ECONOMIC SECTORS AT RISK FROM INVASIVE AQUATIC WEEDS AT LAKE ISTOKPOGA, FLORIDA

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EXECUTIVE SUMMARY

Purpose

To Identify and Quantify Those Components of the Economy at Risk from Invasive Aquatic Weeds in Lake Istokpoga, Highlands County, Florida

The Economy

Highlands County, Florida is a relatively low per capita income county almost 30% below the State of Florida average. Highlands is heavily dependent on natural resources such as the land and water to provide economic growth and prosperity. The agricultural sector directly supports about one in every 7 jobs in the county while the various lakes attract visitors to the county. Highlands County already has one of the lowest percent of the population employed of any county in Florida. While part of this is due to retirees moving into the area, this county persistently suffers from a higher unemployment rate than the state and has been designated "an area of state concern" in terms of maintaining jobs and their growth. Lake Istokpoga in Highlands County which contributes to the economic activity in the area is now at risk from invasive aquatic weeds which threaten a variety of economic sectors (See below) in this county including its important agricultural sector in terms of a source of water for irrigation.

Components of the Economy at Risk From Invasive Aquatic Weeds

Approach to the Inquiry: Primary data to investigate the extent of Lake Istokpoga's risks to invasive aquatic weeds were gathered from an extensive quarterly survey of lake users from July 1, 2003 to June 30, 2004. In total, two-hundred surveys of residents of Highlands County and

those visiting Lake Istokpoga from outside the county were made per quarter for a total of 800 interviews during the year. Data were gathered and analyzed on spending, recreational activities, reaction to invasive aquatic weeds, and demographic characteristics of all users for the purpose of establishing the economic threat of invasive aquatic weeds. Using the creel survey conducted by the Florida Fish and Wildlife Conservation Commission (FWC) in conjunction with the on-site survey conducted as part of this study, it was estimated that 190,637 people used Lake Istokpoga over the last half of 2003 and the first half of 2004 of which 111,742 or about 59% came from outside Highlands County. The rest of these users are residents of Highlands County. With this background, the completion of this study allowed us to establish the economic magnitude of the sectors dependent on Lake Istokpoga as follows:

1.0 Visitors to Lake Istokpoga from Outside Highlands County: It was estimated that visitors from outside Highlands County to Lake Istokpoga directly spent $2.3 million while recreating at the lake which created $328 thousand in wages and about 27 jobs over the last 12 months (July, 2003-June, 2004). This created a multiplier effect on Highlands County of about 1.3 (i.e., $1.3 created for every $1 dollar injected by lake-tourists into the economy). Taking this into account, lake-tourists were responsible for about $3 million in spending; $410 thousand in wages and 32 jobs.

2.0 Residents of Highlands County Use of Lake Istokpoga: Residents of Highlands County are prolific users of Lake Istokpoga. The existence of this natural resource induces residents to use this lake rather than others in the area, thereby keeping the money they allocate to recreation in Highlands County. It is estimated that residents of Highlands County spent $1.22 million while

using Lake Istokpoga during the study period creating $135 thousand in wages and nearly 11 full and part time jobs. The total economic impact of visitors from outside Highlands County and local residents was to stimulate $4.23 million in sales; about $535.5 thousand dollars in wages and almost 43 jobs in the county when combining the two spending components.

3.0 Agricultural Support: Surface water withdrawn from Lake Istokpoga is used to irrigate crops such as citrus and sod farms and provide water for cattle and calves. Presently, there are 18 permits issued to agricultural interest to withdraw up to nearly 37 million gallons of water per day to be used in agriculture. It is estimated that this water supports over 6 thousand acres of agricultural production generating nearly $15 million of cash receipts from a variety of products ranging from citrus to sod farms.

4.0 Flood Control Benefits: Hydrilla and other invasive aquatic weeds may contribute to flooding by raising the water levels through blocking the natural flow of water. Using previous studies, it is estimated that about $4.5 million in flood damage could occur in one year due directly to the growth in high levels of hydrilla. Property and land are at great risk from flooding at even moderate levels if dense growths of hydrilla combine with heavy rainfall.

5.0 Property Values: Based upon previous research, it was estimated that there may be as many as 100 properties around Lake Istokpoga. A proper study of the exact number and kind is warranted given that the owners are directly at risk from hydrilla increases. At about $95,000 a house in Highlands County, the investment in property at risk may be around $95 million. Research in Alabama indicates that high incidence of hydrilla may lower property values from

17% for developed lots and 35% for ~~under~~developed properties which could easily apply to the properties around Lake Istokpoga. The technique of transferring results in one area to another or what is called "benefits transfer" is becoming well established in the economics literature. Using a conservative estimate of a decline of 10% in property values, we can see that increasing the incidence of hydrilla could result in $9.5 million in losses to property owners;

6.0 Recreational Values: The recreational value of Lake Istokpoga is considered a non-market activity since the water; fish and other amenities enjoyed by recreational users are common property. Thus, there is no direct charge measured in an organized market for recreation. By introducing the concept of the willingness to pay to preserve recreation (WTP), we are able to measure the dollar loss in recreational value if it is put at risk by invasive aquatic weeds. During the survey discussed above, we were able to establish the following opinion of users of Lake Istokpoga: (l) Over one-third of the county residents and almost 45% of visitors from outside Highlands County agreed that the current (2003-4) level of hydrilla (about 2,100 acres – 8% cover) was a serious problem to enjoying recreational activities around the lake; (2) a plurality of lake users felt that hydrilla was on the decline and (3) hydrilla places the users recreational value at risk. Residents (69%) and visitors from outside the county (64%) thought that they would lose a substantial amount of their recreational value derived from Lake Istokpoga. Due to recent large hydrilla management expenditures, the incidence of hydrilla has been on the decline and users are beginning to notice this change; however, they still feel that improper management and/ or no management of the hydrilla problem will put recreational values from Lake Istokpoga at risk. At present, we estimate that users of Lake Istokpoga derive $880 thousand annually in recreational value from the aquatic plant management program alone at the current level of hydrilla. This

means that the value of Lake Istokpoga as an asset is worth $29.3 million using a 3% discount rate and assuming the value derived from aquatic plant management is maintained by continued success in the hydrilla control program. The WTP is estimated at $4.62 per person day which is comparable to that found by Bell et al (1998) and Milon et al (1986) in three other lakes in Central Florida.

7.0 Water Management: We found that there was a statistically significant (i.e., 5% level) inverse relationship between the real spending (i.e., herbicide; labor; overhead and fringes) and HAS or hydrilla acres surveyed. Real spending puts all historical dollars in 2001 dollars over the 1988-2001 period for which observations were available. We found that hydrilla, although reduced, is very stubborn or resistant to the spending of real dollars on its control. A 10% increase in real spending on hydrilla decreased HAS by only 5%. Schardt (2004) has recently observed that hydrilla has become increasingly tolerant to fluridone herbicide to the point where up to three times the fluridone concentration that used to be effective controlling hydrilla now must be applied to Lake Istokpoga to achieve the level of hydrilla control in previous years. He has proposed that the level of water in Lake Istokpoga be lowered by as much as two feet below the existing water schedule, and reduce water discharge from the lake during the first few months of the year to increase the concentration and therefore the effectiveness of the fluridone herbicide. It is estimated by Schardt (2004) that nearly $750,000 in hydrilla control costs could have been saved during the 2003 fluridone herbicide treatment by lowering the water level and reducing water discharge during a 90-day fluridone treatment regime. In 2003 dollars, the average expenditure on controlling HAS was about $775,000 over the 1988-2003 period. If there were no side effects of the Schardt management proposal (e.g., flooding downstream as water is sent

through S-68), it would appear that the economic benefits discussed above would be net of all cost meaning that much of the control cost would be reduced by a lower water level while the economic benefits from agriculture to recreation would still accrue.

Recreational Participant and Profile of Users

Recreational Participation: For users of Lake Istokpoga from outside the County, the visit to this lake was not the main purpose of their trip. This was a secondary destination. Of all the users from outside the county, 57% engaged in boat fishing meaning the lake was much more diversified in term of recreational pursuits. Shore fishing and picnicking were also widespread forms of recreation. Nearly three quarters of tourists to Lake Istokpoga owned a boat used on the lake and derived one meal a week when fishing the lake. In contrast to tourists, the trip to Lake Istokpoga by residents of Highlands County was the primary destination (as expected) while only 50% engaged in boat fishing. About one-half of the resident users owned their own boat and about the same as tourists felt the lake provided them with about one meal a week when making a trip.

Socioeconomic Profile of Istokpoga Lake Users: Tourist users to Lake Istokpoga were about 44 years old and had a household income of $46,143. The individuals were predominantly white and African American. About half of the visitors from outside Highlands County were from out of state while the balance was from counties clustered around Highlands County. Most visitors from outside the county did not stay in hotels and motels (i.e., about 10%), but stayed at campgrounds, with relatives, or were day visitors. The demographics of residents of Highlands County were considerably older (48.1 years of age) which follows the demographics of the

county. More African Americans participated in fishing than their percentage in the Highlands County. The brief Executive Summary presented above is reduced to a numerical summary as follows:

A Numerical Summary
Of Present Dollars at Risk from Invasive Aquatic Weeds

Organized Market Related (Annual Values)

Visitors from Outside the County	----	$3.0 Million
Residents of Highlands County	----	$1.0 Million
Agricultural Support	----	$15.0 Million
Flood Control	----	$ 4.5 Million
Property Values	----	$15.0 Million
More Effective Hydrilla Control	----	.75 Million
Total Benefits	----	$39.25 Million

Non-market Related (Annual Values)

Recreational Value	----	$.88 Million

In summary, we have concluded that many facets of the economy are at risk from invasive aquatic weeds, especially hydrilla, which fall under (1) the organized market "effects" and (2) outdoor recreation based upon common property resources and values that are not traded in an organized market (i.e., non-market). Successful hydrilla management in Lake Istokpoga will sustain almost $40 million per year in numerous "market sales" and support about $.88 million in "non-market" recreational value, placing Lake Istokpoga as an asset at a minimum of $25 million. These enormous figures should be compared with costs of invasive aquatic weed control, and in developing strategies to accommodate hydrilla management.

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CHAPTER 1

Introduction

Invasive aquatic weeds cause serious environmental and economic problems in many regions of the United States and throughout the world. Florida's freshwater ecosystems were probably the first in the United States to experience invasions by alien vegetation. Today, the most severe problems in Florida's public waterways are caused by water lettuce and water hyacinth, two floating plants, and hydrilla, a submersed plant. These species can grow to densities that severely impair or prohibit navigation and recreational use of water bodies. There are other economic consequences of their infestations. Hydrilla tends to impair the normal flow of water leading to flood damage. Property values around a lake infested with exotic weeds are likely to fall as the weeds are regarded as a form of pollution. Water withdrawn from a lake is based upon gravitational hydrologic flows. If disrupted by hydrilla, this would negatively impact flood control as well as the agricultural sector's need for proper and optimal irrigation water supply. To minimize the effects of aquatic weed infestation, millions of dollars are spent each year by federal, state and local agencies to control aquatic weeds in Florida.

The literature on the economic impact of invasive aquatic weeds in Florida is very sparse indeed when asking about quantifying the economic damage of such foreign invaders. Such aquatic weeds place numerous economic sectors at risk. A study by Milon et al (1986) investigated aquatic weed control in Central Florida. More specifically, the authors investigated Orange and Lochloosa lakes in the counties of Alachua; Marion and Putnam, Florida. For purposes of their study, users of these lakes were restricted to recreational freshwater fishermen alone even though other economic sectors were most probably at risk (e.g., property values around the lake). Expressed in current or 2003 dollars, all anglers using Orange and Lochloosa

lakes spent $9.59 million per year as a measure of the economic activity associated directly with these lakes. About 56.7% of this total spending was made by anglers from outside the local area creating an injection of $5.44 million. This injection of spending by anglers from outside region creates additional multiplier effects not estimated by the authors. So, the total economic impact was greater than the $9.59 million given above. This distinction will become more apparent when we get to Chapter 3 dealing with Lake Istokpoga and Highlands County, Florida later in this report.

Anglers using Orange/Lochloosa Lakes were also surveyed to determine what was called "aquatic weed control valuation". Local angers (as opposed to those coming from outside the three county area) generally agreed that aquatic weeds are a serious problem (i.e., many economic sectors put at risk) in Florida lakes, but a majority-of both groups agreed that aquatic weeds are a serious problem when it comes to recreational fishing. As we shall argue later in this report, recreational users of a lake receive far more than what they pay for (i.e., market expenditures for goods and services to engage in recreation) in the form of recreational value. Such value is referred to by economists as *use value* and is a well established concept in economics profession. It is based upon the perception that lake resources (e.g., water and fish) are public resources similar to a beach in Miami or coral reef off the Florida Keys. Erosion of a beach or the destruction of coral reef is regarded as an economic loss, but how much? So too is the loss of the *quality* and *quantity* of a freshwater lake such as Orange/Lochloosa through hydrilla infestation. To get at the user value diminished by hydrilla in a lake, they asked lake users what they would be willing to pay for a higher level of hydrilla management. Of interest, the respondents were shown pictures of extremely bad hydrilla conditions in various parts of the lake compared to lesser impacted areas and then they were asked their willingness to pay for an

"improved level". To go from a highly infested lake with hydrilla and water hyacinth to one with slight traces of these exotic weeds, anglers were willing to pay about $24 per year expressed in 2003 dollars for a "weed stamp" per angler since the stamp would be affixed to each fishing license. Given about four trips to these lake per year, then the average willingness to pay would be about $6 per angler trip to reduce the incidence of hydrilla/water hyacinth to a relatively invasive exotic plant free lake. The reason that we have elaborated on the Milon et al (1986) procedure in estimating the willingness to pay for invasive aquatic weed reduction, is that we shall use a variation of this technique in our methodology applied to Lake Istokpoga in Highlands County in Chapter 3 dealing with the recreational impact of invasive aquatic weeds.

Bell et al (1998) prepared an evaluation of the economic impact of invasive aquatic weeds on Lake Tarpon located in Pinellas County, Florida. In terms of economic impact, visitors to Lake Tarpon from outside Pinellas County spent over $31 million expressed in 2003 dollars. This injection of money into the local economy was estimated to create a total of over $50 million when multiplier effects are considered and 614 related part and fulltime jobs (i.e., not estimated in the Milon et al study discussed above). Residents added about $7.7 million dollars in spending for total by both groups of near $58 million supporting over 700 jobs. As Milon et al (1986) established, nearly 50% of the users felt that aquatic weeds were a serious problem to enjoying the recreational experience on Lake Tarpon. Yet, Bell et al (1998) did find a certain insensitivity of users to the degree of invasive weed infestation when the build-up of this foreign species began. The pressure point for Lake Tarpon users was in their reaction to increasing weed infestation (i.e., no interference with boating) in terms of deserting the lake. A mild level of infestation would cause one in four users to abandon Lake Tarpon. The study did focus on the willingness to pay for additional funding to control invasive aquatic weeds. Expressed in 2003

dollars, lake users would be willing to pay nearly $26 per person yearly to reduce the incidence of invasive aquatic weeds in Lake Tarpon. The typical angler to Lake Tarpon spent about 5.5 days per year on this lake. Thus, the willingness to pay per person day would be very close to $5 which is comparable to the $6 per person day found by Milon et al (1986) in the study of invasive aquatic weeds for Orange/Lochloosa Lakes in North Central Florida. The historical literature on the economics of invasive aquatic weeds in Florida is indeed limited to a few studies by which to compare this recent study of Lake Istokpoga.

The purpose of this study is to establish the economic benefits accruing from Lake Istokpoga to various economic sectors in the Highlands County area when the incidence of invasive aquatic weeds, especially hydrilla is kept at a minimum. As we can see from the two earlier studies reviewed above, there is an economic impact on the local region measured in terms of sales, wages, and jobs as well as additional recreational benefits maintained for lake users when invasive aquatic plants are kept to a minimum. The earlier economic studies also draw attention to many economic benefits of aquatic weed control that are not included in such studies. For example, surface water is often withdrawn from a lake for irrigation of agricultural crops. If aquatic weeds impede this use (i.e., via reducing water storage capacity or impeding water delivery), there are likely to be adverse economic effects. Such weeds may also impede flood control where property damage may ensue from such plants. In addition, property surrounding the lake may depreciate with an invasion of exotic weeds which adversely impacts recreational and aesthetic use of the lake. Thus, we shall analyze a diversity of economic benefits from adequate invasive aquatic weed control, especially hydrilla control, using Lake Istokpoga in Highlands County, Florida as a laboratory. But, before we discuss the economic benefits from weed control, we must first look at the economic environment in which Lake Istokpoga exists.

This brings us to a brief economic profile of Highlands County, Florida to place the lake in the proper regional context.

