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GAME AND FRESH WATER FISH COMMISSION

1996-1999

COMPLETION REPORT
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FEDERAL AID IN SPORT FISH RESTORATION

ST. JOHNS RIVER FISHERIES RESOURCES

WALLOP-BREAUX PROJECT F-33

QUALITY FISH MANAGEMENT PROJECT

STUDY XVII. LOWER ST. JOHNS RIVER BASIN SPORT FISHING ENHANCEMENT

Project Leader:	Levi J. Jenkins
Project Biologist:	Jay C. Holder
Project Biologist:	Ryan D. Doorenbos
Administrative Secretary:	Melissa Roberts

Dr. Allan L. Egbert
Executive Director

Edwin J. Moyer, Director
Division of Fisheries

Darrell L. Scovell, Assistant Director
Division of Fisheries/Federal Aid Coordinator

James R. Estes, Chief
Bureau of Fisheries Resources

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STATE: Florida

PROJECT NO.: F-33
STUDY NO.: XVII

PROJECT TYPE: Research

PROJECT TITLE: Quality Fish Management

OBJECTIVE: To provide quality sportfisheries in selected fresh water bodies along the east coast of Florida, especially within the St. Johns River basin.

PERIOD COVERED: 1 July 1996 - 30 June 1999

STUDY TITLE: Lower St. Johns River Basin Sport Fishing Enhancement

OBJECTIVE: To investigate the potential for implementation of regulations or other management techniques designed to provide quality largemouth bass fisheries on Crescent Lake, Lake George and/or other areas of the lower St. Johns River; quality black crappie fisheries on Lake Woodruff, Lake Harney and other areas of the lower St. John River and quality catfish sport fisheries on sections of the St. Johns River where commercial methods of catfish harvest are not allowed. To restore and manage several ponds in local wildlife management and other public areas for educational event type and improved angling opportunities. To document sport fish response to revegetation on Lake Monroe and investigate revegetation of additional areas. To revitalize littoral vegetation communities in Lake Jesup and document sportfish response. To collect broodfish for hatchery production of *Morone* spp. for the St. Johns and Nassau rivers.

ABSTRACT

During the first year of this study project personnel reviewed historical largemouth bass (*Micropterus salmoides*) data for Crescent Lake and Lake George and black crappie (*Poxomis nigromaculatus*) data for Lake Monroe. Intense review of previous findings combined with logistic considerations and public sentiment prompted the preparation and submittance of catch-and-release regulation proposals for largemouth bass on Crescent Lake

and portions of Lake George, as well as a 30.5 centimeter (cm) total length (TL) limit and 25 fish bag limit for black crappie on Lake Monroe. The two largemouth bass proposals were rejected by Game and Fresh Water Fish Commission (GFC) fisheries staff but the black crappie proposal was accepted.

Largemouth bass length-frequency and catch-per-unit-effort (CPUE) data collected during this study for Lake George and Crescent Lake was similar to data from previous studies, indicating modal peaks generally between 33 cm TL and 41 cm TL. As with previous studies, the number of trophy size bass collected declined in both lakes. Length-frequency data taken in fall and spring of each year revealed no appreciable difference in size structure from either lake, suggesting that seasonal sample bias during this study did not exist.

Black crappie age and growth and length-frequency data collected from Lake Monroe during this study was similar to data from previous studies. Electrofishing data revealed mean size for age-5 crappie was above 30.5 cm TL and fast growing crappie in Lake Monroe reached 30.5 cm TL by age-3. The majority of fish harvested by anglers were between 25 cm TL and 31 cm TL (80% less than 30.5 cm TL) prior to the 1 July 1998 effective date of the new length limit. An angler creel survey from October through April revealed that total sport fishing effort dropped from 57,992 angler-hours to 36,483 angler-hours after the length limit went into effect.

Although catfish are available for sport fish harvest, water level extremes in the section of the St. Johns River where commercial fishing is prohibited, as well as angler and media apathy toward catfish sport fishing made development of that fishery unrealistic. Electrofishing samples collected channel catfish to 91 cm TL with an average CPUE of 0.41 fish-per-minute.

Channel catfish to age-10 were collected and indications were that large numbers of catfish were periodically available for sport fish harvest.

Four existing ponds and one constructed during this study were selected for management activities to establish improved bank fishing and/or special event fishing opportunities. Bear Pond in Seminole Forest Wildlife Management Area and Ranch Pond in Tiger Bay Wildlife Management Area became very productive during this study. Oaks Pond (Seminole Forest Wildlife Management Area) required draining and excavation to remove organic deposits and excessive vegetation which contributed to low dissolved oxygen (DO) levels undesirable for sustaining a sport fish population. Excavation was completed and re-fill is in progress. Chronic low DO and other logistic problems resulted in project efforts being minimized on Rattlesnake Pond (Tiger Bay Wildlife Management Area). Jenkins Pond (Dexter/Mary Farms Unit of Lake George Wildlife Management Area) remained turbid after construction and shallow during drought conditions but preliminary management activities were initiated.

A survey of restored vegetation communities conducted on Lake Monroe in spring 1997 revealed the presence of approximately 60 hectares (ha) of newly established vegetation in formerly barren areas along 10.5 kilometers of the northern and western shore. Species diversity in a two ha test plot on Lake Jesup had increased from six species to 13 species subsequent to herbicide application and prescribed burning. The Lake Monroe Restoration, Lake Jesup Littoral Zone Restoration and Shortnose Sturgeon Investigation jobs of this study were discontinued following a severe reduction in project personnel.

Striped bass (*Morone saxatilis*) brood fish were difficult to locate due to unusual extremes in water levels during collection seasons. Other inherent genetic or physiological problems may have contributed to collection difficulties. During an angler creel survey of the Mullet Lake section of the St. Johns River from December 1997 through April 1998, anglers expended an estimated 1,851 hours of effort to catch 1,476 striped bass and hybrid striped bass (*Morone saxatilis* X *M. Chrysops*).

INTRODUCTION

The St. Johns River, meandering slowly north for approximately 500 kilometers (km) from its origin near Melbourne to the Atlantic Ocean at Jacksonville, is the largest river in Florida with its drainage entirely within the state (Figure 1). The lower section of the St. Johns River, from Puzzle Lake downstream, is influenced by several large springs and daily tidal effects. High tides and strong winds cause reverse flow in excess of 250 km upstream. Near Palatka, the river becomes more estuarine with wide lagoon-like features that extend to the ocean. It supports a diverse fishery of freshwater and marine species. Sixty-eight percent of 170 species present in the river are euryhaline (Tagatz 1967). The southern most indigenous population of striped bass (*Morone saxatilis*) in the world historically resides in the St. Johns River. The river historically supported a multimillion dollar commercial fishery (Hale et al. 1984).

Poor land and water use practices which have had a negative impact on the St. Johns River resulted in destruction of native habitat. Population expansion, increased development and recreational usage have placed increasing demands and stress upon the fragile ecosystem of the river and negatively impacted sport fish communities.

The sport fishery in the lower St. Johns River provides one of the richest recreational fishing resources in Florida; however, anglers have expressed concern about smaller average size, fewer numbers and the apparent lack of trophy size largemouth bass

(*Micropterus salmoides*). The low number and small average size of striped bass harvested and low number of panfish harvested were also problems which anglers perceived.

Previous studies on Crescent Lake demonstrated that largemouth bass year-class strengths were positively correlated to abundance of submergent aquatic vegetation (Snyder et al. 1990; Cross et al. 1993). Eelgrass (*Vallisneria americana*) density in Crescent Lake cycled from sparse (occurring along less than 10% of the shoreline) to abundant (occurring along 90% or greater) in five to seven year periods. Angling mortality appeared to be responsible for a reduction in the number of quality and trophy size bass available. A survey of bass fishermen on Crescent Lake indicated 75% favored the promulgation of a catch and release regulation to increase the potential catch of quality or trophy bass (Cross et al. 1996). Historical length-frequency data for Lake George also indicated a potential for development of a quality bass fishery by regulating angler harvest (Cross et al. 1996).

Data from previous studies on lakes in the St. Johns River system indicated angler harvest may be a factor in substantially reducing the abundance of older, larger black crappie (*Pomoxis nigromaculatus*). Studies conducted on Lake Monroe from 1987 through 1990 showed that 98% of black crappie sampled were age-4 or younger (Snyder et al.1990). Those same studies found that crappie collected from Lake George and other sections of the St. Johns River could live to age-13 but less than 6% of those collected were age-5 or older. Past studies have indicated excellent growth rates for crappie in Lake Monroe averaging 229 millimeters total length (mm TL) at age-2, 274 mm TL at age-3 and 302 mm TL at age-4.

Biologists proposed that a reduction in the 50 fish bag limit and the establishment of a minimum size limit would allow more crappie to attain quality size (305 mm TL) before being harvested.

The section of the St. Johns River between US Highway 192 and State Road (SR) 46 has been closed to commercial fishing for over 20 years. Cox and Vosatka (1976) reported that channel catfish (*Ictalurus punctatus*) up to 910 mm TL had been collected during routine sampling of that section of the river and Cross et al. (1990) reported that the number of channel catfish $\geq$ 4.5 kilograms (km) in the area could accommodate a quality channel catfish sport fishery.

Wildlife Management Areas and other state lands within the St. Johns River Basin have borrow pits, ponds and small lakes located near major highways and/or urban areas. Some of the pits and ponds were believed to be suitable for development of high-use fisheries with proper management. Lakes and sections of the St. Johns River are candidate areas for fishing piers and other improvements to create new fishing opportunities for non-boating anglers. Wildlife biologists and Forestry Supervisors were enthusiastic about developing new fishing opportunities on state lands to enhance their long range multi-use plans.

Initial studies of the restoration of Lake Monroe by revegetating the shoreline with eelgrass, bullrush (*Scirpus californicus*) and other desirable aquatics indicated a positive response by sportfish populations. Cross et al. (1996) reported increased numbers of juvenile sportfish coinciding with the increase in available habitat. Continued expansion or additional restoration efforts were needed to assure positive responses by sport fish populations.

Lake Jesup is a hypereutrophic system with limited potential for revegetation with desirable aquatic plants. Creel estimates indicated excellent fisheries for bream (*Lepomis* spp.) and black crappie in Lake Jesup but angler harvest of largemouth bass was almost non-existent (Cross et al. 1996). Extensive portions of the littoral zone have been dominated by cattail (*Typha* spp.) and common reed (*Phragmites australis*). These areas needed to be transformed by burning, herbicide treatment, etc. to favor more desirable aquatic vegetation communities. Aquatic plant and sport fish population response to the transformation of large areas of non-desirable into areas of desirable vegetation needs to be documented.

Stocking of *Morone* spp. in the St. Johns River had created and maintained an excellent sport fishery with an estimated annual harvest of 15,000 fish from the areas surveyed (Cross et al. 1996). Historically, the southern most indigenous population of striped bass resided in the St. Johns River but no natural reproduction has been documented since the early 1950's. Collection of broodfish for hatchery reproduction was necessary to maintain the fishery and protect the species from possible extinction in the St. Johns River. Limited reproduction in the Nassau River also made it necessary to supplement the striped bass population so that a quality fishery could be maintained.

Shortnose sturgeon (*Acipenser brevirostrum*), an endangered species, historically occurred in the St. Johns River but had not been observed since 1982. The decline of this species may have been associated with commercial gillnet fishing, degraded water quality and/or lack of access to possible spawning and thermal refuge areas. Hatchery advances in the propagation of shortnose sturgeon could allow stocking and the re-establishment of a population if genetically appropriate broodfish could be located.

STUDY AREAS

The St. Johns River flows from south to north through 18,600 hectare (ha) Lake George. Three first magnitude springs (Juniper Springs, Silver Glen Springs, and Salt Springs) flow into the lake on the west side. The lake is relatively shallow with an extensive littoral zone of eelgrass, coontail (*Ceratophyllum demersum*) and yellow waterlily (*Castalia flava;* Snyder et al. 1987). Crescent Lake (6,290 ha) is not a mainstream lake but flows into the St. Johns River via Dunns Creek, located on its northern shoreline. Three major tributaries (Haw Creek, Bull Creek and Salt Branch) flow into the lake. The vegetation community is predominantly eelgrass which cycles in density and abundance at five to seven year intervals.

Lake Monroe (3,087 ha), located in Volusia and Seminole counties near several large urban areas including Sanford and Orlando with four public boat ramps, approximately 6 kilometers (km) of bank fishing access and no fish camps, was selected as a black crappie study area. Revegetation by the Florida Game and Fresh Water Fish Commission Lower St. Johns River and Lake Restoration Projects resulted in the establishment of several hundred acres of littoral vegetation (primarily eelgrass and bullrush) in areas that were formerly barren. This activity helped improve water quality, create spawning and nursery areas and contributed to the creation of a quality crappie fishery.

The section of the St. Johns River between Lake Harney (SR 46) and Lake Poinsett (SR 520) lies within the part of the river that is closed to commercial fishing. It is characterized as a shallow flood plain during times of high water and narrow winding channels during low water. During low water periods, catfish and bullheads (*Ictalurus* spp. and *Ameiurus* spp.) are concentrated in narrow channels making them susceptible to angler harvest. The proximity of that part of the river to metropolitan Orlando and the Florida space coast region made it an ideal area to promote quality catfish fishing.

Seminole Forest Wildlife Management Area (Lake County) is located near Interstate Highway 4, US Highways 17 and 92, SR 46 and the City of Sanford. It is a 4,333 ha Wildlife Management Area with several small lakes and borrow pits. Access to the area is excellent and it afforded a good opportunity to develop sport fishing access for non-boating anglers. Bear Pond (5.3 ha) is located near the entrance of the management area at SR 46 and the entire shoreline is open to bank fishing access. Oaks Pond (0.4 ha) is located in the interior section of the management area but close to a primitive camp site. Bank fishing access is excellent and the unimproved road into the pond provided opportunities for wildlife viewing and micro-habitat identification and appreciation.

Tiger Bay Wildlife Management Area (Volusia County) is located near Interstate Highway 4, US Highway 92, SR 40 and the City of Daytona Beach. It is a 9,095 ha Wildlife Management Area with borrow pits and lakes up to 26 ha in size. The proximity to the "World's Most Famous Beach" and major highways contributed to consideration of those borrow pits and lakes as prime areas for bank fishing programs. Rattlesnake Pond (3.2 ha) is located approximately 4.8 km off US Highway 92 in the south section of the management area. The Florida Department of Agriculture, Division of Forestry (DOF) had provided a primitive boat ramp, parking area and picnic tables at Rattlesnake Pond. Approximately 183 meters (m) of shoreline was accessible for bank fishing. Ranch Pond (0.4 ha) is located on the north side of US Highway 92 at the DOF Tiger Bay State Forest office. Educational displays, picnic tables, improved parking area, restrooms and other facilities are located at Ranch Pond. The entire pond is accessible to bank fishing.

Lake George Wildlife Management Area (Volusia and Putnam Counties) is near US Highway 17 and SR 40. This 19,685 ha Wildlife Management Area is more remote from metropolitan areas than Seminole Forest and Tiger Bay Wildlife Management Areas and has several kilometers of frontage on the St. Johns River and Lake George. The number of borrow pits and lakes available for intensive management is limited but it was an ideal area to establish bank fishing opportunities on a part of the St. Johns River where none existed. A section of the river between Lake George and Lake Dexter, with limited open areas for bank fishing, can be reached by unimproved road. Jenkins Pond (0.6 ha) is located in the interior of the management area but is accessible via three different entrances along SR 40 and County Road (CR) 3. The entire shoreline is suitable for bank fishing.

Lake Jesup (4,054 ha), located southeast of Sanford and northeast of Orlando in Seminole County, is a hyper-eutrophic lake with little desirable vegetation or other habitat suitable for largemouth bass production. It is located off the mainstream St. Johns River resulting in very little flushing which contributes to extensive organic deposits. A rather wide flood plain associated with the lake is periodically inundated but usually for relatively short periods of time. These brief floodings create ideal conditions for production of cattail and common reed, but is not conducive to natural growth of more desirable aquatic vegetation without some type of artificial stimulation.

Striped bass brood fish collected for hatchery production of striped bass, sunshine bass (*Morone chrysops X M. saxatilis*) and palmetto bass (*Morone saxatilis X M. chrysops*) to be stocked in the St. Johns River were collected from historical sites from the area near Green Cove Springs to Lake Harney. They were also collected from the Oklawaha and Wekiva Rivers (tributaries of the St. Johns River). Striped bass brood fish used to produce fingerlings for stocking the Nassau River were collected from the St. Marys River between the junction of Bells River to west of the Little St. Marys River. The Mullet Lake section of the St. Johns River (that portion of the river between the Lake Jesup boat ramp off SR 46 upstream to Iron Bend) was selected for an angler creel survey.

Shortnose sturgeon were historically present in the lower stretches of the St. Johns River from its juncture with the Oklawaha River to the area near Green Cove Springs. They also occurred in the Oklawaha River and in Black Creek. Those areas were selected as potential collection sites for broodfish to re-establish species presence in the St. Johns River.

MATERIALS AND METHODS

Largemouth Bass- Lakes George and Crescent

A minimum of 300 largemouth bass from Lake George and Crescent Lake were collected by electrofishing for length-frequency analysis and catch-per-unit-effort (CPUE) each fall and spring. A 9,000 watt generator and Smith-Root 9.0 GPP pulsator was mounted in an aluminum boat which served as the cathode and two boom mounted Wisconsin rings served as the anodes. Voltage and amperage were adjusted for maximum efficiency under varying conditions of conductivity. Bass were measured to the nearest millimeter total length and released. Length-frequency data was expressed in two-centimeter (2-cm) groups (example: 13=12.0-13.9; 15=14.0-15.9 cm, etc.) and CPUE was expressed as bass-per-minute (bass/min). Based upon historical data and public input, the Quality Fish Management (QFM) Project submitted quality largemouth bass proposals for Lake George and Crescent Lake to GFC Division of Fisheries staff in 1997 (Appendices A and B).

Lake Monroe Black Crappie Regulation

Lake Monroe black crappie sampling for age determinations, CPUE and length-frequency analysis was done by electrofishing. Otter trawl and trap nets were used in cooperation with the Game and Fresh Water Fish Commission (GFC) Native Sport Fish Enhancement Project and the University of Florida Institute of Food and Agricultural Sciences (IFAS) Department of Fisheries and Aquatic Sciences. Crappie length-frequency data were expressed in centimeter (cm) groups (example: 10=10.0-10.9, 11=11.0-11.9, etc.) and CPUE data collected by electrofishing, trawl and trap nets were expressed as fish-per-minute (fish/min), fish-per-three-minute trawl or fish-per-net night, respectively. The trawl consisted of a 4.9 m length body with 38.1 mm stretch mesh in the body and 31.8 mm stretch mesh in the bag. The mouth of the trawl was held open during towing with 2.5 cm X 5.0 cm floats attached to the head rope of the trawl mouth and a chain line attached to the foot rope. The trawl was equipped with weighted doors (38.1 cm X 76.2 cm) to spread the mouth and keep the net in contact with the bottom. Each door was attached to the head rope and foot rope by 46.0 cm lead lines which were attached to the boat with a 15.3 m tow line. The net was towed behind a 5.3 m boat equipped with a 115 horse power (hp) outboard motor at approximately 96.0

meters per minute (m/min) for three to five minutes. All trawls were conducted during daylight. Trap nets consisted of two rectangular frames (0.9 m X 1.8 m) and four hoops (0.8 m diameter). The nets had a single slit at the mouth and a single throat (17.0 cm stretch). Each net had a 0.9 m X 20.0 m lead and the entire net was composed of 0.95 cm bar mesh nylon netting. The nets were anchored to the bottom at each end using concrete blocks. Eight to twelve nets were set each date and fished for three or four days (Allen et al. 1999). During electrofishing samples, efforts were made to collect ten crappie per centimeter group for age analysis. Fish collected for age analysis were measured for total and standard length, weighed to the nearest gram and sexed. All fish encountered were measured for total length to analyze length-frequency distributions. Otoliths were removed according to Coleman et al. (1984), placed whole in a black dish with water, and viewed with reflected light at 25X through a stereo-microscope. Annuli were counted and an additional year of age was assigned to those fish collected in late spring that had not set their last annulus. An arbitrary birth date of 1 January was assigned. Mean total lengths for each year class were determined for comparison and expressed in millimeters.

