# STOCKING WILD-ADULT LARGEMOUTH BASS *Micropterus salmoides floridanus* TO IMPROVE FISHING AND ASSOCIATED ECONOMIC ACTIVITY AT LAKE GRIFFIN, FLORIDA

By

KURT WILLIAM LARSON

A THESIS PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2009

To my wife Andrea and my family

ACKNOWLEDGMENTS

I thank the many people who helped me with this project. Special thanks go to my advisor Dr. Dan Canfield Jr. for taking me on as a student and providing me with a project. I also thank my committee members Dr. Charles Cichra and Dr. Charles Adams for their guidance and advice. Special appreciation goes to Porter Hall who was my partner for all the field work in 2006. I again thank Dr. Canfield and his staff that provided me with the largemouth bass transfer data for years I was not directly involved with the project. Gratitude is expressed to Johnny Metcalf and the Greater Orlando Aviation Authority for providing access to all the waters on the Orlando International Airport property and participating in field work. Funding for this project was provided by the Lake County Water Authority with assistance from the Harris Chain of Lakes Restoration Council.

TABLE OF CONTENTS

page

ACKNOWLEDGMENTS ....4

LIST OF TABLES ....7

LIST OF FIGURES ....8

ABSTRACT ....9

CHAPTER

1 INTRODUCTION ....10

2 METHODS ....15

Donor Site ....15
Collection ....15
Transfer and Stocking ....16
Recovery ....17
Creel Survey ....17
Angler Surveys ....18

3 RESULTS AND DISCUSSION ....22

Transfer Program Feasibility ....22
Electrofishing ....22
Creel Survey ....23
Caller Data ....24
Largemouth Bass Stocking ....25
Economic Activity ....26
Public Perception ....26
LAKEWATCH Report ....27
LAKEWATCH Data ....27
Telephone Survey ....28
Survey Results Analyses ....30
Extrapolated Figures ....31
Benefit:Cost Values ....32
Public Funding ....33
Public Support ....34

4 CONCLUSIONS ....42

APPENDIX

A SURVEY ..... 46

B SURVEY RESULTS ..... 47

C SELECTED SURVEY STATISTICS ..... 49

REFERENCES ..... 50

BIOGRAPHICAL SKETCH ..... 53

LIST OF TABLES


| Table | | page |
|---|---|---|
| 2-1 | Activities associated with this study at Lake Griffin, Florida between January, 2004 and December, 2008 | 20 |
| 3-1 | Number of largemouth bass per size class transferred to Lake Griffin, Florida between December 2004 and May 2007 | 35 |
| 3-2 | Estimated weight (kg) of largemouth bass per size class transferred to Lake Griffin, Florida between December 2004 and May 2007 | 36 |
| 3-3 | Location of captured tagged largemouth bass reported by recreational anglers | 37 |
| 3-4 | Economic activity figures and benefit:cost ratios as calculated by LAKEWATCH and extrapolated from the telephone survey results for anglers at Lake Griffin, Florida | 38 |
| 3-5 | Number of respondents from question 9 of the Lake Griffin, Florida angler survey for each county/state residence | 39 |
| 3-6 | Number of respondents (N), and the number of answers to each survey question for anglers at Lake Griffin, Florida between December 2004 and May 2007 | 40 |
| 3-7 | Number of respondents per response for question 5 of the Lake Griffin, Florida angler survey | 41 |
| A-1 | Lake Griffin, Florida angler telephone survey | 46 |
| B-1 | Respondent answers to Lake Griffin, Florida angler survey | 47 |
| C-1 | Number of respondents (N), and mean, minimum (min), and maximum (max) amount of trips, years, and dollars stated by respondents fishing at Lake Griffin, Florida between December 2004 and May 2007 per survey question | 49 |

LIST OF FIGURES

Figure page

1-1 Map of Lake Griffin, Lake County, Florida .....14

2-1 Orange Hallprint plastic-tipped dart tags implanted in largemouth bass greater than 275 mm total length .....21

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

STOCKING WILD-ADULT LARGEMOUTH BASS *Micropterus salmoides floridanus* TO IMPROVE FISHING AND ASSOCIATED ECONOMIC ACTIVITY AT LAKE GRIFFIN, FLORIDA

By

Kurt William Larson

May 2009

Chair: Daniel Canfield Jr.
Major: Fisheries and Aquatic Sciences

Eutrophication has been implicated in the collapse of productive largemouth bass fishing at Lake Griffin (Lake County), Florida. Consequently, the Harris Chain of Lakes Restoration Council recommended and the Lake County Water Authority (LCWA) funded Florida LAKEWATCH to start a wild-adult largemouth bass transfer program for Lake Griffin. After three-years of stocking, the effectiveness of the fish transfer program relative to increasing angler and economic activity was evaluated. The results of the program, as well as angler surveys, were used to determine the feasibility and cost-effectiveness of the largemouth bass transfer program. It was found possible to locate, capture, and stock over 4,000 wild-adult largemouth bass from private waters for at least three continuous years during the cooler months (December thru April) of the year. Largemouth bass angler effort increased by up to three-fold during the stocking program based on Florida Fish and Wildlife Conservation Commission creel survey results. The economic activity generated by the project was estimated to be as much as $2.7 million annually. Therefore, the stocking of wild-adult largemouth bass is recommended to agencies interested in providing a boost to angler activity and economic activity associated with poorly producing water bodies.

# CHAPTER 1
# INTRODUCTION

Eutrophication has been implicated in the collapse of productive fishing activities on lakes throughout the country. Increased frequency and magnitude of fish kills and loss of desirable fish species can occur, as well as a lowering of the perceived aesthetic value of the water body for anglers (Larkin and Northcote 1969; Canfield and Hodgson 1983; Canfield et al. 1985; Lee et al. 1991). Often, the causes of cultural eutrophication, resulting from non-point sources, are not immediately reversible and fishing can remain unproductive for many years during restoration efforts. In naturally eutrophic lakes, nutrient enrichment may not be the primary cause of a fishery decline (Canfield et al. 2000), rather changes in habitat (Johnson et al. 1982; Moyer et al. 1995) may be the primary factor, especially for fish like the largemouth bass *Micropterus salmoides*. To mitigate biological and economic losses to one such lake, Lake Griffin (a 6,679 ha public fish management lake located in Lake County, Florida), an adult largemouth bass transfer program from private, non-fished waters to this public fishing water was initiated in 2004. This effort occurred while the State of Florida implemented major restoration programs in the Harris Chain of Lakes (Harris Chain of Lakes Restoration Council (HCLRC), 2002, 2003, 2004 and 2005 Reports to the Florida Legislature).

The Florida largemouth bass *Micropterus salmoides floridanus* is an important gamefish to Florida's anglers. Largemouth bass fishing in Florida is an important source of revenue, contributing $632 million per year to the economy of Florida (U.S. Department of Interior et al. 2006). When largemouth bass fishing becomes poor on a body of water, management agencies such as the Florida Fish and Wildlife Conservation Commission (FWCC) may implement a stocking program (Smith and Reeves 1986). Typically, small fish (fry and fingerlings) are stocked in large numbers (up to 175,000 per ha) to increase recruitment, but not all lakes respond

well to this type of stocking effort (Loska 1982; Boxrucker 1986). Mortality of small stocked fish can be high (up to 90%), particularly in waters that have no cover or structure (Miranda and Hubbard 1994). Low abundance of aquatic macrophytes or nursery areas have contributed to low recruitment of largemouth bass in Florida lakes (Cailteux 1999). In Florida, the stocking of small fish has yielded limited success, with only a few exceptions (new ponds and reservoirs) (Mesing 2003). Adult stocked fish, however, can exhibit lower mortality (less than 20%) because predation on large fish is less intense (Miranda and Hubbard 1994), but stocking large numbers of adult largemouth bass to improve fishing at a large lake such as Lake Griffin has not been documented in Florida or elsewhere. The best evidence that stocking adult gamefish might be a useful tool for fish management agencies was first provided by the fish rescue programs conducted in the upper Mississippi River drainage in the 1950s (Carlander 1954). The Iowa Department of Natural Resources, for example, relocated adult gamefish from flooded land adjacent to the Mississippi River to public fishing lakes before the waters receded. The second was a study by Baer et al. (2007) where the stocking of adult brown trout (*Salmo trutta*) was reported to enhance recreational fisheries and increase fishing effort for a limited amount of time.

