CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers
Jacksonville District
South Atlantic Division

January 1996

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

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INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

SYLLABUS

The comprehensive Central and Southern Florida (C&SF) Flood Control Project was authorized by the Flood Control Act of 1948 and modified by subsequent acts, as a plan of improvement for flood control, drainage, and other purposes. The Kissimmee River Basin flood control works was authorized as an addition to the C&SF Project by the Flood Control Act of 1954.

In the 1992 Water Resources Development Act (WRDA), Congress jointly authorized the ecosystem restoration of the Kissimmee River and the Kissimmee River Headwaters Revitalization Project. Modifications in the Kissimmee Upper Basin were deemed necessary for the successful restoration of the Lower Basin ecosystem. The 1992 WRDA also stipulates that construction of Kissimmee River Headwaters Revitalization Project will be based on the recommendations provided in the Project Modification Report contained herein. The cost-sharing requirements applicable to this project were established as 50 percent Federal and 50 percent non-Federal. On March 22, 1994, a Project Cooperation Agreement was executed between the Department of the Army and the South Florida Water Management District (SFWMD), which combined the two authorized construction segments into one project, the Kissimmee River, Florida Project.

This Project Modification Report (PMR) provides formulation and assessment for completing the authorized project purposes within the Kissimmee River Upper Basin. These purposes include providing necessary flows for the restoration of the Kissimmee River ecosystem and maintenance of the existing level of flood control within the Kissimmee River Basin. An objective of the study was established to, (a) develop a plan which provides the necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits ascribed to Kissimmee River Restoration, and (b) increase the quantity and quality of the wetland habitat in the Upper Basin lake littoral zones to benefit fish and wildlife.

An array of alternative plans have been formulated and evaluated in coordination with our study partners, the South Florida Water Management District. The plans have undergone extensive coordination with representatives of the U. S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission in the determination of measures which will satisfy the project objectives.

The recommended plan consists of both structural and non-structural modifications to the existing project works within the Upper Kissimmee River Basin. Non-structural components consist of the modification of the existing Lake Kissimmee regulation schedule in order to restore the Kissimmee River and to expand the Upper Kissimmee Basin lake littoral zones. Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress, and Lake Tiger is required to provide the necessary storage requirements for Kissimmee River restoration and expansion of the Upper Basin wetlands. Structural flood control measures were necessary to maintain the existing level of flood protection. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha (C-37), and Lake Hatchineha to Lake Cypress (C-36) will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding. Modifications to the existing Lake Kissimmee water control structure is required to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity.

The recommended plan is expected to at least achieve and probably exceed the environmental benefits assigned to the Kissimmee River Restoration Project which were documented in House Document 102-286, March 17, 1992. In the Upper Basin, the modified Lake Kissimmee regulation schedule will provide both greater, and more natural fluctuations of water levels in the lakes expanding the existing peripheral marsh habitats. The USFWS has predicted that the implementation of the recommended lake regulation schedule would increase the amount of littoral wetlands by 7,236 acres in Lakes Kissimmee, Hatchineha, Cypress, and Tiger. The recommended plan will provide adequate operational flexibility to incorporate management strategies that will allow the project to meet or exceed the varying and unforseen needs of the Kissimmee River Upper and Lower Basin.

The estimated total cost of the recommended plan is $78,356,300; average annual costs are estimated to be $6,170,800 (January 1996 price levels).

Consideration has been given to all significant aspects of the recommended plan in the overall public interest, including engineering feasibility, economic, social, and environmental effects. The recommended plan described in this report provides the best solution to the water resources needs within the Kissimmee River Upper and Lower Basins at this time. The two construction components, Upper and Lower Basin, were formulated as dependent features of the Kissimmee River Project. If, for any reason, the Lower Basin project should not be constructed, the Headwaters Revitalization Project will not be initiated as a stand alone project.