A completed trip access point angler creel survey was conducted at the four public boat ramps on Lake Monroe in spring 1997. The primary goal was to determine actual size of angler harvested black crappie; therefore all fish were measured to the nearest centimeter. A peak season stratified roving clerk angler creel survey with uniform probabilities was conducted from 16 October 1997 through 29 April 1998 on Lake Monroe. Bank anglers fishing from the seawall along Highway 17-92 were also interviewed. The survey was conducted at a rate of ten out of 28 days and divided into three time periods; AM: 0800-1130, MD: 1130-1500 and PM: 1500-1830 (adjusted for daylight savings time). Information collected included hours fished, species targeted and number of fish caught and harvested. A GFC computer program was used to generate estimates for angler effort, harvest and success. The creel clerk measured harvested black crappie at public ramps as time permitted.

A peak season access point creel survey with uniform probabilities funded by the GFC Lake Restoration Project was conducted at four public boat ramps on Lake Monroe boat anglers from 15 October 1998 through 28 April 1999. Conducted at a rate of ten out of 28 days, this survey was divided into two time periods: AM: 1000-1400 and PM: 1400-1800. The four boat ramps included in this survey were divided into two pairs with an approximately equal combined angling effort for each pair determined by previous surveys. On the selected survey day, one pair of boat ramps was selected with the creel clerk beginning at a random point in a circuit between the two boat ramps and expending equal effort at each ramp. However, if no boat trailers were present at a selected ramp, the creel clerk returned to the other ramp in the pair to maximize the number of interviews. A roving clerk creel survey was conducted along the seawall concurrently with the access point creel survey on Lake Monroe. In this survey, bank anglers were interviewed on the south side of Lake Monroe from the boat ramp at Highway 17-92 to the intersection of East Seminole and North Mellonville streets in the city of Sanford. Uniform probabilities were used to select one out of five possible two-hour time periods each survey day. The two-hour time periods began at 0800 and ended at 1800.

Historical crappie data collected from Lake Monroe was used to generate a proposal to establish a more restrictive bag limit and minimum size limit for crappie which was submitted to the GFC Division of Fisheries staff in 1997 (Appendix C). The proposal was submitted to the commissioners, a public meeting was held and personal contact made with businesses which might be directly affected by regulation changes. Local and regional news media were contacted and several articles published to inform the public that a 25 fish bag limit and 30.5 cm TL size limit became effective 1 July 1998.

Middle St. Johns River Channel Catfish Population

Channel catfish were sampled for length-frequency analysis, age determination, CPUE and relative weight (Wr) in the section of the St. Johns River between US Highway 192 and SR 46, including the lower reaches of the Econlockhatchee River. All fish were measured to the nearest mm TL and large fish were weighed to the nearest gram. A minimum of 16 individual fish in each length category as used to calculate condition. Pectoral spines were removed from 56 fish for age analysis and prepared and examined as per Crumpton et al. (1984).

Fish Management on Small Ponds

Fish management activities were conducted on five ponds (borrow pits) in Seminole Forest Wildlife Management Area, Tiger Bay Wildlife Management Area and the Dexter-Mary Farms Unit of Lake George Wildlife Management Area. Jenkins Pond was excavated at Dexter-Mary Farms by DOF in 1997. Agricultural lime was applied where needed to raise pH values, at rates of either 2.25 metric tons or 4.5 metric tons per hectare depending upon acidity of the water. Liquid ammonium polyphospate (10-34-0) was applied at a rate of 9.5 l/ha, as needed, to maintain desirable productivity in Bear Pond. Four Sweeny model DF3A scatter feeders with 12 volt solar chargers were installed at Bear Pond and one at Oaks Pond, Rattlesnake Pond and Ranch Pond. A Sweeny model AF 1100 directional feeder with 12 volt solar charger was installed at Jenkins Pond. Bear, Oaks, Rattlesnake and Ranch ponds were initially stocked with 500 phase II channel catfish per 0.4 ha. Bear, Oaks and Rattlesnake ponds also received 500 bream per 0.4 ha. Ranch Pond had an existing population of bream and largemouth bass and was not stocked with either. Rattlesnake and Oaks ponds developed severe low dissolved oxygen problems and were not stocked with largemouth bass. Three hundred hatchery raised phase II largemouth bass and 150 similarly sized wild largemouth bass were stocked in Bear Pond in cooperation with the GFC Native Sportfish Enhancement Project to provide predatory control over bream and to compare survival and growth rates between hatchery raised bass and bass from wild stock. A modified Schnabel mark and recapture population estimate (Ricker 1975) was conducted during February-March 1998 on Bear Pond.

Jenkins Pond was initially stocked with eastern mosquito fish (*Gambusia affinis*), seminole killifish (*Fundulus seminolis*) and golden shiner (*Notemigonus crysoleucas*) as forage and 50 experimental phase II triploid largemouth bass to compare growth rates with genetically unaltered bass. All ponds received supplemental channel catfish stockings (100 per 0.4 ha) in the winter of 1998. Electrofishing, dissolved oxygen, pH, and secchi disc samples were taken in all of the ponds periodically. Due to continuous low dissolved oxygen in Oaks Pond, the QFM Project, Lake Restoration Project and Division of Forestry pumped it dry and removed excessive vegetation and organic deposits by scraping. Special regulations for each pond were submitted to GFC staff and approved by the commissioners. Clinics, derbies and other special events were conducted at three of the five ponds by the QFM Project, Division of Wildlife (DOW), Central Florida Urban Fisheries Project (CFUFP) and DOF. Preliminary work for the installation of an aluminum, floating, handi-cap accessible T-type pier with an 18 m gangway and 23 m fishing tee for Bear Pond was completed (Figure 2). Preliminary work for a similar straight-line pier with a 9 m gangway and 9 m fishing section for an area known as Bluffton on the St. Johns River was also completed (Figure 3). Bluffton is within the Dexter-Mary Farms Unit of Lake George Wildlife Management Area. The DOF agreed to provide appropriate parking and access to the piers. Sand Lake, a one acre, spring fed pond within Wekiwa Springs State Park, was sampled by electrofishing in February 1996 and January 1997. Water chemistry was also analyzed in February 1996. Five hundred phase II channel catfish were stocked in early spring 1997 and a grand opening childrens derby attended by the QFM Project, CFUFP, DEP and local dignitaries was conducted in May 1997.

Lake Monroe Revegetation Evaluation

Restored littoral zone areas of Lake Monroe were visually surveyed in spring 1997. Due to a severe reduction in QFM project man-power, the survey was not conducted in subsequent years.

Lake Jesup Vegetation Management Evaluation

Approximately 324 ha of cattail and common reed in Lake Jesup were treated with herbicide, burned (with the assistance of the Lake Restoration Project, DOF and GFC Law Enforcement) and retreated. Electrofishing transects were established in treated areas after regrowth for comparison to samples taken in untreated areas. Due to the above mentioned reduction in personnel, this activity was discontinued by the QFM Project after the first year.

St. Johns River Striped Bass Broodfish Collection

In spring 1997, 43 female striped bass in various stages of reproductive development and 38 sexually mature males collected from the St. Johns River were provided to state and federal hatcheries for production of stripers, palmetto bass and sunshine bass. Four female and nine male striped bass brood fish were collected from the

St. Marys River. Striped and palmetto bass were stocked in the St. Johns River (Table 1). Sunshine bass were stocked statewide and 16,425 stripers from the St. Mary River strain were stocked in the Nassau River. Thirty-three female and 57 male stripers were delivered to Welaka National Fish Hatchery in 1998 for fingerling production. Thirty-five sexually mature males were taken to Richloam Fish Hatchery for palmetto and sunshine bass production. In 1999, seven female and 16 male stripers were delivered to Richloam Hatchery; 23 females and 26 males were delivered to Welaka National Fish Hatchery. The state of South Carolina provided striped bass fry to Edenton, North Carolina Federal Fish Hatchery for grow-out to fingerling size. An additional 200,000 fingerlings were stocked into the St. Johns River by Welaka National Fish Hatchery staff as a result of this cooperative effort.

FINDINGS

Largemouth Bass in Lakes George and Crescent

The fall 1996 largemouth bass length-frequency distribution for Lake George indicated a mode at 33 cm TL while the spring 1997 mode was 35 cm TL (Figure 4). Trophy size bass ($\geq$ 55.9 cm TL) represented 1.9% of the fall sample and no trophy size bass were collected in the spring sample. The CPUE for bass collected $\geq$ 24 cm TL was 1.59 bass/min for the fall sample and 1.16 bass/min for the spring sample. Sample modes for fall 1997 and spring 1998 were 37 cm TL and 35 cm TL, respectively (Figure 5). Trophy bass represented 2.6% in the fall and 2.1% in the spring. The CPUE for bass $\geq$ 24 cm TL was 0.76 bass/min in fall and 0.94 bass/min in spring. Fall 1998 and spring 1999 samples exhibited modes at 37 cm TL and 31 cm TL, respectively (Figure 6). The spring 1999 sample had a strong secondary peak at 35 cm

TL. Trophy bass represented 2.2% of the fall sample and 1.5% of the spring sample. The CPUE's for bass $\geq$ 24 cm TL were 1.1 bass/min for fall 1998 and spring 1999 samples.

Length-frequency distributions of largemouth bass sampled in fall 1996 and spring 1997 in Crescent Lake indicated a mode in the 33 cm TL group and 35 cm TL group, respectively (Figure 7). Trophy size bass represented 2.2% of the fall sample and 1.3% of the spring sample. The fall 1996 CPUE for largemouth bass $\geq$ 24.0 cm TL was 1.00 bass/min and the spring 1997 CPUE was 1.59 bass/min. Fall 1997 and spring 1998 largemouth bass length-frequency distributions indicated modes at 39 cm TL and 37 cm TL, respectively (Figure 8). Trophy size bass represented 1.3% of the fall sample and 0.8% of the spring sample. The fall 1997 CPUE for bass $\geq$ 24.0 cm TL was 1.28 bass/min and the spring 1998 CPUE was 2.51 bass/min. Fall 1998 data showed bi-modal peaks at 31 cm TL and 37 cm TL while the 1999 spring sample had a mode of 39 cm TL (Figure 9). Trophy bass represented 1.0% of the fall sample and 0.7% of the spring sample. The fall 1998 CPUE for bass $\geq$ 24.0 cm TL was 1.00 bass/min and the spring 1999 CPUE was 2.92 bass/min.

Lake Monroe Black Crappie Regulation

Historical crappie data from Lake Monroe indicated excellent growth and relatively high angler exploitation (Snyder et al. 1987). The QFM Project investigated the Lake Monroe crappie population to determine its potential as a quality fishery. Evaluations began in spring 1997 with a completed trip access point angler survey to determine the size distribution of angler harvested crappie. The spring 1997 length-frequency distribution for angler harvested crappie exhibited bimodal peaks at 26 cm TL and 28 cm TL (Figure 10). The length-frequency distribution for angler harvested crappie in fall 1997 was similar to spring 1997 with a mode of

26 cm TL (Figure 11). During the peak season 1998-99 creel survey (first season after the 30.5 cm TL limit was enacted), the length-frequency mode for angler harvested crappie had shifted to 31 cm TL (Figure 12). The average trip length for crappie anglers during the 1997 survey was 4.7 hours and approximately 0.8% of angler trips resulted in the harvest of more than 25 crappie (Figure 13). Electrofishing length-at-age data collected in spring 1997, winter/spring 1998 and winter 1999 indicated that the mean size for age-5 crappie was well above 30.5 cm TL (Tables 2, 3, and 4). Electrofishing length-frequency distributions from Lake Monroe showed a mode at 31 cm TL in winter/spring 1998 (Figure 14) and 26 cm TL for winter 1999 (Figure 15). In fall 1997, length-frequency data generated from trawl and trap net samples by IFAS Department of Fisheries and Aquatic Science and the GFC Native Sport Fish Enhancement Project indicated modes at 11 cm TL (Figures 16 and 17). Average electrofishing CPUE was 0.56 fish/min during winter/spring 1998 sampling and 1.74 fish/min during winter 1999. Average CPUE for fall 1997 trawl samples was 3.68 crappie per three minute trawl and 4.07 crappie per net night for trap net sets.

During the October 1997 to April 1998 creel survey, anglers fishing for black crappie expended 78% of the total sport fishing effort (57,992 angler-hours; Table 5). Harvest of black crappie was estimated at 61,234 fish or 70% of the total crappie caught. During the first two months of this survey, a supplementary completed trip angler harvest survey showed 80% of the black crappie harvested were below 30.5 cm TL (Figure 10). Approximately 6,281 angler-hours were expended toward bream (*Lepomis* spp.) harvest and there was little angling effort for largemouth bass.

In the 1998-1999 creel, boat anglers expended an estimated 19,202 angler-hours of total effort with 45.6% (8,763 angler-hours) directed toward black crappie (Table 6). Bank anglers expended nearly as much total effort (17,268 angler-hours), but bream were the most sought after species with 5,479 hours of angler effort (Table 7). Effort directed at black crappie and "other" species followed closely with 4,547 and 4,359 angler-hours, respectively. The "other" category consisted mainly of striped mullet. Angler harvest data also indicated many anglers were harvesting sub-legal black crappie (Figure 12).

Management of Small Ponds

Initial water quality analysis of Bear Pond showed the pond was very acidic with a pH of 2.9 recorded in December 1995. An electrofishing sample at the same time collected no fish of any species. From initial liming in March 1996 until late 1996, the pH fluctuated between 6.9 and 9.4, but stabilized near neutral (mean=7.3) during the remainder of the study period. At first sampling, the water was crystal clear with secchi disk visibility up to eight meters. Several applications of 10-34-0 liquid ammonium polyphosphate fertilizer provided necessary nutrients to allow an algal bloom to develop with subsequent secchi disc readings ranging from 0.7 to 2.0 meters.

Based on length-frequency distributions generated by electrofishing in the three successive months after stocking largemouth bass in Bear Pond, growth appeared normal (Figure 18). In five subsequent electrofishing samples from March 1997 through March 1998, recaptures of wild fish averaged 49% compared to an average of 19% for hatchery raised fish (Porak et al. 1998). Electrofishing surveys six and twelve months later showed growth continued normally (Figure 19). From February through March 1998, a total of 115 bass were collected in six samples, giving a modified Schnabel population estimate of 137 bass (25.8/ha) and a length-frequency distribution that showed an obvious size delineation between stocked fish and naturally reproduced young-of-the-year (yoy) bass (Figure 20).

In an October 1998 electrofishing sample at Bear Pond, channel catfish growth and survival was good with many (n=75) collected in the 345-497 mm TL size range. Largemouth bass (n=37) ranged from 111-453 mm TL indicating reproduction had occurred. The CPUE for bass was 0.84 bass/minute. Numerous bluegill were collected or observed from 80-209 mm TL. Other species collected in small numbers included black crappie, golden shiner, lake chubsucker (*Erimyzon succetta*), warmouth (*Lepomis gulosus*), white catfish (A*meiurus catus*), redear sunfish (*Lepomis microlophus*) and Seminole killifish.

In April 1998 and 1999, the GFC Division of Wildlife (DOW) organized a "Welcome to the Woods" day for a total of 143 adults and children, which included fishing clinics manned by QFM and CFUFP personnel. Three other youth fishing clinics in 1998-1999 were conducted at Bear Pond by DOW with assistance from CFUFP and attended by approximately 100 children.

Water quality analysis of Oaks Pond in late 1995 revealed a pH of 4.9 and a dissolved oxygen reading of 3.8 ppm. An electrofishing sample in January 1996 produced largemouth bass (n=23) ranging from 163-379 mm TL and bluegill (n=14) from 96-226 mm TL. In March 1996, one ton of agricultural lime was applied and resulted in an average pH value of 7.0 (range: 5.4-8.3). One youth fishing clinic for 30 children was held in 1997 before increased biological oxygen demand, attributed to the higher pH, caused dissolved oxygen levels recorded at one meter depth to decrease to as low as 0.3 ppm and only occasionally reach above 3.0

ppm in the following three years. A fish kill of unknown severity occurred in July 1998. Draining and scraping of Oaks Pond in October 1998 resulted in the removal of excessive organic material and aquatic vegetation (primarily fragrant water lily-*Nymphea* spp.). Due to below normal rainfall during the winter/spring of 1998, the pond remained unfilled during the remainder of this study period.

Water quality analysis of Ranch Pond was conducted in November 1995 and revealed satisfactory conditions for sport fish populations. A dissolved oxygen reading of 8.5 ppm at one meter depth was initially recorded and fluctuated seasonally between 6.1 and 12.2 ppm. A heavy algal bloom and fear of a total fish kill prompted personnel to install an aeration system to keep DO levels at an adequate level. The initial pH reading for this pond was 7.5 and averaged 7.4 (range: 6.4-10.0) during the study period.

Ranch Pond was sampled by electrofishing in November 1995 and was determined to have a good existing fish population. Largemouth bass (n=12) ranged from 161-484 mm TL, bluegill (n=40) ranged from 63-238 mm TL and black crappie (n=14) ranged from 138-310 mm TL. Black crappie were removed to prevent overpopulation and competition with largemouth bass for available forage. In three subsequent samples using the modified Schnabel mark-recapture method, populations of bass ($\geq$200 mm) and bream ($\geq$160 mm) were estimated at 30 and 287, respectively. Ranch Pond was sampled again in April 1997 following the addition of an aeration system, feeder installation and stocking of channel catfish. Twelve bass ranging in size from 241-456 mm TL, 16 bluegill from 167-267 mm TL and four channel catfish from 445-498 mm TL were collected. Despite removal in past samples, 16 black crappie were also sampled ranging from 245-326 mm TL. Following a fish kill in July 1998 (a power outage shutdown the aeration system), the pond was sampled by electrofishing in October and 12 largemouth bass (226-495 mm TL), 13 bluegill (57-225 mm TL), 14 black crappie (145-278 mm TL) and one channel catfish (643 mm TL) were collected. Other species collected included golden shiner, Florida gar (*Lepisosteus platyrhincus*), and lake chubsucker.

Two youth fishing programs were conducted at Ranch Pond in conjunction with a DOF "Tiger Bay State Forest Awareness Day." The first was conducted in October 1996 and 85 kids participated. A total of 47 catfish, 50 bream, three largemouth bass and three black crappie was caught. The following year, 76 kids participated but caught only one catfish and 11 bluegill. Eight other youth fishing clinics were held at this site by the CFUFP with 186 and 90 children attending in 1997 and 1998, respectively. Observed catches at those events were usually good. Permits were issued to DOF personnel on three occasions for youth fishing events.

Although the initial dissolved oxygen reading for Rattlesnake Pond was slightly low at 4.8 ppm, this tannin stained pond had a very low pH reading of 2.9. An initial electrofishing sample in November 1995 collected few sportfish. One small largemouth bass (88 mm TL), nine bluegill (44-210 mm TL) and seven warmouth (112-183 mm TL) were collected. The only other fish collected included four redfin pickerel (*Esox americanus*), one lake chubsucker, one Florida gar and five bowfin (*Amia calva*). Following an application of 21 tons of lime in March 1996, the pH increased to an average reading of 4.4 by August 1996. Another 16 tons of lime was added in late August 1996 and the pH rose to an average of 6.1 until last recorded in July 1998. However, dissolved oxygen readings remained low often falling below 3.0 ppm. An electrofishing survey conducted in Rattlesnake Pond in August 1997, after fish feeder installation and channel catfish stocking, again collected few sport fish. Four largemouth bass (67-152 mm TL), six bluegill (128-231 mm TL), two black crappie (152-252 mm TL) and two warmouth (105-138 mm TL) were collected. Dissolved oxygen readings during the period following liming ranged from 0.3 to 6.5 ppm but rarely surpassed 4.0 ppm. In August 1998, project staff and Lake Restoration Personnel measured up to 0.46 m of muck on the pond bottom. Due to poor habitat conditions, management activities ceased in June 1997, except for occasional visits to check to see if dissolved oxygen readings improved.

Two ponds were evaluated for potential fisheries management in the Lake George WMA. One unnamed pond was electrofished in December 1995 but the overall fish population was poor. Forty small bluegill from 66-215 mm TL, two warmouth (183-197 mm TL) and a yellow bullhead (*Ameiurus natalis*)(168 mm TL) were collected. A pH of 6.2 was recorded at sample time. No further activities were carried out on the pond during this reporting period.

