year (Table 7-4).

In summary, invasive plant management programs in Florida could achieve the goal of reducing invasive species through education campaigns on invasive species to Florida residents in order to increase park users' willingness to spend on park fees, which may in turn be used to control invasive plants in state parks. In addition, the knowledge and awareness of the impact of invasive species among Florida residents may lead to increased participation in invasive species management voluntary activities like the Gainesville community annual event of collecting the invasive Air potato which was mentioned in chapter four.

The Importance of Invasive Species Knowledge

To assess the importance of knowledge of invasive plants among the state residents on invasive species management programs, we conducted a small survey on 27 invasive plants experts as park visitors in Florida at the end of the study. We used the same MAU questionnaires for this small survey. From this survey, two attributes (facilities and fees) were not significant while the invasive species attribute was statistically significant (Table 7-5). The invasive plant experts did not give importance to the park fee and facilities but they ranked the invasive species attribute the highest among the four attributes affecting recreational utility (Figure 7-1).

In the overall models (WAS and WPS), fee was the highest ranked in impacting recreational utility. The MWTP to reduce invasive species for the experts was almost three times as much as the MWTP for the general population ($19.25 compared to $6.85 in the plant species model). The MWTP to reduce invasive species for these proven experts was twice as much as the MWTP for respondents who claimed to be invasive species experts ($19.25 vs. $9.63). The WTP to reduce invasive species from Florida residents who visit state parks varies between

$29.1 million and $108.7 million per year with invasive species knowledge level differences. This is the comparison of WTP between residents who have no invasive species knowledge at all and residents who are invasive species experts. From this observation, it is evident that improving invasive species knowledge could significantly increase willingness to pay for invasive species management.

Table 7-1. Annual WTP to control invasive plants in Florida wooded parks (million $)

Attribute	WPS Low	WPS High	WAS Low	WAS High
Facilities	$23.3	$66.6	$25.3	$72.4
Species Diversity	$23.9	$68.5	$33.4	$95.5
Invasive Species	$38.7	$110.5	$40.4	$115.3

Table 7-2. Annual regional WTP to reduce invasive plants levels -WPS

				Regional WTP to reduce invasive plants		
Region	Number of parks	Attendance	MWTP	Total	Few and Dispersed	Numerous and Dense
North FL	52	4,820,594	$5.78	$27,863,033	$17,553,711	$9,194,801
Central FL	24	3,032,471	$7.05	$21,378,921	$13,468,720	$7,055,044
South FL	40	8,275,978	$7.63	$63,145,712	$39,781,799	$20,838,085

Table 7-3. WTP per visit to reduce *Melaleuca* in recreational areas by Florida residents

Expense Range	Number	Percent
$0	275	44
$0-$1	48	8
$1-$4	171	27
$5-$9	58	9
$10-$15	42	7
$16-$25	23	4
$25 +	9	1

Source: Finn, (2005)

Table 7-4. Annual WTP to control invasive species- FL residents with knowledge (million $)

Level of knowledge	WPS	WAS
None	$29.1	$31.6
Moderate	$41.7	$42.5
Experts (self declared)	$54.3	$53.2
Real Experts	$108.7	$108.7

Table 7-5. Coefficient estimate for the attributes (invasive plants experts)

Variable	Coefficient	Std. Error	P>|z|	Relative Importance	MWTP$
Facilities	0.170	0.230	0.460	4	3.82
Species Diversity	0.513	0.279	0.066	2	11.52
Invasive Species	-0.856	0.280	0.002	1	-19.25
Fee	-0.044	0.038	0.244	3	