CHAPTER 2

Economic Profile of Highlands County, Florida

Highlands County is located in South-central Florida. It is an inland county which contains several freshwater lakes such as Lake Istokpoga. Table 2.1 shows the growth in major economic indicators for Highlands County over the 1990-2001 period for which the latest data are available from the U.S. Department of Commerce (2003). The county's economic indicators are compared to the State of Florida as a whole. Over the 1990-2001 period, the population of Highlands County grew by nearly 29% which was somewhat faster than the State of Florida as a whole (i.e., 26.2%). Practically all of this increase in the Highlands County population came through in-migration from other counties in Florida and out of state. Of special note, *aggregate* personal income in Highlands County significantly lagged behind the growth for the State of Florida over the 1990-2001 period shown in Table 2.1. The interaction of income and population growth in Highlands County produces the change in per capita income which is a critical measure of the increase in the level of affluence in this area. Per capita income in Highlands County grew at about one-half the rate of that for the State of Florida over the 1990-2001 period (i.e., 26.1% versus 46.5%). In part, this is a reflection of the industrial base of the county which is concentrated in not only low wage jobs, but for which the demand is not expanding very rapidly. This is demonstrated in the bottom part of Table 2.1 which shows lower average earnings per job in Highlands County than the state average and growing at slower pace over the 1990-2001 period. For example, Highlands County is heavily concentrated in agriculture with orange production ranking 3rd in the State of Florida. The greatest use of land area in Highlands County comes from the cattle industry. Over 60% of the total 700,000 acres of land in the county is used for cattle grazing. Nearly one out of every five employees in the county is

Table 2.1
Population, Income, Per Capita Income, Jobs and Earnings Per Jobs in and Around Lake Istokpoga in Highlands County, Florida

	1990	2001	% Change	Rank of Highlands Among 67 Counties in Florida in 2001
Population Growth				
Highlands County	68,432	88,212	28.9	34
Florida	12,938,071	16,331,739	26.2	N/A
Aggregate Personal Income in $1000				
Highlands County ($) (Thous $)	1,139,979	1,861,058	63.3	35
Florida (Thous $)	258,479,049	467,188,758	80.7	N/A
Per Capita Income Growth				
Highlands County ($) ($)	16,465	20,746	26.1	35
Florida ($)	19,832	29,048	46.5	N/A
Wage & Salary Job Growth				
Highlands County	21,969	27,532	25.3	35
Florida	5,802,287	7,655,940	31.9	N/A
Average Earnings Per Job				
Highlands County($)	18,277	22,171	21.3	54
Florida ($)	22,879	32,643	42.7	N/A

Source: Regional Economic Information System, U.S. Bureau of Economic Analysis, CD Rom-2003.

directly employed in agriculture. Recently, there has been a gradual shift in Highlands County to health-related industries such as Palms of Sebring (assisted living) and tourism. As of 2001, there were nearly 1,900 hotel, motel and condominium rooms in the county. Sebring international raceway is the host for 12 hours of endurance racing every March. The race is attended by 110,000 people (Sebring Chamber of Commerce, 2001/2002). Each fall, a second race is featured which also draws visitors into the local community who need hotel/motel accommodations. Lake Istokpoga, located just south of Sebring, is internationally acclaimed as an excellent natural resource for large mouth bass fishing. This is how our report on the economic activity and the threat to such economic activity at Lake Istokpoga fits into the Highlands County economy.

Table 2.2 shows some revealing statistics about the Highlands County economy for 2001, the most recent year available. First, the unemployment rate is somewhat higher than the State of Florida average. This means that Highlands County is having a relatively more difficult time keeping people employed. A look at the unemployment rate over the last ten years in Highlands County reveals a significantly higher rate than the state average meaning that every job retained by this county is critical to its economy. In addition to a relatively high unemployment rate, the labor force participation rate is considerably lower than the state average. While nearly 74% of Floridians are employed or looking for a job (i.e., the sum of these two groups divided by population is the participation rate), only 57.3% of the residents of Highlands County are in this category. The fundamental reason for this economic phenomenon is to be found in the age structure of the county being, on average, 50 years of age. This average age for Highlands County is one of the highest to be found among Florida counties. We see in Table 2.2 that Highlands County is fifth in terms of median age in the State of Florida with only

Table 2.2
Socioeconomic Characteristics of Highlands County
Containing Lake Istokpoga, 2001

			Rank of Highlands County Among 67 Florida Counties
Recorded Unemployment Rate		%	
Highlands County		5.9	17
Florida		4.8	N/A
		%	
Labor Force Participation Rate			
Highlands County		57.3	49
Florida		73.9	N/A
Poverty Rate (% of Population)		%	
Highlands County		14.2	32
Florida		12.4	N/A
Median Age (Years)			
Highlands County		50	5
Florida		38.7	N/A
Ethnicity (%)	Highlands	Florida	
White	83.5	77.8	5
Nonwhite & Hispanics	16.5	22.2	N/A
% 65 year or Over	33.1	17.5	2
Elements of Per Capita Income			Difference
Per Capita Income $	20,746	29,048	-8,302
Per Capita Earn'g $	7,881	17,037	-9,156
Per Capita Trans $	6,209	4,483	1,726
Income Maint. $	344	316	28
Unemploy Ins $	41	64	-23
Retirement $	5,825	4,103	1,722
Per Capita Dividends, Interest & Rent $ Rent	6,657	7,526	-869
			-8,299

Source: Regional Economic Information System, U.S. Bureau of Economic Analysis, CD Rom-2003.

four other counties having an older age structure. In fact, this county has the highest percent of its white population 65 years and older of any county in Florida (i.e., 38%) This is a remarkable demographic characteristic in a state such as Florida which has one in five of its residents in this category (i.e., 20.5%). Thus, income from work is relatively low in Highlands County and reflects the age structure of in-migration discussed briefly above.

The bottom of Table 2.2 shows the elements of per capita income, our basic level of affluence in Highlands County, compared to the state average. The first column illustrates the critical components of the per capita income of residents of Highlands County which is $20,746 per year or $8,302 lower than the State of Florida. Why is there nearly a 40% differential (i.e., the state average is 40% higher than that revealed for Highlands County)? The fundamental reason is that the income from labor per person in Highlands County is $9,299 below that generated by the State of Florida reflecting two economic factors discussed above: (1) relatively low paying industries (e.g., agriculture) and (2) a relatively low participation rate. The latter is not necessarily adverse to a high per capita income since retirees may bring retirement benefits and capital transfers into the county without working. This is partially true for Highlands County where we see in Table 2.2 that retirement benefits per capita are $1,722 higher in this county when compared to the State of Florida average. Per capita dividends, interest and rent flowing into Highlands County is $869 per person below the state average meaning that retirees to Highlands County bring a relatively low bundle of assets such as stocks (i.e., dividends); bonds (i.e., interest) or property (i.e., rent) into the county when migrating there.

What does this all mean from the standpoint of evaluating Lake Istokpoga and the problem with invasive aquatic weeds? The recreational sector of the lake directly employs workers and produces a multiplier effect by the injection of tourist dollars into the local

economy. Agricultural withdrawal of water from Lake Istokpoga helps maintain this sector and the employees working there. A threat to Lake Istokpoga will have a potentially adverse impact on the already high relative unemployment rate. The expansion of eco-tourism through the use of Lake Istokpoga will contribute to more opportunities in the local economy, even drawing retirees out of retirement if they are skilled fishing guides for example. Excellent fishing may be associated with drawing in those migrants to become residents with a large portfolio of capital assets such as stocks, bonds and other property. Of interest, The Frontier, a regional development entity comprising De Soto, Highlands and Hardee Counties (as well as Glades, Henry and Okeechobee Counties) recently received funds from the State of Florida to promote nature-based and heritage tourism in the region. These counties were recently proclaimed an area of critical concern by Governor Bush. So, our short review shows a definite tie between Highlands County's economy and its health and the maintenance of its natural resources tied to economic growth. That is, Lake Istokpoga cannot be looked at in a vacuum, but must be evaluated in terms of successfully managing invasive aquatic weed control to protect those economic assets at risk! It is the documentation of Lake Istokpoga's assets at risk which is the subject matter of the rest of this report.

CHAPTER 3

Economic Impact of Lake Users on Highlands County

Number of Users by Quarter and Annually

At nearly 28,000 acres, Lake Istokpoga contains 60% of the public access lake surface area in Highlands County. Lake Istokpoga is one of the best fishing lakes in the state. Residents are avid anglers and others travel from all over Florida and the nation to fish Istokpoga. For example, in 2001-02, Highlands County had 9,258 registered boats which when placed on a per capita basis is twice the State of Florida average. Fortunately, there is a creel survey that is taken for Lake Istokpoga by the Florida Fish and Wildlife Commission (FWC). Florida FWC fishery biologists count the number of boat anglers per week day and weekends throughout a period such as a quarter. Although the technique is a little more complicated, it is primarily based on multiplying the estimated number of boat fishermen per day by the number of days in the period under consideration. This yields the number of angler days spent on the lake. The main purpose of the creel survey is to estimate the fishing pressure or harvest of fish from the existing stock to formulate fishing regulations that protect the stock from over fishing. The creel estimates of boat anglers do not take into consideration people fishing after 7:00PM. Also, they do not include those fishing from piers, docks or canals (i.e., shore fishermen). This omission would give the creel survey a somewhat downward bias since not all fishing is counted. We shall have some comments on this potential bias later in this report based upon our sampling of lake users discussed below. Obviously, the creel survey excludes those using Lake Istokpoga for other recreational purposes such as picnicking, camping, observing wildlife, etc. In the Bell et al (1994) and Bell (1998) studies of Lakes Jackson (i.e., near Tallahassee) and Tarpon (i.e., discussed in Chapter 1), picnicking and wildlife observation actually were the number one and

two forms of recreational use of the lakes followed by freshwater fishing. However, the creel data are immensely valuable not only for biological analysis, but as a base from which to estimate the universe of lake users. This study started in the third quarter (July-September) of 2003 and ended with the second quarter (April-June) of 2004. We were greatly aided by John Furse of the Florida FWC in supplying us with number of boat angler days by quarter over this period.

Table 3.1 shows the time sequence of quarters in the first three columns and the number of boat angler days in the fourth column. In one year, there were almost 102 thousand boat anglers using Lake Istokpoga. There was a sharp seasonal angler days peak in the first quarter of the year as shown in Table 3.1. Fishery biologists attribute this peak to the influx of "snowbirds" from out of state seeking to get out of the cold weather from northern states and to fish Lake Istokpoga. Another important factor is that the winter and early spring are times that crappie and bass are spawning, so the chance of catching more and bigger fish is enhanced. From a hydrilla standpoint, winter is also the time when hydrilla is less of a problem (i.e., colder weather slows down growth of hydrilla, algae associated with hydrilla dies back, wind and wave action from the north breaks up hydrilla mats that formed at the water surface, and finally higher water levels allow easier passage over the top of this invasive weed). However, higher water levels require more of the herbicide used to manage hydrilla, not only increasing costs but also jeopardizing the ability to control hydrilla as we shall see in Chapter 8.

The breakdown of angler days by residents is also important to the economic impact of Lake Istokpoga. The reason for this is that those living outside Highlands County pump money into the local economy that has a multiplier effect throughout the area. So, where do the boat anglers

Table 3.1
Estimation of the Number of Boat Anglers; Total Users and Visitors
Using Lake Istokpoga, Highlands County, Florida
by Quarters from 3rd 2003 to 2nd 2004

Quarter	Months	Year	Number of Boat Anglers*	% Boat Anglers of All Users**	Estimated Number of Total Users***	Percent Visitors from Out-Side Highlands County**	Visitors to Highlands County	Percent of Total Users by Quarter-Seasonal Pattern
Third	July-Sept	2003	10,861	49.50%	21,954	58.50%	12,847	11.52%
Fourth	Oct-Dec	2003	24,175	65.50%	36,909	54.00%	19,930	19.36%
First	Jan-Mar	2004	43,060	64.50%	66,760	54.50%	36,385	35.02%
Second	Apr-June	2004	23,405	36.00%	65,014	65.50%	42,580	34.10%
	Total		101,501	53.24%	190,637	58.62%	111,742	100.00%

* Creel Survey Conducted by Florida Fish and Wildlife Conservation Commission
** Sample Survey Conducted by Florida State University under Contract to Florida Department of Environmental Protection.
*** Number of Boat Anglers Divided by Percent of all Users Boat Fishing.

come from? Notice that we refer to the creel survey results in terms of boat-related anglers since such estimates do not include recreational fishermen from shore area which we shall discuss in this chapter. The annual breakdown of the boat anglers was obtained from the Florida FWC as follows:

Residence of Boat Angler Days	**Days**	**Percent of Total**
1. Highlands County	35,438	34.9%
2. Non-Highlands County	66,063	65.1%
3. Florida (except Highlands)	30,803	30.4%
4. Out of State	35,260	34.7%
5. Total (1 + 2)	101,501	100.0%

As far as boat anglers are concerned, about two out of every three fishermen days come from outside Highlands County. Thus, Lake Istokpoga is a force attracting "tourists" to the area as opposed to being used mainly as a recreational resource for local residents. About one out of every two tourists to Lake Istokpoga comes from outside of the State of Florida. This is indicative of a wide market area for the lake.

Our interest in Lake Istokpoga is maintaining its recreational value that might be threatened or at risk by a high incidence of invasive aquatic weeds, especially hydrilla. Therefore, we launched our own survey of lake users in the third quarter of 2003 with the objective of evaluating the economic threat of hydrilla and other aquatic weeds on the economics of this lake. The objective was to obtain a random sample of 200 interviews of all lake users per quarter over a year. Note that interviews included all recreational users of the lake, and not just fishermen. Referring to Table 3.1 again, we see that our independent survey revealed that boat users only and/or boat users pursuing fishing and other forms of outdoor recreation constituted

only 53% of all lake users. Some users of the lake came just for shore fishing while other only to have a picnic. Others came for an array of activities on the same day. This is consistent with the studies of Lakes Jackson and Tarpon discussed above (i.e., there are more recreational activities at a lake than just boat fishing). When adding in other users of Lake Istokpoga, we estimate that in Table 3.1 (i.e., column 6), nearly 191,637 outdoor recreational days were spent at this lake during the July, 2003 to June, 2004 period (Table 3.1, column six). The details on the forms of other kinds of outdoor recreation are discussed later in this chapter. It is of interest that nearly 59% of all users of Lake Istokpoga were from outside Highlands County and numbered 111,742 person days as shown in Table 3.1. When users other than just those pursuing boat fishing are added in to form all users, the seasonal pattern of use changes somewhat as shown by the last column of Table 3.1. The peak attendance quarter is still the first quarter of the year as shown by the last column of Table 3.1, but this is very closely followed by the second quarter of the year under study. The reason for this change is that non-fishing boat users of the lake rose significantly as Highlands County entered the spring of the year. This could be a bit of a statistical aberration since we are dealing with a one-time sample taken for only one year.

Table 3.2 shows the results of sample survey discussed above. This table is divided into residents and non-residents of Highlands County. Lake Istokpoga Park; public boat ramps; Mallards Fish Resort; Henderson's Fish Camp and Trails End Resort were used as interview sites. About 71% of the interviews were made on week days (i.e., five days) while the balance were made on weekends. Although there is some variability from quarter to quarter, it appears that nearly 5.8 out of 10 users interviewed were from outside of Highlands County. This is less than the 6.5 of 10 boat users found by the creel survey indicating that those not engaged in boat use tend to be from the local area. This is reasonable since one might expect local residents to

Table 3.2
Distribution of Sample Survey of User of Lake Istokpoga
Over the July, 2003 to June, 2004 Period

User Group	Quarter 3 (July-Sep)	Quarter 4 (Oct-Dec)	Quarter 1 (Jan-Mar)	Quarter 2 (Apr-June)	Annual Total	Percent of Total (Annual)
Highland County Residents	83	92	91	69	335	41.90%
Non-Residents of Highlands County	117	108	109	131	465	58.10%
From Florida	55	68	56	52	231	28.88%
Outside of Florida	62	40	53	79	234	29.25%
Total Sampled	200	200	200	200	800	100.00%

Source: Survey of Lake Istokpoga by Florida State University

engage in picnicking and wildlife watching at a local area than those coming for the fishing experience. In the survey sample, non-residents equally balance between those living in Florida and those from out of state. More will be said about this later in this chapter when we deal with the demographics of the lake users. The sample survey instrument is shown in Appendix A.1 of this report.

Economic Impact of Lake Istokpoga As Measured by Sales, Wages, and Employment

The most well known economic indicators to the general pubic are sales, wages, and employment produced in an area. Natural resources have historically been very important in expanding sales and employment from the coal mines of Kentucky to the sugarcane fields of South Florida. For Highlands County, we have already addressed the elements of its economic base including the heavy dependence on agriculture, especially oranges and cattle. We now address Lake Istokpoga as a component of this county's economic base. Unlike agriculture, up to this point, no one kept statistics on sales generated by Lake Istokpoga. Detailed economic data on lakes is as important as sales from farms in Florida. As pests are to agriculture, hydrilla is to outdoor recreation at various lakes throughout Florida! Using our survey instrument in Appendix A, we asked various questions that would enable us to quantify the magnitude of the economic contribution of Lake Istokpoga to Highlands County to balance this against the cost of controlling invasive aquatic weeds in Lake Istokpoga. This analysis is shown for the third quarter of 2003.