An electrofishing survey of Jenkins Pond in early September 1997 collected three Seminole killifish. Water quality readings at that time indicated adequate dissolved oxygen (6.0 ppm at surface, 5.2 ppm at one and two meters) and a pH reading of 7.1.
An electrofishing survey conducted in April 1998 produced four bass ranging from 173-222 mm TL. Another survey in November 1998 collected eight bass (247-283 mm TL) as well as five small warmouth and one chain pickerel (*Esox niger*) which had infiltrated the pond.

Initial water quality samples at Sand Lake indicated pH and DO levels conducive to management for sport fish. Electrofishing samples in 1996 and 1997 showed an adequate population of bream and largemouth bass. Supplementary stocking of channel catfish and installation of a feeder (done by Wekiwa Springs State Park employees) was deemed adequate for maintaining a fishery for children visiting the park.

Middle St. Johns River Channel Catfish Population

Electrofishing length-frequency distribution of channel catfish collected from the St. Johns River in spring/summer 1997 ranged from 26 cm TL to 91 cm TL and indicated a mode at 29-cm TL (Figure 21). Proportional Stock Density (PSD) (± standard error) was 32 (6) for six samples combined. A total of 212 channel catfish were collected with 180 stock-length (≥ 280 mm TL), 18 (5) preferred length (≥ 610 mm TL), and 48 (6) memorable length (≥ 710 mm TL). No trophy catfish (≥ 910 mm TL) were collected. CPUE's ranged from 0.04 to 0.82 fish/minute (Figure 22) and averaged 0.41 fish/minute. Wr's calculated from 145 channel catfish (Figure 23) averaged above 100 for all length categories (Table 8). Nine year-classes from age-2 to age-10 were represented with an average difference between mean length at age of 61 mm TL (Table 9). No age-1 channel catfish were collected.

Lake Monroe Revegetation Evaluation

A survey of restored vegetation communities conducted in spring 1997 indicated approximately 60 ha of eelgrass, hydrilla (*Hydrilla verticillata*), giant bulrush and knotgrass (*Paspelidium geminatum*) occurred along 10.5 km of the northern and western shores of Lake Monroe.

Lake Jesup Vegetation Management Evaluation

Species diversity of plants found in a two ha test plot on Lake Jesup increased from six species before herbicide application and prescribed burning to 13 species afterward (Table 10). Percent frequency occurrence of cattail and common reed had decreased.

DISCUSSION

Largemouth bass length-frequency distributions were examined for Lake George and Crescent Lake in spring and fall of each year to determine if there were appreciable differences. Largemouth bass length-frequency distributions from Lake George were similar for fall and spring samples. The mode for each seasonal sample fell within two 2-cm groups and was also similar to samples collected by Cross et al. (1996) during the spring of 1994, 1995 and 1996 (Figure 24). An examination of bass length-frequency distributions (1986-1993) from Lake George revealed that modes have fallen between 25 cm TL and 39 cm TL but most often between 31 cm TL and 37 cm TL (Figure 25). Previous studies indicated that those size classes represented age-2 to age-4 largemouth bass (Snyder et al. 1987). It was apparent from all previous studies, as well as this one, that trophy size largemouth bass compose a small portion of the population (Figure 26). Samples indicated some recovery in the number of trophy bass after implementation of a 35 cm TL size limit in 1992 (Cross et al. 1993). However, continued investigation suggested it was a temporary recovery and a more severe regulation would be necessary to effectively create a substantial trophy largemouth bass fishery on Lake George. Largemouth bass CPUE values from Lake George suggested that fall or spring sampling would be equally productive (fall average = 1.15 bass/min; spring average 1.07

bass/min). Average spring CPUE for this study was higher than that by Cross et al. 1993 (0.59 bass/min).

Data from Crescent Lake gave no indication that sampling during one season (fall or spring) would be preferable, except that fewer fish were encountered, as indicated by lower CPUE's, during fall samples (fall average 1.09 bass/min; spring average 2.34 bass/min). Cross et al. (1993) reported an average CPUE of 1.57 bass/min for 1991 through 1993 spring samples in Crescent Lake. Length-frequency distributions were comparable from season to season and year to year during this study. They were also similar to spring samples presented by Snyder et al. 1990 and Cross et al. 1996 (Figure 27). All of the data showed an abundance of bass between 29 cm TL and 45 cm TL. This study and previous studies continued to document a decline in the number of trophy size bass represented in length-frequency data (Figure 28).

A review of previous studies and cursory electrofishing samples indicated that Lake Monroe was more suitable than Lakes Harney or Woodruff for a QFM proposal to create a quality fishery by restricting harvest and establishing a size limit on black crappie. During fall 1997, written and oral comments, including those received at a public forum, suggested that the fishing public supported stricter regulations on crappie harvest from Lake Monroe. A five year study of crappie harvest on four lakes in Mississippi concluded that harvest regulations such as length limits could be an effective tool for controlling harvest or for manipulating fishing quality (Miranda et al. 1997). Historical data including hoopnet catch, trawl catch, age and growth, angler creel surveys, tagging studies to measure crappie movement and angler exploitation and electrofishing samples led to the conclusion that fast growth rates, good standing crop and high angler harvest were all conditions which existed at Lake Monroe. It was generally assumed that those factors made the possibility of success in creating a quality crappie fishery more realistic.

Angler compliance is an important component of restrictive harvest regulations and is essential for success. Unless a flagrant violation occurred, anglers were given a grace period of approximately six months before the Division of Law Enforcement began issuing citations. From 1 July 1998 through 30 April 1999, a total of 28 warnings and 10 citations for bag limit violations or possession of undersize fish were issued. Those numbers indicated that anglers generally accepted the rule changes on Lake Monroe and would voluntarily comply as the number of larger crappie available to them increased. Peak season creel estimates from the 1997-1998 creel survey indicated that a majority of anglers on Lake Monroe fished for black crappie (78% of total effort). With a 50 fish bag limit and no size restrictions, anglers harvested 70% of the black crappie caught. The angler success rate (1.33 fish/hour) for black crappie harvested compared favorably to past surveys despite poor weather conditions. In year round surveys conducted from September 1992 through September 1995, four-month (September-January) success estimates for anglers harvesting black crappie ranged from 0.88 to 1.42 fish/hour for the third of the year with the highest success rates (Cross et al. 1996). A total of 1,363 angler harvested black crappie were measured from October 1997 through December 1998 and 20% were $\geq$30.5 cm TL. Crappie studies in Mississippi indicated size-selective exploitation occurred in crappie fisheries, with exploitation rates highest for fish 28.0-29.0 cm TL. Size-selective exploitation resulted in removal of intermediate age classes (2-4 years old) in a higher proportion relative to their abundance than younger or older age classes (Dorr et al. 1997). At Weiss Reservoir, Alabama exploitation of crappie was greater for fish over 250 mm TL, suggesting a disproportionate exploitation of large crappie (Reed et al. 1991).

A decrease in fishing effort and harvest was predicted during the first years of the new regulations on Lake Monroe. This would occur until anglers became accustomed to the rule change and crappie less than 30.5 cm TL moved into legal size classes. An access point and roving seawall creel conducted concurrently in 1998-1999 indicated effort for black crappie composed less of the total effort than in previous surveys. The combined effort for all sport fishing during the 1998-1999 surveys totaled 36,470 angler-hours and effort for black crappie accounted for only 36% (13,310 angler-hours) of the total effort.

Length-frequency analysis of catfish from the study area in the St. Johns River indicated a healthy channel catfish population with a low PSD value. This indicated a substantial number of individuals had been recruited into the population. Approximately 62% of the channel catfish collected were between 25.0-35.0 cm TL; however, few individuals attained lengths greater than 37.0 cm TL. Relative stock density of the preferred and memorable length-groups indicated the presence of an acceptable number of larger individuals in the population.

Variation in CPUE for catfish at the six sampling locations was not considered unusual for channel catfish in river systems. Hale et al. (1984) reported catching 1 to 321 fish per trip while using a “monkey rig” to collect catfish on the St. Johns River. Hale et al. (1986) concluded that no discrete populations of channel catfish exist in the St. Johns River and the large variation in number collected was due to temporary clustering. Channel catfish begin spawning in late April and continue to spawn into July (Personal communication, Joe Crumpton), which overlaps the time period that sampling was conducted. Variations in CPUE values could have been a result of movement and reduced feeding activity induced by spawning during the time of sampling.

Overall Wr values for channel catfish was high. Sub-stock length fish (<27.9 cm TL) had the lowest average relative weight of 104 but the Wr value increased as length of fish increased. Channel catfish in the St. Johns River grew faster and lived longer than populations in Iowa, Nebraska, and South Carolina (Brown 1990). In an earlier study, Brown (1990) documented channel catfish to age-8 in the St. Johns River and incremental growth rates of 57 mm TL between mean lengths at age. Little difference in growth rates was found between areas of the river that were commercially fished and those that were not. Channel catfish to age-10 were collected during this study and average incremental growth was 61 mm TL between mean lengths at age.

When first sampled, Bear Pond was very acidic and no fish were present; however the pond responded well to management activities. Liming brought the pH to near neutral, fertilizer provided the needed nutrients for algae and plankton growth and stocked fish had excellent survival and growth rates. Bank anglers were provided a quality area for fishing and pressure on this pond increased substantially during this three year period as evidenced by worn walking trails and debris on the bank leading to the four fish feeders installed in the pond. Information gathered from anglers and observations made while tending feeders indicated that catfish was the species most often fished for and caught. This pond also provided an excellent place for bank fishing activities giving new and inexperienced anglers a positive fishing experience.

Although Oaks Pond had a limited sport fish population when first sampled, raising the pH level did not provide desired results. Dissolved oxygen readings indicated a high biological demand as values rarely surpassed 3.0 ppm (at one meter depth) and often were recorded at 0.3 ppm during mid-day. The low DO values were attributed to organic debris from the dense water lily coverage and waxmyrtle and arrowhead growing along the pond periphery. Although all organic debris was removed, enhancement efforts could not be completed during this study due to lack of rain for refilling. Following refill and completion of enhancement efforts it is believed that excellent bank fishing opportunities will be established.

Despite being highly eutrophic, Ranch Pond had one of the best existing sport fish populations of the ponds selected for management. Installation of an aeration system to prevent overnight dissolved oxygen drops, especially with the added burden of intensive catfish stocking and feeding, helped maintain the fish population of Ranch Pond. The pond was reserved for children sixteen and under and special group fishing events. At the "Tiger Bay State Forest Awareness Day," youth fishing was the most popular event of the days activities.

Rattlesnake Pond had a poor sport fish population due to water quality. The pH level did not rise to a suitable level with the first liming and a second application was necessary. However, as pH levels became acceptable, the dissolved oxygen levels remained low. These low levels were attributed to a higher biological oxygen demand caused by increased pH allowing greater decomposition of organic material present on the pond bottom. Further stocking and management activities ceased pending muck removal to improve fisheries habitat.

The QFM Project investigated fishing opportunities of two ponds in Lake George Wildlife Management Area but one unnamed pond was found to be unsuitable due to its transient nature; thus no management activities were undertaken. The other water body, Jenkins Pond, was newly excavated and allowed to fill naturally. Fill dirt piled nearby caused this pond to remain turbid due to runoff after heavy rains. Removal of suspended solids was attempted using ten bales of alfalfa hay but no noticeable changes resulted. Electrofishing samples collected few stocked bass (attributed to high turbidity levels) but did collect non-stocked warmouth and chain pickerel. Although channel catfish were stocked in spring 1999 and a fish feeder added for supplemental nutrition, further habitat improvements are needed before this pond will be suitable for quality public fishing.

Striped bass broodfish collection was also negatively impacted by weather conditions during this study period. Although weather conditions in the 1996-1997 season were normal, the high water in the spring of 1998 caused increased flow in the St. Johns River and apparently caused striped bass to be more dispersed and difficult to locate. The Wekiva River overflowed its banks temporarily eliminating the normal current which historically attracted striped bass. Increased flow in the Oklawaha River, another tributary of the St. Johns, resulted in more productive broodfish collection but hot dry weather caused the water in hatchery ponds at Welaka Hatchery to surpass lethal temperature for striped bass fry and limited the number of fingerlings available for stocking. Broodfish collection in 1998-1999 occurred under opposite climatic conditions. The spawning season was warmer and dryer than usual and the St. Johns River was much lower than normal. Low water resulted in little or no flow in the river or its tributaries. Many ineligible fish were collected from the bombing targets on Lake George early in the season but none were collected from the Oklawaha River. In late March, eligible six to nine pound female stripers were collected from the bombing targets and the Wekiva River. However, the warm temperatures again had a negative impact on fry production at Welaka Hatchery.

CONCLUSIONS

For various reasons, the GFC Tallahassee fisheries staff rejected proposals for quality largemouth bass management on Lake George and Crescent Lake submitted by the QFM Project in 1997. Historical length-frequency and age data from both lakes suggested that there was a consistent abundance of age-2 to age-4 bass in each lake that could recruit into quality or trophy size-classes if protected from over harvest until they reached larger sizes. The implementation of a 35.6 cm TL minimum size limit and the growing popularity of local, state and national tournament fishing (both factors which encourage catching larger fish) appeared to have led to increased harvest or catch and relocation of bass that had trophy potential. It is clear from figures 27 and 29 that the number of trophy size bass collected from both lakes by electrofishing has decreased substantially. Due to the size of the water bodies and staff limitations, it is impractical to obtain estimates of natural mortality yearly. However, visual observation for many years leads the investigator to believe that habitat and forage base changes which might have negatively affected the bass populations was minimal. It is reasonable to conclude that angling pressure was instrumental in the reduced number of trophy bass in Lake George and Crescent Lake and additional study, perhaps in a smaller, more investigation friendly system, is needed.

Length-frequency distributions and length-at-age data supported historical black crappie data from Lake Monroe. Historical and current data indicated rapid growth rates and an abundance of crappie in size-classes that would create a quality fishery with the establishment of more restrictive harvest regulations.

Effort and harvest estimates for black crappie on Lake Monroe appeared to decline following the implementation of a 30.5 cm TL size limit and 25 fish bag limit. Anglers fishing for black crappie typically were seeking fish for consumptive purposes and, as measured before implementation of the size limit, harvested crappie beginning at approximately 23.0 cm TL. As a result of the size limit, boat anglers were only able to harvest 23% of their crappie and bank anglers harvested only 45%, whereas, in the survey the year before the rule went into effect, anglers harvested 70% of the black crappie caught. Anglers may have shifted their effort to other areas with higher harvest rates but effort and harvest on Lake Monroe is expected to increase when more black crappie are available in the legally harvestable size classes. Indications at the conclusion of this study were that voluntary compliance of the new minimum size limit and bag limit would be sufficient to allow a good test of the hypothesis of limited harvest creating a quality crappie fishery.

Bear Pond located in Seminole Forest Wildlife Management Area and Ranch Pond in Tiger Bay WMA provided good quality bank fishing opportunities, especially for non-boating anglers who were unable to fish most public fishing areas. Public bank fishing areas are becoming more important as development in Florida continues to reduce public access to many ponds and lakes. Most of the ponds being managed are close to major metropolitan areas making them ideal for bank fishing events. Oaks Pond (Seminole Forest WMA) and Rattlesnake Pond (Tiger Bay WMA) require additional habitat enhancement before stocking to maintain a quality sport fish population.

The upper St. Johns River channel catfish population is firmly established and available for anglers. Based on our sampling data, the population appeared to have consistent recruitment and an acceptable number of larger individuals in the system. Like most fish populations, the density of individuals varied considerably and had the potential to be quite high in areas. Relative condition of channel catfish in all length categories was good which indicated an adequate forage supply.

RECOMMENDATIONS

(1) Continue to collect largemouth bass length-frequency data from Lake George.

(2) Largemouth bass investigations to determine angler harvest of trophy size fish should be implemented on a smaller lake in the St. Johns River system.

(3) Black crappie investigations to evaluate the impact and success of new size and bag limit regulations on Lake Monroe should continue.

(4) Activities to promote new or additional fishing opportunities on public lands should be continued.

(5) Sportfish population response to newly restored vegetation areas in Lake Jesup should be evaluated.

(6) Continue the collection of striped bass brood fish to stock *Morone* spp. in the St. Johns River.

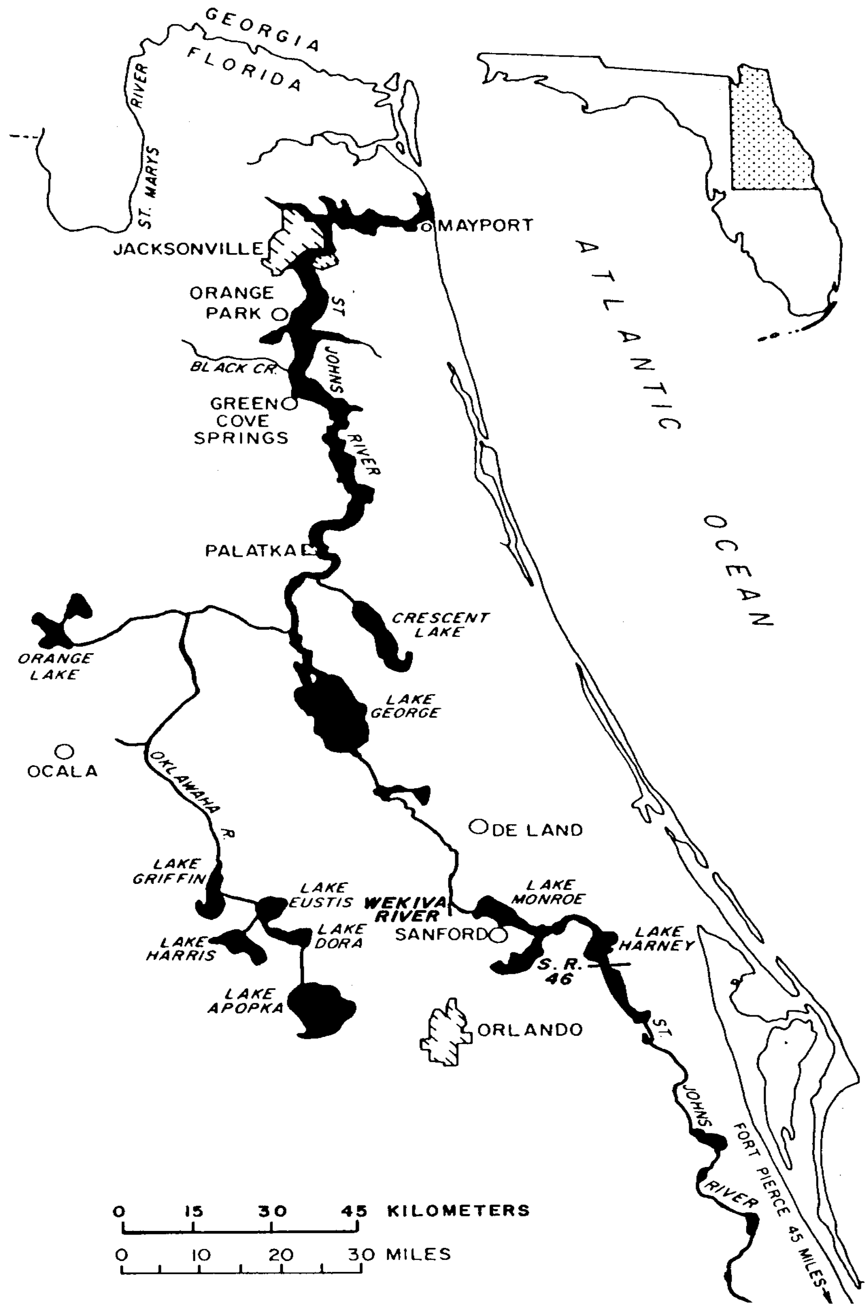
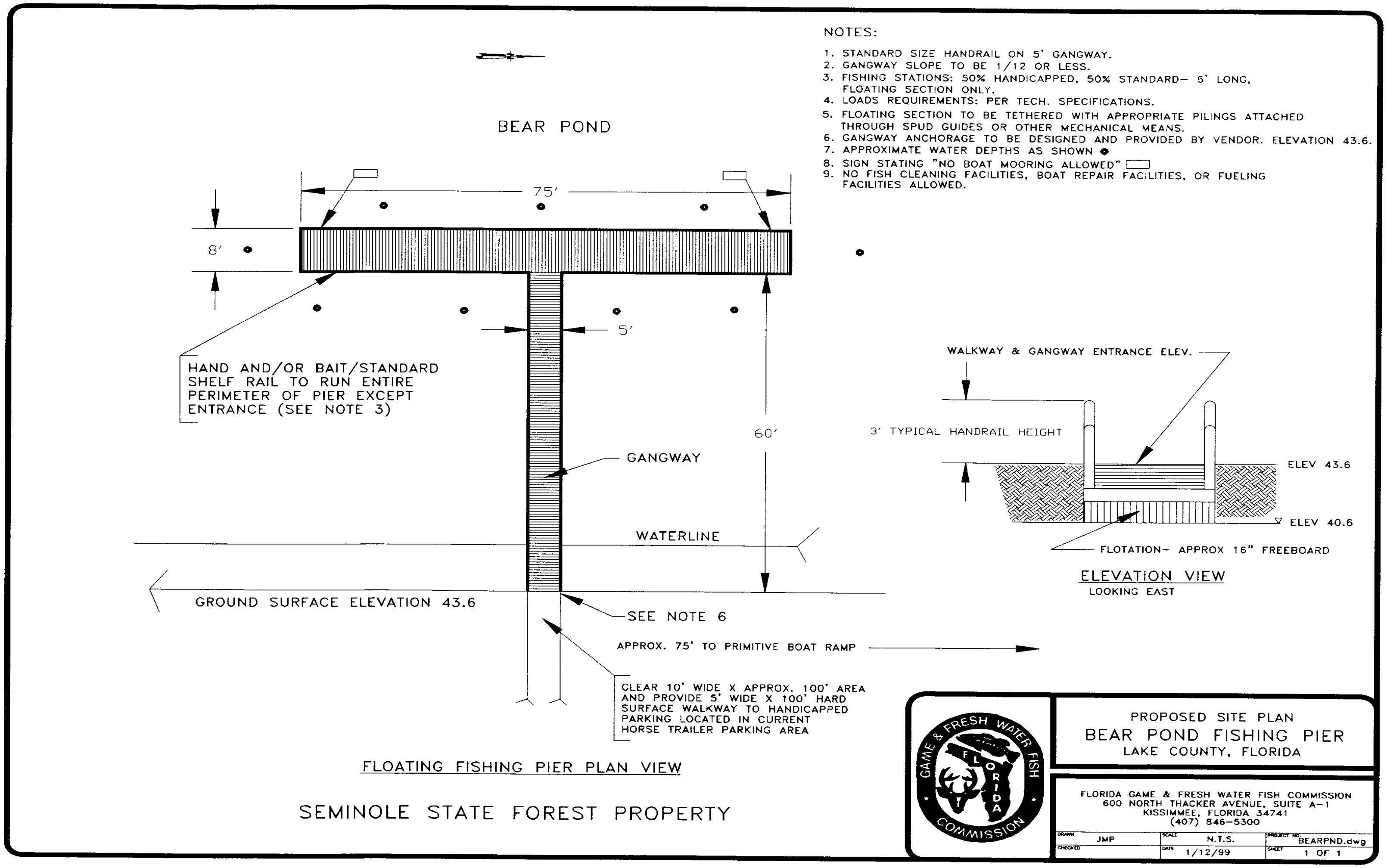