Lake Griffin, the farthest downstream lake in the Harris Chain of Lakes (Fig. 1-1), is renowned for largemouth bass and black crappie (*Pomoxis nigromaculatus*) fisheries (Benton 2000). Due to extensive shallow marshes, 3,642 ha are available for continuous public fishing in Lake Griffin, while an additional 2,873 ha of marsh are available for public fishing when water levels are high (Shafer et al. 1986). Therefore, depending on water level, the total available area of fishable water can vary from 3,642 ha to 6,515 ha. There is no report on the economic value of fishing for Lake Griffin alone, but a study by Milon and Welsh (1989) stated that the annual

value of fishing on Lakes Griffin and Harris in 1988 was estimated at $1.7 million dollars, with the total economic activity associated with fishing estimated at $2.3 million dollars annually. Corrected for inflation, these values in 2008 would be $3.14 million and $4.25 million, respectively (Consumer Price Index, U.S. Department of Labor 2008). From the winter of 1987/1988 to the winter of 1998/1999, the value of the fishery at Lake Griffin declined about 90% (from $3.1 million to $312,570) with substantial economic loss to the community (Benton 2000). The peak values reported by Benton (2000) and by Milon and Welsh (1989), suggests that the fishery was productive and valuable in 1988. The decline in the fishery was directly linked to a decline in the largemouth bass population, which reached a historical low in 1999 (Benton 2000). The mean biomass of sport fish (as estimated by use of blocknets and rotenone) in the littoral zone of Lake Griffin was 81% lower in 1999 (66 kg/ha) than in 1986 (345 kg/ha). Electrofishing by FWCC also showed an extremely low abundance (total CPUE < 0.04 fish/min) of adult largemouth bass, and no reproduction by largemouth bass was documented (Benton 2000). Consequently, HCLRC (in 2002) recommended to the Legislature and management agencies that adult largemouth bass be stocked into Lake Griffin to mitigate economic losses to the local economy, while other restoration projects were underway (e.g., nutrient removal, aquatic macrophyte planting).

In the summer/fall of 2004, the Lake County Water Authority (LCWA) accepted the recommendation of the HCLRC and funded the University of Florida/Institute for Food and Agricultural Sciences' (UF/IFAS) Florida LAKEWATCH program for three years to transfer large numbers (4,000+ per year) of adult (>200 mm total length, Nieman et al. 1979) largemouth bass into Lake Griffin. Non-fished, private donation waters were located on the property of the Greater Orlando Aviation Authority (GOAA), at the Orlando International Airport (MCO).

Largemouth bass were collected from these water bodies from December 2004 to May 2007. During this period, there was no direct funding to evaluate the effectiveness of the different components of the stocking program or the overall effectiveness of the stocking program on stimulating economic activity in the Lake Griffin area. Therefore, this project was conducted to provide this information to others who might be considering a similar adult largemouth bass stocking program for their lake. The feasibility of each aspect of the project was evaluated and defined as the final objectives (objectives in this project changed over time in response to political influences).

The objectives were 1) to evaluate the feasibility of annually collecting over 4,000 adult largemouth bass from private waters and transferring the fish to a distant (112 km) lake (i.e., logistics of locating and moving fish), 2) to evaluate the contribution to Lake Griffin anglers (i.e., do fish live long enough to be caught), 3) to determine the percent contribution of stocked fish to the receiving fishery, and 4) to provide an assessment of the feasibility of the stocking program on the economic activity of the largemouth bass fishery at Lake Griffin (i.e., resulting economic activity vs. cost of the program).

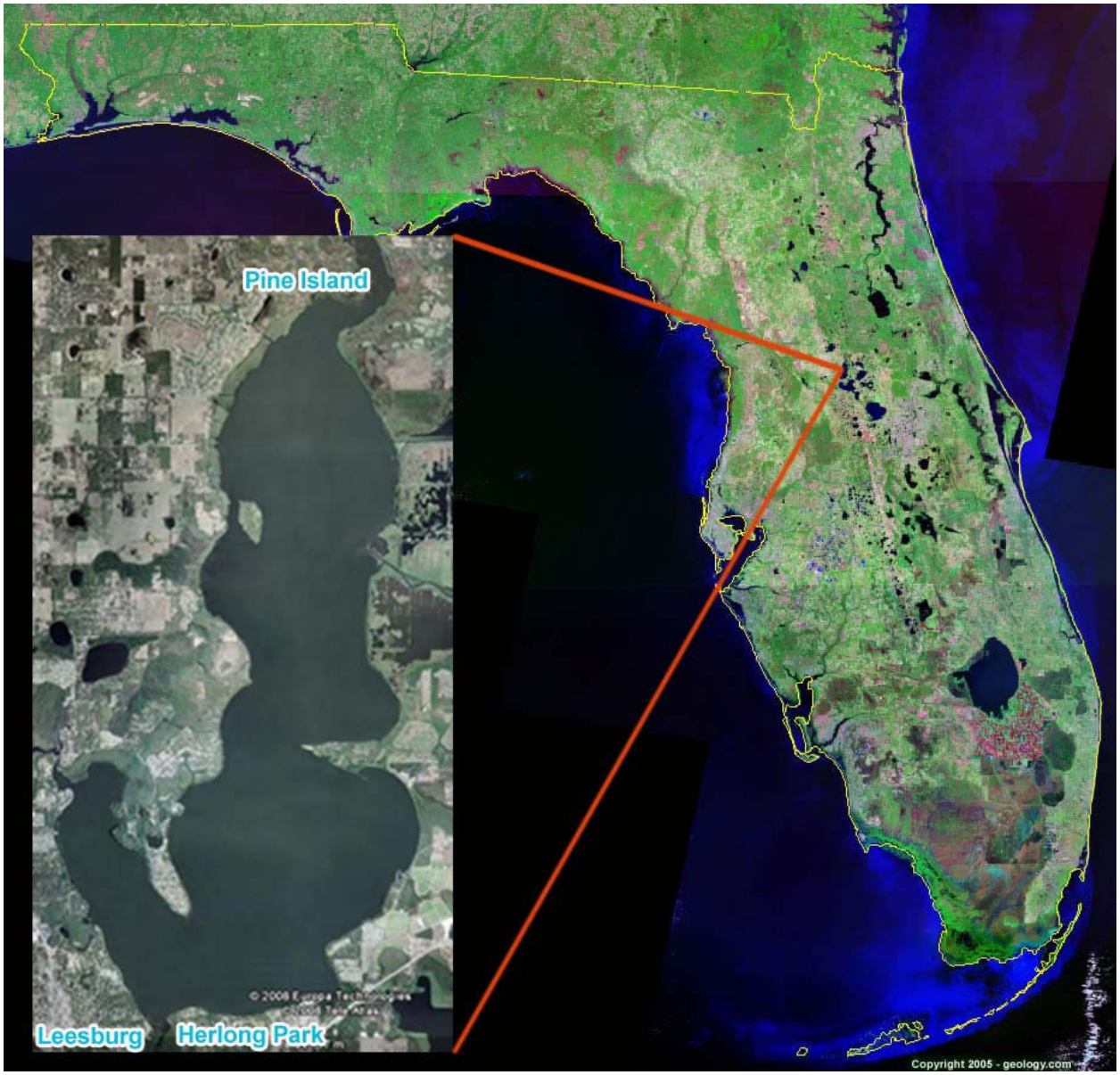


Figure 1-1. Map of Lake Griffin, Lake County, Florida

# CHAPTER 2
# METHODS

## Donor Site

To begin a fish transfer project, a donor site must be located that is capable of producing an annual yield suited to the objectives developed for the receiving lake (4,000+ adult fish per year for Lake Griffin, dictated by the contract with LCWA). Florida LAKEWATCH reached out to the community and established a partnership with the Greater Orlando Aviation Authority which offered the waters located at the Orlando International Airport (MCO). MCO proved to be an excellent donor site for the collection of adult largemouth bass because of the large number of accessible water bodies (over 85 lakes and ponds interconnected with canals).

## Collection

To collect wild largemouth bass for transportation, Florida LAKEWATCH determined the most efficient method for capturing fish alive and in healthy condition was by use of electrofishing. LAKEWATCH used electrofishing boats equipped with a 5-kw generator (Honda EG5000) and either a Smithroot model VI-A pulsator or a Coffelt model VVP-15 pulsator. One individual operated the boat and pulsator, while one or two individuals netted fish from the bow of the boat.

The scientific collection permit issued by the FWCC stipulated that only *Micropterus salmoides floridanus* be transferred into Lake Griffin. The genetic makeup of largemouth bass populations at MCO and other potential donation sites was assessed during the summer of 2004 using the electrophoresis methods of Childress (2004) to ensure collected fish were *M. s. floridanus*. MCO is located in the zone of Florida where *M. s. floridanus* is the dominant largemouth bass subspecies (Philipp et al. 1983).