Tables 3.3 through 3.6 show the economic impact expressed in sales, wages and employment of the direct spending of "tourists" or those coming from outside of Highlands County. Let us consider Table 3.3 for the 3rd quarter of 2003. At the top of the table we show all visitor days multiplied by the percent of those days spent by all users (i.e., residents plus non-

Table 3.3
Estimation of the Direct Economic Impact of Out of County Visitors to Lake Istokpoga, Highlands County, Florida

	3rd Quarter, 2003 All People Attending Lake Istokpoga (Annual)	Percent of Annual Attend. In Quarter (Seasonal)	Percent of All Attendees Visitors from Outside County	=	Estimated Quarterly Visitors to Lake (Days)
Non-Resident Visitors to Istokpoga	190,637	11.52%	58.50%		12,847

Percent of Visitors from Outside County by Accommodation Mode & Other Statistics	Sample Size	Percent by Accom	Visitor Days by Accom	Party Size	Length of of Stay
Hotels and Motels	12	10%	1,285	2.1	2.7
Friends and Family	39	33%	4,240	2.1	2.7
Camping	30	26%	3,340	2.9	3
Day Trip Only	36	31%	3,983	3	1
Total	117	1	12,847		

Estimated Spending Per Party and Day by Accommodation Mode	$EPPD (Daily Spending Per Party)	$EPPED (Daily Spending Per Person
Hotel and Motels	$103.34	$49.21
Friends and Family	$38.19	$18.19
Camping	$52.16	$17.99
Day Visitors	$35.98	$11.99

Estimated Spending, Wages and Employment	Spending	Wages	Employment
Hotel and Motels	$63,221.49	$9,427.63	3.33
Friends and Family	$77,100.97	$8,977.31	2.83
Camping	$60,079.80	$8,861.87	3.03
Day Visitors	$47,765.81	$6,949.12	2.08
Total	$248,168.07	$34,215.93	11.27

Source: Table 3.1 and Survey by Florida State University

Table 3.4
Estimation of the Direct Economic Impact of Out of County Visitors to Lake Istokpoga, Highlands County, Florida

	4th Quarter, 2003 All People Attending Lake Istokpoga (Annual)	Percent of Annual Attend. In Quarter (Seasonal)	Percent of All Attendees Visitors from Outside County	=	Estimated Quarterly Visitors to Lake (Days)
Non-Resident Visitors to Istokpoga	190,637	19.36%	54.00%		19,930

Percent of Visitors from Outside County by Accommodation Mode & Other Statistics	Sample Size	Percent by Accom	Visitors by Accom	Party Size	Length of Stay
Hotels and Motels	11	10%	1,993	3.1	3
Friends and Family	34	31%	6,178	3.7	2.8
Camping	37	34%	6,776	3.5	3.4
Day Trip Only	26	25%	4,983	2.6	1
Total	108	100%	19,930		

Estimated Spending Per Party and Day by Accommodation Mode	$EPPD (Daily Spending Per Party)	$EPPED (Daily Spending Per Person
Hotel and Motels	$104.26	$33.63
Friends and Family	$33.75	$9.12
Camping	$79.49	$22.71
Day Visitors	$36.51	$14.04

Estimated Spending, Wages and Employment	Spending	Wages	Employment
Hotel and Motels	$67,029.09	$9,915.97	3.57
Friends and Family	$56,353.38	$5,676.69	1.71
Camping	$153,892.64	$21,757.82	7.57
Day Visitors	$69,972.82	$8,447.22	2.62
Total	$347,247.93	$45,797.70	15.47

Source: Table 3.1 and Survey by Florida State University

Table 3.5
Estimation of the Direct Economic Impact of Out of County Visitors to Lake Istokpoga, Highlands County, Florida

	1st Quarter, 2004 All People Attending Lake Istokpoga (Annual)	Percent of Annual Attend. In Quarter (Seasonal)	Percent of All Attendees Visitors from Outside County	=	Estimated Quarterly Visitors to Lake
Non-Resident Visitors to Istokpoga	190,637	35.02%	54.50%		36,385

Percent of Visitors from Outside County by Accommodation Mode & Other Statistics	Sample Size	Percent by Accom	Visitors by Accom	Party Size	Length of Stay
Hotels and Motels	11	10%	3,638	2	3.3
Friends and Family	33	30%	10,915	2.6	3.2
Camping	44	40%	14,554	3.1	3.7
Day Trip Only	21	20%	7,277	2.6	1
Total	109	100%	36,385		

Estimated Spending by Party and Day by Accommodation Mode	$EPPD (Daily Spending Per Party)	$EPPED (Daily Spending Per Person
Hotel and Motels	$109.18	$54.59
Friends and Family	$54.83	$21.09
Camping	$69.49	$22.42
Day Visitors	$47.37	$18.22

Estimated Spending, Wages and Employment	Spending	Wages	Employment
Hotel and Motels	$198,624.55	$32,161.27	11.31
Friends and Family	$230,189.76	$26,026.00	8.31
Camping	$326,242.43	$44,276.64	15.12
Day Visitors	$132,580.57	$17,660.06	5.59
Total	$887,637.31	$120,123.97	40.33

Source: Table 3.1 and Survey by Florida State University

Table 3.6
Estimation of the Direct Economic Impact of Out of County Visitors to Lake Istokpoga, Highlands County, Florida

	2nd Quarter, 2004 All People Attending Lake Istokpoga (Annual)	Percent of Annual Attend. In Quarter (Seasonal)	Percent of All Attendees Visitors from Outside County	=	Estimated Quarterly Visitors to Lake
Non-Resident Visitors to Istokpoga	190,637	34.10%	65.50%		42,580

Percent of Visitors from Outside County by Accommodation Mode & Other Statistics	Sample Size	Percent by Accom	Visitors by Accom	Party Size	Length of Stay
Hotels and Motels	15	11%	4,876	3.3	2.9
Friends and Family	42	32%	13,652	3.9	3.1
Camping	44	34%	14,302	3.9	3.4
Day Trip Only	30	23%	9,751	4.2	1
Total	131	1	42,580		

Estimated Spending Per Party and Individuals by Accommodation Mode	$EPPD (Daily Spending Per Party)	$EPPED (Daily Spending Per Person
Hotel and Motels	$124.39	$37.69
Friends and Family	$55.48	$14.23
Camping	$87.30	$22.38
Day Visitors	$59.96	$14.28

Estimated Spending, Wages and Employment	Spending	Wages	Employment
Hotel and Motels	$183,778.36	$29,584.42	10.19
Friends and Family	$194,201.56	$27,713.72	8.35
Camping	$320,135.54	$48,310.84	16.15
Day Visitors	$139,208.31	$22,247.36	6.53
Total	$837,323.77	$127,856.34	41.22

Source: Table 3.1 and Survey by Florida State University

residents) for the year in that quarter and then multiplied by the percent of all users that live outside Highlands County. In the 3rd quarter of 2003, 12,847 non-resident days were spent at Lake Istokpoga as shown in Table 3.3. Note that this is the same number shown in the second to last column of Table 3.1. So far, we have not used the survey data collected by interviews at Lake Istokpoga. But, next we used our survey data to see how these days were distributed by what is called the accommodation mode. If visitors to Lake Istokpoga are coming from outside the county, they either stay in the county or are what we call "day visitors" from another area. For example, of the 117 parties interviewed from outside of Highlands County, 10% stayed in a hotel/motel during the 3rd quarter of 2003. The rest of the out-of-county users of the lake stayed with friends and family, camped, or were day visitors. Staying with friends and family in Highlands County was the most popular accommodation mode for the 3rd quarter of 2003. All non-resident county days were distributed among the accommodation modes based upon sample size. Such small samples may have considerable statistical variability so the reader is warned to view sample sizes under 30 with caution. We also included the average party size and length of stay in the area. As we shall see below, the typical "tourist" to Lake Istokpoga said he or she came to the area as part of a multi-destination trip. Also, we have gathered data on the total number of user days on the lake which would include those users coming for more than one day. So, the length of stay does not enter into our calculations of the economic impact, but is provided for other marketing purposes. In the center of Table 3.3, we have $EPPD which is the total expenditures per party day at Lake Istokpoga. This is derived by asking the survey respondent what the party as a group spent for lodgings, restaurants, grocery stores, guides, bait and other sundry expenditures which are discussed in great detail below. Note that the average party staying in a hotel/motel in Highlands County spent $103.34 per day shown in Table 3.3.

Dividing this by a party size of 2.1 persons yields an expenditure of $49.21 per person day or $EPPED. When multiplied by the number of person days or 1,285, we have expenditures by out-of-county Lake Istokpoga users in the 3rd quarter of 2003 staying in motels/hotels of a little over $63,221. This would be of particular use to the hotel and motel industry in the area. Following this procedure for all four accommodation modes (i.e., we realize that day visitors do not have accommodations, but they are listed as a residual category), we estimate that "tourists" to Highlands County attracted by Lake Istokpoga contribute almost a quarter of a million dollars in spending directly injected into the local area in what economists sometimes call "the first round of spending". The reader should be aware that we are not dealing with resident spending related to the lake at all. This will be discussed later.

Although sales or spending by those from outside Highlands County may be of interest, we are most interested in the wages and jobs that this spending creates when the spending takes place for example from a motel or a local pub. To make such estimates, we consulted the 1997 Economic Census for Highlands County published by the U.S. Department of Commerce on its website (2004, http://www.census.gov/epcd). For each industry in Highlands County, we have from this source the sales, wages paid, and employees for each category upon which visitors from outside the county spent their approximately $248,168 in the 3rd quarter of 2003. From this source, we can obtain the sales generated per employee and the wages as a percent of total spending by spending category. Thus, total sales by category (not shown here, but later in this chapter) divided by the sales/employee ratio yields an estimate of total employment for the 3rd quarter of 2003. Since we are dealing with 1997 dollars in the Census of Business, all dollar values are updated to 2003 using the consumer price index. Wages are estimated by multiplying the percent wages are of sales for any spending category based upon information from the 1997

Census of Business discussed above. According to Table 3.3, the slightly less than a quarter of a million dollars in spending generated about $34,216 in wages and 11.27 full and part time jobs. A fraction of a job may be regarded as a part time job. Let us see if this makes any sense. If we divide wages created by the employment created, we get $3,036 per worker for the 3rd quarter of 2003. If the worker is employed in all four quarters, then his or her annual salary is $12,144. From Table 2.1 in Chapter 2, we see that the average earnings per job in Highlands County paid $22,171. Thus, workers employed in industries servicing visitors to Lake Istokpoga for the 3rd quarter of 2003 are paid but 55% of the average for the county. Why is this true? First, the tourist sector has a complex of industries that are relatively low skilled like cleaning rooms or serving dinner. This low skill mix contributes to lower wages than the average which includes every skill from medical practice to selling hot dogs. Second, the tourist sector has a high seasonal component as we discussed in reference to Table 2.1 in Chapter 2. Thus, the lake-based industry by its very nature has a lot of part time work even during peaks in the season when a few extra people are hired part time to fill the gap created by the surge in demand. In the off-season, employers like to spread job opportunities around and offer a lot of part time employment with few fringe benefits. This is the second reason behind the relatively low wages paid in the "tourist industry" catering to those from outside the county using Lake Istokpoga for outdoor recreation.

Table 3.4 is a replication of the model developed in Table 3.3 (and discussed above) for the 4th quarter of 2003. Note that at the top of Table 3.3 we estimate 19,930 user days, a 55% jump over the user days for Lake Istokpoga in the 3rd quarter of the year. Although expenditure per party ($EPPD) day was comparable to that in the 3rd quarter, the size of the party was generally higher (e.g., hotel/motel was 2.1 versus 3.1 when 3rd is compared to 4th quarter), thereby lowering expenditures per person day for the 4th quarter. Still, the jump in users

increased spending to over $347 thousand for the 4th quarter compared to about $248 million for the 3rd quarter, a 40% increase. Wages created by this increase in spending from the 3rd to the 4th quarter rose from about $34 thousand to $46 thousand, a 28% increase. Finally, employment related to Lake Istokpoga jumped from 11.27 employees in the 3rd quarter to 15.47 employees in the 4th quarter, a 37% increase. One reason that wages and employment do not increase at the same rate as sales or expenditures is a shift in the composition of spending. A shift toward more capital-intensive goods such as gasoline and marine slips compared to restaurants would explain this effect. This is likely to be a random event depending on quarter to quarter changes in buying.

As discussed earlier, the 1st quarter of the year is most likely to be the peak of the season for a variety of reasons such as large fish and minimized effect of hydrilla. According to Furse (2004, personal communication), the "snowbird effect" is likely to be predominant. In Table 3.5, we see that 36,385 user days were spent at Lake Istokpoga in the 1st quarter of 2004. This represents an 82.6% increase over the 4th quarter of 2003. Expenditures by Istokpoga lake users escalated 156%, reinforcing a strong seasonal effect. The increase was due to the combined effects of more visitors from outside the county coupled with a substantial rise in expenditures per day for those using hotels and motels, staying with friends and family, and day visitors as shown when comparing Table 3.4 with Table 3.5. Wages paid as a result of this spending rose from about $46 thousand in the 4th quarter of 2003 to $120 thousand from those paid in the 1st quarter of 2004; a 160% jump. Such wages supported a rise in employment from 15.47 in the 4th quarter of 2003 to 40.33 employees in 1st quarter of 2004 or about 160%. The seasonal swings in economic activity associated with Lake Istokpoga are certainly very pronounced, especially between the last quarter of the year and the first quarter of the following year.

Even though the 1st quarter of each year seems to be the peak measured by boat fishing days, it is not for all users which includes shore fishing, picnicking, and nature observations to mention a few activities which will be reviewed in detail later in this chapter. By the 2nd quarter of 2004, all user days reached a four quarter peak of 42,580, 17% above the 1st quarter of 2004. This is shown in Table 3.6. A comparison of spending per person day revealed a fall from the "Snowbird" quarter of the year (i.e., 1st quarter of 2004). This was mostly due to a rise in party size. It should be pointed out that party size can vary from quarter to quarter on a rather random basis or as a result of sample variability. From the 1st quarter of 2004 to the 2nd quarter of 2004, spending by lake tourists from outside the county actually fell from about $888 thousand to $837 thousand, a 5.5% decline. Despite the rise in the number of person days, it was offset by a decline in spending per person day resulting in a softening in economic expansion in the 2nd quarter of 2004. Thus, measured by spending, the 1st quarter of the year studied still remained the seasonal peak. Wages increased by 5.5% while employment edged up by 2.2%. Again, these changes are the direct result of a shift in the percent of goods that are capital as compared to labor intensive goods. In this case, there was a shift to more labor-intensive goods.

Tables 3.3-3.6 can be consolidated into a quarterly economic profile and an annual summary. Further, we said that we collected data on expenditure categories and this can be included in the summary table. Consider Table 3.7 is the summary of the direct economic impact over the July, 2003 – June, 2004 period of study. We use the word direct since this is the initial injection of dollars by visitors to Lake Istokpoga that live outside the county. This is a segment of the tourist sector in Highlands County, and as was shown above, the sector that rents hotels and camping grounds in which to stay. Many such visitors stay with friends and family while a large segment comes just for the day. Table 3.7 summarizes some of the data presented in early

Table 3.7
All Visitors from Outside County
Estimation of Spending; Employment and Wages
Related to Lake Istokpoga, 3rd Quarter, 2003 to the
2nd Quarter, 2004

	2003		2004		Annual
Time Period	3rd	4th	1st	2nd	
Number of Visitors	12,847	19,930	36,385	42,580	111,742
Size of Party	2.6	3.5	2.7	3.9	3.175
Spending Per Party/ Day	$47.80	$57.27	$64.86	$75.47	$61.35
Spending Per Person/ Day	$18.38	$16.36	$24.02	$19.35	$19.53
Aggregate Spending by Visitors Outside Highlands	$248,168	$347,248	$887,637	$837,324	$2,320,377
Lodging	$52,044	$81,189	$206,158	$182,004	$521,395
Food & Beverages	63,027	92,718	225,754	203,885	$585,384
Marinas	21,637	14,348	44,908	133,892	214,785
Bait	39,562	55,911	185,232	117,673	398,378
Gas	53,183	77,979	165,171	138,326	434,659
Shopping	15,728	19,924	48,972	46,722	131,346
All Other	2,973	5,263	11,354	14,840	34,430
Wages Created by Spending	$34,216	$45,798	$120,124	$127,857	$327,995
Employment Created by Spending	11.27	15.47	40.33	41.22	27.08

Source: Table 3.3-Table3.6; Spreadsheets for Expenses

tables and allows the reader to see statistics such as party size, spending per party day, and spending per person day for all tourists using Lake Istokpoga. Spending per person was highest in the 1st quarter of 2004 where the so-called "Snowbird Effect" is so prevalent. Under the aggregate spending, we show estimates of how much is spent on each item while on a tourist's visit. There were seven categories on our survey instrument (See Appendix A), including some items that are unique to the lake such as marina rentals and bait. Over the four quarter period, tourists to Lake Istokpoga spent $2.32 million after entering Highlands County. Looking at the annual expenditures by category, over $585 thousand was spend on food and beverages followed closely by over $521 thousand on lodgings. Restaurants, grocery stores, and hotels/motels are, of course, classic tourist based industries in communities throughout Florida. These establishments accounted for nearly 48% of all spending related to tourist visits to Lake Istokpoga. Marinas and bait shops also dominated the spending with $215 thousand and $398 thousand spent respectively on an annual basis. These industries are, of course, unique to lakes and occupy slightly over 26% of all spending during the year. The second leading category of spending in the neighborhood of nearly $400 thousand was on gasoline getting from home and to the recreational site. While in Highlands County, lake tourists also did miscellaneous shopping at local stores of over $131 thousand per year as shown in Table 3.7. Finally, miscellaneous spending of $34.43 thousand was less than 2% of total spending. This is a good indicator since it means that we have accounted for about 98% of the spending by well-defined and understood categories.

The direct tourist spending to Lake Istokpoga created, on average, over 27 full and part time jobs during the year supported by wages of $327,995 or about $12,112 per year. The relatively low annual wages per employee in the lake's tourist sector was discussed above as to

be a function of the relatively low skilled demand in these industries coupled by their part time nature. But, as we clearly saw in our economic profile of Highlands County, a "job" is a precious commodity. Governor Bush declared the area in which Highlands County is located an area of critical state concern (See Florida Trends, 2004). In this case, there is a clash between the economy and threats to the environment in the sense that invasive aquatic weeds such as hydrilla do not contribute to job creation, but act as a deterrent to the viability of Lake Istokpoga and the economic activity it supports. This is fairly transparent, but it is sometimes argued that the environment is an obstacle to economic growth. Meyer (1992) in his study of economic growth and the environment finds that the U.S. record of the past two decades (1973-1989) clearly and unambiguously refutes that there is a trade-off between the environment and the economy. As we shall discuss below, the reduction in invasive aquatic weeds will actually enhance economic growth and or prevent economic decline. That is, being effective lake managers (e.g., successfully controlling hydrilla) will greatly contribute to the economy as shown in this report.

Table 3.8 takes the elements of direct expenditures by tourists to Lake Istokpoga and translates them into the total economic impact. As money is spent on hotels and motels or restaurants by visitors to Highlands County, it is re-spent by both the businesses (e.g., purchases of other goods in the community) receiving the money and their employees. This goes on through successive rounds, but at each round some business or worker buys something from outside Highlands County. A simple purchase from QVC or order for farm machinery by orange growers produced outside Highlands County creates what we call "leakage" in each round of spending. Finally, the injection of dollars runs its course. But, in this economic process, more and more jobs and wages are created than the initial impact of the spending. This is called the "multiplier process". Each industry has its own multiplier since the magnitude of the leakage

Table 3.8
Direct and Indirect Economic Impact on Highlands of Lake Istokpoga, July, 2003- June, 2004

Category of Spending	Direct Spending* (Annual)	SAM Multiplier**	Total Spending (Annual)
Lodging	$521,395	1.331	$697,997
Food & Beverages	585,384	1.285	752,218
Marinas	214,785	1.357	291,464
Bait	398,378	1.357	540,599
Gasoline	434,659	1.215	528,111
Shopping	131,346	1.2	157,615
Other	34,430	1.2	41,316
Total	$2,320,377	1.297	$3,009,320
	Employment Multiplier		
Employment Created First Spending Round	27.08	1.16	31.41
	Wages Multiplier		
Wages Created in First Spending Round	$327,995	1.25	$409,994
	$327,995	1.25	$409,994

* See Table 3.7
**Includes direct, indirect and induced effects

starts at different points depending on the nature of the industry. Generally, the more diversified the community, the higher the multiplier since goods and services are more likely to be bought locally (e.g., a town with 100 people is less likely to have a funeral home than one with 10,000 people). Highlands County is not highly diversified so the multiplier for tourist spending is not expected to be high. These are well established principles of economic behavior.