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SECTION 1

INTRODUCTION

The Kissimmee River Basin (Figure 1-1) is located in central Florida and is comprised of the Upper and Lower Basins. While the Kissimmee River Valley makes up the Lower Basin, the Upper Basin, which is the focus of this report, forms the headwaters of the Kissimmee River and is comprised of the Kissimmee Chain of Lakes, (PLATE 1-1, Study Area Map).

In the 1960s, the Kissimmee River was channelized and water control structures were constructed within the Upper and Lower Kissimmee Basins as part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project (Figure 1-2). Even as channelization was being completed in 1971, a movement was underway to restore the Kissimmee River and regain lost environmental values.

In the 1992 Water Resources Development Act, Congress authorized construction of the project to restore the ecosystem of the Kissimmee River including the Kissimmee River Headwaters Revitalization Project. Authorization of the Headwaters Revitalization component was justified based on it being a prerequisite for successful restoration of the Lower Basin ecosystem. This Project Modification Report has been prepared to document the conclusions of the Headwaters Revitalization Study.

The Kissimmee River Headwaters Revitalization Project was addressed programmatically in the Final Integrated Feasibility Report and Environmental Impact Statement (EIS) on Environmental Restoration, Kissimmee River, Florida, and was filed with the U.S. Environmental Protection Agency (EPA) January 17, 1992. The present document supplements the programmatic report-EIS under the concept of "tiering" (paragraph 1.4). Certain information presented in the former document is only summarized in this document, which concentrated on issues specific to the Headwaters Revitalization. The former report-EIS is available from the U.S. Army Corps of Engineers (Corps) at the address listed on the cover sheet of this document.

This section describes the study's authority, partners, purpose, and scope, discusses compliance with the National Environmental Policy Act, and provides a brief overview of the Upper Basin of the Kissimmee River.

major constraint of project design and implementation was the requirement to maintain the same level of flood protection as provided by the current flood control project. Another design constraint was to maintain existing navigation conditions.

The scope of the analyses and studies summarized in this report were of the level required to:

(1) design the physical features of the project, based on established environmental, flood control and navigation criteria, and develop the most cost effective and functional combination of these features from the alternative plans studied;

(2) coordinate the project design with other involved governmental agencies and local interests;

(3) undertake, where necessary, the updating or modification of environmental documentation and economic and social impact evaluations;

(4) provide the basis for a firm, current estimate of project cost;

(5) provide the basis for any required non-Federal cooperation and acquisition of easements and lands, and for negotiation of relocation agreements;

(6) establish operating and maintenance requirements and determine that the project will meet such requirements;

(7) facilitate the orderly scheduling and programming of funds for design and construction of the project.

Consistent with the above-cited authorities, the Corps and the State of Florida, with the USFWS as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of lakes in the Upper Kissimmee River Basin. The study has been conducted in accordance with current Federal water resources planning procedures and guidelines, with assistance and support from numerous State and Federal agencies and other interests.

1.4 STUDY AREA

The Kissimmee River Basin, as shown in Figure 1, is the largest watershed providing surface water to Lake Okeechobee, the second largest freshwater lake in the United States. The entire Kissimmee River Basin comprises 3,013 square miles. The Lake Istokpoga area (622 sq. miles), Lower Kissimmee River Basin (758 sq. miles), and the Upper Kissimmee Basin (1633 sq. miles) make up the principle divisions in the watershed. The Upper Basin, also referred to as the "Headwaters" in this report, is comprised of numerous lakes regulated by a system of canals and water control structures managed by the SFWMD. The Upper Basin, which is located in Orange, Polk, and Osceola Counties, is bounded to the south by State Road 60. It is here where the basin's largest lake, Lake Kissimmee, discharges into the channelized Kissimmee River. At this point, the Kissimmee River becomes a canal feature of the basin's flood control project referred to as Canal 38 or C-38. The Lower Basin includes the tributary watersheds of the channelized Kissimmee River between the outlet of Lake Kissimmee and Lake Okeechobee.