Figure 1. Map of the St. Johns River.


NOTES:
1. STANDARD SIZE HANDRAIL ON 5' GANGWAY.
2. GANGWAY SLOPE TO BE 1/12 OR LESS.
3. FISHING STATIONS: 50% HANDICAPPED, 50% STANDARD– 6' LONG, FLOATING SECTION ONLY.
4. LOADS REQUIREMENTS: PER TECH. SPECIFICATIONS.
5. FLOATING SECTION TO BE TETHERED WITH APPROPRIATE PILINGS ATTACHED THROUGH SPUD GUIDES OR OTHER MECHANICAL MEANS.
6. GANGWAY ANCHORAGE TO BE DESIGNED AND PROVIDED BY VENDOR. ELEVATION 43.6.
7. APPROXIMATE WATER DEPTHS AS SHOWN ●
8. SIGN STATING "NO BOAT MOORING ALLOWED"
9. NO FISH CLEANING FACILITIES, BOAT REPAIR FACILITIES, OR FUELING FACILITIES ALLOWED.
BEAR POND
75'
8'
5'
60'
HAND AND/OR BAIT/STANDARD SHELF RAIL TO RUN ENTIRE PERIMETER OF PIER EXCEPT ENTRANCE (SEE NOTE 3)
GANGWAY
WATERLINE
GROUND SURFACE ELEVATION 43.6
SEE NOTE 6
APPROX. 75' TO PRIMITIVE BOAT RAMP
CLEAR 10' WIDE X APPROX. 100' AREA AND PROVIDE 5' WIDE X 100' HARD SURFACE WALKWAY TO HANDICAPPED PARKING LOCATED IN CURRENT HORSE TRAILER PARKING AREA
FLOATING FISHING PIER PLAN VIEW
SEMINOLE STATE FOREST PROPERTY
WALKWAY & GANGWAY ENTRANCE ELEV.
3' TYPICAL HANDRAIL HEIGHT
ELEV 43.6
ELEV 40.6
FLOTATION– APPROX 16" FREEBOARD
ELEVATION VIEW
LOOKING EAST
GAME & FRESH WATER FISH COMMISSION
FLORIDA
PROPOSED SITE PLAN
BEAR POND FISHING PIER
LAKE COUNTY, FLORIDA
FLORIDA GAME & FRESH WATER FISH COMMISSION
600 NORTH THACKER AVENUE, SUITE A-1
KISSIMMEE, FLORIDA 34741
(407) 846-5300
JMP
N.T.S.
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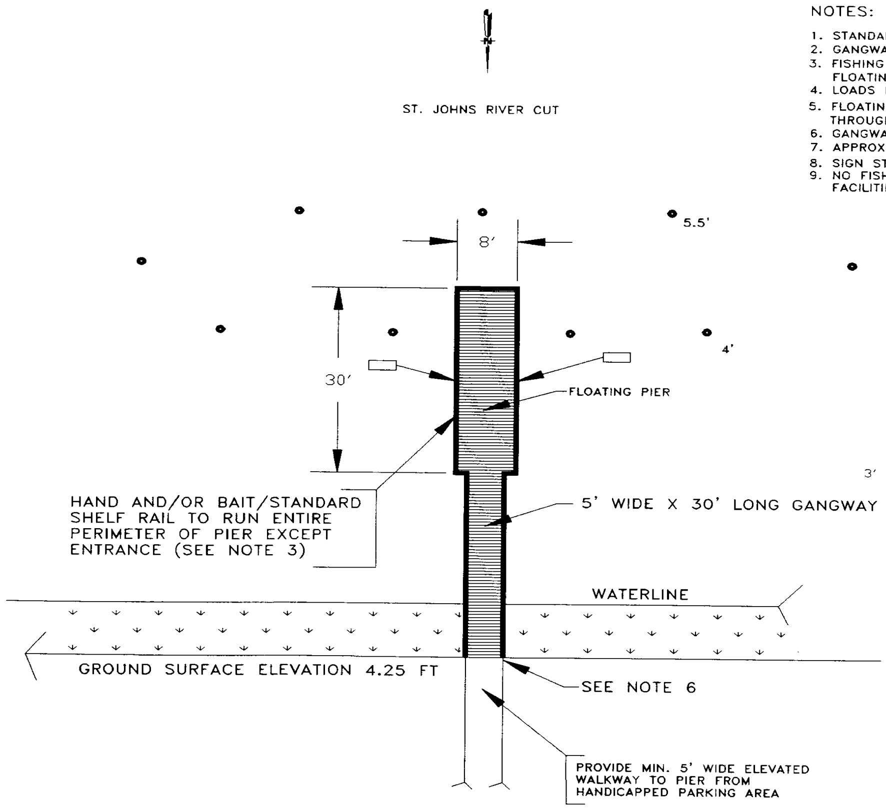
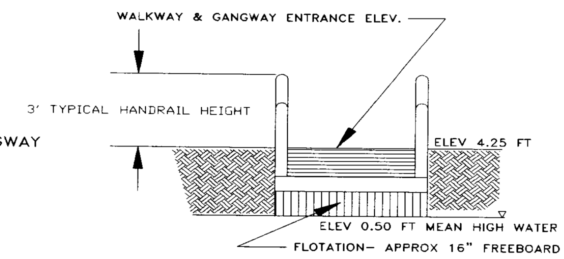
NOTES:

1. STANDARD SIZE HANDRAIL ON 5' GANGWAY.
2. GANGWAY SLOPE TO BE 1/12 OR LESS.
3. FISHING STATIONS: 50% HANDICAPPED, 50% STANDARD– 6' LONG, FLOATING SECTION ONLY.
4. LOADS REQUIREMENTS: PER TECH. SPECIFICATIONS.
5. FLOATING SECTION TO BE TETHERED WITH APPROPRIATE PILINGS ATTACHED THROUGH SPUD GUIDES OR OTHER MECHANICAL MEANS.
6. GANGWAY ANCHORAGE TO BE DESIGNED AND PROVIDED BY VENDOR– ELEV. 4.25 FT.
7. APPROXIMATE WATER DEPTHS AS SHOWN ●
8. SIGN STATING "NO BOAT MOORING ALLOWED" ▭
9. NO FISH CLEANING FACILITIES, BOAT REPAIR FACILITIES, OR FUELING FACILITIES ALLOWED.



FLOATING FISHING PIER PLAN VIEW



ELEVATION VIEW
LOOKING NORTH

LAKE GEORGE STATE FOREST PROPERTY

PROPOSED SITE PLAN
BLUFFTON FISHING PIER
VOLUSIA COUNTY, FLORIDA

FLORIDA GAME & FRESH WATER FISH COMMISSION
600 NORTH THACKER AVENUE, SUITE A-1
KISSIMMEE, FLORIDA 34741
(407) 846-5300

DRAWN	SCALE	PROJECT NO.
JMP	N.T.S.	BLUFF1.dwg
CHECKED	DATE 5/6/99	SHEET 1 OF 1

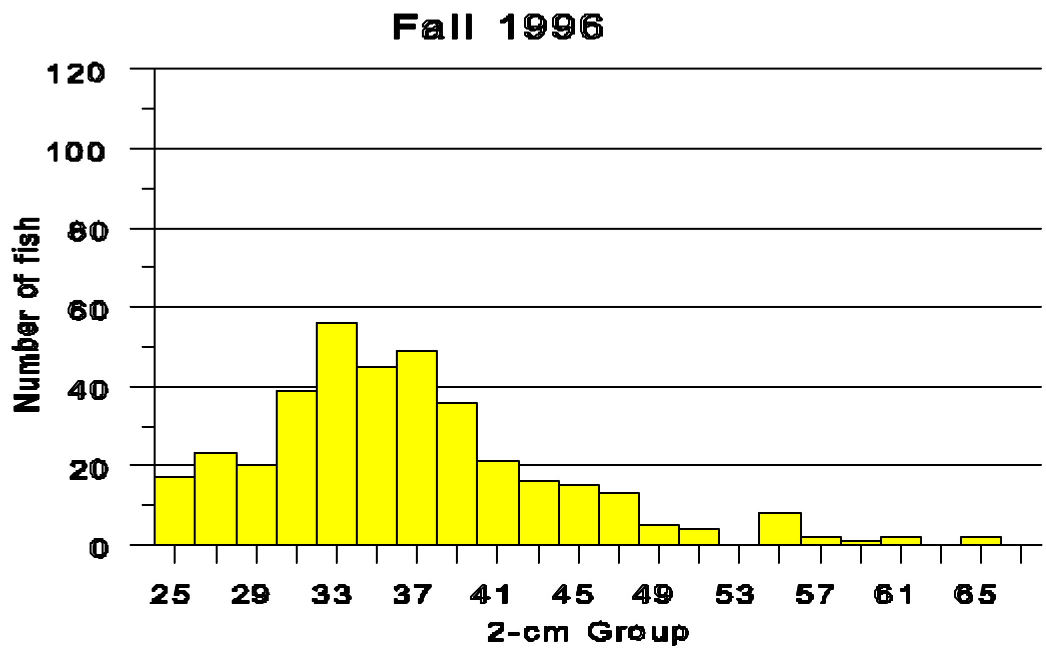
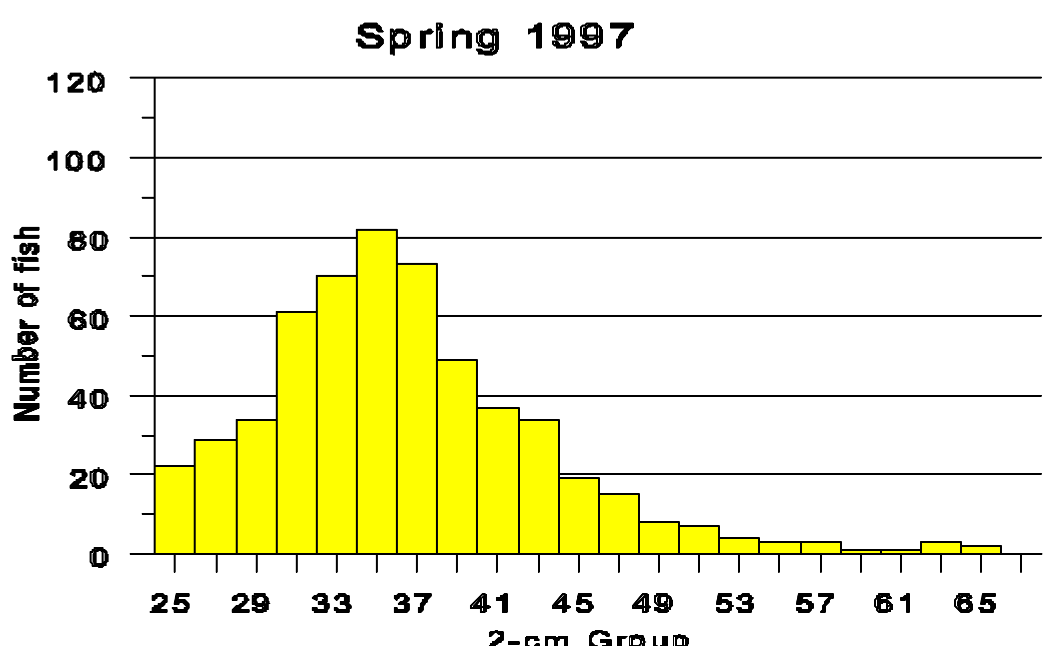


Figure 4. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected by electrofishing from Lake George, fall 1996 and spring 1997.

N = 374

N = 557



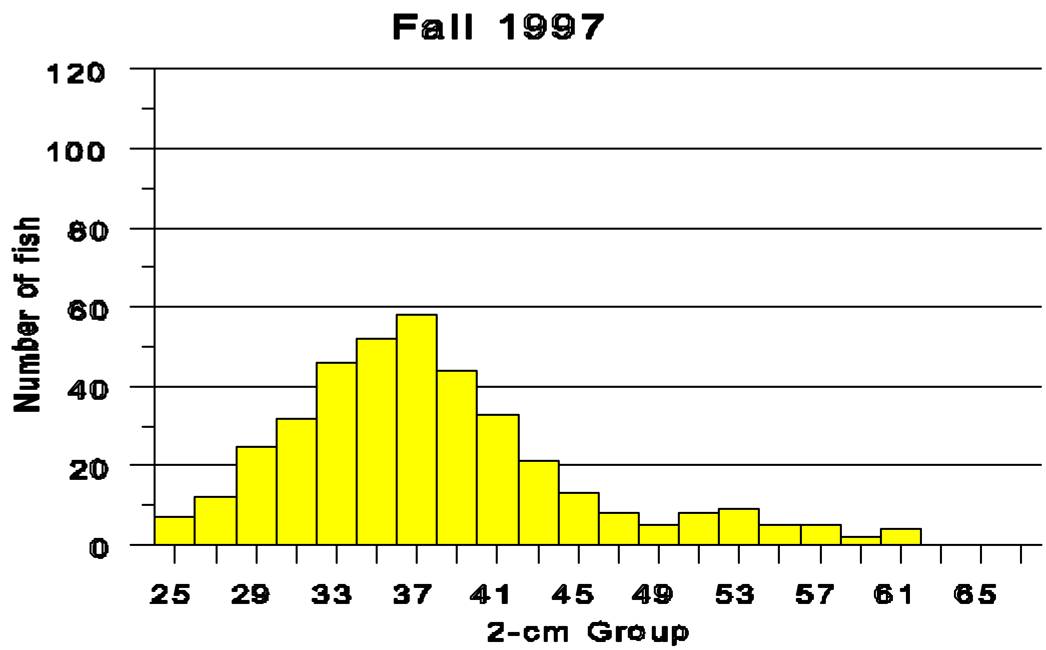
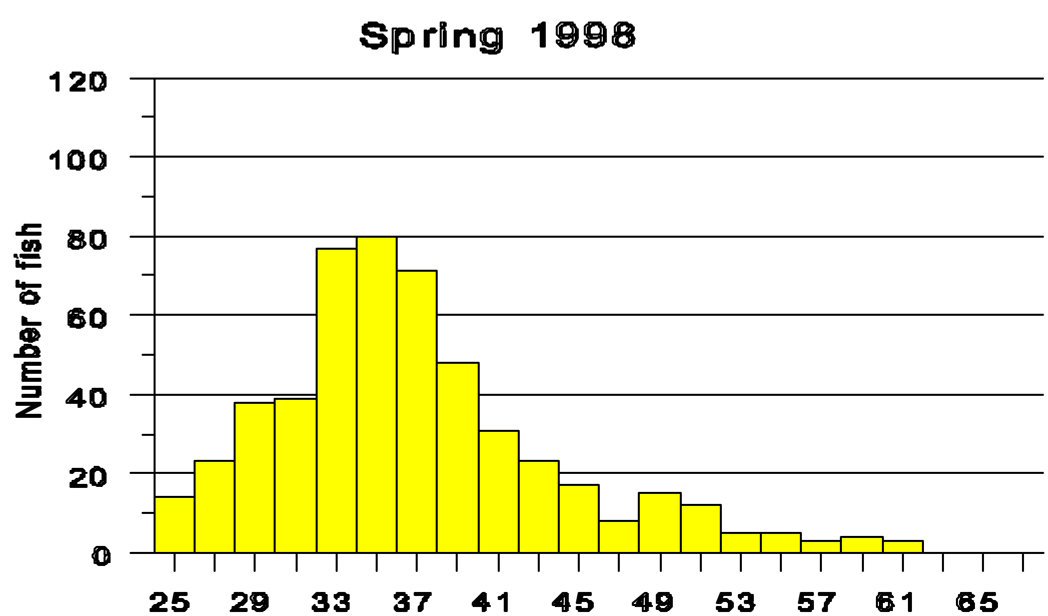


Figure 5. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected by electrofishing from Lake George, fall 1997 and spring 1998.