The first column of Table 3.8 shows the direct spending by those individuals coming from outside Highlands County of slightly over $2.32 million for the 12 months under study. As discussed above, this spending multiplies throughout the county. We purchased the IMPLAN model to give us multipliers derived in Highlands County. They are in the second column of numbers in Table 3.6. Note that the multipliers are relatively small (i.e., multipliers in more diversified areas would be higher) with the average being 1.297. As the reader can see, the impact of this kind of spending adds a little under $700,000 for a total impact of slightly over $3 million on the local community. We have used the employment and wages multipliers from IMPLAN to derive nearly 32 jobs created with a payroll of nearly $410 thousand dollars or $13,053 per job yearly.

The presence of Lake Istokpoga allows local residents to use this important natural resource. If this resource were not available in Highlands County, one could make the argument that residents might go to other counties to enjoy outdoor recreation. This would represent a loss to Highlands County as more money would “leak out” of the local community. This is one reason why we interviewed local residents; to see how much they add to the local economy by using resources available in Highlands County. Consider Table 3.9. The number of residents is shown by quarter and number to be almost 79,000 person days. Thus, about 41.4% of all users of

Table 3.9
All Resident Quarters Table
Estimation of Spending by Highland County Residents
Related to Lake Istokpoga, 3rd Quarter, 2003 to the
2nd Quarter, 2004

	2003		2004		Annual
Time Period	3rd	4th	1st	2nd	
Number of Residents	9,107	16,979	30,375	22,434	78,895
Size of Party	2.6	2.9	2.7	3.7	3
Spending Per Party/ Day	$32.71	$48.79	$42.20	$57.07	$45.19
Spending Per Person/ Day	$12.58	$16.82	$15.63	$15.42	$15.11
Aggregate Spending by Residents	$114,573	$285,657	$474,653	$346,029	$1,220,912
Lodging	0	0	0	0	0
Food & Beverages	$46,341	$106,382	$185,400	$108,714	$446,837
Marinas	6,865	8,255	11,138	4,487	30,745
Bait	13,661	31,616	71,775	38,562	155,614
Gas	34,572	94,497	136,238	110,836	376,143
Shopping	10,088	30,270	49,725	30,559	120,642
All Other	3,047	14,637	20,363	52,872	90,931
Wages Created by Spending	$13,503	$31,200	$52,998	$35,846	$133,547
Employment Created by Spending	4.41	10.14	17.42	11.36	10.84

Source: Table 3.1 and Spreadsheets on Spending

Lake Istokpoga are from Highlands County. This creates about $1.22 million in spending and supports $133.5 million in wages and nearly 11 jobs.

Thus, we have the economic impact of both the visitors from outside Highlands County and those living in this county by adding Tables 3.8 and 3.9 as follows:

Economic Impact at Risk from Invasive Aquatic Weeds

Category	Direct	Indirect	Total
Tourist from Outside			
Highlands County	$2,320,377	$688,943	$3,009,320
Residents	$1,220,914	0	$1,220,914
Total Sales	$3,541,291	$688,914	$4,230,235
Total Employment	37.92	4.33	42.25
Wages	$461,542	$81,999	$543,541

What kind of economic impact is "at risk" due to invasive aquatic weeds. Later, we shall try to quantify how the incidence of aquatic weed infestation might impact recreation and spending in the community. Given the premise that invasive aquatic weeds such as hydrilla will deter users from Lake Istokpoga, what kind of economic impact is at risk in Highlands County? Our estimate is that at present, Lake Istokpoga is responsible for approximately $4.23 million dollars in retail sales; over 42 jobs supported by approximately $.543 million in wages. In terms of employment and wages, Lake Istokpoga accounts for only .15% of employment and .08% of wages generated by the entire economy.

Recreational Characteristics of Users of Lake Istokpoga

In our survey work discussed above, we were also interested in the characteristics of those people using Lake Istokpoga. This is very important in marketing the lake to both people

inside and outside Highlands County. It also outlines the demographics of those users that are at risk from the infestation of the lake by hydrilla and other invasive weeds. Consider Table 3.10 which summarizes some characteristics of those using the lake who live outside Highlands County. Tourists to the lake combine their trip with other activities which is very typical of people visiting areas for more than one day. Only 41.9% of the visitors from outside Highlands County make Istokpoga their primary destination. And, remember these visitors pump money directly and indirectly into the local economy as discussed above. Combined with invasive aquatic weeds, this puts visits to the lake at a great risk since most visitors can either divert to other lakes and/or activities. In the 1st quarter of 2004, only about a third of the visitors from outside Highlands County made Lake Istokpoga as their "primary destination". The possibility of substitution of lake sites and/or other activities is very high for Lake Istokpoga making it at risk from rising hydrilla and other invasive aquatic weeds.

What do users from outside Highlands County do at Lake Istokpoga? The immediate answer might be that they fish, but our findings indicate that is not exactly the whole tale. As part of our interview, we asked those recreating at Lake Istokpoga about the kind of recreational activities engaged in. Such activities could be one dimensional (e.g., I only fish from a boat) or multi-dimensional (e.g., I went fishing and then went camping in the afternoon). So, we gave an individual user the possibilities of doing a multitude of things at the lake or just one activity. Bell (1990) has shown that Lake Jackson outside Tallahassee, although known for its great bass fishing, attracted many people who only did picnicking while at the lake. Table 3.10 shows the results of our survey of lake users from outside Highlands County by quarter and also has an annual summary. We were particularly interested in boat fishing since this is the sole basis for

Table 3.10
Recreational Participation by Visitors from Outside Highlands County to Lake Istokpoga from 3rd Quarter, 2003 to the 4th Quarter, 2004

Time Period	2003 3rd	2003 4th	2004 1st	2004 2nd	Annual Average
Purpose of Trip to Lake (%)					
Primarily to Visit Lake	45.3	41.7	37.6	42.7	41.85%
Lake Combined with Another Destination	54.7	58.3	62.4	57.3	58.18%
Kinds of Recreational Activities Participated in at Lake	Sample	Sample	Sample	Sample	Annual
Boat Fishing					
(1) Boat Fishing Only	10	12	13	12	47
(2) Boat Fishing and Camping Only	16	15	22	9	62
(3) Boat Fishing and Pinicking Only	27	17	33	19	96
(4) Boat Fishing & All Other	5	36	17	2	60
Shore Fishing					
(1) Shore Fishing Only	1	4	1	15	21
(2) Shore Fishing & Any Other Activity	8	6	7	39	60
Camping Only	2	1	3	1	7
Picnicking Only	7	7	13	9	36
Sightseeing Only	6	6	0	0	12
Other Forms of Recreation Other Than Above	35	4	0	25	64
Total Sample	117	108	109	131	465
Percent Participating in Boat Fishing Only or In Conjunction with Any Other Activity	49.6	74.1	78	32.1	57.00%
Own a Boat Used on Lake (%)					
Yes	77.8	73.1	78	71	74.97%
No	22.2	26.9	22	29	25.03%
How Many Meals Do You Expect to Come from Fish Caught on This Trip (Average for All Sample)	1	1	1.1	0.9	1
Size of Party	2.6	3.5	2.7	3.9	3.2
Length of Stay on Trip	4.6	4.5	4.5	4.6	4.6

Source: Department of Economics, Florida State University

the creel survey which emphasizes, quite properly, fishing. Surprisingly, of the 465 people surveyed from outside Highlands County, for example, during the year, only 47 or 10% said they only came to the boat fish! Of course, as can be seen from Table 3.10, many came to Lake Istokpoga to boat fish and engage in other recreational activities. On an annual basis and from quarter to quarter this was also surprising. Only 57% of all users were either solely or partially involved in boat fishing. 17.4% of the lake users stated that they were either solely or partially involved in shore fishing which is not covered by the creel survey. About 28% of the users were involved in picnicking and other activities. This tells us that there are multiple recreational interests at Lake Istokpoga based upon our survey. These many recreational interests attract visitors from outside Highlands County. Almost three quarters of these visitors owned their own boat that was used at the lake. There was also more than just recreation involved at Lake Istokpoga as anglers relied on their fishing to provide one meal a week. This is often overlooked in fishing. This primary recreation does afford individuals a food supply and, in some cases, can be a substantial augmentation of one's food supply. We call this "subsistence fishing". The average party to the lake was 3.2 individuals spending 4.6 days while in the area. We did not pursue what was done while staying in the area and only counted the day the party was interviewed.

In Table 3.11, we have the same conceptual categories shown in Table 3.10, but the former is for residents of Highlands County. As might be expected, almost 93 percent of residents said Lake Istokpoga was their primary destination. Since all the days were day trips, this is hardly surprising. But again, recreational activities were diverse for residents. Less than 50% of those responding engaged in boat fishing and/or boat fishing plus other recreational activities. Nearly 25% were involved in shore fishing and/or shore fishing plus other recreational

Table 3.11
Recreational Participation by Residents of Highlands County to Lake Istokpoga from 3rd Quarter, 2003 to 2nd Quarter, 2004

Time Period	2003 3rd	2003 4th	2004 1st	2004 2nd	Annual Average
Purpose of Trip to Lake (%)					
Primarily to Visit Lake	85.5	95.7	89	92.8	90.80%
Lake Combined with Another Destination	14.5	4.3	11	7.2	9.20%
Kinds of Recreational Activities Participated in at Lake	Sample	Sample	Sample	Sample	Annual
Boat Fishing					
(1) Boat Fishing Only	26	23	25	17	91
(2) Boat Fishing and Camping Only	0	0	0	0	0
(3) Boat Fishing and Pinicking Only	14	24	18	12	68
(4) Boat Fishing & All Other	1	4	0	1	6
Shore Fishing					
(1) Shore Fishing Only	14	11	15	19	59
(2) Shore Fishing & Any Other Activity	2	10	13	13	38
Camping Only	0	0	1	0	1
Picnicking Only	9	5	18	7	39
Sightseeing Only	15	10	1	0	26
Other Forms of Recreation	2	5	0	0	7
Total Sample	83	92	91	69	335
Percent Participating in Boat Fishing Only or In Conjunction with Any Other Activity	49.4	55.4	48.4	43.5	49.18%
Own a Boat Used on Lake (%)					
Yes	50.6	53.3	53.8	52.2	52.48%
No	49.4	46.7	46.2	47.8	47.52%
How Many Meals Do You Expect to Come from Fish Caught on This Trip (Average for All Sample)	1.1	1.2	1	1	1.1
Size of Party	2.6	2.9	2.7	3.9	3

Source: Department of Economics, Florida State University

activities. It should be pointed out that all categories in Table 3.11 are discrete. Any overlapping has been purposely removed. For example, those involved in shore fishing do not include boat fishing shown just above. About one-third of the resident users participated in picnicking alone or in conjunction with other activities (e.g., boat fishing). Slightly more than one-half of the resident users owned their own boat used on Lake Istokpoga. This is down considerably from that observed in Table 3.10 for visitors from outside Highlands County. Residents obtained a little more than one meal a week from the lake which is not unexpected. We would expect that subsistence fishing would be more for residents since the cost of getting to the lake is much lower. Residents had slightly smaller parties than that shown by those coming from outside the county.

Socioeconomic Characteristics of Lake Users

The socioeconomic characteristics of the user population of Lake Istokpoga are important since they may determine, in part, how at risk they are to invasive aquatic weeds and their will to pressure governments for more expenditures on weed control where they recreate. Table 3.12 shows a socioeconomic profile of users of Lake Istokpoga that are from outside Highlands County. The median age of visitors from outside Highlands County to the lake was 44.6 years old. As shown in Chapter 2, Florida as a whole has an average age of 38.7 years, but attracts visitors that are much older. According to 2002 Florida Visit Study (Visit Florida, 2003), the average age of adult travelers to Florida in 2002 was 45.1 years. Although the age structure of visitors to Highlands County is similar to other tourists, median household income of Istokpoga visitors is $44,681 compared to $64,600 for out of state visitors to Florida (Visit Florida, 2003). Some of this difference may be associated with the fact that Lake Istokpoga attracts people from neighboring counties in Florida. Freshwater recreational fishing is usually inversely related to

Table 3.12
Demographic and Descriptive Statistics of Recreational Users from Outside Highlands County of Lake Istokpoga
3rd Quarter, 2003 to 2nd Quarter, 2004

Time Period	2003 3rd	2003 4th	2004 1st	2004 2nd	Annual Quarterly Average
Characteristics					
Interviews	117	108	109	131	117
Average Age	47.3	42.9	44	44.3	44.6
Medium Household Income	$43,736	$42,550	$46,296	$46,143	$44,681
Ethnicity (%)					
White	79.5	79.6	81.7	90.8	82.9
African American	17.9	17.6	16.5	9.2	15.3
Hispanic	0.9	1.9	0.9	0	0.9
Asian & Other	1.7	0.9	0.9	0	0.9
Point of Origin (%)					
Florida	47	63	62	40	53
Georgia	6	7	6	18	9
South Carolina	5	6	5	2	5
New York	5	4	8	12	7
Ohio	5	4	5	5	5
North Carolina	4	2	3	2	3
Alabama	4	0	1	0	1
Wisconsin	4	3	0	0	2
Illinois	4	5	0	5	4
All Other	16	6	19	16	11
County of Origin from Inside Florida(%)					
Polk	20	20	13	18	18
Lake	11	2	6	0	5
Hardee	11	30	19	20	20
Okeechobee	10	7	11	8	9
Desoto	10	13	0	16	10
All Other	38	28	51	38	38
Average Miles Live from Lake	37	35	29	20.3	30.3
Mode of Travel to Lake (%)					
Auto	90.8	100	93.5	93.5	94.5
Bus	6.1	0	2.8	3.5	3.1
Other	3.1	0	3.7	3	2.4
Accommodations(%)					
Hotel/Motel	10.3	10.2	10.1	11.5	10.5
Campgrounds	25.6	34.3	40.4	33.6	33.5
Friends & Family	33.3	31.5	30.3	32.1	31.8
Day Trip Only	30.8	24.1	19.3	22.9	24.2

Source: Survey by Florida State University, 2003-2004

income as people switch to saltwater fishing and more exotic forms of recreation as their income rises.

The ethnicity is predominantly “white”, but “African American” shows a strong second place at over 15% of the adult users of Lake Istokpoga as shown in Table 3.12. Bell (1978) has shown that with all things remaining the same except ethnicity, African Americans have a higher per capita consumption of fish. This may have its roots in subsistence fishing brought on by a lower per capita income for African Americans than Caucasians. Lake Istokpoga attracts about 53% of the out-of-county guests from Florida counties and the balance from out-of-state such as Georgia, South Carolina, and New York as shown in Table 3.12. Within Florida, residents from Polk and Hardee Counties account for about 38% of in-state visitors to Istokpoga in Highlands County. It would appear that this lake has an out of state following (i.e., the so-called “Snowbird Effect” discussed in Chapter 2) as well as neighboring counties. The in-state counties appear to be clustered around Highlands County. On average, visitors to Lake Istokpoga live or stay a little over 30 miles from the lake. Even though you may live in New York, the usual answer to this question would be the distance from a motel or hotel. So, users of Lake Istokpoga have not traveled too far when they arrive at the lake as indicated by Table 3.12. This conclusion is reinforced by the mode of travel which is 94.5% by private or rented auto. As the reader may remember, we divided visitors in the early part of this chapter by mode of accommodation. This is the usual procedure for the analyses of tourism since industries such as hotel/motel and campground can be differentiated from staying with friends and family and one day trips. One out of ten visitors from outside Highlands County to Lake Istokpoga stayed in a hotel/motel. In terms of accommodating guests to the lake, about one-third stayed at campgrounds while about the same number stayed with friends and family. About one in four tourists to Highlands County

who visited Lake Istokpoga was a day visitor who came from a neighboring county. In terms of tourism to the lake, they are individuals who are more elderly who receive a relatively low median family income compared to the average visitor to Florida. These visitors are more likely to be African-American who select campground as an accommodation mode rather than the typical tourist to Florida who stays with family, friends, or in a hotel/motel.

Finally, Table 3.13 shows the economic profile of residents of Highlands County using Lake Istokpoga. The average age of residents is 46.4 years of age which is about the same as Highlands County's general population. Median household income of those using the lake is much higher ($41,476) than those median household incomes in Highlands County. It would appear that the relatively more affluent individuals in Highlands County are attracted to Lake Istokpoga. The ethnic composition of users of the lake is very close to that observed in Highlands County (e.g., 79.2% white in the sample compared to 83.5% in Table 2.2, Chapter 2). The typical user of the lake has lived in Florida for 19 years and in Highlands County for nearly 15 years which is typical for older people that have moved into the county as retirees. As opposed to tourists to the lake, residents, as expected, only travel a little over 7 miles to Lake Istokpoga from their home which is about 25% of the distance traveled by tourists.