## Transfer and Stocking

LAKEWATCH began the first year of largemouth bass transfer into Lake Griffin in December 2004 and ended fish transfers in May 2005 (Table 2-1). The second (December 2005 to May 2006) and third (December 2006 to May 2007) stocking efforts were conducted similarly to the first year, but K. Larson was the biologist in charge of the second year transfer program, and assisted during the third year (Table 2-1). The transfers began in December and ended in May because the lake's water temperature was below the 26 C thermal limit mandated by the FWCC largemouth bass transfer permit. All captured and stocked largemouth bass were measured to the nearest millimeter for total length (TL). All fish were given a left-pelvic fin clip prior to being transferred to Lake Griffin, while fish larger than 275 mm TL were also implanted with an orange Hallprint type PDA plastic-tipped dart tag (Fig. 2-1). The tag was imprinted with an individual identification number and a contact telephone number for Florida LAKEWATCH (Fig. 2-1). Once marked, fish were placed into an aerated hauling box located on a pick-up truck and then transported to boat ramps located around Lake Griffin. At Lake Griffin, the fish were transferred from the trucks, with nets, into aerated-hauling boxes, located on boats, which were then used to distribute the fish throughout the lake. Fish were typically released near shoreline vegetation. However, if it was determined that the fish release was being observed by participants in one of several largemouth bass tournaments held during the study period, fish were then released in open-water near the middle of the lake.

Total fish numbers and estimated weights (calculated from FWCC's length-weight equation for largemouth bass (log (weight (g)) = -5.47 + 3.24 x log (length (mm))); John Benton pers. comm. 2007) for all fish transported to Lake Griffin were recorded. While project contract requirements focused on the total number of largemouth bass greater than 200 mm TL

transported, individual weights of fish stocked were estimated because the author's experiences suggest that the public views quality largemouth bass in terms of weight of each fish.

## Recovery

Immediately after each December–May period of stocking (2004-2007), an evaluation of the transfer program's potential effect on the resident largemouth bass population was conducted by collecting largemouth bass via electrofishing from the near-shore waters of Lake Griffin (Table 2-1). Largemouth bass were sampled at 16 sites, which were spaced equal distances around the perimeter of Lake Griffin. Ten minutes of electrofishing were conducted at each site with one netter on the bow of the boat attempting to collect only those largemouth bass greater than 200 mm TL. All sampled fish were examined for pelvic fin-clips and/or orange Hallprint dart tags. The number of marked and unmarked largemouth bass was recorded to determine the percentage of stocked fish in Lake Griffin's largemouth bass population.

## Creel Survey

A roving creel survey is conducted by FWCC annually as part of the Harris Chain of Lakes monitoring program (Table 2-1). K. Larson assisted with the creel survey June 2006 through March 2007 (Table 2-1). The creel survey was conducted on the main part of Lake Griffin (Herlong Park in the south to Pine Island in the north) and was not conducted on the many canals and other backwater/marsh areas connected to the lake. Anglers encountered along the creel survey route were interviewed regarding targeted specie(s), length of time fishing (hrs), and the number of fish caught. Data were analyzed using FWCC's creel analysis program (Creel Analysis Version 1.0, located at the FWCC Eustis lab, was used with the assistance of John Benton).

## Angler Surveys

Angler call-ins, regarding caught tagged fish, were recorded by LAKEWATCH personnel (primarily by K. Larson) between January 1, 2006 and December 31, 2007 (Table 2-1). Information collected for the survey included the angler's name, the fish's tag number and size, location caught, and release or kept status of the fish. In addition, a second survey was conducted between May 25, 2007 and December 31, 2007 on a portion of anglers reporting tagged fish (Table 2-1). These respondents were either interviewed during their initial report or called back (randomly selected from the list of callers). The anglers were asked nine short-answer or "yes or no" questions to estimate the effect of Lake Griffin fishing effort on the regional economic activity (Table A-1). Respondents to the survey were those interested enough to call. The respondents were not randomly selected from all anglers using Lake Griffin during the study period because the total population of users was not known. Because of limited funding, no reward was associated with reporting a tag, as has been done at other Florida lakes (e.g., Rodman Reservoir; Henry 2003). Only a subset of total users (those curious enough to report their catch) were identifiable for the phone survey. The results, however, represent the experiences and views of an active and interested segment of Lake Griffin anglers.

Once the phone surveys were complete, the results were used to investigate aspects of Lake Griffin largemouth bass angler behavior and estimate monetary values for the Lake Griffin largemouth bass fishery. The results were also used to identify three types of economic benefits 1) total expenditures by residents and non-residents, 2) expenditures by non-residents, and 3) value (to Lake Griffin anglers, benefit:cost ratio) of providing improved largemouth bass fishing. To test for significant differences between the means (of answers given by respondents to selected questions), a t-test was used (MS Excel 2008). In addition, the estimated values from the survey were extrapolated to total expenditures and compared to those of the completed

LAKEWATCH estimates (see LAKEWATCH 2007). The comparison allowed for an evaluation of LAKEWATCH's methods, and the effectiveness the largemouth bass transfer program had on Lake Griffin's regional economic activity.

Table 2-1. Activities associated with this study at Lake Griffin, Florida between January, 2004 and December, 2008

| | [A]**2004** | | | [A]**2005** | | | [A]**2006** | | | [A]**2007** | | | **2008** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Activity** | JFMA | MJJA | SON**D** | **JFMA** | **M**JJA | SON**D** | **JFMA** | **M**JJA | SON**D** | **JFMA** | **M**JJA | SOND | JFMA | MJJA | SOND |
| Stocking | | | X | X | X | X | X | X | X | X | X | | | | |
| Creel Survey | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Angler Survey #1 | | | | | | | X | X | X | X | X | X | | | |
| Angler Survey #2 | | | | | | | | | | | X | X | | | |
| [B]Electrofishing Survey | | | | | X | | | X | | | X | | | | |

[A]**Bold** months are stocking months.
[B]Electrofishing conducted to assess percentage of Stocked Largemouth Bass in Lake Griffin.

Figure 2-1. Orange Hallprint plastic-tipped dart tags implanted in largemouth bass greater than 275 mm total length

# CHAPTER 3
# RESULTS AND DISCUSSION

## Transfer Program Feasibility

The total number of largemouth bass stocked into Lake Griffin since December 2004 was 13,933 (> 200 mm TL), including 10,538 tagged largemouth bass (> 275 mm TL). A total of 4,021 largemouth bass over the minimum legal length limit (356 mm TL) were transferred during the program. Between December 2004 and May 2005, a total of 4,234 largemouth bass were stocked. For the second year of stocking, a total of 5,033 fish were transferred and 4,666 fish were moved between December 2006 and May 2007 (Table 3-1). The transported minimum legal-length (356 mm TL) fish ranged in weight from 0.6 to 6.8 kg and anglers have reported catching tagged fish up to 4.5 kg, which has generated considerable support in the angling community. The estimated total weight of largemouth bass transferred was 17,269 kg (Table 3-2). These numbers demonstrate the feasibility of locating 4,000+ adult largemouth bass from private Florida waters and transporting them to a distant public fishing lake for at least three consecutive years. The primary limitations to such a program are the area of available private water containing fish to be removed for stocking, fish genetics, personnel time on the water, and distance from private waters to the lake targeted for stocking. Each of these limitations imposes costs that will ultimately determine the total cost of an adult largemouth bass stocking program for any specific water body.

## Electrofishing

LAKEWATCH and FWCC conducted electrofishing surveys after each period of stocking (summer of 2005, 2006, and 2007) to determine if the number of largemouth bass in Lake Griffin was increased by the adult-largemouth bass stocking program. LAKEWATCH personnel and anglers did not observe any deceased largemouth bass immediately after stocking

(up to one week). After the first period of stocking in 2005, 15 marked (stocked) of 151 total largemouth bass (10%) were captured in a single day of May electrofishing from seven of 12 lake-wide sampling transects. FWCC captured 19 marked of 98 total largemouth bass (18%) from 13 of 29 lake-wide sampling transects during multiple days of electrofishing. Similar results occurred in 2006 when LAKEWATCH captured 10% (15 of 153) and FWCC captured 9% (19 of 209) stocked largemouth bass. In 2007, LAKEWATCH captured 13% (123 of 1,023) and FWCC captured 10% (27 of 282) stocked largemouth bass. The consistent capture, of stocked largemouth bass over the three sampling periods, indicates that the stocking program had increased the largemouth bass population by at least 10% (electrofishing recapture mean of 11.7% stocked largemouth bass). However, these percentages for Lake Griffin are underestimates of the contribution of stocked fish to the Harris Chain of Lakes because largemouth bass tagged and released in Lake Griffin have been caught and reported by recreational anglers from other lakes in the Chain as well as other connected and non-connected waters (Table 3-3). Clearly, the largemouth bass can move great distances or are transported by the anglers themselves. Because the transferred fish, greater than 200 mm TL, represent approximately 10% of the in-lake bass population, it is clear that stocking of large numbers of largemouth bass can positively affect largemouth bass abundance in a short period of time (3 years) even in a lake the size (3,815 ha to 6,000+ ha depending on water level) of Lake Griffin.