N = 389

N = 516



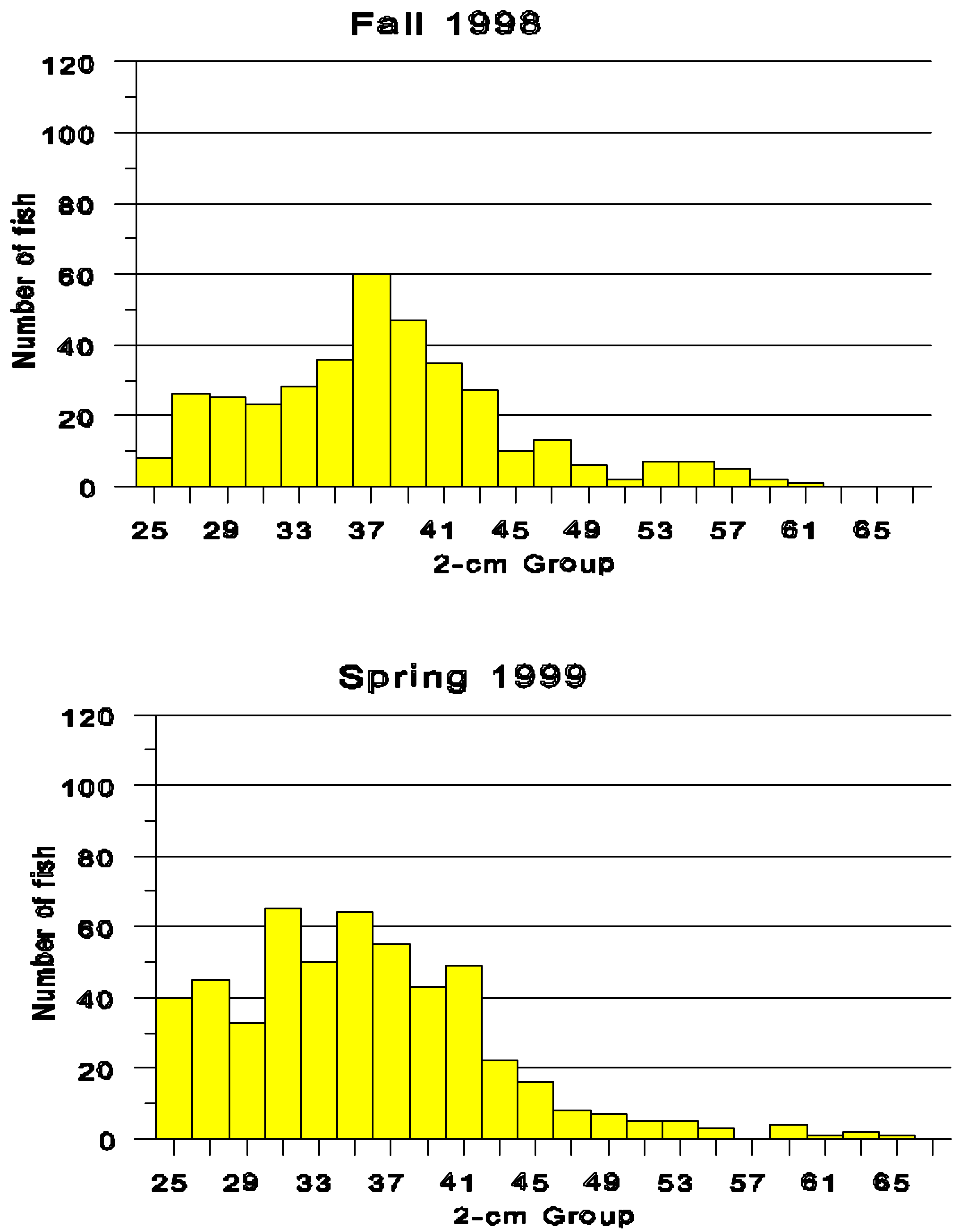
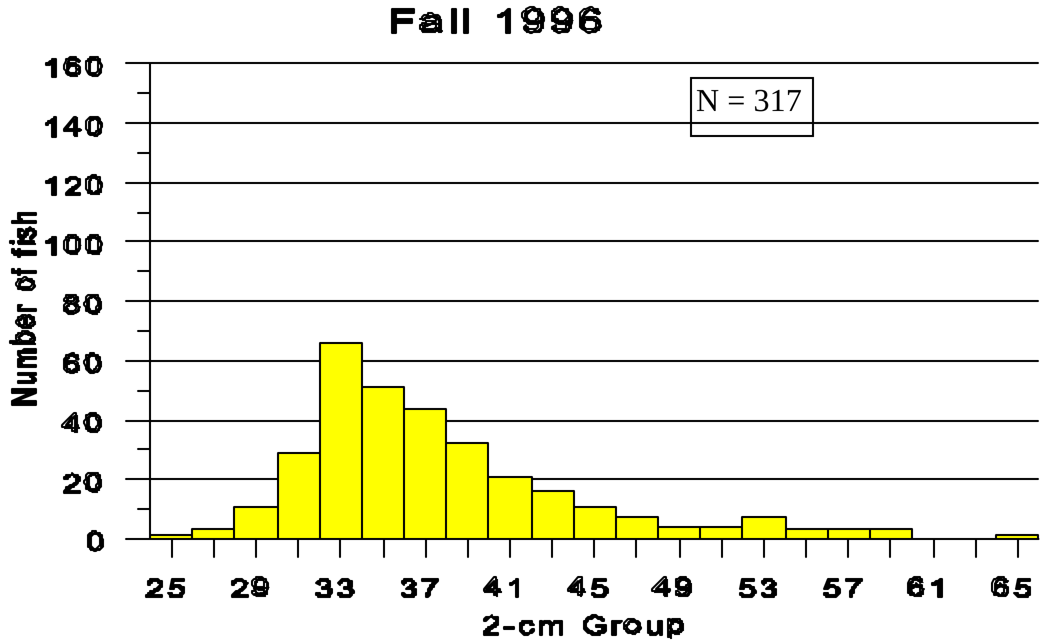


Figure 6. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected by electrofishing from Lake George, fall 1998 and spring 1999.



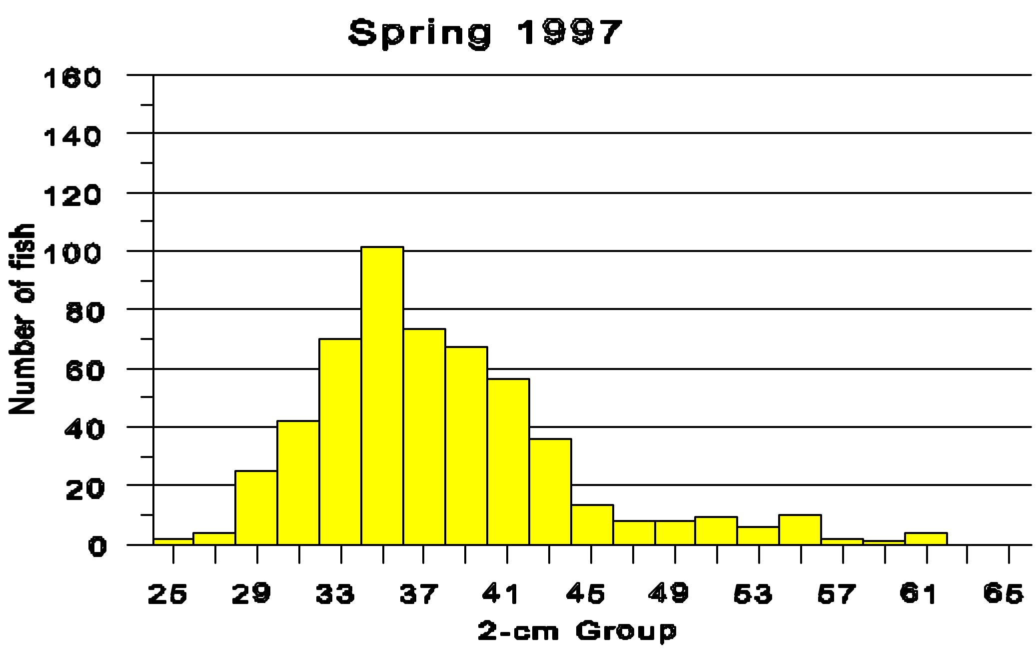
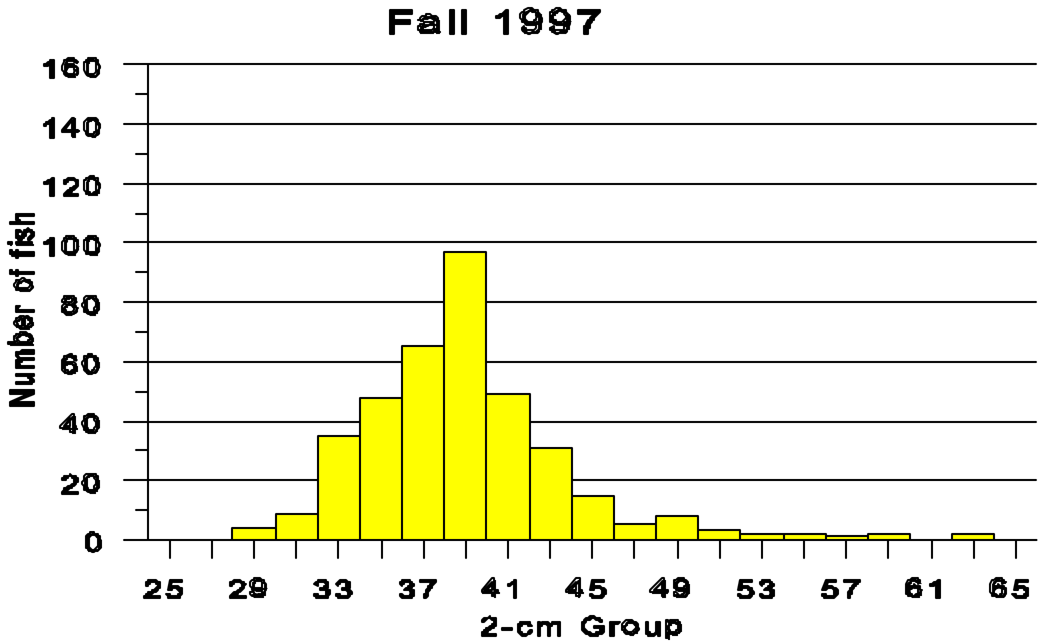


Figure 7. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected by electrofishing from Crescent Lake, fall 1996 and spring 1997.



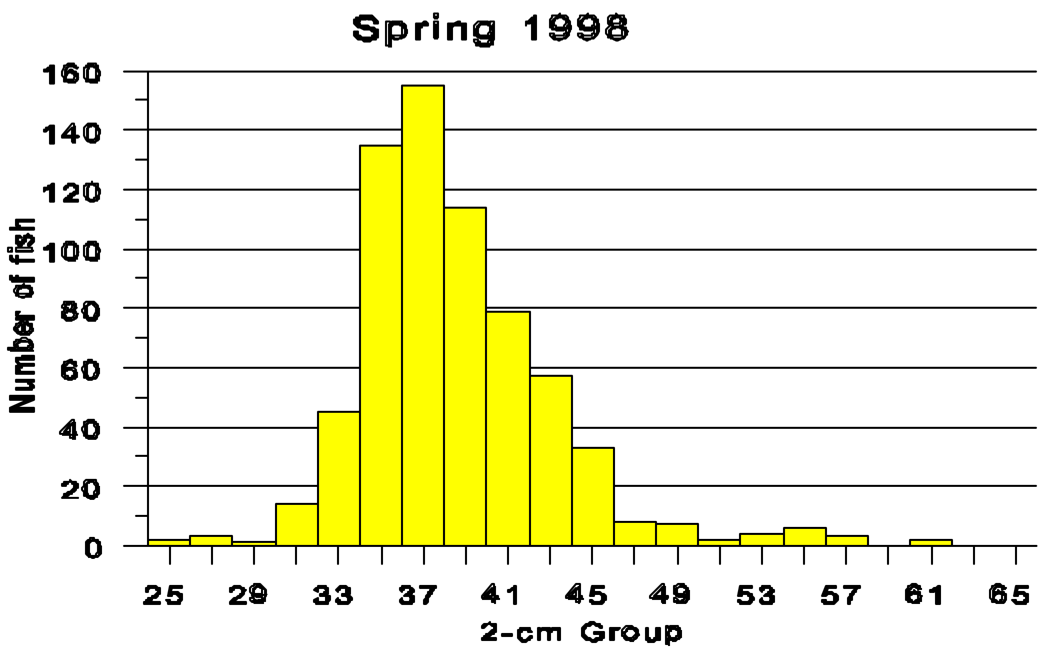


Figure 8. Length-frequency distributions of largemouth bass $\geq$ 24 cm TL collected by electrofishing from Crescent Lake, fall 1997 and spring 1998.

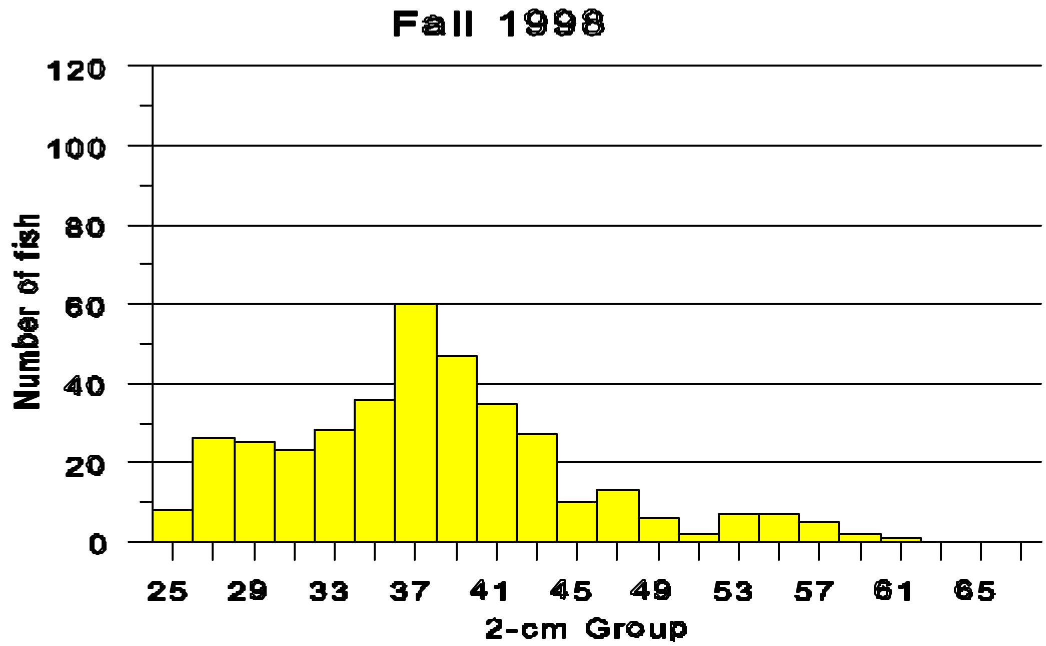
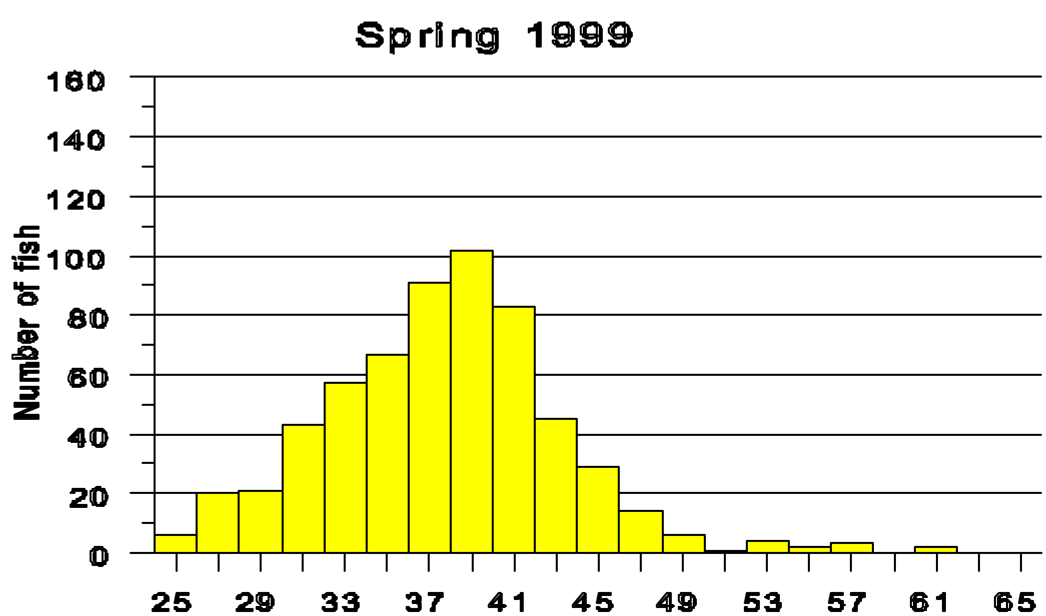


Figure 9. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected by electrofishing from Crescent Lake, fall 1998 and spring 1999.

N = 307



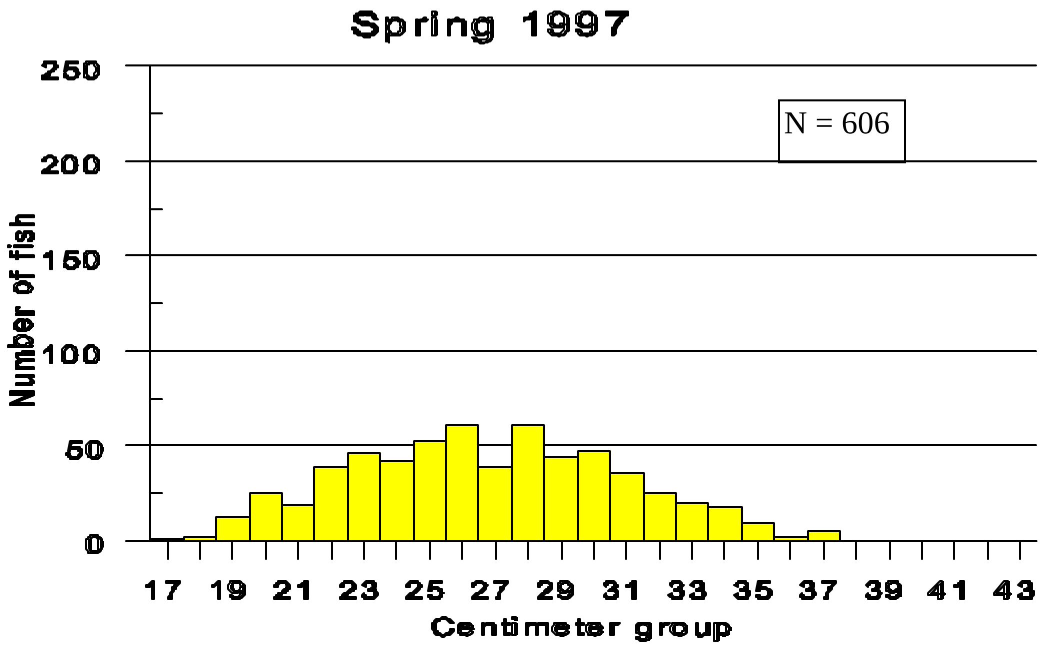


Figure 10. Length-frequency distribution of black crappie harvested from Lake Monroe by anglers, spring 1997.

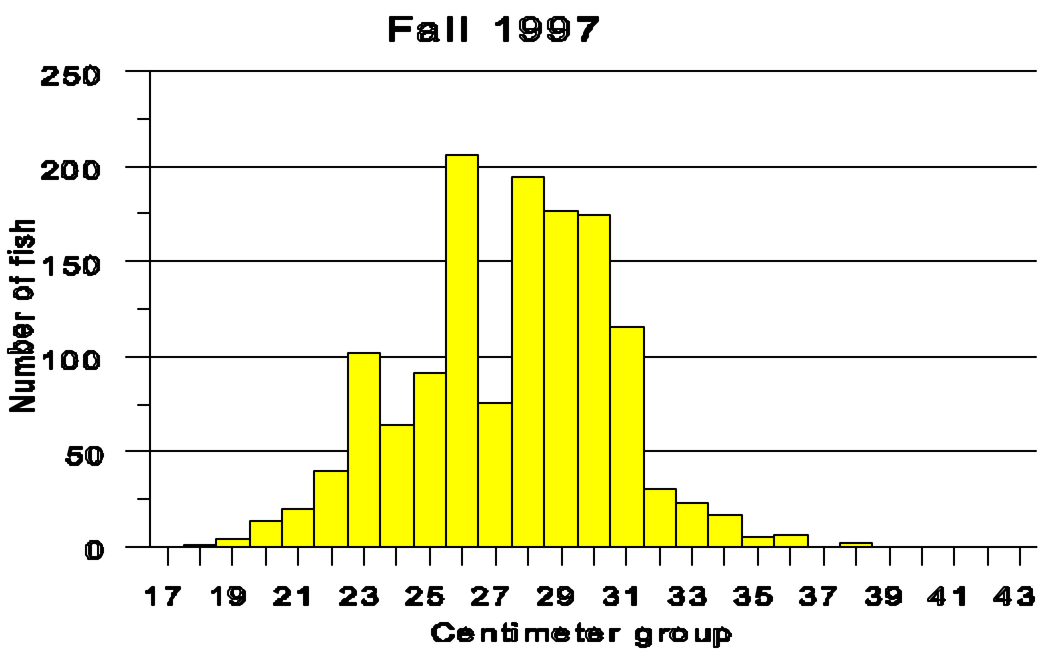


Figure 11. Length-frequency distribution of black crappie harvested from Lake Monroe by anglers, fall 1997.