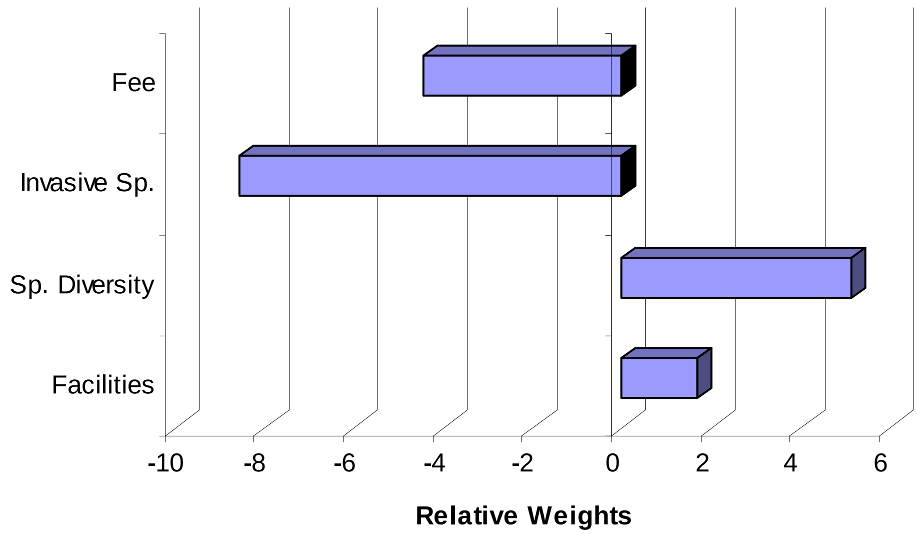


Figure 7-1. Relative weights of attributes for invasive plants experts

CHAPTER 8
SUMMARY AND CONCLUSIONS

The determination of the impact of invasive plants in outdoor recreation utility in Florida parks is important for proper decision-making about invasive plant management. The revenues and satisfaction realized from state parks are important to many residents' quality of life and are an important element of the state's economy.

This study provides information about residents' preferences for state parks based on park attributes including invasive plants. A Multi-attribute model was designed to assess these preferences and was implemented through the Internet to Florida residents. The model consisted of seven different choices sets each with two alternatives for each of the two surveys separated by animal and plant species diversity. The plant species survey contained four attributes; facilities condition, native plant diversity, presence of invasive species and the park fee. The animal species survey had the same attributes as the plants survey but with animal species diversity instead of the native plant diversity attribute.

Responses to the Multi-attribute surveys were analyzed using the conditional logit model to determine which factors significantly influenced park choices, the implied ranking of the attributes and the alternatives based on the utility and the marginal willingness to pay for the attributes. All the attributes were significant but demographic characteristics like age, income and education had no influence on the relationship between recreational utility and invasive species. The invasive species attribute had the most impact on preference probabilities while the park fee impacted utility the most. Invasive species attitude characteristics (which included invasive species knowledge, if a person have been affected by the species or have taken action against invasive plants and if the person think invasive plants are beneficial) had a significant impact on choice preference and, therefore, willingness to pay for the invasive species attribute. To the contrary being a member of an environmental club did not have any impact, most likely because we had a negligible number of environmentally conscious respondents (6%).

The MWTP for the various attribute levels ranged from $4.13 to $7.15. The MWTP to reduce invasive species was higher than the MWTP to improve facilities or increase native plants and animals. Estimated annual statewide WTP based on fiscal year 2005-2006 park attendance, ranged from $38.7 to $110.5 to reduce invasive plants, $23.3 to $66.6 million to improve facilities and $23.9 to $68.5 million dollars to improve plant species diversity. For the animal species model, the annual WTP ranged from $40.4 to $115.3 to reduce invasive plants, $25.3 to $72.4 million to improve facilities and $33.4 to $95.5 million dollars to improve animal species diversity. The WTP to reduce invasive species ranged from $29.1-$108.7 million per year with different levels of invasive species knowledge among Florida residents.

Since the results from the two surveys were relatively similar, a quick analysis was done at the end of the study combining the two surveys. Results for the combined model for all the attributes are between the plant species and the animal species model results since overall the animal species model had relatively higher estimates.

MWTP were calculated for three regions in order to capture any differences in WTP and determine if they were related to the extent of invasive species currently in the region. South Florida, which is relatively highly affected by invasive plants, had the highest MWTP for all the attributes including the invasive species attribute.

The study determined the extent to which the park preferences and MWTP varied based on individual specific factors. These results allow us to identify various aspects within the population, which offers the opportunity for policy makers to capture the aspects to focus on in dealing with invasive plants. The realized effect of knowledge and perception of invasive species on choice preference and MWTP for the invasive species attribute could give some direction on how to deal with invasive species in the state more specifically in recreational parks.

Since our MWTP values were higher than in past studies and free parks were preferred the most, increasing park fee may not be a feasible option. An educational program would be an appropriate approach towards the solution to invasive species in Florida parks. Residents could be educated on the overall impact of invasive species both to the state economy and destruction to the environment to improve their MWTP to reduce invasive species. Since demographic characteristics when interacted with the invasive species attribute did not play an important role in choice preference, the question is not who should be targeted to eradicate invasive species but rather how the populations' knowledge and awareness should be improved.