Table 3.13
Demographic and Descriptive Statistics of Recreational Users from Highlands County (Residents) Who Used Lake Istokpoga from 3rd Quarter, 2003 to 4th Quarter,2004

Time Period	2003 3rd	2003 4th	2004 1st	2004 2nd	Annual Quarterly Average
Characteristics					
Interviews	83	92	91	69	84
Average Age	43.9	46.6	47	48.1	46.4
Median Household Income	$34,183	$38,984	$36,152	$56,583	$41,476
Ethnicity (%)					
White	86.7	71.7	80.2	78.3	79.2
African American	9.6	22.8	17.6	20.3	17.6
Hispanic	3	5.4	2.2	1.4	3.2
Asian & Other	0	0	0	0	0
Years Live in Florida	17.2	19.9	18.1	20.8	19
Years Lived in Highlands County	12.6	16.1	14.2	16.1	14.8
Average Miles Lived from Lake	7.2	10.2	7.1	4.5	7.3

Source: Survey by Florida State University, 2003-2004

CHAPTER 4

Recreational Benefits at Risk from Invasive Aquatic Weeds

The Concept of Use Value and Application to Lake Istokpoga

In the last chapter, we estimate what is called the economic impact of tourists and resident spending while recreating at Lake Istokpoga. We went through a thorough review of the kinds of recreation engaged in while at the lake from boat fishing to sightseeing. In addition to the economic impact, there is a second kind of economic value which is at risk at Lake Istokpoga. Unfortunately, this kind of value is not well understood outside the economics profession, but is actually just as, if not more critical than what we called the "economic impact" in Chapter 3. The latter (i.e., economic impact) allows us to get to the lake (e.g., gasoline spending); stay near the lake (e.g., hotels and motels spending) and facilitates our use of the lake (e.g., bait, guides and marinas spending), but there is no charge for the use of the lake. Lakes, like beaches, coral reefs, and fish are common property resources. Thus, there is no charge for the use of these resources, yet the user derives "value" from the use of a beach, a reef and, of course, a lake. This is called "use value" meaning that there is value that can be expressed in money terms per day at the lake as it is being used for recreation. This use value is recognized by all U.S. government agencies and is part of the Principles and Standards of water management. For example, the U.S. Army Corps of Engineers will not contribute to the nourishing of a beach unless they know the use value created by these efforts which cost considerable sums of money. If one damages a coral reef, courts will award damages based upon the use value of the reef lost to general public. If an oil tanker truck accidentally spilled oil into Lake Istokpoga, the owner of the truck would be sued by the State of Florida for the use value lost plus clean-up cost. Thus, invasive aquatic weeds put use value at risk in the same manner as a polluter such as the oil

tanker truck example given above. Use value cannot be measured by market forces since there is no overt owner that could charge one a fee to fish (i.e., fishing licenses are small or negligible per day and are not set by market forces) in the lake or engage in picnicking or swimming. Yet, government agencies spend large sums of money to protect these common property natural resources since they yield large amounts of use value to the general public.

The usual method employed to measure use value is what economist call "willingness to pay". In our sample of 800 users of Lake Istokpoga, we asked people what annual fee they would be willing to pay to use the lake for recreation. The fee would cover everyone in their party and all times during the year they used the lake. (See Appendix A: Survey Instruments, Question 28). The money collected would be used to manage (e.g., law enforcement, maintenance of public facilities, water quality testing) the lake including invasive aquatic weed management. We found that the use value or willingness to pay for Lake Istokpoga was about $32 per year. We feel that this a very conservative estimate since it would cover a party for all the visits made during the year. As long as the one recreating went with the person paying the fee on every day of the year they recreated, they would be covered. In economics, we call the person as a member of the party that is not subject to the fee a "free rider" or someone that receives value, but does not pay a fee for such value. This question was asked to both tourists and residents so it represents the weighted response of both groups. One would have to purchase a Lake Istokpoga user license to implement the revenue collection. The time constraints of the survey instrument precluded asking everyone in the party whether they would purchase a right to use the lake since many parties had people of varying ages (e.g., small children, etc) and those using their own boats on occasion. The typical party for both tourists and residents to the county was approximately 3 people including a lower number of 1.8 for just boat anglers. Eliminating persons recreating free

with one party but heading up a party where they own a boat, we feel that size of the party should not be any larger than 1.3. The time and money constraints on surveying precluded us from doing an intensive analysis of age structure and activities done alone or with other people that would not pay anything to recreate at the lake. Thus, payment of $32 per year would probably be somewhat in the neighborhood of $25 per person annually ($32/1.3). This not only seems reasonable, but certainly within the confines of someone having an annual household income of about $42,000 as discussed under Demographics in the last chapter. The typical boat angler (tourists and residents) spends about 3.65 days at Lake Istokpoga per year according to the Florida FWC (i.e., personal communication with Furse, 2004). Other users such as those that picnic or go for sightseeing are likely to be less ardent than the typical angler, visiting the lake, on average, about 3 times per year. Thus, we estimate that the use value per day for Lake Istokpoga to be about $8.33 per person day ($25/3). Note that this is the willingness to pay for all government services needed (i.e., not just invasive aquatic weed management) to provide total use value per day. Note that these are only approximate numbers since a thorough study of use value alone would swamp the resources we had available for this work. In our review of the literature in Chapter 2, we found the willingness to pay per day for just aquatic weed control was less than our $8-$9 derived here for all services render to the lake. This is as expected since the government not only has the responsibility for aquatic weed control, but other activities such as law enforcement and maintenance of public facilities. We shall focus on weed control below in terms of what part of the $8.33 per day would users be willing to pay just for invasive aquatic weed control.

What is the use value generated by Lake Istokpoga on an annual basis? In Table 3.1, we estimated that there were 190,637 person days spent in the process of recreation on Lake

Istokpoga. Using our user day estimate for total recreational value of $8.33, there would be an annual flow of $1.588 million per year. Assuming no increase in the number of users per year, this is an annual flow into a large number of years (e.g., infinity) given that the lake is maintained and preserved, meaning, in part, that there is a vigorous program to prevent the spread of invasive aquatic weeds. Using a real (i.e., adjusted for inflation) discount rate to deflate future flows back to the present of 3%, the asset value of Lake Istokpoga is conservatively estimated at nearly $53 million. Thus, a $53 million asset in the form of a lake in Highlands County is at risk when invasive aquatic weeds are considered a threat to the value of this asset. More pointedly, invasive aquatic weeds allegedly erode and destroy the recreational experience which has an estimated user value to the public as discussed above. But, what evidence do we have regarding this statement. This is the subject matter of the next section.

The Public View of Invasive Aquatic Weeds

In the interview of 800 users of Lake Istokpoga, we wished to establish a firm foundation for the allegation that invasive aquatic weeds are a serous problem to enjoying recreational opportunities around Lake Istokpoga. Unless the public is firmly convinced of the role of such weeds in their recreational experience, they would not be willing to pay to have such weeds eradicated. We have shown in the previous section that for all public services including control of invasive aquatic weeds to maintain the lake assets that the public is willing to pay an annual fee.

Our interest is to get some qualitative information on just how strong the users of Lake Istokpoga are in agreeing hydrilla/water lettuce are a serious problem. One must be aware that we are asking this question in a year when hydrilla infestation is fourth lowest in the last 16

years. Therefore, this could characterize the answers received by the public both as to the severity of the invasive aquatic weed problem and their willingness to pay for weed control. The timing of the survey (i.e., during a low point in the hydrilla cycle) may have an unknown influence. Consider Table 4.1.

In response to the question on how serous the hydrilla/water lettuce is to recreational opportunities at Lake Istokpoga, we have shown the answers for each quarter we sampled plus the annual average. Of note, less than 2% of the lake users including both residents and visitors from outside Highlands County "strongly agreed" that aquatic weeds were presently a serious problem. We feel this is a direct result of the ongoing campaign to control hydrilla. However, nearly 42% "agreed" that aquatic weeds were still a problem to enjoying recreation on Lake Istokpoga. A little over 24% of the users "disagreed" that aquatic weeds were a serious problem to enjoying recreational opportunities on the lake while less than 5% strongly disagreed. Nearly one out of every four users simply had no opinion or did not know. Visitors from outside Highlands County seemed more sensitive to the present conditions of invasive aquatic weeds than residents. For tourists, the trip is longer and more important in terms of time and money. So, out-of-county visitors may be much more sensitive to aquatic weed infestations than residents where the recreational experience to the lake is a less prominent event in terms of time and money as documented by our study in Chapter 3. Based upon this study and Bell et al (1998), it would appear that many of those using a lake for recreation are relatively insensitive to low or even medium levels of hydrilla prevalence. Also, some anglers subscribe to the thesis that hydrilla is a food or shelter for bass and enhances the size of the fish. They also feel that bass and other species are easier to catch when aggregating around a mass of hydrilla. There appears to be

Table 4.1
Perception of Invasive Aquatic Weed Being a Problem to Enjoying Recreational Opportunities on Lake Istokpoga by Various Users, 2003-2004

QUESTION ASKED--- If we say that invasive aquatic weeds such as hydrilla/water lettuce are a serious problem to enjoying recreational opportunity around Lake Istokpoga would you	Quarter 3 July-Sept 2003	Quarter 4 Oct-Dec 2003	Quarter 1 Jan-Mar 2004	Quarter 2 Apr-June 2004	Annual Average
	(Percent of Each Group Answering from Five Alternatives)				
1. Strongly Agree (All Users)	4.00%	0.00%	1.50%	1.50%	1.75%
Residents of Highlands County	6.00%	0.00%	0.00%	0.00%	1.50%
Visitors to Highlands County	2.60%	0%	1%	2.30%	1.45%
2. Agree (All Users)	41.50%	40.00%	41.50%	43.00%	41.50%
Residents of Highlands County	36.10%	37.00%	37.00%	40.60%	37.68%
Visitors to Highlands County	45.30%	42.60%	46.80%	44.30%	44.75%
3. Disagree (All Users)	19.00%	29.50%	24.50%	23.50%	24.13%
Residents of Highland County	20.50%	42.40%	42.40%	26.10%	32.85%
Visitors to Highlands County	17.90%	18.50%	21.10%	22.10%	19.90%
4. Strongly Disagree (All Users)	4.50%	5.00%	3.50%	4.50%	4.38%
Residents of Highlands County	1.20%	1.10%	1.10%	1.40%	1.20%
Visitors to Highlands County	6.80%	8.30%	4.60%	6.10%	6.45%
5. Don't Know/No Answer (All Users)	31.00%	25.50%	23.00%	27.50%	26.75%
Residents of Highlands County	36.10%	19.60%	19.60%	31.90%	26.80%
Visitors to Highlands County	27.40%	30.60%	26.60%	25.20%	27.45%

Note: Sample size for all users was 200 interviews per quarter

Source: Department of Economics, Florida State University.

a lack of controlled experiments to test these hypotheses, but whether true or not, may explain a rather bland reaction to certain levels of hydrilla. At high levels, hydrilla will make navigation difficult if not impossible for boats equipped with propellers.

Since the money spent on hydrilla control recently has been larger than the historical average, we wished to know whether Lake Istokpoga users had noticed much change in hydrilla over the last 3-4 years (i.e., $3.6 million dollars has been spent on hydrilla control over 2000-2003 period which is 25% above the historical average expenditure). The results are shown in Table 4.2. Less than 2% of residents and those from outside Highlands County felt that hydrilla concentration was getting higher. Just under 32% of the users felt that the level of hydrilla was "about the same" over the last 3-4 years. According to the Bureau of Invasive Aquatic Plant Management of the Florida Department of Environmental Protection (Ludlow, personal correspondence, 2003), hydrilla acres surveyed (HAS) has dropped in Lake Istokpoga from 19,386 in 2000 to 2,111 in 2003, a 90% decline. Of course, much of hydrilla is beneath the water surface where one would have to be a boat rider and/or angler to encounter. Many use Lake Istokpoga as a camping and or picnic grounds so the surface of the water may appear different than from the three dimensional look where both surface area and vertical water volume is considered. To the credit of the recent hydrilla program, nearly 40% of all users felt that hydrilla concentration was getting "smaller" over the last 3-4 years. The residents of Highlands County (50%) were more convinced of the efficacy of the hydrilla reduction program than the visitors from outside the county (32.3%). Still, over one in four users did not know or had no answer to our question. Although not a universal response, it would appear that the plurality of users were well aware that hydrilla had been reduced over the last 3-4 years.

Table 4.2
Temporal Sensitivity of Users of Lake Istokpoga to Government Actions to Control Invasive Aquatic Weeds As of 2003-04

QUESTION ASKED -- Over the last few years(3-4), have you noticed that invasive aquatic weeds as they cover the lake's surface are getting?	Quarter 3 July-Sept 2003	Quarter 4 Oct-Dec 2003	Quarter 1 Jan-Mar 2004	Quarter 2 Apr-June 2004	Annual Average
	(Percent from Each Group Answering from Four Alternatives)				
1.Larger (All Users)	1.00%	1.50%	1.00%	1.00%	1.11%
Residents of Highlands County	2.40%	3.30%	2.20%	1.40%	2.78%
Visitors to Highlands County	0%	0%	0%	0.80%	0.20%
2.About the Same (All Users)	27.00%	35.50%	30.50%	32.50%	31.38%
Residents of Highlands County	38.60%	42.40%	39.60%	34.80%	38.85%
Visitors to Highlands County	18.80%	29.60%	22.90%	31.30%	25.65%
3. Smaller (All Users)	35.50%	43.00%	40.00%	39.00%	39.38%
Residents of Highland County	51.80%	46.70%	48.40%	53.30%	50.05%
Visitors to Highlands County	23.90%	39.80%	33.00%	32.10%	32.20%
4. Don't Know/No Answer (All Users)	36.50%	20.00%	29.00%	27.50%	28.25%
Residents of Highlands County	7.20%	19.60%	19.60%	11.60%	14.50%
Visitors to Highlands County	57.30%	30.60%	44.10%	35.90%	41.98%

Note: Sample size for all users is 200 interviews per quarter

Source: Department of Economics, Florida State University.

Finally, we wished to know how users of Lake Istokpoga would react if "no funds were available and hydrilla rapidly covered the lake". What, if anything, would these users do and how do they perceive they would be impacted? This posed a possible threat to their use of Lake Istokpoga for recreation. We felt that people or users might react more strongly and reveal their true feeling if the threat of massive amount of hydrilla covering Lake Istokpoga was perceived. Consider the results in Table 4.3. We have shown the results for the four quarters of the sample and the annual summary. Consider the annual summary. How would the users REACT? Nearly 50% of all users would flee to another lake if funds were cut back to the point where hydrilla covered the lake. Visitors were more apt to substitute another lake than residents which is understandable due to the large number of freshwater lakes in Southeast Florida and even in Highlands County. We did not say anything about funds for hydrilla control at other lakes in the area. Nearly one in four users would contact their state representative to restore such funds. Users showed a high propensity to pressure state and local representatives to restore such cuts in funding if it approached the point where hydrilla covered the lake. Only a little over 8% of all the users said they would use the Save Lake Istokpoga Association to address the decline in funding. This may be due to the lack of familiarity with this organization. An organization is likely to be politically more effective than an array of individuals. Finally, nearly 43% of all users would talk to others, but basically do nothing in the face of such cutbacks.

Such a cutback in funding would apparently have an impact on users of Lake Istokpoga as shown at the bottom of Table 4.3. We gave the respondent a number of alternatives including "no impact", but overwhelmingly the user respondents felt there would be a "substantial loss in recreational value". In fact, over 68% of the residents of Highlands County felt that they would lose a substantial amount of recreational value while over 63% of the visitors from outside of the

Table 4.3
Reaction and Impact on Users of Lake Istokpoga if No Funds Were Available for Aquatic Weed Control
2003-2004

QUESTION	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Annual
Due to a $2 million campaign to control hydrilla over the last few years, this weed covers less than 10% of Lake Istokpoga. If no funds were available and hydrilla rapidly covered the entire lake, how would you	July-Sept	Oct-Dec	Jan-Mar	Apr=June	
	(Percent of User Group Indicating How They Would React/ Be Impacted - Multiple Responses Accepted in Survey)				
REACT					
All Users					
Go to Another Lake	47.00%	50.00%	51.00%	49.50%	49.38%
Contact State Representative	21.50%	26.50%	22.50%	26.50%	24.25%
Contact Local Representative	17.50%	26.00%	18.00%	24.50%	21.50%
Join Save Lake Istokpoga Association	5.50%	11.00%	8.50%	8.50%	8.38%
Talk to Others/Do Nothing/No Reaction	30.00%	44.50%	49.00%	46.50%	42.50%
Residents					
Go to Another Lake	39.80%	48.90%	41.80%	37.70%	42.05%
Contact State Representative	26.50%	28.30%	28.60%	29.00%	28.10%
Contact Local Representative	22.90%	29.30%	28.60%	27.50%	27.08%
Join Save Lake Istokpoga Association	6.00%	18.50%	13.20%	14.50%	13.05%
Talk to Others/Do Nothing/No Reaction	37.30%	55.40%	50.60%	55.00%	49.58%
Visitors					
Go to Another Lake	52.10%	50.90%	58.70%	55.70%	54.35%
Contact State Representative	17.90%	25.00%	17.40%	25.20%	21.38%
Contact Local Representative	13.70%	23.10%	9.20%	22.90%	17.23%
Join Save Lake Istokpoga Association	5.10%	4.60%	4.60%	5.30%	4.90%
Talk to Others/Do Nothing/No Reaction	24.80%	33.50%	46.70%	41.20%	36.55%
IMPACT					
All Users					
Lose A Substantial Recreational Value	60.00%	72.50%	64.50%	64.00%	65.25%
Lose Use of Recreational Equipment	69.00%	67.00%	57.00%	62.00%	63.80%
Lose An Importance Source of Food	18.00%	28.50%	19.00%	35.00%	25.13%
No Impact	15.00%	7.50%	14.00%	10.50%	11.75%
Residents					
Lose A Substantial Recreational Value	63.60%	78.30%	64.80%	66.70%	68.35%
Lose Use of Recreational Equipment	81.80%	63.00%	64.80%	53.60%	65.80%
Lose An Importance Source of Food	20.00%	34.50%	28.60%	65.20%	37.08%
No Impact	21.00%	0.00%	0.00%	0.00%	5.35%
Visitors					
Lose A Substantial Recreational Value	59.00%	67.60%	64.20%	62.60%	63.35%
Lose Use of Recreational Equipment	77.80%	70.40%	50.50%	66.40%	66.28%
Lose An Importance Source of Food	16.20%	23.10%	11.00%	35.00%	21.33%
No Impact	25.60%	13.90%	25.70%	16.00%	20.30%

Note: 200 Interviews of all groups made per quarter.
Source: Department of Economics, Florida State University

county felt the same way. When these users talk about recreational value it is obvious that they are talking about "use value" since they will retain the money they would have spent on Lake Istokpoga to spend on something else. This, we believe, supports our well grounded theory that use value not only exists, but is possibly the dominant factor in the recreational experience (i.e., the measure in dollar terms what users obtain from a natural resource). Also, those losing use value claimed they would lose the use of recreational equipment running from boats to rods and reels. This would not only apply to durable goods like boats, but would have an adverse "economic impact" for the kinds of variable expenses spent on Lake Istokpoga (i.e., bait, guides, lodgings). Remember, we did not include spending on such durable goods in our survey since they are so variable over time. A full economic impact analyses would include, of course, such items. Of interest, nearly one in four users of the lake claimed that a rise in hydrilla coverage to the entire lake would produce a loss in food. As indicated in Chapter 3, fishermen get about one meal a week from Lake Istokpoga. For some, this may be subsistence fishing which is critical to maintaining their lives. However, those losing more than 3 meals a week were very scarce in our sample so we do not think this is a widespread factor, yet it is important to a minority of the users.