The Upper Basin includes the "Kissimmee Chain of Lakes" (Plate 1-1). The Kissimmee Chain of Lakes consists of Lakes Tohopekaliga, East Tohopekaliga, Hart, Mary Jane, Myrtle, Preston, Alligator, and Gentry in the upper region. The lower portion of the chain includes Lakes Cypress, Hatchineha, Kissimmee, Pierce, Marion, Rosalie, Weohyakapka, Tiger, Jackson, and Marian. These lakes range in size from a few acres to 55.5 square miles. Studies for this report were primarily focused on those lakes affected by the proposed project modification, namely Lakes Kissimmee, Hatchineha, and Cypress and the tributary lakes - Lakes Rosalie, Tiger, and Jackson.

The Upper Basin is the more heavily populated and intensively developed part of the watershed. Principal municipalities within the Upper Basin are the southern half of Orlando, Kissimmee, which is the hub of the cattle industry in central Florida, St. Cloud, and Haines City. Walt Disney World is located in the Reedy Creek Improvement District in the upper portion of the basin.

1.5 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

The National Environmental Policy Act of 1969 (NEPA), as amended, is the nation's charter for environmental protection. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Section 102(2) of NEPA contains action-forcing provisions to make sure that Federal agencies act according to the letter and spirit of the Act. The Act includes a provision for preparation of a detailed statement, now called an Environmental Impact Statement (EIS), on the effects of a proposed major Federal action that will significantly affect the human environment. The Federal regulations for implementing the procedural provisions of NEPA were published by the Council on Environmental Quality (CEQ) in the Code of Federal Regulations (CFR) as 40 CFR Parts 1500-1508 (43 Federal Register 55978-56007, November 29, 1978).

This report documents the Corps' study of measures for optimizing environmental enhancements in the Upper Kissimmee Basin while reestablishing adequate flow to achieve restoration of the Lower Kissimmee Basin. It employs two concepts established in the Council on Environmental Quality's regulations implementing National Environmental Policy Act procedures: (1) integration and (2) tiering.

Integration is based on the CEQ provision that "any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork" (40 CFR 1506.4). Corps' regulations permit an EIS ("environmental document") to be either a self-standing document combined with and bound within a feasibility report ("agency document"), or an integration of NEPA-required discussions in the text of the report. In view of the environmental nature of this study, and to consolidate documentation into one consistent report, the Corps elected to integrate discussions that could have appeared as an EIS with the Section 1135 Report. Sections in this integrated report that include CEQ-required discussions are marked with an asterisk in the Table of Contents to assist readers in identifying such material.

Tiering was established by CEQ to provide *"coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin-wide program statements or ultimately site-specific statements).... Tiering is appropriate when the sequence of statements or analyses is...from an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage....Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe" (40 CFR 1508.28 and 1502.20).* Tiering was applied to the study of Federal actions for the environmental restoration of the Kissimmee River (Lower Basin). The integrated report-EIS on restoration of the Kissimmee River was the early stage statement, and this integrated report-EIS on Upper Basin restoration is the supplement.

1.6 PRIOR STUDIES AND REPORTS

Large amounts of data have been gathered and analyzed in conjunction with studies of the Kissimmee River Basin. The studies deal with a wide range of subjects including environmental concerns, economics, water quality, recreation, hydrology, and sources of water pollution. A few selected studies are listed and briefly described in the following sections.

* **"Part II, Supplement 5, General Design Memorandum, Kissimmee River Basin, 1958 - Central and Southern Florida Project for Flood Control and Other Purposes"** - This report presented the results of hydrologic and hydraulic investigations for development of the plan of improvement for the Kissimmee River Basin. It presented the hydraulic criteria and supporting recommendations relative to the construction of the Kissimmee flood control works.

* **The Fish and Wildlife Service**, as part of the FY-79 Coordination agreement with the Corps, prepared a reconnaissance report on the fish and wildlife resources in the Kissimmee area. The report was completed in August 1979.