The next question is how the invasive species knowledge was acquired for respondents who had the knowledge. The answer to this question will determine how the education program on invasive species could be implemented. It is therefore recommended that future studies find out how residents acquire knowledge about invasive species and use these means to educate the public about invasive species.

One limitation of this study is that it was too broad considering the various types of parks in the state's park system. It would also have been best to gather research data through face to face interviews at the parks with the actual park users rather than gathering the information from any Florida resident through Internet.

Finally, caution should be taken when referring to the statewide willingness to pay estimates because the MWTP for the attributes made inference to out of state park visitors who were not part of the analyzed samples.

APPENDIX A

MAIN SURVEY

Survey Cover Letter

Dear Florida Resident,

We are requesting your participation in a University of Florida survey on **Recreation and Invasive Plants in Florida's State Parks** *(the link to the survey webpage is located at the bottom of this letter)*. You have been selected as a part of a small sample of Florida residents who are being asked to complete this online questionnaire. Please take a few minutes to complete the survey.

This survey is divided in three parts. In the first part you will be asked to provide different valuations about a specific natural area and a second one of your choice, which is optional. In the second part you will be asked to give your opinion about what effects invasive species have had in your decision of which location to attend and enjoyment when engaging in outdoor recreational activities. Finally, we will ask you to give us some socio-economic information for our analysis.

Remember that to participate in this survey you must be 18 years or older. Participation is voluntary. You do not have to answer any questions you do not wish to answer. You are free to stop the questionnaire at any time. There are no anticipated risks, compensation, or other direct benefits to you as a participant in this study. You may be assured of complete confidentiality. You will not be identified or connected with the questionnaire in any way and participation is totally anonymous. Results will only be reported as summarized data. The information gathered in this study may be published in professional journals or presented at scientific meetings, but will not be accessible as individual data.

The survey is funded by the Florida Department of Environmental Protection and is administered by the University of Florida and the Institute of Food and Agricultural Sciences. For questions about this study, please feel free to contact graduate student investigators Santiago Bucaram (santibu@ufl.edu) or Frida Bwenge (fbwenge@ufl.edu). For questions about your rights as a research participant, please contact the University of Florida Institutional Review Board (PO Box 112250, Gainesville, Fl 32611, telephone 352-392-0433).

Please remember that your answers to this survey are extremely important and may impact your future enjoyment of Florida's state parks.

Thank you for your cooperation.

WEB SURVEY LINK: http://www.surveymonkey.com/s.asp?u=864193701263

QUESTIONNAIRE (WPS)

Do you live in Florida?

- Yes
- No

What is the county of your primary residence in Florida? (choose from the menu below)

How frequently have you participated in nature related outdoor activities at each of the following locations during the past 12 months?

	Daily	Weekly	Monthly	Once every 2 to 3 months	Once every 4 to 6 months	Once every 7 to 12 months	Not at all
OCEAN AND BEACH							
RIVER AND LAKE							
WOODED PARK							

WOODED PARK

We would like to know more about how invasive plants affect your recreation decisions and your enjoyment of Florida parks.

In the questions to follow we would like you to:
(1) Compare pairs of "WOODED" parks
based on the 4 features shown in the table on the right
(2) Indicate your preference by choosing ONE park
(3) Do this 7 times

This part of the survey should take no more than 5 minutes

1.- PARK FACILITIES CONDITION: Park facilities include parking lots, boat docks, boat ramps, picnic tables, restrooms, showers, among others
2.- DIVERSITY OF PLANT SPECIES: Include all the plants which are natural or indigenous to Florida
3.- FEES: Include fees for admission, parking, camping among others
4.- PRESENCE OF INVASIVE SPECIES: All non-native plants known to disrupt ecosystem processes

WOODED PARK

About the two Wooded parks:

(1) The two parks are your only alternatives
(2) Each park is the same distance from your home
(3) Both parks offer the following activities and facilities

CASE 1 OF 7

	PARK A	PARK B
Facilities condition	Minimal	Adequate
Native plant diversity	Moderate	High
Presence of invasive species	Few and dispersed	Numerous and dense
Fees	$10	$20

Which of the two parks do you prefer?

◯ Park A ◯ Park B

CASE 2 OF 7

	PARK A	PARK B
Facilities condition	Minimal	Excellent
Native plant diversity	Low	High
Presence of invasive species	None	Few and dispersed
Fees	Free	$20

Which of the two parks do you prefer?