Willingness to Pay to Curb Invasive Aquatic Weeds

In the beginning of this Chapter, we discussed the concept of user value. We argued that it is a measure of recreational value. Although the recreational value comes from the common property natural resource such as a lake, it can only be sustained if other variables that sustain this resource are not put at risk. From our survey discussed above, we see that invasive aquatic weeds put the attributes of the lake that provide recreation at risk. This is why we have an aquatic weeds management program. The use value of the lake comes from a variety of

government programs to sustain the resource and given the propensity of invasive aquatic weeds to reduce recreational value as discussed above is probably a large component of use value (i.e., the absence of aquatic weeds will enhance use value or be a large part of it). We asked respondents how much they would be willing to pay for a weed control stamp that would be renewed annually. Of course, weed control is but one of the government services provided to protect the lake as a natural resource so we would expect that the willingness to pay (WTP) for control of invasive aquatic weeds would be less than the WTP for all government services. It should be reiterated for the reader that we are trying to estimate the use value of the lake by relating it to the maximum willingness to pay for the use of the resource by putting the question in terms of government services needed to preserve and sustain the resource. The resource would not be available unless the government spent money on it via tests of water quality, aquatic weed control, maintenance of facilities (e.g., public boat ramps, picnic tables, campgrounds, etc), and law enforcement. Hopefully, this is asking for the WTP for the recreational experience since it is "free", but not available without costs of government. Using the technique of asking the respondent about their willingness to pay at progressively higher annual values per party for only the protection of the resource from invasive aquatic weeds, we arrived at a median value of $18 a year which is shown in Table 4.4. This is a little more than one-half of the WTP for the use of the resource supported by the entire complex of government services needed to supply a homogeneous resource. In Table 4.4, this works out to $4.62 per day which is slightly lower than that found by Milon et al (1986) and Bell et al (1998) mentioned in Chapter 1. The former found that the willingness to pay (in current dollars) for invasive aquatic weed control was about $6 per day while the later estimated a value of $5 per day for Lakes Orange/Lochloosa and Tarpon respectively for Central Florida. We were rather astounded at the uniformity at the three lakes of

Table 4.4
A Comparison of Use Vale for All Government Services and the Aquatic Program for Lake Istokpoga, Highlands County, Florida

Items	All Government Services	Aquatic Weed Program
WTP/Party/Year	$32.00	$18.00
Adjusted Party Size*	1.3	1.3
WTP/Person/Year	$24.62	$13.85
Days/Year	3	3
WTP/Person/Per Day	$8.21	$4.62
Person Days Per Year**	190,637	190,637
Annual Flow of Use Value	$1,564,201.03	$879,863.08
Capitalized Value of Lake***	$52,140,034.19	$29,328,769.23
Percent Capitalized Value Due Aquatic Weed Control		56.25%

* Adjusted downward for "free rider effect"

** Table 2.1

*** Annual Flow of Use Value/ Discount Rate of 3%

the WTP per person day for aquatic weed control. The willingness to pay for any item is heavily influence by one's income. The WTP expressed in 2003 dollars is fairly comparable across the three studies as well as the other characteristics of the users. We calculated an annual aggregate willingness to pay for invasive weed protection of nearly $880 thousand per year as shown in Table 4.4. The asset value for this component of the WTP is slightly over $29.3 million dollars or over 56% of the value of the Lake Istokpoga. This provides analysts with the elements of a potential benefit-cost ratio where the economic benefits of aquatic weed control are $880 thousand per year. These economic benefits are based upon the conditions posed in the WTP question that "… tax revenue would no longer be available for controlling aquatic weeds.'' We did not indicate how extensive the hydrilla infestation would become under the elimination of tax support or how many years it would take.

Reaction of Lake Users to Various Degrees of Hydrilla Infestation

After the first quarter of surveying users of Lake Istokpoga, we reviewed our survey instrument for some possible improvement. We felt that we needed more information on the reaction of lake users to increasing levels of hydrilla above the relatively low levels observed in 2003-2004. Many residents of Highlands County have lived in the county for about 15 years so they should be acquainted with varying levels of hydrilla. Tourists from outside of Highlands County also have been coming to Lake Istokpoga for quite some time and have had similar familiarity as that for residents. We added a question dealing with the potential reduction in days that would be cut back with increasing levels of hydrilla coverage of the lake from the present 5-10%. In effect, we said to both residents and visitors, what percent of the present days spent at the lake (yearly) would be cut back as the percent of hydrilla coverage increased by 25%, 50%, 75%, and 100%. We said that a cutback of zero (i.e., no cutback no matter what level of hydrilla

prevailed) under any of these scenarios would be acceptable. Thus, for the last three quarters we asked this question and obtained the following average for these quarters:

Hydrilla Coverage of Lake Istokpoga	Percent of Person Days Cut Back (Average)
25%	24.27%
50%	35.10%
75%	53.07%
100%	61.93%

The results were as expected in that as hydrilla worsened in the lake, users of this resource would decrease their annual days spent at the lake. These responses were also in agreement with the respondents' answers to the question regarding their reaction to increasing hydrilla discussed above. The prime response was to "go to other lakes". However, the reaction was rather inelastic meaning that a percentage increase in hydrilla was not matched with the same or greater reduction in annual days at Lake Istokpoga. Even with 100% coverage of the lake by hydrilla, people would still use the lake. Some "recreation" would still take place. Of course, this is a projection by users and could be vastly altered once an engine burns out or fishing lines become hopelessly tangled in hydrilla growth at or just beneath the surface of the water. The reduction in days recreated would negatively impact both the economic impact discussed in Chapter 3 and the recreational use value discussed in this Chapter. The potential loss or values from that which is now received from Lake Istokpoga would be placed at risk if hydrilla increased. This is shown in Table 4.5.

Note that we have divided the table into the "economic impact" and "recreational use value" components that will respond to the cut back in days as the level of hydrilla infestation rises. The base is 5-10% coverage of hydrilla with the current (2003-2004) economic impact and

Table 4.5
Estimated Potential Economic Losses from Increases in Hydrilla Concentration to the "Economic Impact" and "Use Value" Presently Produced at Lake Istokpoga in Highlands County, Florida

Coverage of Hydrilla Across Acres of the Lake		Percent Cut Back in Days	Economic Impact* Value (Mil of $)	Economic Loss (Mil of $)	Recreation Use** Value Flow Per Year (Mil of $)	Economic Loss (Mil of $)
5-10%	Present Condition	0%	$4.23	$0	$0.88	$0
	Potential Conditions					
25%		24.27%	$3.20	$1.03	$0.67	$0.21
50%		35.10%	$2.75	$1.48	$0.57	$0.31
75%		53.07%	$1.99	$2.24	$0.41	$0.47
100%		61.93%	$1.61	$2.62	$0.34	$0.54

* See early part of Chapter 4

** Total Recreational Loss

Source: Survey by Florida State University

total recreational value. If hydrilla were to cover 50% of Lake Istokpoga, for example, users will cut back their days by 35.1% expressed in user days and presumably divert their recreational pursuits to other lakes. The total economic impact of $4.23 million on Highlands County would fall to $3.30 million, a $1.03 incremental decline. A quarter of Lake Istokpoga's economic impact on Highlands County would vanish. This would also reduce jobs and wages by 24.27%. Lake Istokpoga also generates user value as extensively discussed in this chapter. Current estimates in this study put all recreational value measured by the willingness to pay for maintaining Lake Istokpoga by government at about an annual flow of $880,000 per year. In Table 4.5, we see that an increase in hydrilla to the point where it covers 75 percent of the lake will produce a cut back in days by 53.07% and total recreational value per year will fall to $410,000, a $470,000 incremental decline. For each of these components of the economy of Highlands County, they are definitely at risk given the response of the Lake Istokpoga users to our survey.

Now, we turn to Chapter 5 and the economic dimensions of water withdrawal from the lake, which is still another economic component at risk from increases in invasive aquatic weeds. Water is taken from the lake and used for agricultural purposes in Highlands County and surrounding areas.

CHAPTER 5

Agricultural Value Supported by Water Withdrawal

Agricultural Dependence on the Supply of Water

As pointed out in Chapter 2, agriculture is one of the most important industries in Highlands County. The Florida Statistical Abstract (2003) indicates that cash receipts for agricultural products in Highlands County were $193,552,000 in 2001. These receipts supported 2,070 jobs in the agricultural sector or 7.5% of all employment in Highlands County making this sector the largest sector in the county. The number employed varies considerably during the year depending on the harvest season. The agricultural sector is composed of citrus crops, livestock, and agricultural services. In the citrus component, Highlands County ranked 3rd in terms of the production of oranges in the State of Florida In 2002-2003, this county produced 29,331 boxes of oranges which was second only to Polk County, the state leader in the production of oranges. See Citrus Summary 2002-2003 (204). Using a price of $5.34 per box, it is estimated oranges produced in Highlands County yielded about $156,628,000 or about 80% of all farm receipts in the county. Because of the variability of agriculture, this percent of value of total production of agricultural commodities is likely to vary significantly from year to year. As mentioned in Chapter 2, the Highlands County cattle industry occupies 60% of the 700,000 acres of land in the county. In 2003, this industry produced 102,000 cattle and calves. Using about $190 per cow/calf from Florida Department of Agriculture, we estimate that the cattle industry in Highlands County receives $19,380,00 in 2002 for its beef production. These two components of agriculture production may yield as much as 90% by value of total farm receipts produced in the county.

Florida's agriculture, that is highly dependent on the water supply for irrigation during the dry seasons, also requires flood control to prevent crops and land damage during the wet

season. The advent of invasive aquatic weeds puts canals and impoundments at risk in terms of supply of water to agriculture in both Highlands County and surrounding areas. Such weeds can occupy up to 70% of the volume of a water channel, irrigation or watering pond, thus greatly reducing water-storage and water-movement efficiency according to University of Florida (2004). In Florida, agricultural irrigation uses over 3 billion gallons of freshwater per day. Agriculture is by far the largest user of freshwater in Florida using 48% of the total freshwater withdrawals from ground and surface water. Citrus crops by far use the most water (about 1.5 billion gallons per day), followed by sugarcane (about .68 billion gallons per day).

In Highlands County, the aggregate demand/supply of fresh water was 174.55 million gallons per day (MGD) in the year 2000 of which 17.26 MGD was supplied by surface water (e.g., lakes) or nearly 10% with the balance being supplied by ground water. Agriculture accounted for 160.31 MGD or almost 92% of the total water supply. As the population of Highlands County is projected to grow from 89,000 in 2002 to 115,000 or 29% by the year 2020 (University of Florida, 2003), there will be increasing pressure on the supply of water of which 10% is supplied by surface water provided, in part, by Lake Istokpoga. Finally, there is every indication that those in agriculture may select surface water withdrawal over ground water. Bower (personal correspondence, 3/24/04) of the South Florida Water Management District indicates " In general, if a permittee has surface and ground water as sources, they will usually heavily favor use of surface water because it's more economical to obtain. Large-diameter, high capacity, low-head differential pumps are usually cheaper to run than wells". This is but another reason to think that Lake Istokpoga's economic benefits are not just restricted to recreation. Thus, a vital part of the Highlands County economy will be put at risk by invasive aquatic

weeds. We shall now focus on the role of Lake Istokpoga in supplying water to agriculture in Highlands County and the potential threat of invasive aquatic weeds.

Permitted Withdrawal of Water from Lake Istokpoga by Agriculture

To assess how dependent agriculture is upon withdrawal of water from Lake Istokpoga, we obtained detailed permittee data from the South Florida Water Management District (SFWMD) on withdrawal from Lake Istokpoga for agricultural purposes. Table 5.1 shows a summary of the data obtained from the SFWMD by agricultural crop. This took a special computer run by the SFWMD since they look at total withdrawal and individual applicants, but rarely deal with an entire industry. There are presently 18 active permits pertaining to the withdrawal of water from Lake Istokpoga according to the SFWMD. All receive an allocation, but those in the SFWMD feel that they use all of their allocation. Actual pumpage from the allocation has been confined to recent years while many permits are old and have been "grandfathered-in" as not requiring pumpage data. Of the 18 permits, only 7 require pumpage data so adding water withdrawal among many users means that one is adding allocations and actual pumpage information. This is the best the SFWMD has to offer so we have an "estimate" of water withdrawn from Lake Istokpoga. Given the economics of surface versus groundwater mentioned above, the SFWMD feels that not having pumpage data from all users is of little consequence. Table 5.1 indicates that the SFWMD has allocation/pumpage from Lake Istokpoga at about 13.58 billion gallons per year from all agriculture in the area, mostly in Highlands County with the largest withdrawal taken by sod farms followed by the citrus industry. Farms may extend across county boarders so some of the water may go to agriculture in counties other than Highlands, but officials at the SFWMD felt that this would be minor. Water withdrawal and especially usage is usually expressed in most

Table 5.1
Pumpage/Allocation of Surface Water Permitted by the SFWMS from Lake Istokpoga, Highlands County (Average 1998-2003)

Crop	Number of Active Permits	Number Required to Report Pumpage Data	Total Pumpage/ Allocation (Billions of Gallons Per Year)	Total Pumpage/ Allocation (Millions of Gallons Per Day-MGD)
Citrus	5	1	1.72436	4.724274
Pasture*	7	4	4.81159	13.18244
Sod**	2	2	0.286002	0.783567
Sugarcane	1	0	1.65667	4.538822
Combo***	3	0	4.87257	13.34951
Total	18	7	13.35119	36.57861

* Crop is Hay
** Pertains to Sod Farms
*** Combination of Citrus, Pasture, Sod and Sugarcane

Source: South Florida Water Management District (unpublished data from District files)

situations as millions of gallons per day or MGD. The last column of Table 5.1 shows the withdrawal of water by each agricultural sector in terms of MGD to keep with convention. According to the University of Florida (2004), agriculture uses 3 billion gallons of freshwater per day. This sector is the largest single user of water in the State of Florida using about 48% of the total freshwater withdrawal from ground and surface water. Only about 1.24% of all the water used by agriculture (our 13.35119 billion/yr in Table 1 divided 365 times 3 billion gallons per day or 1,095 billion) is withdrawn from Lake Istokpoga. As we narrow in on the region, this is magnified somewhat with the higher propensity to use surface over ground water by agriculture. This is an important issue for the region containing Highlands County with its lakes.

Table 5.2 shows the second step in establishing the economic importance of the withdrawal of water from Lake Istokpoga. For each agricultural sector (e.g., citrus), we must know the irrigation per used acreage. These data are only available on a statewide basis, but should not vary greatly from area to area. Table 5.2 shows the MGD of water used by the four agricultural sectors and the "combo" sector (i.e., permits are sometimes issued for a variety of crops) and the acres irrigated. This yields the water used for irrigation per acre in the State of Florida by agricultural sector. For example, the citrus industry in Florida uses approximately 2,285 million gallons of water per day (i.e., millions of gallons of water per day divided by over 824,000 acres). The last column in Table 5.2 is critical. It shows how many acres, on average, would be supported by the withdrawal of water from each agricultural sector under study using present practices and standards. This is derived by taking the pumpage/allocation from, for example, citrus of about 4.72 MGD in Table 5.1 and dividing that by water used/needed per acre from Table 5.2. Among all crops, Table 5.2 shows estimated acres of production of irrigated

Table 5.2
Water Withdrawn for Irrigation by Crop and Per Acre in Florida in 2000

Crop	Water Withdrawn in Florida for Irrigation in Millions of Gallons Per Day (MGD)	Acres in Production in Florida	Water Used Per Acre for Irrigation in Florida (Gal/Day)	Estimated Number of Acres Supported By Lake Istokpoga Waters**
Citrus	1,884.18	824,602	2,284.96	2,067.55
Pasture***	204.41	130,028	1,572.05	8,385.53
Sod****	210.13	76,221	2,756.85	284.2253
Sugarcane	856.85	404,123	2,120.27	2,140.68
Combo*****	3,155.57	1,434,974	2,199.04	6,070.60
Total				18,948.58

* Gallons of Irrigation Water Divided by Acres Irrigated
** Total Pumpage/Allocation of Water from Lake Istokpoga (Table 5.1) Divided by Water Used Per Acre for Irrigation in this table.
*** Crops in
Hay
**** Pertains to Sod Farms
***** Combination of Citrus; Pasture; Sod and Sugarcane

Source: South Florida Water Management District; Statistical Abstract of Florida (2003)

agricultural products in and around Highlands County to be almost 19,000 acres. The Statistical Abstract of Florida (2003) reported that Highlands County had 489,579 acres of farmland, but a lot of this acreage was not in production or consisted of woodlands so it is difficult to compare our estimate of farm acres irrigated with any aggregate total for Highlands County.