**Creel Survey**

Increasing the number of largemouth bass in a water body, with a limited fishery, only impacts the regional economic activity (a key issue in most fish management discussions) if angler effort at the water body is increased as a result of stocking. FWCC's creel survey results show that the 2002/2003 largemouth bass fishing effort at Lake Griffin was 724 ± 168 angler-hours, but increased in 2003/2004 to 2,649 ± 533 angler-hours. After the first year of stocking,

angler effort in 2005/2006 nearly doubled to 4,034 ± 675 angler-hours. In 2006-2007, the fishing effort had nearly tripled to 6,443 ± 1,012 angler-hours when compared to the effort during 2003/2004. Although the effort increase can not definitively be linked to the stocking program, the increase in largemouth bass angling effort is what would be predicted with a large-scale stocking program such as the largemouth bass transfer program at Lake Griffin. The increase correlates directly with the stocking program.

**Caller Data**

Between January 1, 2006 and December 31, 2007, anglers placed 377 phone calls reporting catches of tagged fish. There were 293 calls in 2006 and 84 calls in 2007. The mean number of calls per month was 15.7, and the mean number of calls per year was 188.5. These calls came to LAKEWATCH without any advertisement of the stocking program, public announcements requesting anglers to report caught tagged-fish, or monetary rewards for reporting tagged fish. When no monetary rewards are given to anglers reporting their catches (as was the case for the Lake Griffin largemouth bass), 10% of catches of marked fish are typically reported (Henry 2003). Thus, a reporting rate of 10% assumed to be the maximum.

Not all caller data were available for the tagged largemouth bass reports received between January 1, 2006 and December 31, 2007. The two reasons for this are: 1) Anglers not willing to remain on the phone to answer questions and 2) Incomplete information left on LAKEWATCH's answering machine. As a result, 326 catch locations were recorded and 319 kept or release statuses were recorded. Of the 326 locations, 84 (26%) were from the main part of Lake Griffin, 212 (65%) were from adjacent waters (e.g., connected canals, marshes), and 30 (9%) were from other waters (e.g., Lake Harris) (Table 3-3). Of the 319 kept or released statuses, 287 (90%) fish were released and 32 (10%) fish were kept.

## Largemouth Bass Stocking

While anglers may like to see larger fish stocked into a lake for an "immediate fix" of the problem, fisheries biologists need to consider the size and numbers of fish stocked. Stocking larger size largemouth bass would be preferred by most fisheries biologists because mortality rates fall for larger fish because of a decline in predation (Miranda and Hubbard 1994). A total of 6,909 largemouth bass, between 200 and 305 mm TL (Table 3-1), were transferred during the program because they are often the most abundant size group of largemouth bass in Florida waters and they have a higher survivability rate than fry or fingerling largemouth bass (Hoyer and Canfield 1996). When largemouth bass of this size are stocked into a lake with abundant forage fish, as is the case for Lake Griffin, they should grow and provide keeper-sized (356 mm TL) fish to Florida anglers within the next 1 to 2 years (Hoyer and Canfield 1994). They also can spawn within one year, therefore fish in this size range should contribute to the fishery for several years (see DeVries and Stein 1990). These fish could also become important to a fishery where reproduction has been limited (Benton 2000).

There is evidence, from this transfer program, that stocked largemouth bass can live long enough to be caught multiple times. A total of 20 tagged largemouth bass were caught/reported multiple times (18 two times and 2 three times). The time between captures ranged from 7 days to 9.5 months and growth ranged from none to 0.91 kg. Nearly 90% of anglers reported releasing the fish (see caller data section), suggesting that Lake Griffin is a mostly catch and release largemouth bass fishery. There is additional evidence that the transferred fish can persist for multiple years as well. The shortest time between stocking and capture was 1 day, and the longest was 2 years and 7 months. These data alleviate doubt that transferred fish do not live more than a few days, and cannot be caught multiple times. In addition, some fish are

presumably spawning each year (pers. comm. with anglers who have observed tagged largemouth bass on spawning beds).

While stocking larger-sized fish can provide a relatively immediate stimulation to a declining fishery, the stocking program should only be viewed as a "temporary" fix to the problem especially if habitat is limited. The word "temporary", however, must be placed into context relative to the objectives of any major stocking program. Certainly stocked fish will die, but their death could occur soon after stocking or after many years of living in the water body. Angler dissatisfaction may not occur for several years as stocked largemouth bass can produce sufficient young that recruit into the fishery. Consequently, it is unknown how long the "temporary" improvement will last in any specific lake. The Lake Griffin stocking program, however, provides clear evidence that the stocking of larger-sized largemouth bass can provide a valuable and nearly immediate (1-2 years) boost to recreational angler catch. Based on the findings from this study, similar results may be obtained at other lakes within Harris Chain.

## Economic Activity

### Public Perception

Largemouth bass fishing is a major source of revenue ($632 million per year) to Florida's economy (U.S. Department of Interior et al. 2006). Despite fishing being an important part of the economy, a question arising when undertaking a large-scale stocking program of large fish is whether the benefits of such an effort to the community exceed the costs. The public wants to know if the project is just benefiting a "few" largemouth bass anglers or enhancing the overall economic activity in the community. The largemouth bass transfer program conducted by Florida LAKEWATCH was not designed to directly measure economic impacts at Lake Griffin, but information was collected that can provide insights into the impact on economic activity for the Lake County Water Authority (LWCA), the project funding agency. The available information

from this study of Lake Griffin suggests that there is a positive benefit:cost ratio, where benefits are defined as estimated expenditures by anglers greater than the cost of largemouth bass stocking. .

**LAKEWATCH Report**

After the last period of largemouth bass transfers, LAKEWATCH composed and presented a report of the data to the LCWA (LAKEWATCH 2007). Most notably included were numbers/sizes of largemouth bass transferred, caller data, and estimates of regional economic activity. LAKEWATCH used the caller data (number of calls) to extrapolate a range of economic activity estimates based on the results from the 2001 National Survey of Fishing, Hunting, and Outdoor Recreation (U.S. Department of Interior et al. 2001). An angler telephone survey was conducted on a portion of callers to evaluate the feasibility of LAKEWATCH's methods, and to gain limited, but more direct, insights on Lake Griffin's regional economic activity.

**LAKEWATCH Data**

LAKEWATCH used numbers from the 2001 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (U.S. Department of Interior et al. 2001) and phone calls to extrapolate a range of estimated expenditures on Lake Griffin (Table 3-4). The factors used by LAKEWATCH were: mean fishing day expenditure per Florida angler ($53, corrected for inflation), mean fishing days per year per Florida angler (16), mean yearly fishing expenditure per Florida angler ($1,570, corrected for inflation), and total phone calls (377). LAKEWATCH estimated the direct fishery values between January 2006 and December 2007 (the duration of angler phone calls, 2 years) (LAKEWATCH 2007). In LAKEWATCH's estimate, it was assumed that each call represented only one angler fishing for one day, the fishing expenditure for the callers was $19,981 ($53/day x 377 anglers). Many callers, however, indicated there were

two individuals on the fishing boat so the dollars expended based on the direct phone calls could be as much as $39,962 ($53/day x 754 anglers). The estimate for 2 anglers assumes that no shared costs exist when more than one angler is involved in a trip. Because Lake Griffin is fished by more anglers than those calling in to report catching tagged fish, and the community hosts many major largemouth bass tournaments (e.g., BASS), LAKEWATCH felt that these expenditure estimates were a gross underestimate of total economic activity (LAKEWATCH 2007).

When no monetary rewards are given to anglers reporting their catches (as is the case for the Lake Griffin largemouth bass), as few as 10% of captured fish are typically reported (Henry 2003). Therefore, LAKEWATCH estimated expenditures were calculated for 3,770 anglers (each call represented one angler fishing one day) and 7,540 anglers (each call represented two anglers fishing one day). As a result, LAKEWATCH estimated expenditures ranged from $199,810 ($53/day x 3,770 anglers) to $399,620 ($53/day x 7,540 anglers) for the 10% phone reporting rate over two years (LAKEWATCH 2007). LAKEWATCH felt that these values were an underestimate of total economic activity as well.