◯ Park A ◯ Park B

CASE 3 OF 7

	PARK A	PARK B
Facilities condition	Excellent	Adequate
Native plant diversity	High	Low
Presence of invasive species	None	Numerous and dense
Fees	$20	Free

Which of the two parks do you prefer?

○ Park A ○ Park B

CASE 4 OF 7

	PARK A	PARK B
Facilities condition	Minimal	Excellent
Native plant diversity	High	Moderate
Presence of invasive species	Few and dispersed	None
Fees	$10	$20

Which of the two parks do you prefer?

○ Park A ○ Park B

CASE 5 OF 7

	PARK A	PARK B
Facilities condition	Adequate	Excellent
Native plant diversity	Moderate	High
Presence of invasive species	None	Numerous and dense
Fees	$10	Free

Which of the two parks do you prefer?

○ Park A ○ Park B

CASE 6 OF 7

	PARK A	PARK B
Facilities condition	Excellent	Minimal
Native plant diversity	Moderate	High
Presence of invasive species	Few and dispersed	Numerous and dense
Fees	$10	Free

Which of the two parks do you prefer?

○ Park A ○ Park B

CASE 7 OF 7

	PARK A	PARK B
Facilities condition	Excellent	Minimal
Native plant diversity	High	Low
Presence of invasive species	Numerous and dense	None
Fees	$20	$10

Which of the two parks do you prefer?

- ○ Park A
- ○ Park B

There are two other types of parks that are highly impacted by invasive plants. Of the two, which one would you answer more questions about?

- ○ Ocean and Beach
- ○ River and Lake
- ○ Neither. I would like to proceed to other questions

CASE 7 OF 7

	PARK A	PARK B
Facilities condition	Excellent	Minimal
Animal species diversity	High	Low
Presence of invasive species	Numerous and dense	None
Fees	$20	$10

Sample for WAS

Which of the two parks do you prefer?

- Park A
- Park B

ADDITIONAL QUESTIONS (1/4)

Please indicate your knowledge of invasive plants prior to this survey.

- I knew a lot about invasive plants
- I knew a little about invasive plants
- I knew nothing about invasive plants

ADDITIONAL QUESTIONS (2/4)

Indicate your agreement or disagreement with the following statements:

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Invasive plants have affected my enjoyment of outdoor recreation activities in State Parks					
Invasive plants have affected the number of my visits to State Parks					
Invasive plants have affected which State Parks I attend					
Invasive plants can also provide benefits to Florida's parks					

ADDITIONAL QUESTIONS (3/4)

Have you taken any personal actions in response to invasive plants in Florida?

- ◯ Yes
- ◯ No

Examples of actions against invasive species are:
To become active to help remove invasive plants from natural areas;
To drive or travel farther to visit an alternative location with fewer invasive plants;
To donate money or supplies to help remove invasive plants from natural areas; among others

ADDITIONAL QUESTION (4/4)

Please indicate whether you have done any of the following in response to invasive plants:

- ☐ I helped remove invasive plants from natural (public) areas
- ☐ I made a personal contribution (money or supplies) to help remove invasive plants from natural (public) areas.
- ☐ I have driven to farther parks just to avoid invasive species plants
- ☐ Other (please specify)

DEMOGRAPHIC QUESTIONNAIRE (1/4)

Please indicate the area that best describes where you live

- ◯ Urban Area – city or town
- ◯ Suburban Area- within 5 miles of a city center or town
- ◯ Rural Area - more than 5 miles from a city center or town

Please indicate your gender

- ◯ Male
- ◯ Female

Please indicate your age

- ◯ 18 - 24
- ◯ 25 – 34
- ◯ 35 – 44
- ◯ 45 – 54
- ◯ 55 – 64
- ◯ 65 or older

DEMOGRAPHIC QUESTIONNAIRE (2/4)

Please indicate your marital status

- ◯ Single, never married
- ◯ Married
- ◯ Divorced
- ◯ Widowed

How many people including yourself occupy the residence where you live?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ more than 5

How many people under age 18 live with you?

- ◯ None
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ more than 5

DEMOGRAPHIC QUESTIONNAIRE (3/4)

Indicate the highest level of education you have completed

- ◯ Some high school
- ◯ High school graduate
- ◯ Associate (AA) or 2 year technical degree
- ◯ Bachelor (BA, BS, or other 4 year degree)
- ◯ Advanced or Professional training beyond a bachelor degree

Indicate your race or ethnic background

- ◯ White/Caucasian
- ◯ Black/African-American
- ◯ Hispanic, Latino, Chicano
- ◯ Asian or Pacific Islander
- ◯ Native American

Is anyone in your household affiliated with an environmental organization?