Table 5.3 shows the cash value produced by agricultural crops compared to the total acreage used. For example, for Florida as a whole, citrus produced $996.81 million in the year 2002 using 727,600 acres of land or an estimated cash value per acre of $1,328.77. Some or most of this acreage may be irrigated. Irrigating crops will obviously keep them from yielding nothing in a drought, but is well beyond the scope of this report to see whether prices or costs of the final agricultural commodities produced are elevated or reduced by irrigation. Table 5.3 shows that cash yields per acre range from a low of $271.60 in the production of hay per acre to $1,328.77 in the production of citrus products per acre in 2002. We then took the estimated acreage "supported" by Lake Istokpoga through water withdrawal by crop and multiplied this by the cash yield per acre to arrive at the value supported by irrigation. Returning to Table 5.3, it is apparent that all crops produced with the aid of surface water from Lake Istokpoga had a cash value at market of an estimated $15.1 million. As measured by sales, agricultural support by Lake Istokpoga exceeds even the direct spending that we have estimated in conjunction with recreation of a little over $4 million. Since most agricultural production is exported out of Highlands County, it is a fundamental part of the economic or export base of the community. However, we have been only able to link about $15 million of the nearly $194 million in cash for agricultural commodities produced in Highlands County to the withdrawal of water from Lake Istokpoga or about 7.7%. Such withdrawal of water still remains an important element of the economic base of Highlands County and is at risk from increasing incidence of invasive aquatic

Table 5.3
Estimated Economic Value at Risk from Agricultural Dependence on the Surface Water of Lake Istokpoga in Highlands County, Florida, 2002

Crop	Cash Value Of Crops in Florida (Mil of $)	Total Acreage in Production in Florida (1000 of Acres)	Estimated Cash Value Produced Per Acre ($)	Estimated Cash Value of Crops Supported by Lake Istokpoga* (Mil of $)
Citrus	$966.81	727.6	$1,328.77	$2.75
Pasture**	$76.05	280	$271.60	$2.28
Sod***	$111.96	65.185	$1,717.57	$0.49
Sugarcane	$559.60	461	$1,213.88	$2.79
Combo****	1,714.42	1533.785	$1,117.77	$6.79
Total Value Supported by Withdrawal				$15.10

* Cash Value Per Acre Multiplied by Number of Acres Supported by Lake Istokpoga in Table 5.2
** Crops in Hay
*** Pertains to Sod Farms
**** Combination of Citrus, Pasture, Sod, and Sugarcane

Florida Department of Agriculture and Tables 5.1 and 5.2 in this Chapter.

weeds which reduces water-storage and movement and literally “drinks up” and transpires a portion of the water that could be used for irrigation. There is little debate that invasive aquatic weeds put the withdrawal of water from Lake Istokpoga at risk.

CHAPTER 6

The Economics Impact of Invasive Aquatic Weeds on Flooding

Flooding Without Invasive Weed Complications

The Lake Istokpoga Basin has been modeled to simulate and assess the flooding potential of the lake for selected hypothetical storm events of varying magnitudes. Much of this work has been done by Searcy (1993) for the South Florida Water Management District. The important thing about this initial modeling is that it first assumes that there are no invasive aquatic weed infestations associated with Lake Istokpoga and this was true for hydrilla which was not introduced until the late 1970s. It is important to note that it would also be true if the extent of invasive aquatic weeds would be reduced/maintained to such a level where they were not a biological, hydrological or economic factor in the system. Let us first look at the supply of water.

Presently, the Lake Istokpoga Basin is supplied with water from (1) rainfall adjusted for evapotranspiration; (2) Arbuckle Creek on the north side of the Lake; and (3) Josephine Creek on the northwest side of the lake. According to Highlands Today (2002), 95% of surface water in Highlands County flows into Lake Istokpoga by way of Josephine and Arbuckle Creeks. Too much rainfall directly on the lake plus that from run-off of the two creeks will produce flooding in the area around the lake. This will raise the lake level where potential economic damage is very possible. However, Lake Istokpoga has a flow of water out of the lake at structure S-68 at the southeast end of the lake. Since 1962, the flow of the water out of the lake has been controlled by the USACE and the SFWMD. Thus, those wishing to alter the water level in the lake must appeal to these agencies. See Jeff Schardt (2004) below in Chapter 8 for a discussion of lowering the lake level for a period of the year to increase the effectiveness of fluridone herbicide to control hydrilla. S-68 presently has two discharge capacities: (1) 3,000 and (2) 5,900

cfs (i.e., cubic feet per second). Searcy (1994) stated that the original design of S-68 assumes 3,000 cfs and up to 5,900 cfs capacity based upon downstream capacity. This additional capacity is on a secondary basis. So, in the case of a storm, S-68 may be used to reduce the degree of flooding. What does modify flooding mean?

Based upon a study by the SFWMD (1968) of buildings around Lake Istokpoga below 43 feet NGVD (i.e., National Geodetic Vertical Datum or the elevation of water surface above a given datum such as the mean sea level), Searcy (1994) demonstrated the potential impact on structures flooded by a hypothetical storm hitting Lake Istokpoga which is shown in Table 6.1. As the storm's intensity rises, the number of structures impacted by flooding also increases with the fixed capacity of S-68 and the higher level of capacity of S-68. In Table 6.1, the Standard Project Storm (SPS) is more severe than the 100-year hypothetical storm and may be considered the worse case scenario. Assuming that the structures are residential housing and that the year 2000 purchase price of $95,330 for homes in Highlands County prevails, we can see the value at risk as storm levels increase. This is perhaps one of the worse case scenarios since many structures modeled by Searcy were not residential housing. Existing conditions are characterized by limited outlet capacity at S-68 and flows over Highlands County Road 621 (CR-621) with lake stages of 40.8 feet NGVD or greater. The regulation schedule calls for water levels in the lake not to exceed 39.5 feet NGVD. One expensive alternative is to enlarge or modify S-68 to 5,900 cfs which would cost about $750,000 in 2003 dollars. Without a consideration of invasive aquatic weeds (i.e., they do not exist in this scenario), two economic losses are possible as follows (1) property damaged by the flood would be replaced or rebuilt at the values indicated in Table 6.1 and (2) the value of property would be lowered if some of the existing property were thought to be in a deep flood plain. Thus, the review of the little literature dealing with flooding

Table 6.1
Number of Structures Flooded by Hypothetical Storm of Varying Degrees at Lake Istokpoga, Florida

Hypothetical Storm	S-68 Capacity 3,000 cfs	S-68 Capacity 5,900 cfs
5-years	27	26
10-years	36	30
50-years	41	36
100-years	55	45
Standard Project Storm (SPS)	59	55

Source: Searcy(1994)

Table 6.2
The Effect of Hydrilla on Flooding for Lake Istokpoga, Florida

Design Event	Water Level Above Weed Scenario (Feet Above Regulations)		Difference in Feet
	Worst Hydrilla* 1988	Best Hydrilla** 1992	
SPF	8.7	3.6	5.1
100	7.1	3.4	3.7
50	5.3	3.2	2.1
10	2.3	1.9	0.4
5	1.8	1.3	0.5

*Highest Level of Hydrilla in Lake Istokpoga at 13,000 HAS
**Lowest Level of Hydrilla in Lake Istokpoga at 2,000 HAS

Source: Searcy (1994)

and Lake Istokpoga exposes its potential economic damage from flooding without the introduction of invasive aquatic weeds.

Flooding with Invasive Aquatic Weeds

We have already shown that Lake Istokpoga has a lot of potential for flooding nearby structures on the basis of various storm events. Further, S-68 as an outlet to prevent such flooding is questionable in terms of capacity and presents another problem for regulatory authorities (i.e., allowing the water to overrun a state road as part of a flood control strategy may be questioned by some in terms of not only the damage to the road, but flood damage to structure by not having enough capacity built into S-68). With the USACE, it all comes down to a "benefit-cost ratio" or the necessity that economic benefits exceed cost. Investigating the expansion of S-68 to see if economic benefits exceed cost is beyond the scope of this study.

Searcy (1993) introduced the impact of rooted, aquatic plant growth within the Lake Istokpoga water system using the FEMA/SURGE model. Since neither of the authors of this report are engineers, we can only speak to what is concluded by papers on aquatic weeds and water flow. It is for others to judge as to whether this modeling and computations are done adequately. Management of Lake Istokpoga includes the control of invasive aquatic plants. It is strongly argued that operations for flood control discussed above can be greatly impaired by un-checked aquatic plant growth, especially hydrilla. The SURGE model represents rooted, aquatic plants as increased friction losses, and /or modified bathymetry, partial blockages (i.e., submerged barriers) or total blockage (i.e., non-submerged barriers). Rooted aquatic plants were introduced as reducing depths along with friction increases to see what their impact might be on the ability of the USACE/SFWMD to control flooding. Other studies such as Shih and Rahi (1981) have used this approach on other lakes. Two scenarios were used as follows: (1) Worst-

case scenario: 1988 and (2) Best-case scenario: 1992. The hydrilla acres surveyed were 13,000 in 1988 and only 2,000 in 1992. These dates were selected by Searcy who wrote his paper on this subject in 1993. The Design Event (i.e., kind of storm) was the SPF (i.e., Standard Project Storm), 5-year, 10-year, 50-year, and 100-year for looking at the level of flooding with varying amounts of hydrilla. The level of hydrilla for 2003 was 2,111 acres surveyed. So, if we were looking at Lake Istokpoga today, then we would be looking at something more akin to the 1992 results. Because of a rather massive spending program on reducing the level of hydrilla in recent years, this invasive aquatic weed would be less of a factor in creating flood conditions in the lake. The present management of Lake Istokpoga assumes the present capacity of the major outlets of the lake (i.e., S-68, the overflow of sections of Highland County Road 621, and G-85, a smaller outlet). G-85 is the Istokpoga Canal on the mid-east side of lake. To point out the potential of SURGE, we picked cell #1 at the North end of Lake Istokpoga to see the results.

Table 6.2 shows the results of imposing two levels of hydrilla on a spot in the lake in terms of water level above the maximum pool in the existing water regulation which is 39.5 feet NGVD as discussed above. Let us take an example. During the worst period for hydrilla (1988) the effect of this infestation is to raise the water level by 8.7 feet or from 39.5 feet (i.e., regulatory objective) to 48.2 feet which would involve extensive flooding. If the Florida Department of Environmental Protection reduced the hydrilla to that existing in 1992, then the water level would only be raised to 43.1 feet, a 3.6 feet increase. This level of hydrilla would make the SPF flood event less damaging to property and the shoreline than with a higher incidence of hydrilla. In this example, an 85% reduction in hydrilla (i.e., from 13,000 acres to 2,000 acres) reduced the incidence of flooding by over 41% (i.e., from 8.7 to 3.6). These simulations are typical of the rest of the cells showing a rise in the maximum water level when

the empirical level of hydrilla is raised. A six-fold increase in hydrilla is used when comparing 1993 and 1988. This may seem like an extreme case; however, DEP records indicate that Lake Istokpoga has supported as much as 25,800 acres of hydrilla (1996) in this 27,700-acre reservoir. Since Searcy (1993) was using a simulation model, no statistical inferences can be drawn from the reported data. However, the implications of his results indicate that reduced levels of hydrilla will reduce water levels given any Design Event thereby providing positive economic benefits. Increased levels of hydrilla put the potential for flooding and therefore people and structures at risk. Thus, expenditures on hydrilla control will have an economic payoff of enhancing the efficiency of flood control in the Istokpoga Basin. In conclusion, we can say that a six-fold increase in hydrilla will raise the maximum water level for a SPF storm by over 2 feet above the mean of the figures presented in Tables 4-6 (i.e., all grids of Lake Istokpoga) in the paper prepared by Search (1999).

Some Empirical Results from the Simulation Model

Based on a shoreline study by Highlands County in the early 1990's, 418 structures were present on the shoreline of Lake Istokpoga. Such structures are a combination of private residences and businesses. This number has certainly increased over the last fourteen years. As we saw in Chapter 2, population in Highlands County increased by about 30% over this period. Thus, we would expect more structures to be at risk today. As we saw above, the peak stage (ft NGVD) for any storm event would be raised by about 2 feet with a six-fold increase in hydrilla. As an example, a 10-1 event (-a flood once every10 years) would raise the NGVD peak to 41.33 peak flooding an estimated 30 structures (i.e., 7% of the total number of structures) and impacting to some degree (i.e., partial flooding) 217 structures (i.e., 52%). If hydrilla had increased by 5-6-fold, this would act like a 100-year storm flooding 59 structures (14%) and

impacting 302 structures to some degree (72%). Over the 1990-2003 period, hydrilla has oscillated about 5 different times with a 5-6-fold increase or decrease. It would appear that hydrilla is a significant player in the hydrology of Lake Istokpoga acting to block or reduce the outflow of rainfall and other inflows into the lake and place structures at extreme risk.

In 2000 dollars, the average price of residential houses was as indicated above at about $95,330. Assume that the 418 structures found in the shoreline of Lake Istokpoga were residential and there was no change in this number since the early 1990's (a very conservative assumption). Such structures would be worth $39.85 million. Further assume a 10-year storm without hydrilla. Then, 30 structures would be flooded and possibly never be rebuilt. A loss of $2.86 million in property values would occur, less the value of land. The land left may not be marketable since it is in a dangerous flood plain. If hydrilla increased six-fold, then 59 structures valued at $95, 330 per structure would amount to $2.8 million. Also, 85 structures would be impacted. We can only speculate on the damage to these structures. Assuming a very conservative 10% damage from the flood, this would amount to $.8 million for a total damage of $3.8 million. Highlands County has grown at an annual rate of 2.5% in population since 1990. Assuming the structures grew at this rate from 1993, damage would rise to about $4.5 million. This is likely to be conservative since people are attracted to lake-front property.

In 1996, the number of hydrilla acres surveyed (NAS) was at its peak for the 1987-2003 period registering 25,800. By 1997, hydrilla acres surveyed (NAS) was reduced to 4,800 or about a 5-6-fold decrease for a cost of $1.74 million spent on herbicide; labor; materials and overhead to reduce the incidence of hydrilla. With this analyses, it is quite likely that an expenditure of $1.74 million on herbicide and other sundry items could have prevented a 5.4 million loss if 1996 had been a 10-year storm event coupled with an infestation of hydrilla. One may ague that

the damages calculated above do not come every year, but hydrilla management costs must be incurred every year. Hydrilla treatment is comparable to a police force that must be maintained for random events of individuals and especially of nature. In this case, such random events include storms that are likely to be greatly enhanced in their risk to not only property, but life itself. A more intensive study may show that even with the probability of storms factored into expenditures on hydrilla and related items this program is very cost-effective given the way this weed enhances flooding potential as demonstrated in this chapter.

CHAPTER 7

Property Values and Aquatic Weeds

Property Values and Aquatic Weeds

One of the major sectors at risk from invasive aquatic weeds in Florida is the residential property sector. The segment of this sector most directly at risk is residential property located on water bodies. In Highlands County, Florida there were 37,471 households in 2000 of which 79.7% are owner occupied (29,864). Such households may be part of a subdivision which may or may not be on a lake. In general, property values are elevated when such property is on a lake since the lake offers aesthetic values and close proximity to recreational pursuits. This is why people like to be near or on the beach or along lake or river shorelines in Florida; because of the scenic view and access to recreation. Sometimes net amenities do not always occur since gross amenities are offset with the advent of hurricanes in case of beaches or invasive aquatic weeds in the case of lakes. That is, water bodies such as Lake Istokpoga, may experience lower prices for property and waterfront lots when the lake is highly invaded with hydrilla. This is called a "negative externality" by economists since what is happening is that the state, in this case, may be allowing water pollution in the forms of invasive aquatic weeds to negatively impact the value of private property. In the case of aquatic weeds, there is no overt polluter except those individuals that help facilitate the importation of hydrilla into the country or into a specific water body.

The impact of invasive aquatic weed infestation on residential property values was investigated at Lake Guntersville, AL as part of the Joint Agency Project between the US Army Corps of Engineers and the Tennessee Valley Authority. Lake Guntersville is a highly popular recreational destination undergoing increasing development for permanent residents and tourists.

The low flow conditions in the mid-1980's lead to the explosion of hydrilla and problems with access to the lake because of high plant growth at waterfront lots and lake access points. A residential shoreline properties study modeled the relationship between residential property values and levels of aquatic plants over the 1981-1990 period. This report was published by Driscoll (1994). A hedonic model was used to relate residential property values to overall market conditions, neighborhood effects, and property-specific characteristics, including aquatic plant levels. For developed and undeveloped waterfront lots, the presence of aquatic plants from shore to open water had a significant effect on selling price. Complete control of aquatic plants increased property values by 17% for developed lots and 35% for undeveloped properties while plant levels had no effect on sale prices of back lots. This technique could have been used in the Lake Istokpoga study except that its funding level did not extend to such a study which would involve not only the collection of property values, but a field survey to quantify invasive aquatic weeds associated with each property unit. Such a survey would have to identify the nature of the aquatic weed, its duration near the property, and its measurement. It would involve some surveyors with biological expertise as well. This would have to be done for developed and undeveloped lots where ownership and knowledge of the terrain may not be known on a day-to-day basis (e.g., absentee owners). Also, recent sales for like property as used by property appraisers would have to be used to assign a value to each property since property appraisal values available from tax collectors are vastly understated (e.g., your property value depends on how recent the sale is). This would be a major study in itself and is well beyond the scope of this study. However, since Lake Guntersville was impacted by hydrilla and is in the southern part of the United States, it would be instructive to see how the parameters found in Lake Guntersville fit into the Lake Istokpoga study.

In a SFWMD (1988) study of the location of buildings around Lake Istokpoga, it was established that there were 413 structures (e.g., homes) with floor elevations below 43 feet NGVD. Such structures are highly subject to flooding and form a limited percentage of the total structures. For example, let us assume that in 2000, there were more than twice the number of structures than studied in 1988 or about 1,000 around Lake Istokpoga. If these structures were all houses (i.e., in reality they will be houses, various house trailers, lots, etc) and we apply the average price of about $95,000 for houses in Highlands County to this total we have about $95 million. This is not a large figure at all for real estate, but shows the magnitude of numbers for which we may be dealing if we had a thorough study of the property ringing Lake Istokpoga. The Guntersville, AL study discussed above indicated that for all property around a lake not infested with hydrilla, that the advent of this weed will reduce the property values in general by at least 10%. Thus, if the property around Lake Istokpoga is at risk through inability to control invasive hydrilla, we might expect in a very short time, since the real estate market instantly captures such changes, a 10% decline in property values or $9.5 million at a minimum. In the Guntersville study, a 10% decrease in the value of lake shore property resulted in a loss of over $1 billion. Our preliminary estimate is that a large coverage of hydrilla from shore to the open lake will result in millions of dollars of property value loses. In Michigan, at Houghton Lake, the advent of invasive aquatic weeds lead to the formation of a special taxation district for the lake. Each shore property was taxed at $250 per year while those away from the lake were taxed at $100 per year. This was, in part, their willingness to pay which we discussed in Chapter 3 for weed control. A survey indicated that such tax levels were not only tolerated, but residents felt that this protection of the value of their property at risk to invasive aquatic weeds was a “good

investment". Our very rough estimate of $9.5 million for Lake Istokpoga without a thorough study seems truly low, but should be on the list of economic benefits of invasive weed control.