To calculate another estimate for angler expenditure from January 2006 through December 2007, LAKEWATCH multiplied the previous figures by the Florida angler mean of 16 fishing trips per year (assuming all trips were taken at Lake Griffin) as reported by the U.S. Department of Interior (2001). Therefore, angler expenditures might have ranged from $3,196,960 ($53/day x 16 trips x 3,770 anglers) to a maximum of $6,393,920 ($53/day x 16 trips x 7,540 anglers) (LAKEWATCH 2007).

**Telephone Survey**

Independent of HCLRC funding for fish stocking, a phone survey was conducted to assess angler and economic activity on Lake Griffin (Table A-1). In addition, the survey allowed

the comparison of these new data to that of LAKEWATCH's estimated values (LAKEWATCH 2007). There were 51 responses to each of the nine questions in the telephone survey (Appendix B). Of the 377 anglers, reporting tagged largemouth bass captures, only 51 were contacted due to incorrect or withheld phone numbers, the inability to contact reporters, and time constraints. Lake County residents represented 55% (28) of the survey respondents (Table 3-5). Forty-five percent (23) of the respondents were non-county residents (Table 3-5). Of the non-county residents, 61% (14) were Florida residents and 39% (9) were out-of-state residents (Table 3-5). The mean trip expenditure per angler was $43, and the mean angler trips per year was 64 (Table 3-4). Angler reported mean largemouth bass fishing expenditure per year of $1,587 (Table 3-4). The total direct expenditure by the 51 respondents was $80,915. The total expenditure was greater for residents ($55,270) than non-residents ($25,645). The mean expenditure per year was also greater for residents ($1,974) than non-residents ($1,115), but the mean expenditure per day was greater for non-residents ($52) than residents ($25). There were two respondents (both non-residents) who targeted largemouth bass zero days per year, resulting in two annual expenditures of $0. The two respondents still spent money fishing Lake Griffin, but in the pursuit of species other than largemouth bass.

The mean years of fishing Lake Griffin was 8.3 and the majority (55%) of anglers had been fishing Lake Griffin five years or less. Twenty-nine percent (15) of the anglers said they were caching more fish since the largemouth bass transfer program began (Table 3-6). Only 8% (4) had been catching less and 63% (32) had been catching the same amount (no change). Half (2) of the anglers, that were catching fewer fish, cited inaccessibility to the lake (low water in canals) as the reason. Forty-one percent (21) of anglers said they were fishing more since the largemouth bass transfer program began (Table 3-6). Only 8% (4) said they were fishing less and

51% (26) were fishing the same amount (no change). Half (2) of the anglers, that were fishing less, cited inaccessibility to the lake (low water in canals) as the reason. Most anglers (57%, a total of 29) had no knowledge of the largemouth bass transfer program, while 33% (17) knew a little, 6% (3) knew a moderate amount, and 4% (2) knew a lot (Table 3-7). The mean amount anglers were willing to donate to a stocking program similar to the largemouth bass transfer program was $32 (Table C-1). Most (65%) were willing to donate $20 or less. All 51 anglers supported the largemouth bass transfer program at the cost of $15 per fish (Table 3-6).

**Survey Results Analyses**

Twenty-nine of the survey respondents said they knew nothing about the Lake Griffin largemouth bass stocking program, whereas 22 said they at least knew a little. Of the anglers, that said they knew nothing, 12 (41%) said they were fishing more, while 9 (41%) of the anglers, who said they knew at least a little, were fishing more. Thus on average, there does not seem to be a difference in fishing activity between anglers who knew nothing about the program and anglers who knew something.

The contribution amount that respondents were willing to donate to an adult largemouth bass stocking program on Lake Griffin were used to compare possible differences between residents and non-residents as well as between the length of time fishing Lake Griffin. The difference between resident angler donation values (N = 28, mean = $38.93) and non-resident donation values (N = 23, mean = $23.48) was not significant (P = 0.26) at the 95% confidence level. The difference between donation values of anglers who have fished Lake Griffin for five years or less (N = 28, mean = $34.82) and donation values of anglers who have fished Lake Griffin for more than five years (N = 23, mean = $32.98) was not significant (P = 0.36) at the 95% confidence level.

**Extrapolated Figures**

The values estimated by LAKEWATCH and those calculated from the phone survey represent a portion of total economic activity. Total economic activity is not only the expenditures by anglers, but also related industries in the region (e.g., hotels). To evaluate the economic values estimated by LAKEWATCH, estimated angler expenditures were calculated based on the telephone survey results. In addition, the LAKEWATCH values (two year expenditures) were normalized on an annual basis for comparison (Table 3-4). An estimate for a portion of total economic activity (residents + non-residents) was calculated for one year. Using the 10% report rate (Henry 2003) assumption, no shared cost assumption between two anglers, and annual expenditures from the phone survey, the values might have ranged from $2,991,495 (188.5 x 10 x $1,587) for one angler to $5,982,990 (188.5 x 2 x 10 x $1,587) for two anglers. These values are greater than the 2007 LAKEWATCH estimate normalized on an annual basis, and similar to the two year LAKEWATCH estimate (Table 3-4).

If fish were not stocked into Lake Griffin, many anglers would still fish. From the phone survey, nearly 30% of the anglers said they were catching more fish and 41% proclaimed they are fishing more since the stocking program was initiated. If only 41% of the expenditures generated by fishing at Lake Griffin can be attributed to the stocking program, the dollar figures would range from $1,226,513 ($2,991,495 x 0.41) for one angler per boat, to $2,453,026 ($5,982,990 x 0.41) for two anglers per boat (Table 3-4). Nearly half (45%) of the anglers interviewed were not residents of Lake County. If this percentage was attributed to “new” money, then the county could have gained between $1,346,173 ($2,991,495 x 0.45) for one angler and $2,692,346 ($5,982,990 x 0.45) for two anglers (Table 3-4). Again, these values are estimates for a portion of the total economic activity, but are possibly the best estimates for what Lake County gained as a result of the stocking program.

**Benefit:Cost Values**

Estimating economic dollars, associated with fishing over a short period of time, is difficult. It is, however, clear that freshwater fishing is a major, albeit diffuse, industry in Florida (U.S. Department of Interior et al. 2006). Fishing at two of the Harris Chain of Lakes (Lake Griffin and Lake Harris) was valued in the millions of dollars during the 1980s (Milon and Welsh, 1989). While the range of estimated values for the Lake Griffin fishery may be useful, the community (LCWA included) may be more interested in what it received for the money invested in stocking adult largemouth bass. There are two methods for expressing the economic activity resulting from this project. The first is local economic activity, which are the extrapolated figures from all responses. The second is non-local economic activity, which are the extrapolated figures from the non-county residents only. The distinction was made between the two because if county residents did not fish at Lake Griffin, they would likely be spending those dollars elsewhere in the county. The non-county residents made a choice to travel to Lake County and fish at Lake Griffin. If they had not, those dollars would have been spent elsewhere.

In Florida, the State assigns a replacement or recreational value to largemouth bass (Florida Administrative Code 62-11.001). For the largemouth bass released into Lake Griffin since December 2004, the total replacement value and recreational replacement values in 2007 dollars would be $238,074 and $364,134, respectively (LAKEWATCH 2007).The replacement value for one year of stocking was $79,358 (LAKEWATCH 2007). These estimates demonstrate that the LCWA received considerable value for the fish stocked into Lake Griffin. The value for the fish, however, would increase significantly if LCWA had to purchase these from private hatcheries (assuming large numbers of similar sized adult fish could be obtained) because the supply of large adult fish in private hands is limited. Furthermore, state hatcheries cannot provide a solution because production costs for adult largemouth bass are too great (Rick Stout FWCC

pers. comm. 2008). The total cost (funding amount allocated to largemouth bass stocking) to LCWA for stocking was $394,221 over three years, and $131,407 each year (LAKEWATCH 2007). Because LCWA received at least $79,358 worth of largemouth bass (conservative value) each year, the actual cost of the program each year was at most $52,049 ($131,407 - $79,358). If the values estimated by LAKEWATCH are used, the benefit:cost values could range from: 30.7:1 to 61.4:1 for one year (Table 3-4). Using the telephone survey estimates, the benefit:cost values could range from 23.6:1 to 115:1 (Table 3-4). Benefit:cost, as estimated from the phone survey, could range from 23.6:1 to 47.1:1, based on 41% increase in fishing, if the stocking program got the anglers to return to Lake Griffin. Benefit:cost from "new" money entering the county (non-resident expenditures) could range from 25.9:1 to 51.7:1 (Table 3-4). Again, these figures are probably conservative based on the economic losses (90%) that occurred in the late 1990s (Benton 2000). It is also important to note that none of these calculations include the dollars generated through the many largemouth bass tournaments being held in the Harris Chain of Lakes (Marty Hale FWCC pers. comm. 2008), which can generate as much as $3 million in three days (Wisconsin DNR 2007).