- ◯ Yes
- ◯ No

DEMOGRAPHIC QUESTIONNAIRE (4/4)

What is your employment status? (Check only one answer)

- ◯ Employed
- ◯ Not employed, but seeking work
- ◯ Not employed and not seeking work
- ◯ Student
- ◯ Retired

What is your annual household income before taxes? (Check only one answer)

- ◯ Less than $14,999
- ◯ $15,000 - $34,999
- ◯ $35,000 - $59,999
- ◯ $60,000 - $74,999
- ◯ $75,000 - $99,999
- ◯ $100,000 - $149,999
- ◯ More than $150,000

Thank you for participating in this study. The information you provided is important. For questions about this study, please contact graduate research assistants Santiago Bucaram (santibu@ufl.edu) or Frida Bwenge (fbwenge@ufl.edu). For questions about your rights as a research participant, contact the University of Florida Institutional Review Board (PO Box 112250, Gainesville, Fl 32611, telephone 352-392-0433). Click here to qualify for your incentive

Thank you for your time. This study was developed exclusively for Florida residents.

For questions about this study, please contact graduate research assistants Santiago Bucaram (santibu@ufl.edu) or Frida Bwenge (fbwenge@ufl.edu).

For questions about your rights as a research participant, contact the University of Florida Institutional Review Board (PO Box 112250, Gainesville, Fl 32611, telephone 352-392-0433).

THANK YOU!

APPENDIX B
PARK RANKING BY UTILITY

Table B-1. Park ranking by utility -WPS

FA	PS	IS	FE	FA	PS	IS	FE	Utility
2	2	0	0	Excellent	High	None	Free	1.246
1	2	0	0	Adequate	High	None	Free	0.939
2	1	0	0	Excellent	Moderate	None	Free	0.930
2	2	1	0	Excellent	High	Few and dispersed	Free	0.737
0	2	0	0	Minimal	High	None	Free	0.632
1	1	0	0	Adequate	Moderate	None	Free	0.623
2	0	0	0	Excellent	Low	None	Free	0.614
2	2	0	10	Excellent	High	None	$10	0.506
1	2	1	0	Adequate	High	Few and dispersed	Free	0.430
2	1	1	0	Excellent	Moderate	Few and dispersed	Free	0.421
0	1	0	0	Minimal	Moderate	None	Free	0.316
1	0	0	0	Adequate	Low	None	Free	0.307
2	2	2	0	Excellent	High	Numerous and dense	Free	0.228
1	2	0	10	Adequate	High	None	$10	0.199
2	1	0	10	Excellent	Moderate	None	$10	0.190
0	2	1	0	Minimal	High	Few and dispersed	Free	0.123
1	1	1	0	Adequate	Moderate	Few and dispersed	Free	0.114
2	0	1	0	Excellent	Low	Few and dispersed	Free	0.105
0	0	0	0	Minimal	Low	None	Free	0.000

Table B-2. Park ranking by utility-WAS

FA	AS	IS	FE	FA	AS	IS	FE	Utility
2	2	0	0	Excellent	High	None	Free	1.330
1	2	0	0	Adequate	High	None	Free	1.043
2	1	0	0	Excellent	Moderate	None	Free	0.952
2	2	1	0	Excellent	High	Few and dispersed	Free	0.873
0	2	0	0	Minimal	High	None	Free	0.756
2	2	0	10	Excellent	High	None	$10	0.690
1	1	0	0	Adequate	Moderate	None	Free	0.665
1	2	1	0	Adequate	High	Few and dispersed	Free	0.586
2	0	0	0	Excellent	Low	None	Free	0.574
2	1	1	0	Excellent	Moderate	Few and dispersed	Free	0.495
2	2	2	0	Excellent	High	Numerous and dense	Free	0.416
1	2	0	10	Adequate	High	None	$10	0.403
0	1	0	0	Minimal	Moderate	None	Free	0.378
2	1	0	10	Excellent	Moderate	None	$10	0.312
0	2	1	0	Minimal	High	Few and dispersed	Free	0.299
1	0	0	0	Adequate	Low	None	Free	0.287
2	2	1	10	Excellent	High	Few and dispersed	$10	0.233
1	1	1	0	Adequate	Moderate	Few and dispersed	Free	0.208
1	2	2	0	Adequate	High	Numerous and dense	Free	0.129
2	0	1	0	Excellent	Low	Few and dispersed	Free	0.117
0	2	0	10	Minimal	High	None	$10	0.116
2	2	0	20	Excellent	High	None	$20	0.050
2	1	2	0	Excellent	Moderate	Numerous and dense	Free	0.038
1	1	0	10	Adequate	Moderate	None	$10	0.025
0	0	0	0	Minimal	Low	None	Free	0.000