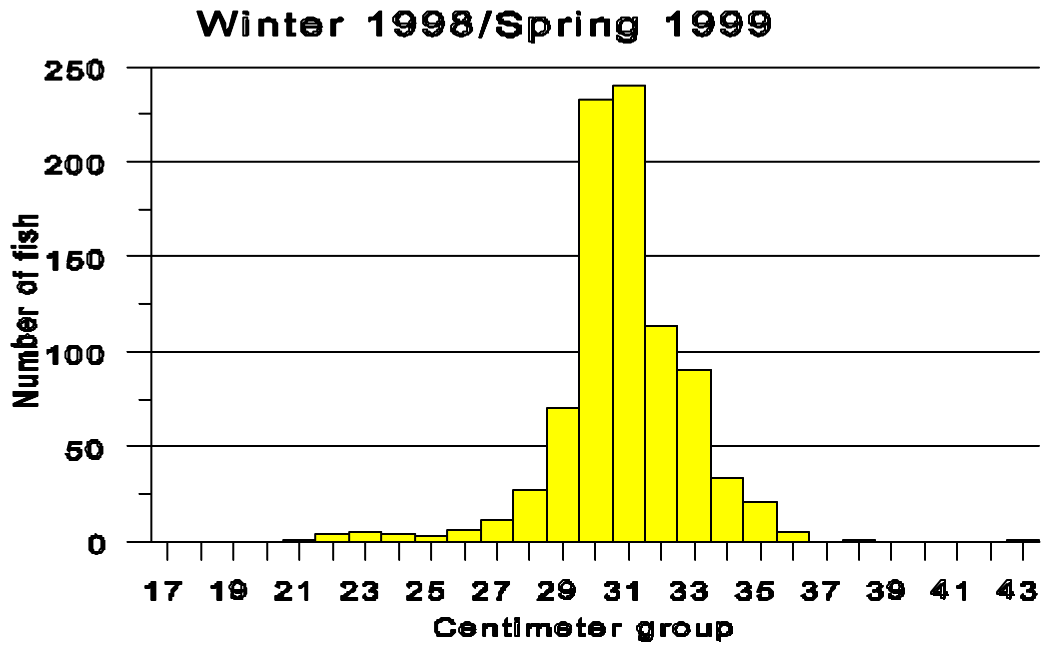


Figure 12. Length-frequency distribution of black crappie harvested from Lake Monroe by anglers, winter 1998/spring 1999.

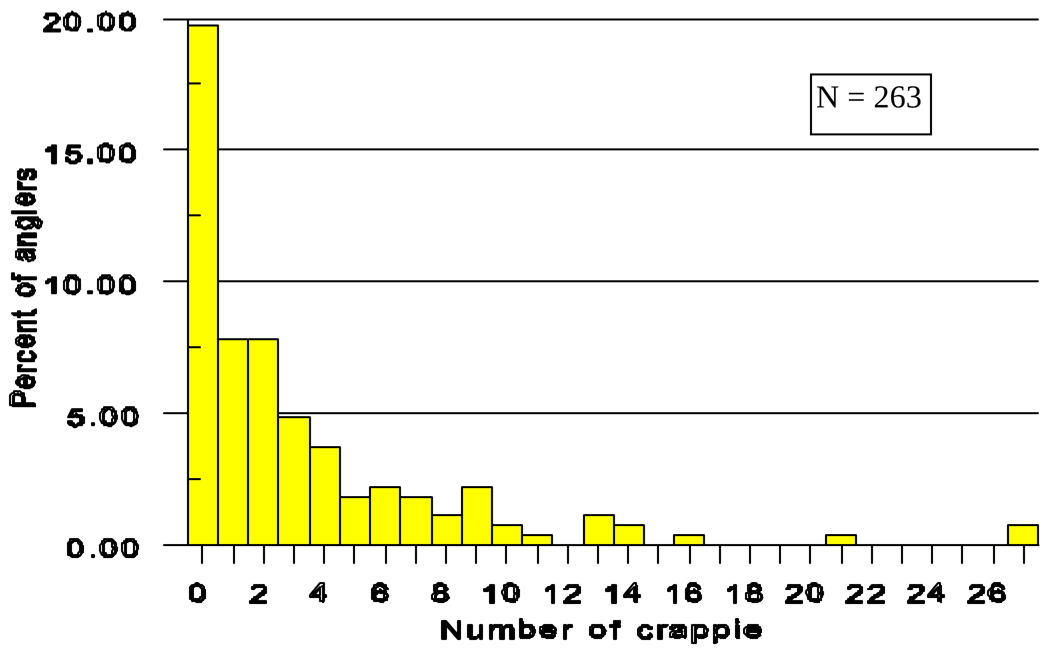


Figure 13. Number of black crappie harvested per trip by percentage of anglers on Lake Monroe, March through May, 1997. Data is based on completed trip surveys.

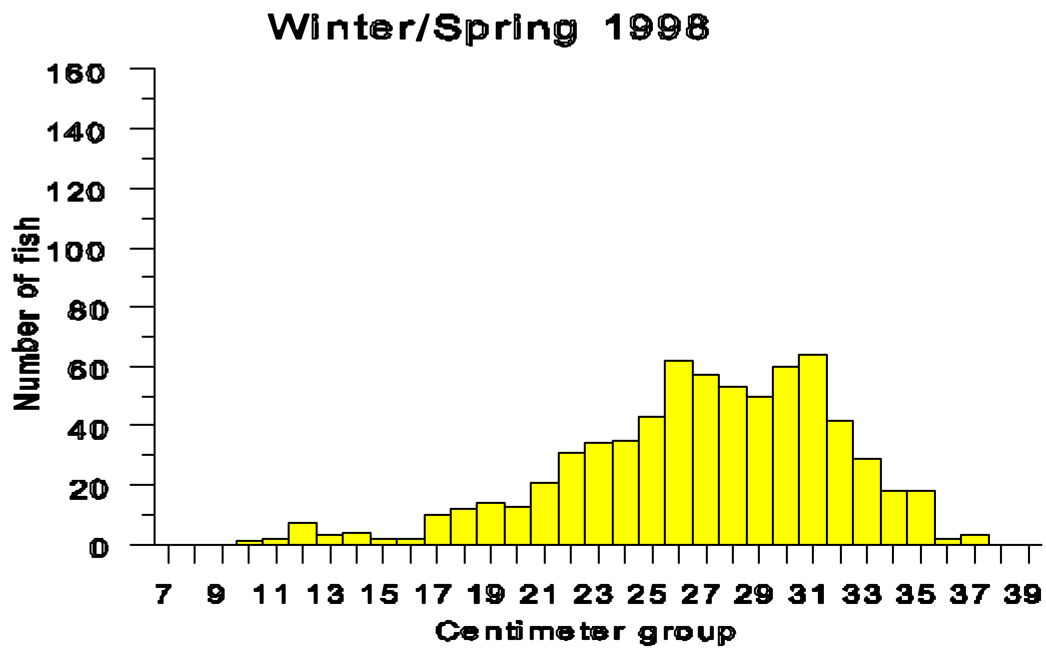


Figure 14. Length-frequency distribution and age composition of black crappie collected by electrofishing from Lake Monroe, winter/spring 1998.

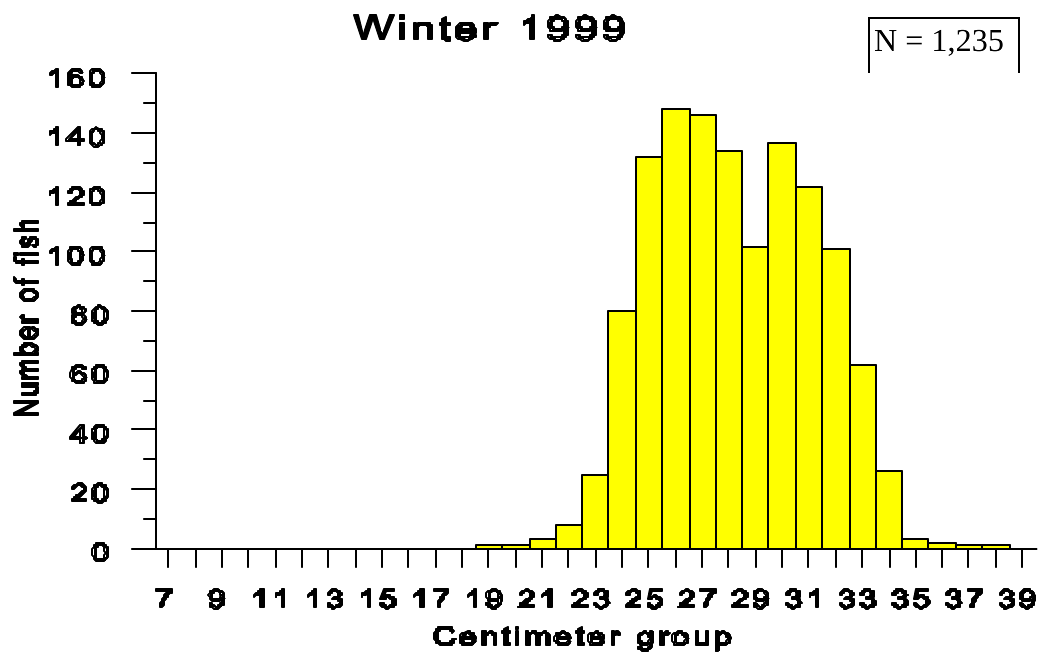


Figure 15. Length-frequency distibution and age composition of black crappie collected by electrofishing from Lake Monroe, winter 1999.

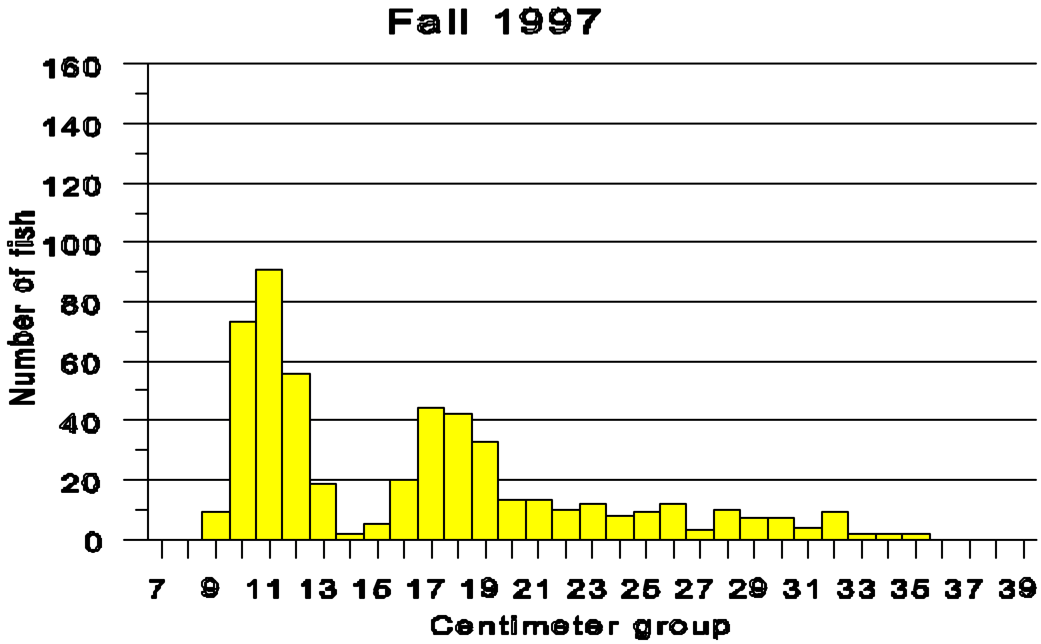


Figure 16. Length-frequency distribution of black crappie collected by trawl from Lake Monroe, fall 1997.

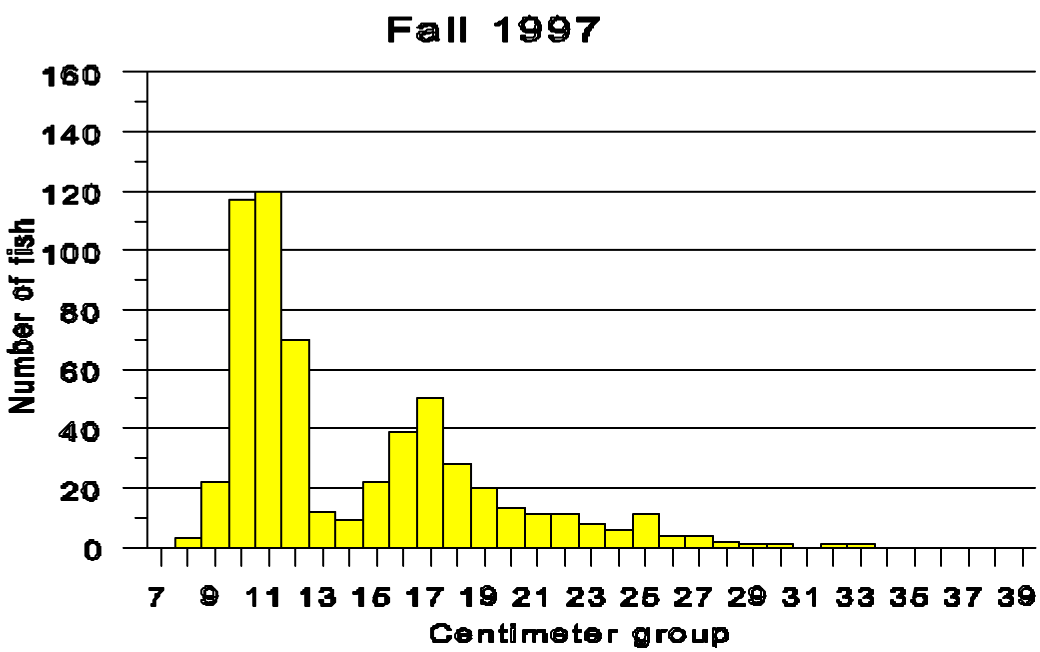


Figure 17. Length-frequency distribution of black crappie collected by trap net from Lake Monroe, fall 1997.

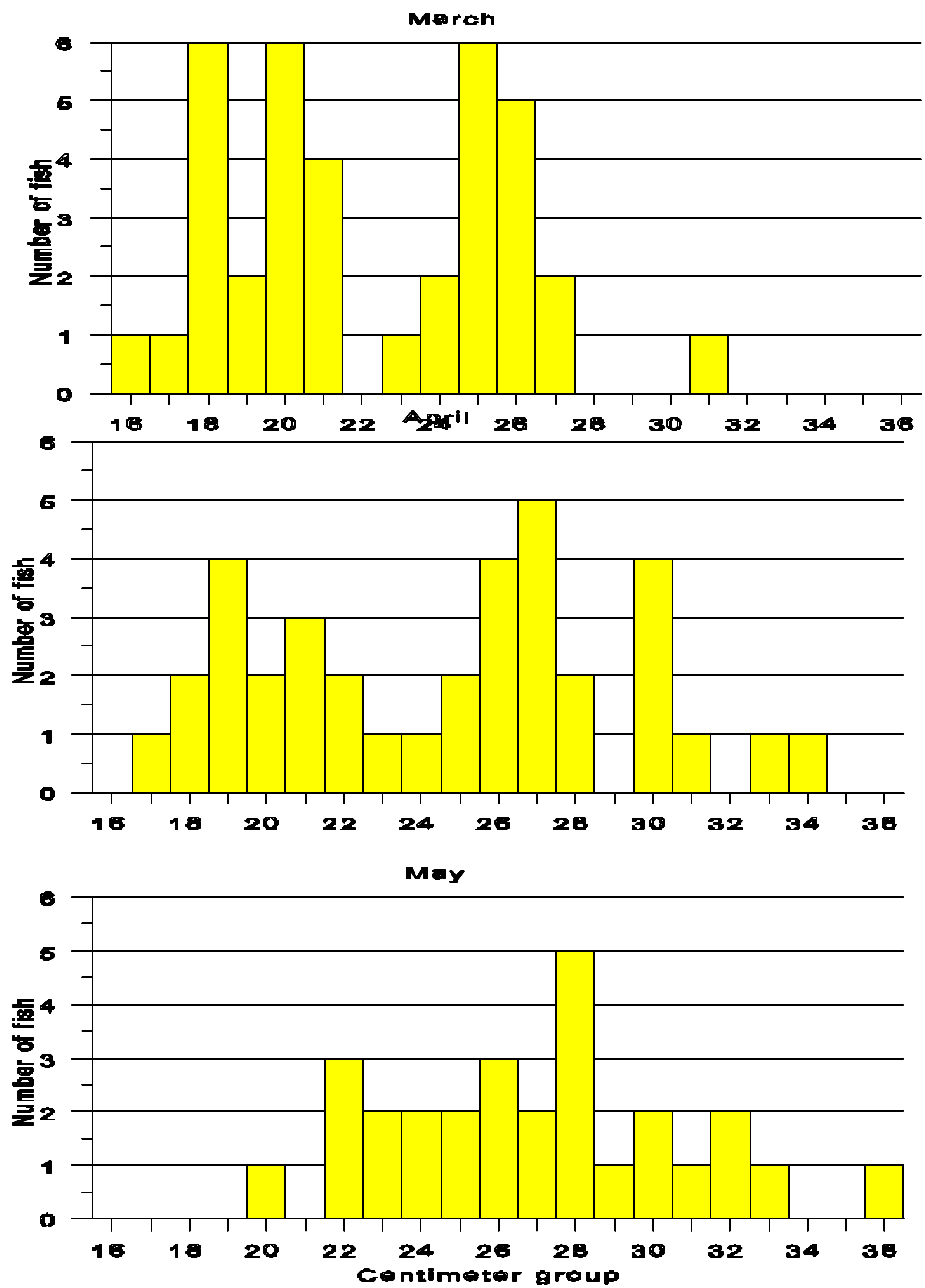


Figure 18. Length-frequency distributions of stocked largemouth bass collected from Bear Pond in Seminole Forest Wildlife Management Area in March, April and May 1997.