CHAPTER 8

Cost Control of Invasive Aquatic Weeds

Recent History of the Cost to Control Invasive Aquatic Weeds

Table 8.1 shows a detailed history of both the hydrilla acres surveyed (HAS) and the cost of control with fluridone herbicide, the primary hydrilla control method applied on Lake Istokpoga over the 1987-2003 period. HAS is hydrilla acres surveyed by the Bureau of Invasive Aquatic Plant Management (BIPM), Florida Department of Environmental Protection and is the primary indicator of the degree of hydrilla infestation while HAT is the hydrilla acres actually treated in any given year. HAT has averaged about 14% of the actual hydrilla acres surveyed. As one can see, HAS fluctuated in a radical manner over this period reaching a high in 1996 at 25,800 acres and a low of 475 acres in 2001. Of interest, HAS shows no time trend over the period indicating that the BIPM has apparently kept hydrilla at bay over the time period under consideration (1987-2003). From 1988-2003, the BIPM spent over $11.3 million on hydrilla control averaging about $707,565 per year for Lake Istokpoga. It should be pointed out that costs include not only herbicide, but labor, materials, overhead, and fringes to conduct the hydrilla control. Neither figure is in real dollars or adjusted for inflation. This will become critical in our discussion below. The average hydrilla treatment cost per acre was almost $567 over the period under study.

Of great importance and discussed below, Schardt (personal correspondence, 2004) has suggested a use of the environment, or more specifically, the water level in Lake Istokpoga to reduce hydrilla control costs. Using the data in Table 8.1, we first asked the question of relation, if any, between HAS and $HTC or the incidence of hydrilla and the program control cost for Lake Istokpoga respectively. Preliminary correlations between the incidence of hydrilla and

Table 8.1
Invasive Aquatic Weed Infestation and Financial Control Expenditures
Related to Lake Istokpoka Over the 1987-2003 Period

Year	HAS (# Acres)	HAT (# Acres)	$HTC (Dollars)	$AHTCA (Dollars)	$RHTC (Real $)	$RAHTCA (Real $)	PPI 2003=100
1987	3600	N/A	N/A	N/A	N/A	N/A	0.737
1988	13000	495	182160	368	241271.5	487.4172	0.755
1989	3000	2447	1252864	512	1581899	646.4646	0.792
1990	8500	915	479460	524	576274	629.8077	0.832
1991	10600	905	497750	550	580805.1	641.7736	0.857
1992	2000	2400	1372800	572	1574312	655.9633	0.872
1993	9000	0	0	0	0	0	0.882
1994	19800	0	0	0	0	0	0.887
1995	18400	550	338800	616	374778.8	681.4159	0.904
1996	25800	465	232965	501	251854.1	541.6216	0.925
1997	4800	2650	1735750	655	1870420	705.819	0.928
1998	950	0	0	0	0	0	0.918
1999	1896	2380	1635060	687	1743134	732.4094	0.938
2000	19384	50	31200	624	34361.23	687.2247	0.908
2001	475	2575	1377625	535	1384548	537.6884	0.995
2002	2694	300	134100	447	136836.7	456.1224	0.98
2003	2111	2639	2050503	777	2050503	777	1
					12400998	8180.728	
SUM88:03	142410	18771	11321037	7368	775062.4	511.2955	
MEAN	8377.0588	1104.1765	665943.353	433.411765			

EXPLANATION OF TERMS:

HAS = Hyrilla Acres Surveyed by DEP (Indicator of Degree of Hydrilla Infestation);

HAT = Hydrilla Acres Treated by He Herbicides Fluridone and Contacts Over Time Period;

$HTC = Total Dollars Spent on Hydrilla Treatmen Cost Including Herbicide; labor, overhead and fringes

$AHTCA = Average Hydrilla Treatment Cost Per Acre;

$RHTC = Real Dollars Spent on Hydrilla Treatment

$RAHTCA = Real Average Hydrilla Treatment Cost Per Acre;

PPR = Producers Price Index Excluding Foods with 2003 = 100 or Current Dollars

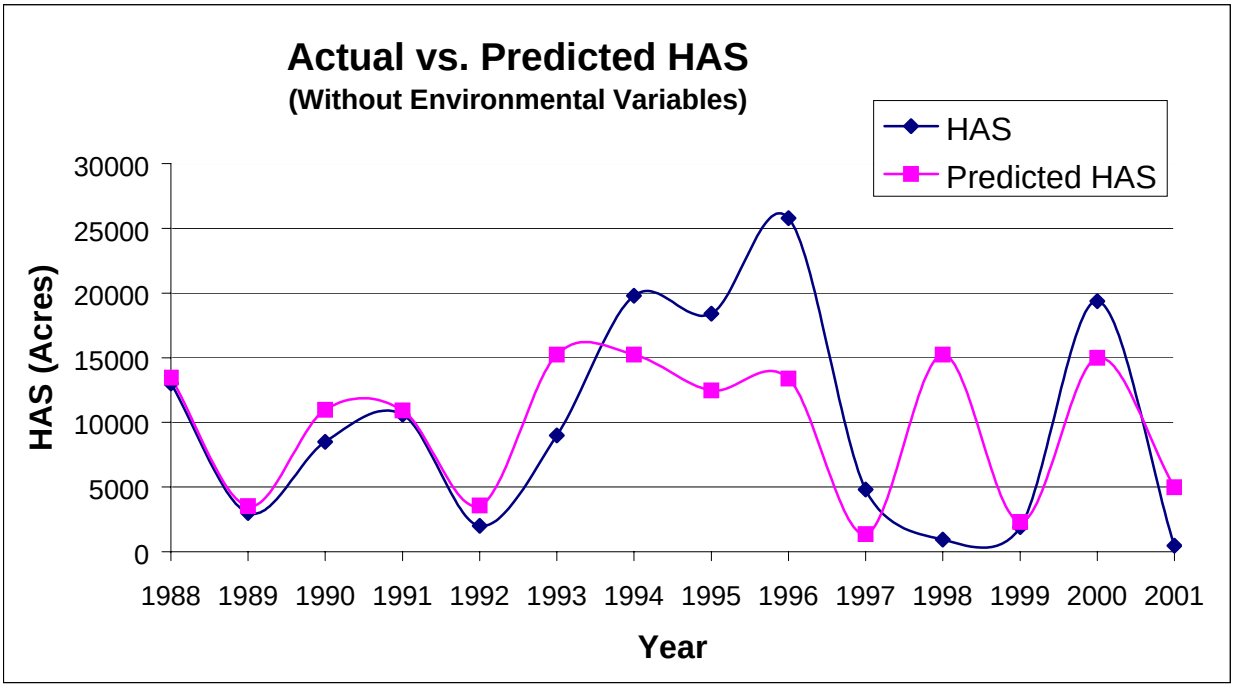
SOURCE: BUREAU OF AQUATIC WEEDS, FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
U.S. BUREAU OF LABOR STATISTICS FOR PROUCER PRICE INDEX

efforts to control this weed revealed “little” relation between HAS and $HTC. Over the 1988-2001 period (where data are available for each year), there has been a significant amount of inflation in all kinds of cost that tend to distort relationships. At the end of Table 8.1, we show that the producers price index (PPI) rose over 36%; therefore, nominal dollars (i.e., dollars in name only) would not show the real allocation of funds to control the incidence of hydrilla. We deflated the cost series by the PPI to arrive at a time series on the real cost ($RHTC) of applying resources to control hydrilla. The following equation was obtained:

(1) HAS(t) = 13,786 – 6.30E-03 $RHTC : R-Square = .36

Real expenditures on hydrilla control reduced the incidence of this invasive aquatic weed as indicated by the negative sign on $RHTC (i.e., real total cost per year spent on hydrilla control). This control variable was statistically significant at the 1% level. This was a much better result than using nominal levels of expenditures in that real hydrilla expenditures can reduce HAS or the incidence of hydrilla. Over the period studied (1988-2001), the equation (1) indicated that a 10% increase in the real cost of controlling hydrilla resulted (at the means) in a 5% reduction in the incidence of hydrilla or HAS. Lags between expenditures and results were unsuccessful so spending this year took effect in reducing hydrilla in the same year. The difficulty in reducing hydrilla is shown in the inelasticity of its incidence to real expenditures. As we mentioned earlier, Schardt (2004) has commented on this fiscal problem in a paper provided to the authors and discussed below. Figure 8.1 shows the oscillation in HAS or the incidence of hydrilla and real spending over the 1988-2001 period. Real expenditures on hydrilla seem to track the incidence of hydrilla downward when real expenditure/cost rose and upward when control expenditures/cost fell. In most of the years, the predicted

Figure 8.1: Actual and Predicted Incidence of Hydrilla (HAS) Influenced by Real Control Cost



amount of hydrilla followed control expenditures; however, some years more than others may have been influenced by fluctuations in environmental factors (e.g., rainfall; water temperature, etc.) accounting for the difference between prediction of HAS by spending/cost and the actual incidence of hydrilla observed. Obviously, hydrilla control cost is central to dealing with the incidence of hydrilla in many lakes. A Method to Control Cost

We have shown that spending real dollars on hydrilla control is reasonably effective. This means that appropriations for hydrilla control must consider inflation in allocating money to this effort. But, beyond that, there are ways that have been suggested to better use fluridone which is a slow-acting herbicide that interferes with hydrilla's ability to produce chlorophyll and feed itself. Fluridone must keep in contact with hydrilla for 75-90 days at or above its susceptibility level. Schardt (2004) has suggested that the regulatory authorities lower the lake to an elevation of 37.5ft NGVD for a period of 2.5-3.0 months between January 1 and May 1, depending upon current and forecast weather conditions, to accommodate hydrilla control using fluridone herbicide. The control would be accomplished by keeping the gate at S-68 (southern part of Lake Istokpoga) shut for a period of 75-95 days after treatment initiation. Even though the lake level would rise even to 39.5ft level, the fluridone would be prevented from being discharged as treated water from the system. The guiding principle is to keep the appropriate concentration of fluridone and the exposure to hydrilla for an extended period of time. Current water regulations can weaken fluridone effectiveness by allowing S-68 to remain open, drawing off herbicide-treated water. This may be part of the reason why we get such an inelastic response of HAS to real expenditures on controlling hydrilla as discussed above. Schardt (2004) states "As much as $750,000 would have been saved in the 2004 initial fluridone treatment cost if Lake Istokpoga were treated at 37.5ft versus 39.5ft." Lower water volume translates into lower herbicide use to

achieve the same level of hydrilla control. Lowering the water level to allow fluridone to work most efficiently can be done with consideration to other in-lake processes and uses as well as downstream impacts according to Schardt (2004). This is a persuasive argument to the USACE and the SFWMD to utilize S-68 to lower the water level, keep fluridone at its maximum effectiveness and allow the water to flow downstream after it has been used most efficiency in the Lake Istokpoga Reservoir to control hydrilla. All means should be examined to increase the cost-effectiveness of controlling hydrilla which is becoming increasingly resistant to fluridone herbicide.

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APPENDIX A

Appendix A.1: Survey Instrument for Users of Lake Istokpoga Living Outside Highlands County;

Appendix A.2: Survey Instrument for Users of Lake Istokpoga Who Are Residents of Highlands County.

Appendix A.3: Added Questions to A.1 and A.2 for October-November, 2003 to April-June, 2004.

APPENDIX A.1

Outside Highlands County Visitor Survey 2003 & 2004

Economics Survey for Invasive Aquatic Weeds in Lake Istokpoga, Florida

Site: 1 Lake Istokpoga Park, 2 Public Boat Ramp, 3 Pruitts Landing, 4 Henderson Fish Camp, 5 Mossy Cove Resort, 6 Trails End Resort, 7 Cypress Isle RV Park, 8 Neiberts Resort, 9 Mallards Fish Resort

Q1 In what state do you live? _____
Q2 In what county do you live? _____
Q3 Mode of travel to the lake: 1. Auto 2. Bus 3. Other
Q4 Size of party (including children and yourself): _____
Q5 Length of stay on this trip: 1. #Days ____
Q6 Accommodations Used if Stayed Overnight:: (Circle one)
1. Day Trip Only
2. Hotel/Motel
3. Friends/Family
4. Campground
5. Condominium

Q7 Do you own a boat used on this Lake? Yes ___ No___
Q8 Was your purpose for this trip primarily to visit the Lake or combined with another destination? (Circle one)
1. Primarily 2. Combined

Q9 Ethnicity: (Circle one)
1. White
2. African American
3. Hispanic
4. Asian
5. Other

Q10 Age _____
Q11 Total Household Income (Circle one)
1. Under $20,000
2. $20,000 to $29,999
3. $30,000 to $39,999
4. $40,000 to $49,999
5. $50,000 to $59,999
6. $70,000 to $79,999
7. $80,000 to $89,999
8. $90,000 or more

For all the members of your party, please estimate the average amount spent on the following per day while at and around the lake:
Q12. $_____ Lodging
Q13. $_____ Food/Beverages (Restaurants & Stores)
Q14. $_____ Marina/Recreational Fees (guides, boat rentals)
Q15. $_____ Bait and Tackle
Q16. $_____ Gasoline bought at and around Lake
Q17. $_____ General Shopping
Q18. $_____ All Other Spending

While at the lake on this trip, what recreational activities did you participate in? (Check all that apply)
Q19 _____ Freshwater Fishing from a boat
Q20 _____ Freshwater Fishing from shore _____
Q21 _____ Camping in a Tent/ R.V. Trailer/Primitive Area
Q22 _____ Engaging in Nature Study
Q23 _____ Picnicking
Q24 _____ Sunning, Swimming and Playing on Beach
Q25 _____ Hiking
Q26 Other (Specify)_____

Q27 How many meals to you expect to come from fish you catch in the Lake? # of Meals _____

Q28 Everyone that uses the Lake derives recreational value, but except for a fishing license, there is no fee for using the Lake. Suppose that the Lake were not free, but you had to pay an annual fee to the State to fund all of management such as water quality testing; aquatic weed control; maintenance of public facilities and law enforcement. You could use the Lake for as many days as you wish per year and it would cover all in your party. I will read off an annual Lake Istokpoga fee and please stop me when I get to a fee you would not be willing to pay.

1. $5
2. $10
3. $20
4. $30
5. $40
6. $50
7. $75
8. $100
9. $150
10. $200
11. Over $200
12. Don't Know/No Answer

Q29 If we're to say that "invasive aquatic weeds such as hydrilla and hyacinth/water lettuce are a serious problem to you and others in your party enjoying recreational opportunities around Lake Istokpoga", would you: (Circle one)
1. Strongly agree
2. Agree
3. Disagree
4. Strongly Disagree
5. Don't Know/No Answer

Q30 Over the last few years (3-4), have you noticed that the invasive aquatic weeds as they cover the Lake's surface are getting : (Circle one)
1. Larger
2. Smaller
3. About the Same
4. Don't Know/No Answer

Q31 Due to a $2 million campaign to control hydrilla over the last few years, this weed covers less than 10% of Lake Istokpoga. If no funds were available and hydrilla rapidly covered the entire Lake, how would you react or be impacted ? (Circle all that apply)

React
1. Call/Write by state representative
2. Call/Write local officials
3. Join the Save Lake Istokpoga Association
4. Talk about it among fellow Lake users
5. Go to another lake without the weeds
6. Do nothing, but wish for the good old days
7. No reaction

Impacted
1. Lose a substantial recreational value at the Lake
2. Be unable to use much of my recreational equipment
3. Lose an important source of food
4. No impact

Q32. Everyone that uses Lake Istokpoga derives recreational value, but except for a fishing license, there is not a fee for controlling invasive aquatic weeds. This is one of many components of lake management to improve your recreational experience. Suppose that the funds were no longer available for the State of Florida to continue this program. To fund such a program, you and your fellow users of the Lake would have to pay a voluntary annual user fee to fund an invasive aquatic weed control program. This would be similar to the highly successful duck stamp program where purchases by duck hunters buy habitat for ducks. You could use the Lake for as many days a year you wish and the fee would cover all those in your party. Not purchasing a weed stamp would mean there would be inadequate funds to control aquatic weeds. How much would you be willing to pay per year for a "weed control stamp"? $_____

Q33. Controlling aquatic weeds in Lake Istokpoga is a costly operation. Current efforts are designed to prevent the Lake from being infested by weeds to such an extent that they will not decrease your recreational enjoyment. The cost of these programs are paid for from state tax money. Suppose for the moment that a tax revenue would no longer be available for controlling aquatic weeds. One solution would be to require a lake user to purchase a special Lake Istokpoga "weed control permit" or "stamp" that would be good for one year. You could use the Lake for as many days a year as you wish and the fee would cover all those in your party. If the stamp cost $2 per year, would you be willing to purchase such a stamp in order to use Lake Istokpoga and to prevent the Lake from becoming choked with weeds. (Circle one):
1. Yes
2. No
3. Would go to another lake
4. Don't Know/No Answer

Q34. Suppose $2 was not enough to keep aquatic weeds at a reasonable level, say 5-10% of the Lake's surface, and the fee had to be raised. I will read higher fees and stop me when I get to the fee you would not be willing to pay to fund the weed program.

1. $5
2. $8
3. $10
4. $15
5. $20
6. $25
7. $30
8. $50
9. $75 or more
10. Don't Know/No Answer

Q35. How many miles do you live from Lake Istokpoga:? # of miles: ____

THANK YOU FOR YOUR TIME

APPENDIX A.2

Outside Highlands County Visitor Survey 2003 & 2004

Economics Survey for Invasive Aquatic Weeds in Lake Istokpoga, Florida

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2. $8
3. $10
4. $15
5. $20
6. $25
7. $30
8. $50
9. $75 or more
10. Don't Know/No Answer

Q35. How many miles do you live from Lake Istokpoga:? # of miles: ____

THANK YOU FOR YOUR TIME

APPENDIX A.3

Note: After the Survey started in the July-September, 2003 period, we added the following question for each quarter running from October-December, 2003 to April-June, 2004:

Residents and Visitors

We would like to find out your reaction to increasing levels of hydrilla. What percent would your present days to Lake Istokpoga annually would you cutback if hydrilla increased from the present 5-10% coverage of the surface if hydrilla increased to

Hydrilla Coverage of Lake Istokpoga	Percent of Person Days Cutback
25%	_____%
50%	_____%
75%	_____%
100%	_____%