**Public Funding**

Respondents said they would donate $32 per year on average for a stocking program on Lake Griffin similar to the LAKEWATCH adult largemouth bass transfer program. The cost of the largemouth bass transfer program was $131,407/year (LAKEWATCH 2007). Given the $32 mean donation rate, 4,106 largemouth bass anglers would have to be willing to make a donation per year to cover the cost of this program. If each phone call represented two anglers, about 5,860 anglers (293 calls x 10% report rate x 2 anglers) fished Lake Griffin in 2006, more than enough to cover the cost of the program for one year. To implement a theoretical collection of

donations, a Lake Griffin or Harris Chain of Lakes largemouth bass stamp could potentially be purchased, along with a FWCC freshwater fishing license to support yearly stocking.

## Public Support

Nearly all (90%) of the respondents knew either nothing or little about the Lake Griffin largemouth bass stocking effort. If the tagged largemouth bass were advertised, like in the study by Henry (2003), I would have expected more than 377 reports with the same report rate for a no reward system (10%). For the anglers reporting caught fish, 90% indicated that they were practicing catch and release and were pleased with the largemouth bass transfer program. On a few occasions, excited anglers were able to witness the transfer of large fish from the hauling box to their fishing spot. One angler reported catching stocked largemouth bass at the release point for the next two days, and was thrilled with the stocking program. Angler psychology plays an important role in an angler's decision to fish a specific water body (LAKEWATCH 2007). A positive fishing experience at Lake Griffin enhances the probability that an angler will return.

Table 3-1. Number of largemouth bass per size class transferred to Lake Griffin, Florida between December 2004 and May 2007

| Year | Total Length (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 200 to 254 | 255 to 305 | 306 to 356 | 357 to 406 | 407 to 458 | 459 to 508 | 509 to 559 | 560 to 610 | 611+ | Total |
| 2005 | 837 | 1144 | 938 | 651 | 332 | 168 | 87 | 50 | 27 | 4234 |
| 2006 | 1041 | 1195 | 1060 | 842 | 484 | 221 | 116 | 50 | 24 | 5033 |
| 2007 | 1517 | 1175 | 946 | 492 | 275 | 142 | 80 | 31 | 8 | 4666 |
| Total | 3395 | 3514 | 2944 | 1985 | 1091 | 531 | 283 | 131 | 59 | 13933 |

Table 3-2. Estimated weight (kg) of largemouth bass per size class transferred to Lake Griffin, Florida between December 2004 and May 2007

| Year | Total Length (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 200 to 254 | 255 to 305 | 306 to 356 | 357 to 406 | 407 to 458 | 459 to 508 | 509 to 559 | 560 to 610 | 611+ | Total |
| 2005 | 243 | 675 | 976 | 1096 | 840 | 618 | 455 | 356 | 259 | 5518 |
| 2006 | 327 | 747 | 1137 | 1420 | 1229 | 807 | 584 | 333 | 206 | 6790 |
| 2007 | 471 | 734 | 1009 | 844 | 702 | 522 | 400 | 210 | 69 | 4961 |
| Total | 1041 | 2156 | 3122 | 3360 | 2771 | 1947 | 1439 | 899 | 534 | 17269 |

Table 3-3. Location of captured tagged largemouth bass reported by recreational anglers

| Location | Number of Largemouth Bass |
|---|---|
| Main Lake Griffin | 84 |
| Adjacent Lake Griffin Waters | 212 |
| Outside Lake Griffin | 30 |
| Unknown | 51 |
| Total | 377 |

Table 3-4. Economic activity figures and benefit:cost ratios as calculated by LAKEWATCH and extrapolated from the telephone survey results for anglers at Lake Griffin, Florida

| | LAKEWATCH | | Phone Survey | [A]Benefit:Cost Ratio | |
|---|---|---|---|---|---|
| | One Year | Two Year | One Year | LAKEWATCH (one year) | Phone Survey |
| **Mean Trip Cost** | *$53 | | $43 | | |
| **Mean Trips per Year** | *16 | | 64 | | |
| **Mean Angler Expenditure per Year** | *$1,570 | | $1,587 | | |
| **Estimated Expenditures (extrapolated to one or two years)** | | | | | |
| 1 Angler | $1,598,480 | $3,196,960 | $2,991,495 | 30.7:1 | 57.5:1 |
| 2 Anglers | $3,196,960 | $6,393,920 | $5,982,990 | 61.4:1 | 115.0:1 |
| **41% Fishing more since stocking** | | | | | |
| 1 Angler | | | $1,226,513 | | 23.6:1 |
| 2 Anglers | | | $2,453,026 | | 47.1:1 |
| **"New" money (45% of anglers were non-county residents)** | | | | | |
| 1 Angler | | | $1,346,173 | | 25.9:1 |
| 2 Anglers | | | $2,692,346 | | 51.7:1 |

*Values are from 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.
[A]Benefit:cost calculated by dividing estimated value by cost of stocking for one year ($52,049)

Table 3-5. Number of respondents from question 9 of the Lake Griffin, Florida angler survey for each county/state residence

| | | Out-of-County | |
|---|---|---|---|
| | Lake County | Florida | State |
| Q9 County/state of residence? | 28 | 14 | 9 |

*Locations in Appendix B.

Table 3-6. Number of respondents (N), and the number of answers to each survey question for anglers at Lake Griffin, Florida between December 2004 and May 2007

| | N | Yes | More | Less | No |
|---|---|---|---|---|---|
| Q3 Change in fish catching? | 51 | 19 | 15 | 4 | 32 |
| Q4 Change in fishing trips? | 51 | 25 | 21 | 4 | 26 |
| Q7 Support program at $15/fish? | 51 | 51 | | | 0 |

Table 3-7. Number of respondents per response for question 5 of the Lake Griffin, Florida angler survey

| | 0 None | 1 A little | 2 A moderate amount | 3 A lot |
|---|---|---|---|---|
| Q5 How much knowledge of stocking program? | 29 | 17 | 3 | 2 |

# CHAPTER 4
# CONCLUSIONS

Many aquatic professionals have concluded that the ecological restoration of the Harris Chain of Lakes will take decades (Harris Chain of Lakes Restoration Council, 2004). To bring area lakes (i.e., Lake Griffin), with poor fishing reputations, up to an acceptable fishing status will require large numbers of fish, given the size (155 to 12,489 ha) of the lakes in the Harris Chain of Lakes.

The Florida LAKEWATCH research/demonstration project clearly shows that large numbers (4,000+) of Florida largemouth bass, greater than 200 mm TL, can be located in private Florida waters, successfully captured in a short time period (a few months) during the cooler period of the year, and transported successfully to a distant public fishing lake. LAKEWATCH was also able to accomplish this for three consecutive years, with funding from LCWA each year. One stipulation was that all fish transported to Lake Griffin were of the *M.s. floridanus* subspecies because of genetic contamination concerns by the Florida Fish and Wildlife Conservation Commission.

For the Lake Griffin stocking program, a source of acceptable fish was found in the private waters located on the property of the Orlando International Airport (MCO), with the consent of the Greater Orlando Aviation Authority (GOAA), where there is no public fishing. Airports throughout Florida are beginning to undertake efforts to reduce fish populations to minimize bird strikes on airplanes. A fish transfer program is well accepted by airport authorities because of a preference not to kill fish. Consequently, airports like MCO could become long-term providers of large numbers of adult (greater than 200 mm TL) largemouth bass in Florida. Other sources of private non-fished donor waters can also be found in Florida. These include power plant cooling lakes, quarry pits, Department of Transportation lakes, golf course ponds,

and citizen-owned water bodies. Again, the genetic strain of the fish may have to be determined prior to transportation if the state fish and wildlife agency have concerns about genetic stock mixing. It is this "win-win" situation that makes fish transfer programs a viable management tool to improve fishing in public water bodies.

The transferred largemouth bass could either replace or complement fish grown at FWCC's hatcheries. The limited electrofishing studies conducted by LAKEWATCH and FWCC also demonstrated that many largemouth bass released into Lake Griffin survived and were distributed throughout the lake. More importantly, the transferred fish comprised a substantial percentage of Lake Griffin's largemouth bass population. The advantages of using these fish over hatchery-grown fish, therefore, are that they are of larger size (greater survivability), acclimated to living in Florida waters, and large enough (quality-sized, $\geq$ 275 mm TL) to contribute immediately to the fishery (Mesing 2003). The benefit:cost values from wild-adult largemouth bass transferred into Lake Griffin provide evidence that this method is advantageous to the management agency (LCWA).