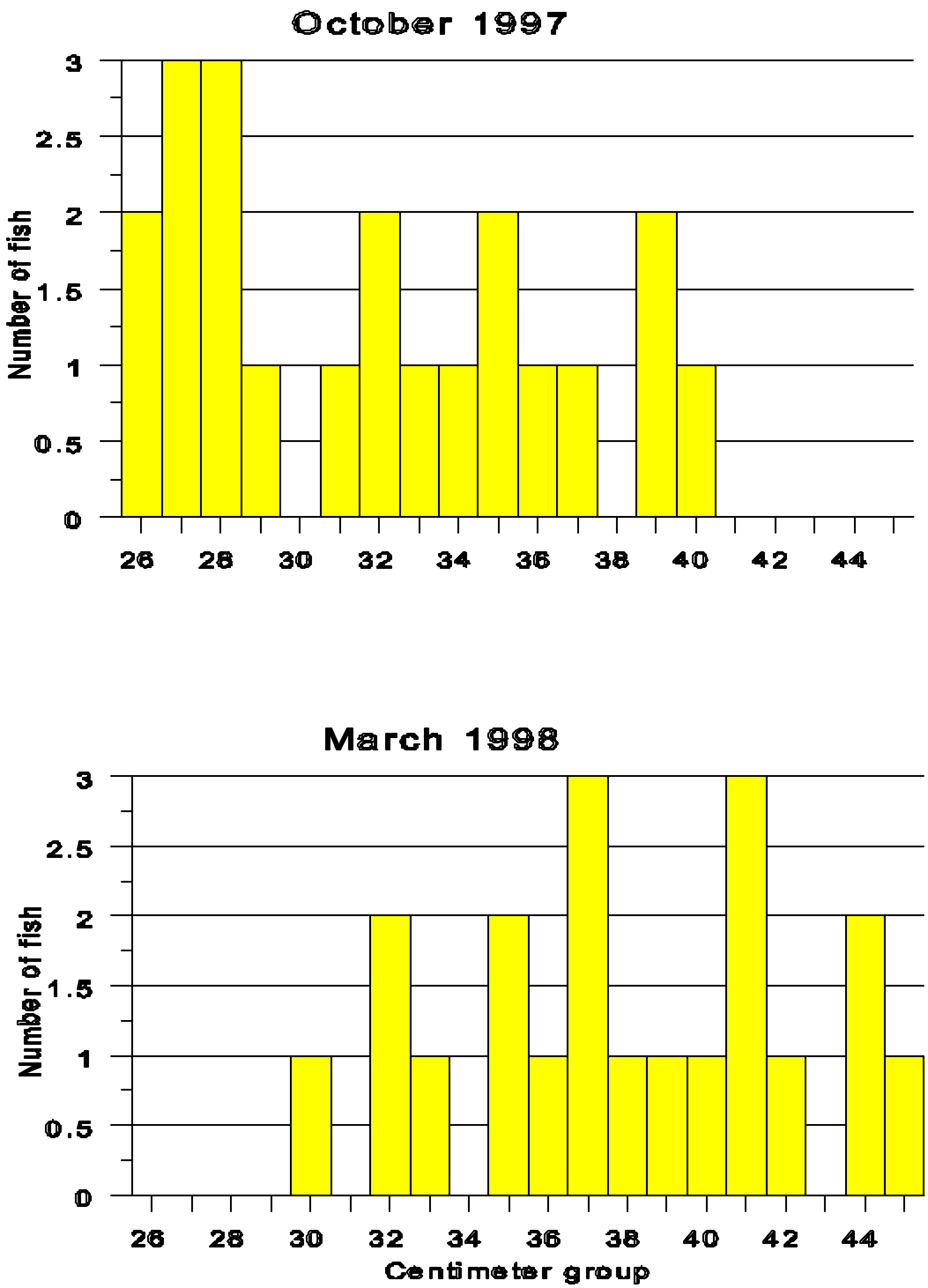
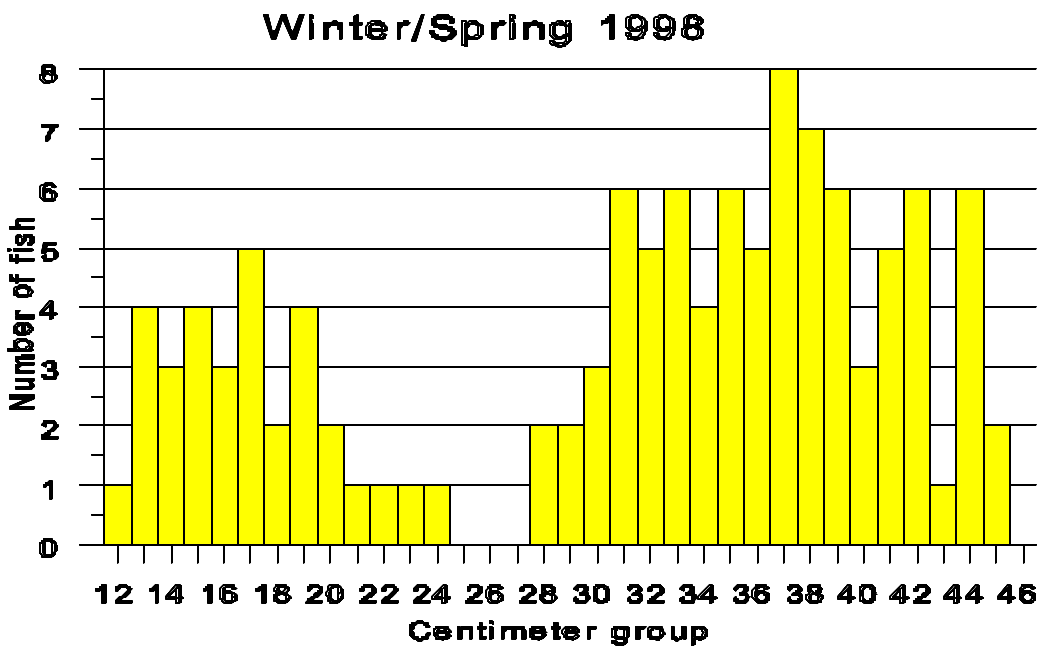
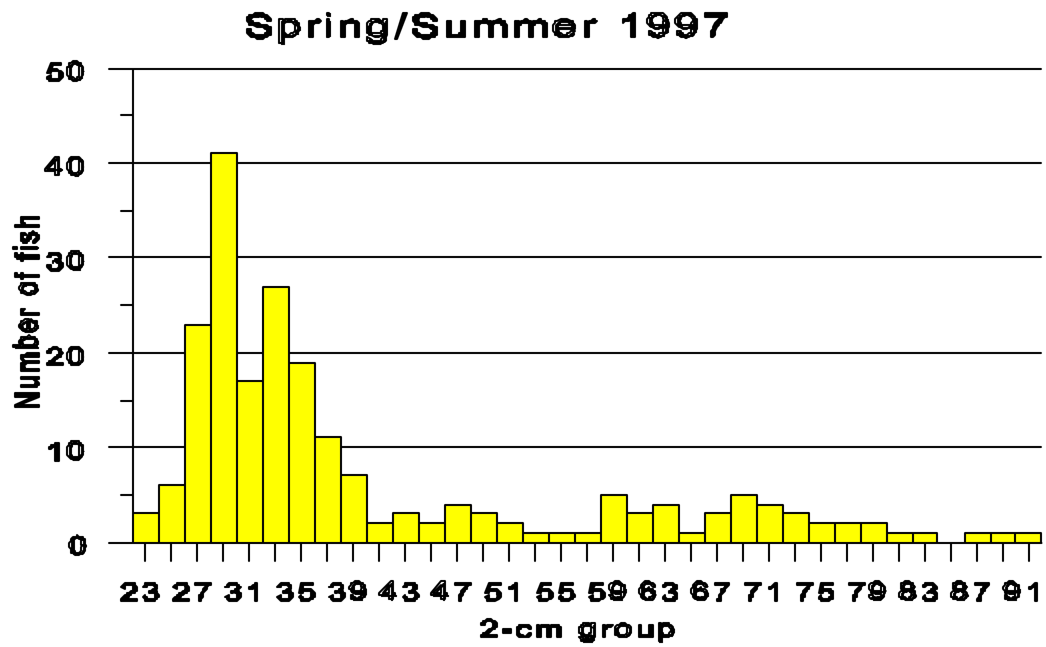


Figure 19. Length-frequency distributions of stocked largemouth bass collected from Bear Pond in Seminole Wildlife Management Area in October 1997 and March 1998.



Winter/Spring 1998
Number of fish
0
1
2
3
4
5
6
7
8
12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46
Centimeter group

Figure 20. Length-frequency distribution of largemouth bass collected by



electrofishing from Bear Pond, winter/spring 1998.

Figure 21. Length-frequency distribution of channel catfish collected by electrofishing from the St. Johns River between Highway 46 near Lake Harney and Highway 520 near Lake Poinsett, spring/summer 1997.

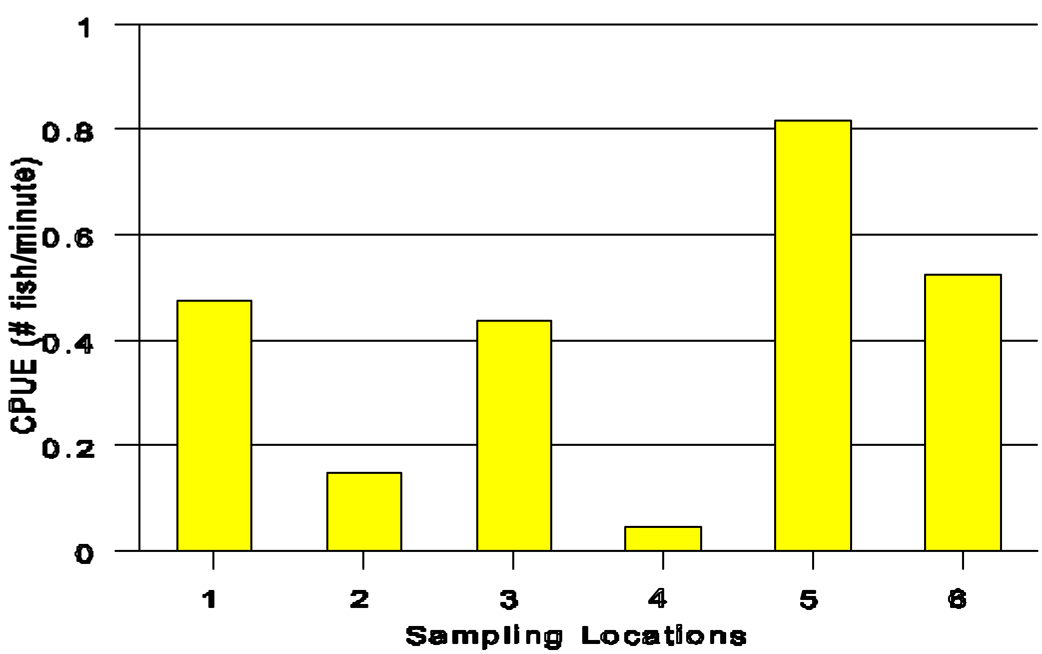
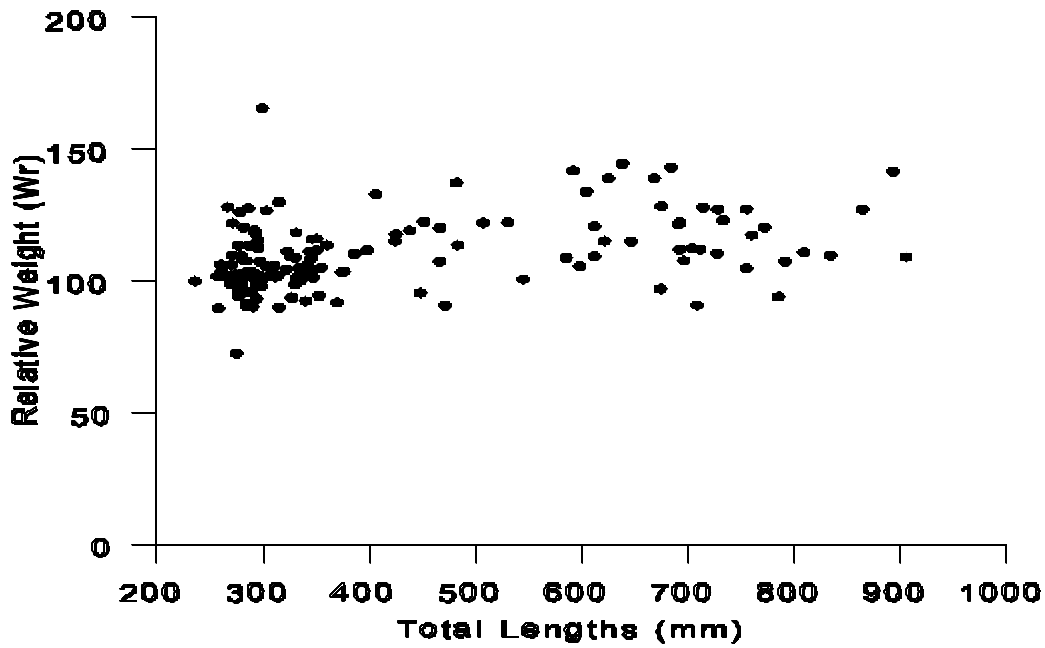


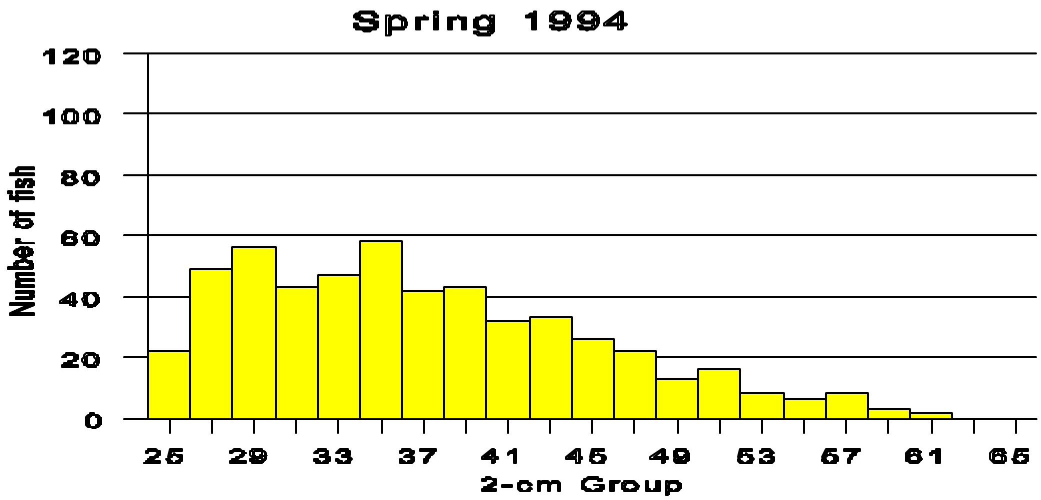
Figure 22. Catch-per-unit-effort (CPUE) of channel catfish collected by electrofishing from the St. Johns River, spring/summer 1997. Sampling locations on the

St. Johns River;1-Hatbill Ramp, 2-SR 520,3-South Hwy 46, 4-North



Hwy 46, 5-Puzzle Lake Area, and 6-Little Econlockhatchee River.

Figure 23. Relative weight (Wr) of channel catfish collected from the St. Johns River, spring/summer 1997.


Spring 1994
Number of fish
0
20
40
60
80
100
120
25
29
33
37
41
45
49
53
57
61
65
2-cm Group

N = 529

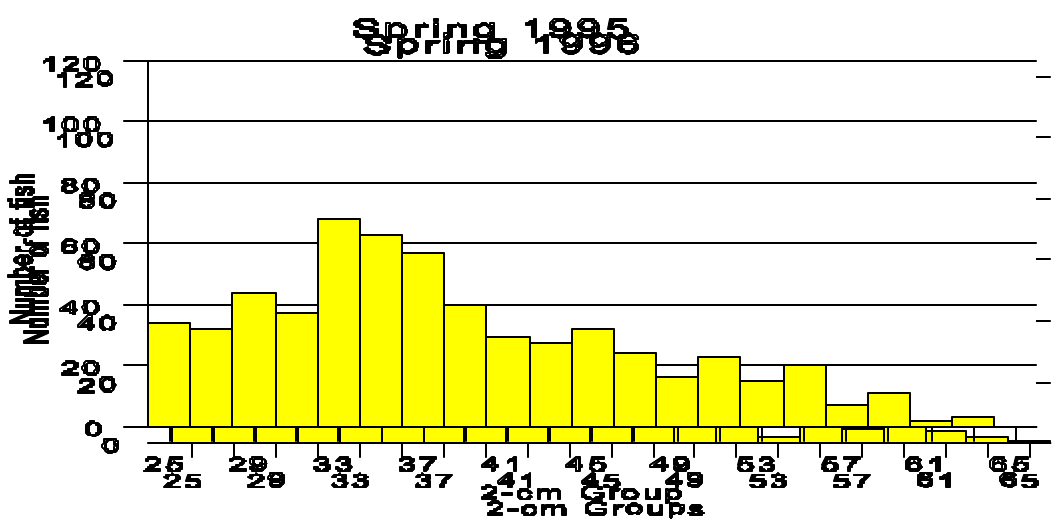

Spring 1995
Spring 1996
Number of fish
0
20
40
60
80
100
120
25
29
33
37
41
45
49
53
57
61
65
2-cm Group
2-cm Groups

Figure 24. Length-frequency distributions of largemouth $\geq$ 24 cm TL collected by electrofishing from Lake George, spring 1994, 1995 and 1996.

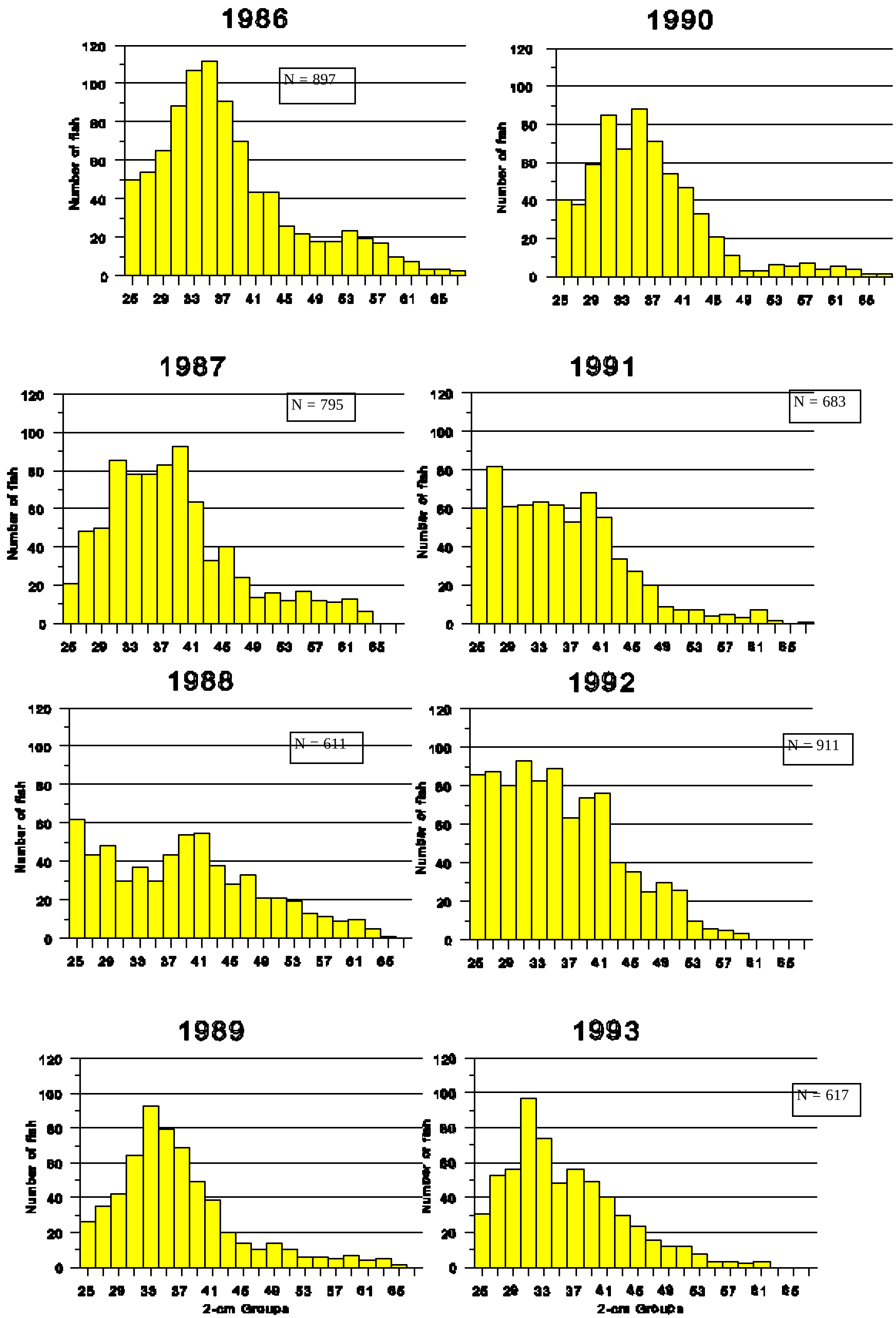
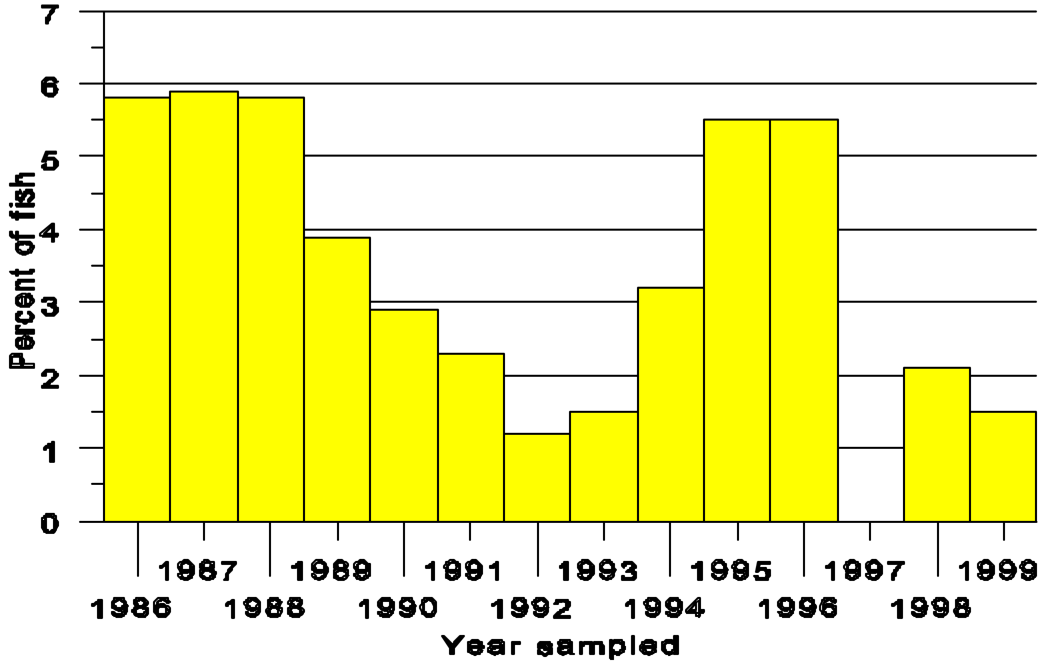
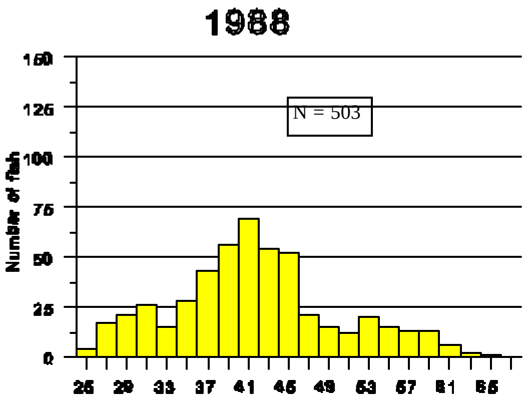