APPENDIX C
WOODED PARK CLASSIFICATION BY REGIONS

Table C-1. Park classification by regions

NORTH FLORIDA	NORTH FLORIDA	CENTRAL FLORIDA
ALFRED B. MACLAY	BIG SHOALS	ANASTASIA
BALD POINT	BIG TALBOT ISLAND	BLUE SPRING
BIG LAGOON	CEDAR KEY	BULOW CREEK
BLACKWATER RIVER	CEDAR KEY SCRUB	BULOW PLANTATION RUINS
CAMP HELEN	CRYSTAL RIVER PRESERVE	CATFISH CREEK
DEER LAKE	DEVIL'S MILLHOPPER	DE LEON SPRINGS
ECONFINA RIVER	DUDLEY FARM	DUNN'S CREEK
FALLING WATERS	FANNING SPRINGS	FAVER-DYKES
FLORIDA CAVERNS	FORT CLINCH	FORT MOSE
GRAYTON BEACH	FORT COOPER	GAMBLE ROGERS
HENDERSON BEACH	FORT GEORGE ISLAND	HONTOON ISLAND
LAKE JACKSON MOUNDS	GOLD HEAD BRANCH	KISSIMMEE PRAIRIE
LAKE TALQUIN	HOMOSASSA SPRINGS	LAKE KISSIMMEE
LETCHWORTH MOUNDS	ICHETUCKNEE SPRINGS	LAKE LOUISA
OCHLOCKONEE RIVER	LITTLE TALBOT ISLAND	LOWER WEKIVA RIVER
PONCE DE LEON SPRINGS	MANATEE SPRINGS	NORTH PENINSULA
ROCKY BAYOU	MARJORIE KINNAN RAWLINGS	RAVINE
SAN MARCOS DE APALACHE	O'LENO	ROCK SPRINGS RUN
ST. ANDREWS	OLUSTEE BATTLEFIELD	SEBASTIAN INLET
ST. GEORGE ISLAND	PAYNES PRAIRIE	SILVER RIVER
ST. JOSEPH PENINSULA	PEACOCK SPRINGS	ST.SEBASTIAN RIVER
TARKILN BAYOU	RAINBOW SPRINGS	TOMOKA
THREE RIVERS	SAN FELASCO HAMMOCK	WASHINGTON OAKS
TOPSAIL HILL	STEPHEN FOSTER	WEKIWA SPRINGS
TORREYA	SUWANNEE RIVER	
WAKULLA SPRINGS	TROY SPRINGS	

Table C-1. Continued.

SOUTH FLORIDA	SOUTH FLORIDA
ALAFIA RIVER / CYTEC	PAYNES CREEK
ANCLOTE KEY	WERNER-BOYCE
AVALON	BAHIA HONDA
CALADESI ISLAND	CAPE FLORIDA
CAYO COSTA	CORAL REEF
COLLIER-SEMINOLE	CURRY HAMMOCK
DADE BATTLEFIELD	FORT PIERCE INLET
DON PEDRO ISLAND	FORT ZACHARY TAYLOR
EGMONT KEY	HUGH TAYLOR BIRCH
FAKAHATCHEE STRAND	INDIAN KEY
GASPARILLA ISLAND	JONATHAN DICKINSON
HIGHLANDS HAMMOCK	KEY LARGO HAMMOCK
HILLSBOROUGH RIVER	LLOYD BEACH
HONEYMOON ISLAND	LONG KEY
KORESHAN	MACARTHUR BEACH
LAKE JUNE	OLETA RIVER
LOVERS KEY	SAVANNAS
MADIRA BICKEL MOUND	SEABRANCH
MOUND KEY	ST. LUCIE INLET
MYAKKA RIVER	WINDLEY KEY FOSSIL REEF
OSCAR SCHERER	

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BIOGRAPHICAL SKETCH

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She began another Masters of Science program in food and resource economics in August, 2005. Frida plans to work for an international organization in development planning and poverty eradication in her home continent, Africa, after completing her M.S. degree requirements at the University of Florida.