After each year of stocking, the transferred largemouth bass comprised 10% of Lake Griffin's total largemouth bass population. A question remains, why did the percentage of stocked Lake Griffin largemouth bass not increase after multiple years of stocking? Based on discussions with anglers, it is likely that many of the largemouth bass moved on their own to adjoining canals and marshes, other lakes in the Harris Chain, or were moved by the anglers to non-connected lakes. Largemouth bass tournament weigh-ins are held on lakes Eustis and Harris, but tournament anglers catch and keep fish from Lake Griffin. These Lake Griffin fish are then released into those other lakes. Some anglers view tagged largemouth bass as a curiosity, or wanted the fish due to their size and transported them to their hometown water bodies.

Consequently, the FWCC creel survey seems to greatly underestimated the true largemouth bass fishing effort at Lake Griffin and the other Harris Chain of Lakes because at least 74% (242 out of 326) of anglers reporting tagged largemouth bass locations were not fishing the main lake (creel area).

Another objective of this study was to evaluate the effect on economic activity of Lake Griffin's largemouth bass fishery. Information solicited from anglers reporting captured tagged fish, as well as the results of the angler survey, indicate that people fishing Lake Griffin were catching a substantial number of the transferred largemouth bass and that anglers were spending their money in the Lake Griffin area. Economic returns should continue over the next few years given the practice of catch and release by most largemouth bass anglers and reproduction by the stocked fish. This is supported by the creel survey results, which indicate greater angler effort and subsequent fishery-related expenditures since the stocking program began. The magnitude and duration of economic returns to the community, however, will require that anglers maintain a positive attitude about fishing at Lake Griffin. The unique aspect of the Lake Griffin largemouth bass transfer program was the large number of wild adult fish that were released in a relatively short amount of time (3 years). These fish were immediately available to recreational anglers as evidenced by an angler reporting catches of tagged fish only one day after a stocking event. Such quick success improves anglers' views of the Lake Griffin largemouth bass fishing, and will likely increases their fishing effort as indicated by discussions with anglers and survey findings.

Results of this study suggest that future yearly stocking of at least 4,000 adult largemouth bass would increase the angler interest in Lake Griffin and continue the improved economic activity. Compared to decades of restoration costs to fully revitalize Lake Griffin largemouth bass fishing, the transfer program can provide an immediate, short-term boost to angler and

economic activity at a relatively low cost. LCWA received an immediate benefit:cost of up to $78, whereas the wait for a return on decades of restoration costs could be just that, decades. The community must also decide what benefit:cost value is acceptable before starting a fish transfer program. It is recommended that fish transfer programs are considered by agencies seeking to enhance short-term angler and economic activity on a water body given the appropriate circumstances such as fish transfer resources (vehicles, personnel, etc.), proximity of donor water bodies to receiving water body, and sufficient numbers of fish in donor water bodies. If these conditions are met, fish transfer programs similar to the one on Lake Griffin can be successful on other water bodies that are in need of fish.

APPENDIX A
SURVEY

Table A-1. Lake Griffin, Florida angler telephone survey

**Question 1**. On average, how many LMB fishing trips per year do you take on Lake Griffin? _____

**Question 2**. How many years have you been fishing (for LMB) on Lake Griffin? _____

**Question 3**. Have you experienced a change in your fishing success (number catching now vs. before) for LMB on Lake Griffin in the past 3 years? Yes ( ) No ( )

If Yes … less LMB? ( ) more LMB? ( )

**Question 4**. Has the number of fishing trips you take targeting LMB on Lake Griffin each year changed during the past 1-3 years? Yes ( ) No ( )

If Yes … increase or decrease? _____

**Question 5**. How much have you heard about stocking programs on Lake Griffin before catching the first tagged fish?

Nothing ( 0 )
A little ( 1 )
A moderate amount ( 2 )
A lot ( 3 )

**Question 6**. How much do you (and fishing partner(s)) typically spend (including truck/boat gas, oil, bait, tackle, lodging, launch fee, boat rental, food etc.) for a fishing trip on Lake Griffin? … rough estimate … $ _____

**Question 7**. Suppose you had to pay to keep stocking LMB in Lake Griffin, how much would you be willing to contribute on an annual basis $ _____

**Question 8**. Currently, the Lake Griffin stocking program costs approximately $15 per fish stocked. At this price, would you be in favor of this program continuing into the foreseeable future? Y ( ) N ( )

**Question 9**. What county do you live in? _____

APPENDIX B
SURVEY RESULTS

Table B-1. Respondent answers to Lake Griffin, Florida angler survey

| Q1. | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 |
|---|---|---|---|---|---|---|---|---|
| 6 | 20 | Yes, More | Yes, More | 1 | 50 | 100 | Yes | Orange |
| 100 | 1 | Yes, More | Yes, More | 0 | 10 | 10 | Yes | Lake |
| 0 | 8 | No | No | 0 | 10 | 0 | Yes | Marion |
| 220 | 7 | Yes, More | Yes, More | 1 | 50 | 100 | Yes | Lake |
| 10 | 30 | No | No | 1 | 30 | 10 | Yes | Marion |
| 20 | 3 | No | No | 0 | 10 | 10 | Yes | Virginia |
| 350 | 1 | No | No | 0 | 15 | 100 | Yes | Lake |
| 10 | 20 | No | No | 0 | 30 | 10 | Yes | Marion |
| 80 | 9 | Yes, More | Yes, More | 0 | 25 | 0 | Yes | Marion |
| 30 | 1 | No | No | 0 | 150 | 50 | Yes | Clay |
| 45 | 1 | Yes, More | Yes, More | 1 | 10 | 20 | Yes | Lake |
| 52 | 7 | Yes, More | Yes, More | 0 | 25 | 20 | Yes | Lake |
| 30 | 7 | Yes, Less | Yes, Less | 1 | 100 | 50 | Yes | Lake |
| 30 | 5 | Yes, More | Yes, More | 3 | 20 | 25 | Yes | Lake |
| 300 | 4 | Yes, More | Yes, More | 0 | 30 | 10 | Yes | Lake |
| 50 | 4 | No | Yes, More | 0 | 60 | 50 | Yes | Marion |
| 100 | 5 | No | No | 0 | 5 | 0 | Yes | Lake |
| 25 | 12 | Yes, More | Yes, More | 0 | 10 | 0 | Yes | Lake |
| 200 | 1 | No | Yes, More | 0 | 5 | 0 | Yes | Lake |
| 38 | 5 | Yes, More | Yes, More | 3 | 20 | 30 | Yes | Lake |
| 75 | 1 | No | No | 1 | 50 | 10 | Yes | Lake |
| 1 | 35 | No | No | 0 | 10 | 10 | Yes | Lake |
| 12 | 3 | Yes, More | No | 2 | 50 | 100 | Yes | Lake |
| 30 | 3 | No | No | 1 | 10 | 20 | Yes | Lake |
| 300 | 4 | Yes, More | Yes, More | 1 | 5 | 50 | Yes | Lake |
| 30 | 1 | No | No | 2 | 45 | 20 | Yes | Lake |
| 2 | 1 | No | No | 1 | 50 | 0 | Yes | Pasco |
| 45 | 18 | No | Yes, More | 0 | 10 | 0 | Yes | Lake |
| 300 | 2 | No | No | 1 | 5 | 10 | Yes | Lake |
| 12 | 3 | No | No | 1 | 10 | 10 | Yes | Kentucky |
| 7 | 1 | No | No | 0 | 50 | 50 | Yes | Kentucky |
| 0 | 23 | No | No | 0 | 25 | 0 | Yes | Kentucky |
| 7 | 6 | No | Yes, More | 0 | 285 | 15 | Yes | Kentucky |
| 45 | 5 | Yes, Less | Yes, More | 2 | 50 | 10 | Yes | Lake |
| 10 | 22 | No | Yes, Less | 0 | 10 | 0 | Yes | Lake |
| 7 | 1 | No | No | 0 | 290 | 0 | Yes | New Jersey |
| 30 | 5 | Yes, More | Yes, More | 0 | 10 | 25 | Yes | Lake |
| 15 | 11 | No | Yes, More | 0 | 50 | 20 | Yes | Marion |
| 15 | 10 | No | No | 0 | 70 | 20 | Yes | Hillsborough |
| 70 | 10 | No | Yes, Less | 1 | 15 | 15 | Yes | Ohio |