1986
N = 897
1990
1987
N = 795
1991
N = 683
1988
N = 611
1992
N = 911
1989
1993
N = 617
Number of fish
2-cm Groups
25 29 33 37 41 45 49 53 57 61 65
0 20 40 60 80 100 120

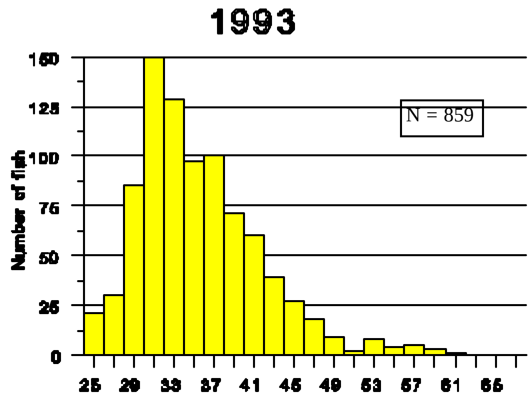
Figure 25. Length-frequency distributions of largemouth bass ≥ 24 cm TL collected from Lake George, spring 1986 through spring 1993.

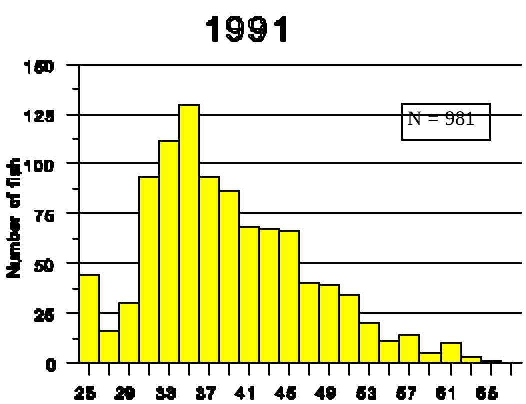


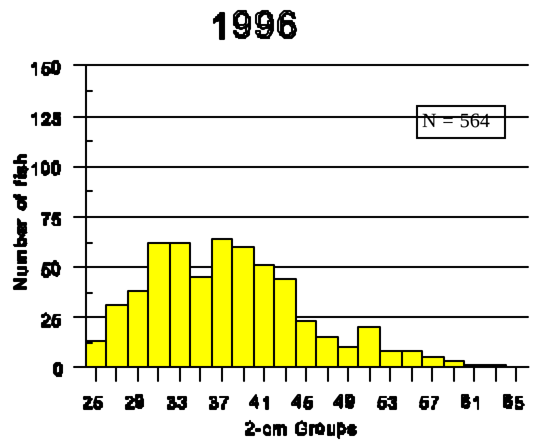
7
6
5
4
3
2
1
0
Percent of fish
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year sampled

Figure 26. Percentage of largemouth bass of trophy size (≥ 55 cm TL) collected by spring electrofishing from Lake George,1986 through 1999.


1988
N = 503
Number of fish
0
25
50
75
100
125
150
25 29 33 37 41 45 49 53 57 61 65


1993
N = 859
Number of fish
0
25
50
75
100
125
150
25 29 33 37 41 45 49 53 57 61 65


1991
N = 981
Number of fish
0
25
50
75
100
125
150
25 29 33 37 41 45 49 53 57 61 65


1996
N = 564
Number of fish
0
25
50
75
100
125
150
25 29 33 37 41 45 49 53 57 61 65
2-cm Groups

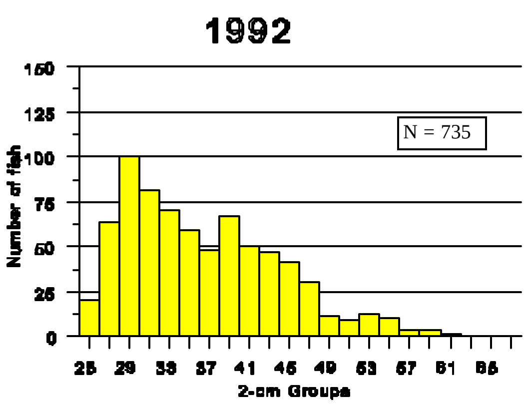

1992
N = 735
Number of fish
0
25
50
75
100
125
150
25 29 33 37 41 45 49 53 57 61 65
2-cm Groups

Figure 27. Length-frequency distributions of largemouth bass $\geq$ 24 cm TL collected by electrofishing from Crescent Lake, spring 1988, spring 1991 through 1993 and spring 1996.

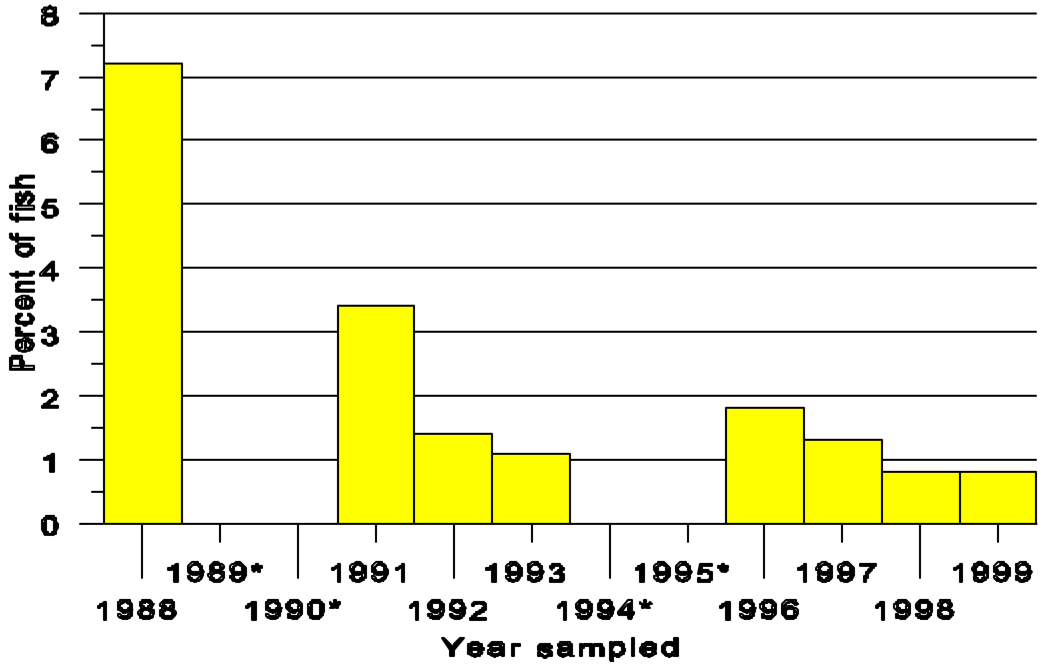

0
1
2
3
4
5
6
7
8
Percent of fish
1988
1989*
1990*
1991
1992
1993
1994*
1995*
1996
1997
1998
1999
Year sampled

Figure 28. Percentage of largemouth bass of trophy size (≥ 55 cm TL) collected by spring electrofishing from Crescent Lake, 1988 through 1999. (* No data collected during these years.)

Table 1. Total number, by year, of striped bass and striped bass hybrids stocked into the lower St. Johns River by the Florida Game and Fresh Water Fish Commission (1970-1999).

	Number		
Year	Striped bass		Striped bass hybrids
1970-71	Program initiated/1200 striped bass fingerlings raised but lost in ponds prior to stocking (disolved oxygen depletion).		
1972	184,000		0
1973	24,300		0
1974	180,550		0
1975	577,750		0
1976	499,760		0
1977	679,400		0
1978	0		0
1979	372,625		0
1980	846,600		0
1981	0		811,150
1982	787,000		0
1983	1,193,960		268,050
1984	500,825		224,500
1985	0		320,000
1986	779,600		0
1987	592,200	(Includes 1,800 Phase II fish)	211,600
1988	337,185	(Includes 66,885 Phase II fish)	299,700
1989	594,388	(Includes 77,613 Phase II fish)	234,500
1990	1,000,100		518,000
1991	255,000		548,000
1992	633,420		563,000
1993	765,550		615,000
1994	675,000		755,000
1995	958,118		272,000
1996	2,100,765		240,600
1997	612,695		296,980
1998	200,000		631,217
1999	773,331		387,240

Table 2. Minimum, maximum, mean total length (mm) and percent ≥ 305 mm TL of black crappie year-classes (N = 37) collected by electrofishing from Lake Monroe, spring 1997.

Year Class	Age	Mean	Minimum	Maximum	Number	% ≥ 305
1996	1	---	---	---	0	0.0
1995	2	259	229	288	13	0.0
1994	3	275	261	282	6	0.0
1993	4	305	281	332	9	55.6
1992	5	315	307	323	4	100.0
1991	6	323	311	335	2	100.0
1990	7	347	338	354	3	100.0

Table 3. Minimum, maximum, mean total length (mm) and percent ≥ 305 mm TL of black crappie year-classes (N = 223) collected by electrofishing from Lake Monroe, winter/spring 1998.

Year Class	Age	Mean	Minimum	Maximum	Number	% ≥ 305
1997	1	138	118	166	14	0.0
1996	2	212	170	290	67	0.0
1995	3	269	212	338	80	12.5
1994	4	310	276	343	11	63.6
1993	5	331	287	355	28	92.9
1992	6	329	281	355	6	83.3
1991	7	342	---	---	1	100.0
1990	8	354	316	376	12	100.0
1989	9	353	350	358	3	100.0
1988	10	---	---	---	0	---
1987	11	356	---	---	1	100.0

Table 4. Minimum, maximum, mean total length (mm) and percent ≥ 305 mm TL of black crappie year-classes (N = 148) collected by electrofishing from Lake Monroe, winter 1999.

Year Class	Age	Mean	Minimum	Maximum	Number	% ≥ 305
1998	1	---	---	---	0	0.0
1997	2	236	198	275	30	0.0
1996	3	270	226	338	39	10.3
1995	4	297	241	342	52	42.3
1994	5	332	323	342	3	100.0
1993	6	338	305	385	13	100.0
1992	7	340	326	369	8	100.0
1991	8	346	343	348	2	100.0

1990	9	366	---	---	1	100.0

Table 5. Creel estimates for sport fish from Lake Monroe, 16 October 1997 - 29 April 1998.

	Effort (angler-hours)	Harvest (#)	Success (fish/hour)
Largemouth bass			
Caught	2,400	803	0.28
Harvested		344	0.12
Released		459	0.16
Black crappie			
Caught	45,360	87,130	1.89
Harvested		61,234	1.33
Released		25,895	0.57
Bream (*Lepomis* spp.)	6,281	6,943	1.19
Morone spp.			
Caught	859	3,187	1.02
Harvested		1,070	0.83
Released		2,117	0.19
Catfish	626	1,719	0.61
Other	2,466	2,305	0.74

Table 6. Access point creel estimates for sport fish from Lake Monroe, 15 October 1998 - 28 April 1999.

	Effort (angler-hours)	Harvest (#)	Success (fish/hour)
Largemouth bass			
Caught	6,899	2,246	0.37
Harvested		177	0.03
Released		2,068	0.34
Black crappie			
Caught	8,763	16,660	2.05
Harvested		3,855	0.45
Released		12,805	1.61
Bream (*Lepomis* spp.)	1,998	4,648	2.26
Morone spp.			
Caught	637	1,588	1.52
Harvested		864	1.24
Released		724	0.28
Catfish	210	665	1.41
Other	695	580	0.10

Table 7. Creel estimates for bank anglers on the Lake Monroe seawall, 15 October 1998 - 28 April 1999.

	Effort (angler-hours)	Harvest (#)	Success (fish/hour)
Largemouth bass			
Caught	285	18	0.05
Harvested		0	0.00
Released		18	0.05
Black crappie			
Caught	4,547	1,636	0.39
Harvested		744	0.18
Released		892	0.21
Bream (*Lepomis* spp.)	5,479	4,889	0.80
Morone spp.			
Caught	1,310	1,426	0.99
Harvested		1,397	0.99
Released		29	0.00
Catfish	1,301	1,132	0.47

Other	4,359	1,321	0.19

Table 8.Average relative weights, sample size, and standard error of channel catfish collected from the Puzzle Lake Area on the St. John's River in Spring/Summer of 1997.

Length Categories (TL mm)	Average Wr	Sample Size	Standard Error
Substock Length (≤279)	104	22	± 2.52
Stock-Quality Length (280-409)	106	74	± 1.34
Quality-Preferred Length (410-609)	116	17	± 3.28
Preferred-Memorable Length (610-709)	120	16	± 3.82
Memorable-Trophy Length (≥710)	117	16	± 2.84

Table 9.Age, year class, mean, minimum, and maximum lengths of channel catfish collected from the St. Johns River near Puzzle Lake area in Spring/Summer of 1997.

Age	Year Class	Mean (Sample size)	Minimum (mm)	Maximum (mm)
2	1995	302 (10)	258	424
3	1994	350 (12)	268	507
4	1993	536 (6)	448	704
5	1992	613 (9)	451	760
6	1991	638 (9)	438	864
7	1990	708 (5)	598	834
8	1989	845 (2)	785	905
9	1988	758 (2)	708	809
10✸	1987	791 (1)	791	791

✸ one fish

Table 10. Change in species diversity and percent frequency of plant species found in surveys of a two hectare test plot of the Lake Jesup marsh.

Plant Species	Percent Frequency 10/31/95	Percent Frequency 10/30/96
Alternanthera philoxeroides		6.0
Bare		2.5
Ceratopteris thalictroites	1.3	2.5
Cyperus sp.		1.5
Hydrocotyle sp.		16.9
Kosteletzkya sp.	8.8	2.5
Ludwigia octovalvis		1.5
Paspalum fluitans		3.0
Phragmites australis	40.3	28.9
Polygonum sp.	5.7	12.4
Sarcostima sp.		6.9
Spartina sp.	5.7	3.5
Typha sp.	65.4	57.2

LITERATURE CITED

Allen, M.S., M.M. Hale and W.E. Pine. In Press. A comparison of trap nets and otter trawls for sampling black crappie in two Florida lakes. North American Journal of Fisheries Management.

Brown, S.G. 1990. Catfish age and growth in the upper St. Johns River, Florida, Appendix A. St. Johns River Fishery Resources. Completion Report, Study XIV, Lower St. Johns River Basin Fisheries Investigation. Wallop-Breaux F-33. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Cox, D.T., E.D. Vosatka and R.E. Rawlings. 1976. D.J. F-25. Stream Investigations Completion Report, Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Coleman, W.S., S. Crawford, W. Porak. 1984. Age and growth of largemouth bass. Florida Game and Fresh Water Fish Commission. Final Report, Federal Aid Project F-24. Tallahassee, Florida, USA.

Cross, F., R.L. Eisenhauer, S.G. Brown and D.L. Benson. 1990. St. Johns River Fishery Resources. Completion Report, Study XIV, Lower St. Johns River Basin Fisheries Investigation. Wallop-Breaux F-33. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Cross, F., L.J. Jenkins, J.E. Hayes, R.L. Testa and J.C. Holder. 1993. St. Johns River Fishery Resources. Completion Report, Study XIV, Lower St. Johns River Basin Fisheries Investigation. Wallop-Breaux F-33. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Cross, F., L.J. Jenkins, J.E. Hayes and J.C. Holder. 1996. St. Johns River Fishery Resources. Completion Report, Study XIV, Lower St. Johns River Basin Fisheries Investigation. Wallop-Breaux F-33. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Crumpton, J.E., M.M. Hale and D.J. Renfro. 1984. Aging of three species of Florida catfish utilizing three pectoral spine sites and otoliths. Proceeding of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 38:335-341.

Dorr, B.S., and L.E. Miranda. 1997. Completion Report Number 163, 1 July 1992-30 June 1997, Grant Number F-105-Chapter 8, Size selectivity of angling in Mississippi crappie fisheries. Mississippi Department of Fisheries, Wildlife and Parks, Jackson, Mississippi, USA. 79-91.

Hale, M.M., J.E. Crumpton and D.J. Renfro. 1984. Commercial fisheries investigation. Annual Progress Report. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Hale, M.M., J.E. Crumpton and Dennis Renfro. 1986. Catfish movement and distribution in the St. Johns River, Florida. Proceeding of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 40:297-306.

Miranda, L.E., R.E. Brock and B.S. Dorr. 1997. Completion Report Number 163, 1 July 1992-30 June 1997, Grant Number F-105-Chapter 6, Growth, fishing and natural mortality of crappies in Mississippi. Mississippi Department of Fisheries, Wildlife and Parks, Jackson, Mississippi, USA. 56-70.

Porak, W.F. and S. Crawford. 1998. Stocking evaluation for sub-adult (Phase II) largemouth bass. Native Sportfish Enhancement Project. Annual Performance Report. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Reed, J.R. and W.D. Davies. 1991. Population dynamics of black crappies and white crappies in Weiss Reservoir, Alabama: implications for the implementation of harvest restrictions. North American Journal of Fisheries Management 11:598-603.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 of the Fisheries Research Board of Canada.

Snyder, L.E., L.J. Jenkins, C.K. McDaniel, J.E. Hayes and R.L. Testa. 1987. St. Johns Fishery Resources. Completion Report, Study VI, Largemouth bass population investigations of the lower St. Johns River. Dingle-Johnson F-33. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Snyder, L.E., C.K. McDaniel, L.J. Jenkins, J.E. Hayes, R.L. Testa. 1990. St. Johns River Fishery Resources. Completion Report, study XI, Top level predator sport fish investigations on the lower St. Johns River. Dingle-Johnson F-33, Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Tagatz, M.E. 1967. Fishes of the St. Johns River, Florida. Quarterly Journal of the Florida Academy of Science. 30:25-30.

PREPARED BY:

Date:_______________

Levi J. Jenkins
Project Leader

and

Date:_______________

Jay C. Holder
Project Biologist

and

Date:_______________

Ryan D. Doorenbos
Project Biologist

APPROVED BY:

Date:_______________

James R. Estes, Chief
Bureau of Resources

and

Date:_______________

Darrell L. Scovell, Assistant Director
Division of Fisheries/Federal Aid Coordinator

and

Date:_______________

Edwin J. Moyer, Director
Division of Fisheries