Table B-1 Continued

| Q1. | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 |
|---|---|---|---|---|---|---|---|---|
| 25 | 8 | Yes, Less | Yes, Less | 1 | 20 | 50 | Yes | Lake |
| 15 | 3 | No | No | 0 | 30 | 10 | Yes | Orange |
| 15 | 10 | No | No | 0 | 80 | 15 | Yes | Orange |
| 70 | 10 | No | No | 1 | 20 | 20 | Yes | Ohio |
| 30 | 10 | Yes, More | Yes, More | 1 | 30 | 50 | Yes | Lake |
| 20 | 5 | No | No | 0 | 35 | 10 | Yes | Orange |
| 5 | 2 | No | No | 1 | 20 | 25 | Yes | Missouri |
| 5 | 3 | Yes, More | Yes, More | 1 | 50 | 300 | Yes | Lake |
| 170 | 12 | Yes, Less | No | 0 | 20 | 50 | Yes | Lake |
| 30 | 40 | No | Yes, More | 0 | 125 | 100 | Yes | Alachua |
| 200 | 2 | No | No | 0 | 20 | 20 | Yes | Lake |

APPENDIX C
SELECTED SURVEY STATISTICS

Table C-1. Number of respondents (N), and mean, minimum (min), and maximum (max) amount of trips, years, and dollars stated by respondents fishing at Lake Griffin, Florida between December 2004 and May 2007 per survey question

| | N | Mean | Min | Max |
|---|---|---|---|---|
| Q1 How many trips per year? | 51 | 64 | 0 | 350 |
| Q2 How many years fishing? | 51 | 8 | 1 | 40 |
| Q6 How much spent per trip? ($) | 51 | 43 | 5 | 290 |
| Q7 How much of a donation? ($) | 51 | 32 | 0 | 300 |

# REFERENCES


Baer, J., M. Blasel, and M. Diekmann. 2007. Benefits of repeated stocking with adult, hatchery-reared brown trout, *Salmo trutta*, to recreational fisheries. Fisheries Management and Ecology 14:51-59.

Benton, J.W. 2000. Central Florida fisheries development: Lake Griffin fisheries improvement. annual report for 1999-2000. Florida Game and Freshwater Fish Commission. Tallahassee, Florida 10-31.

Boxrucker, J. 1986. Evaluation of supplemental stocking of largemouth bass as a management tool in small impoundments. North American Journal of Fisheries Management 6:391-396.

Cailteux, R. L, D. A. Dobbins, and J. J. Nordhaus.1999. Apalachicola/Ochlockonee completion report. Study XV: Evaluation of sportfish harvest restriction on Lakes Jackson and Talquin. Wallop-Breaux Project F-37. Florida Game and Freshwater Fish Commission. Tallahassee, Florida.

Canfield, D.E. Jr., R.W. Bachmann, and M.V. Hoyer. 2000. A management alternative to Lake Apopka. Lake and Reservoir Management 16:202-221.

Canfield, D.E. Jr., and L.M. Hodgson. 1983. Prediction of Secchi disc depths in Florida lakes: impact of algal biomass and organic color. Hydrobiologia 99:51-60.

Canfield, D.E. Jr., S.B. Linda, and L.M. Hodgson. 1985. Chlorophyll-biomass-nutrient relationships for natural assemblages of Florida phytoplankton. Water Resource Bulletin 21:381-391.

Carlander, H.B. 1954. A history of fish and fishing in the Upper Mississippi River. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Childress, J.R. 2004. Identification of *Micropterus salmoides floridanus* populations in barrow pit ponds using cellulose acetate electrophoresis. M.S. Thesis. University of Florida. Gainesville, Florida.

DeVries, D.R., and R.A. Stein. 1990. Manipulating shad to enhance sport fisheries in North America: An assessment. North American Journal of Fisheries Management 10:209-223.

Henry, K.R. 2003. Evaluation of largemouth bass exploitation and potential harvest restrictions at Rodman Reservoir, Florida. M.S. Thesis. University of Florida. Gainesville, Florida.

Hoyer, M. V., and D. E. Canfield, Jr. 1994. Handbook of common freshwater fish in Florida lakes. Spec. Pub. 160. University of Florida/Institute of Food and Agricultural Sciences. Gainesville, Florida.

Hoyer, M. V., and D. E. Canfield, Jr. 1996. Largemouth bass abundance and aquatic vegetation in Florida lakes: An empirical analysis. Journal of Aquatic Plant Management 34:23-32.

Johnson, W.E., L.J. Jenkins, M. Wicker, J. Bitter, L. Prevatt, and S. Turner. 1982. Final report for investigations project. Study V: Creel census studies. Dingell-Johnson Project F-30. Florida Game and Freshwater Fish Commission. Tallahassee, Florida.

LAKEWATCH. 2007. Restoration of the economic vitality of Lake Griffin's largemouth bass fishery. University of Florida. Gainesville, Florida.

Larkin, P.A., and T.G. Northcote. 1969. Fish as indices of eutrophication. In Eutrophication, causes consequences, correctives. Proceedings of a symposium, June 11-15, 1967, Madison, Wisconsin. National Academy of Sciences, Washington, D.C. 256-273.

Lee, G.F., P.E. Jones, and R.A. Jones. 1991. Effects of eutrophication on fisheries. Review of Aquatic Sciences 5:287-305.

Loska, P. M. 1982. Stocking bass to improve your fishing – is it the key to better fishing? Bass Research Foundation. Starkville, Mississippi.

Mesing, C. 2003. Lake Talquin largemouth bass stocking evaluation. Annual Report. Florida Fish and Wildlife Conservation Commission. Tallahassee, Florida.

Milon, J.W., and R. Welsh. 1989. An economic analysis of sport fishing and the effects of Hydrilla management in Lake County, Florida. Economics Report 118, Food and Resource Economics Department. University of Florida. Gainesville, Florida.

Miranda, L.E., and W.D. Hubbard. 1994. Winter survival of age-0 largemouth bass relative to size, predators, and shelter. North American Journal of Fisheries Management 14:790-796.

Moyer, E.J., M.W. Hulon, J.J. Sweatman, R.S. Butler, and V.P. Williams. 1995. Fishery responses to habitat restoration in Lake Tohopekaliga, Florida. North American Journal of Fisheries Management 15:591-595.

Nieman, D.A., M.D. Clady, and G.E. Gebhart. 1979. Sexual maturity of small yearling largemouth bass in Oklahoma. Oklahoma Academy of Sciences 59:51-52.

Philipp, D.P., W.F. Childers, and G.S. Whitt. 1983. A biochemical genetic evaluation of the northern and Florida subspecies of largemouth bass. Transactions of the American Fisheries Society 112:1-20.

Shafer, M. D., R. E. Dickinson, J. P. Heaney, and W.C. Huber. 1986. Gazetteer of Florida Lakes. Publication No. 96. Florida Water Resources Research Center. University of Florida. Gainesville, Florida.

Smith, B. W., and W. C. Reeves. 1986. Stocking warm water species to restore or enhance fisheries. Pages 17-29 *in* R. H. Stroud, editor. Fish culture in fisheries management. American Fisheries Society, Fish Culture Section and Fisheries Management Section. Bethesda, Maryland.

U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, Census Bureau. 2001. National survey of fishing, hunting, and wildlife-associated recreation.

U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, Census Bureau. 2006. National survey of fishing, hunting, and wildlife-associated recreation.

U.S. Department of Labor, Bureau of Labor Statistics. 2008. Consumer price index.

Wisconsin Department of Natural Resources. 2007. Evaluation of the bass fishing tournament pilot program. Bureau of Fisheries Management Administrative Report 61. Madison, Wisconsin.

# BIOGRAPHICAL SKETCH

Kurt William Larson was born in October, 1982 in International Falls, Minnesota, the son of Stephen and Mary Larson. He graduated from Downers Grove South High School (with honors), Illinois in 2001. He received his Bachelor of Science degree in wildlife ecology and conservation (cum laude) from the University of Florida in 2005. He became interested in fisheries and wildlife at an early age, notably while playing with the minnows in the minnow bucket while his parents fished. As he grew older, interest in fishing continued for larger quarries, and he targeted species from Hawaii to Florida and points in between. He moved to Gainesville, Florida in fall 2001 to begin studies at the University of Florida and focused his scientific interests on herpetology and ichthyology. After graduating, he worked briefly for the Wildlife Ecology Department identifying and cataloguing insects. Soon after this project had finished, he was contacted by the Fisheries Department and began working for Dr. Dan Canfield as a biologist. During this time, he was appointed team leader of the Lake Griffin largemouth bass transfer program. In the fall of 2006, he enrolled in graduate school at the University of Florida under the advisement of Dr. Dan Canfield. After his graduation in spring 2009, he plans to continue in the field of fisheries and aquatic science science.