* **"Central and Southern Florida, Kissimmee River, Florida - Final Feasibility Report and Environmental Impact Statement", 1985** - This Corps' report evaluated the feasibility of modifying the existing flood control system in the Kissimmee River Basin. Numerous alternatives were considered to address the primary objectives of improving water quality, enhancing fish and wildlife resources, maintaining the flood damage prevention capabilities, providing water supply, and increasing recreational opportunities in the basin. Based on the limits of existing water resource authority, the report determined that there was no justification for Federal participation in the modifications of the Kissimmee River portion of the C&SF project.

* **"Kissimmee River Restoration - Alternative Plan Evaluation & Preliminary Design Report"** - This study was developed by the SFWMD and published in June 1990. This study adopted a broader, single goal - to restore the ecological integrity of the Kissimmee River. Whereas the previous Corps' feasibility study had focused on component parts of the environment, primarily wetlands and water quality, and how to improve each part individually, the SFWMD focused on restoration of the entire natural system, including its component parts and the interactions among them - the ecosystem. Flood control and navigation were to be maintained, while water quality and water supply should not be adversely affected. SFWMD concluded that the Level II Backfilling Plan was the best

approach to restore the integrity of the Kissimmee River ecosystem. The report also concluded that some alteration of the Upper Lakes regulation schedule must be implemented for restoration of the Kissimmee River to be successful.

* **"Feasibility Report and Environmental Impact Statement - Environmental Restoration of the Kissimmee River, FL, 1992"** - The Congressional authority for the Corps' second feasibility study of the Kissimmee River directed that the study be based on implementing the SFWMD's Level II Backfilling Plan. With the tiering concept established by CEQ, this programmatic document addressed restoration of both the Upper Basin, through the "Headwaters Revitalization Project," and the Lower Basin, through the South Florida Water Management District's (SFWMD) "Level II Backfilling Plan." The study focused on the Lower Basin alternatives and presented recommendations ready for decision in 1992. Four Lower Basin restoration alternatives previously developed by the SFWMD were evaluated by the Corps. The Level II Backfilling Plan recommended by SFWMD was selected for further evaluation and development. A modified Level II Backfilling Plan was recommended for restoration of the ecological integrity of the Lower Kissimmee River Basin. The recommended plan called for a more natural physical environment in the lower Kissimmee River by backfilling 29 miles of C-38 and excavating 11.6 miles of new river channel. This would restore about 50 square miles of river floodplain ecosystem.

1.7 EXISTING PROJECT AUTHORIZATIONS

Kissimmee River, Florida, Navigation Project - In 1902, Congress authorized the Corps to construct a navigation project on the Kissimmee River. The project consisted of a channel with a required depth of three feet at normal stages and a width of 30 feet. It extended about 109 miles from the town of Kissimmee down the Kissimmee River to Fort Basinger, and includes a side channel along the Istokpoka Canal to Lake Istokpoka.

Kissimmee River Basin, Central and Southern Florida Project for Flood Control and Other Purposes - The Kissimmee Basin Project is a segment of the authorized C&SF project for flood control and other purposes. The Kissimmee River Basin flood control works were authorized by the Rivers and Harbors Act of 1954, (Public Law 780, 83rd Congress) as presented in House Document No. 643, Eightieth Congress. Figure 1 details the components of the authorized project. The Kissimmee River and Lake Istokpoga Basins portion of the project have several purposes, as specified below:

a. Flood Control - Protection of lands adjacent to the lakes and along the Kissimmee River from frequent and prolonged flooding.

b. Water Supply - Provision of water supply for agricultural uses within the Kissimmee River and the Kissimmee lakes.

c. Navigation - Provide for navigation on the Kissimmee River and all lakes in the Upper Kissimmee River Basin. Locks are provided at control structures on the main watercourse between Lake Tohopekaliga and Lake Okeechobee.

d. Fish and Wildlife - Maintenance of lake stages at a desirable level for fish and wildlife purposes and for recreational purposes.

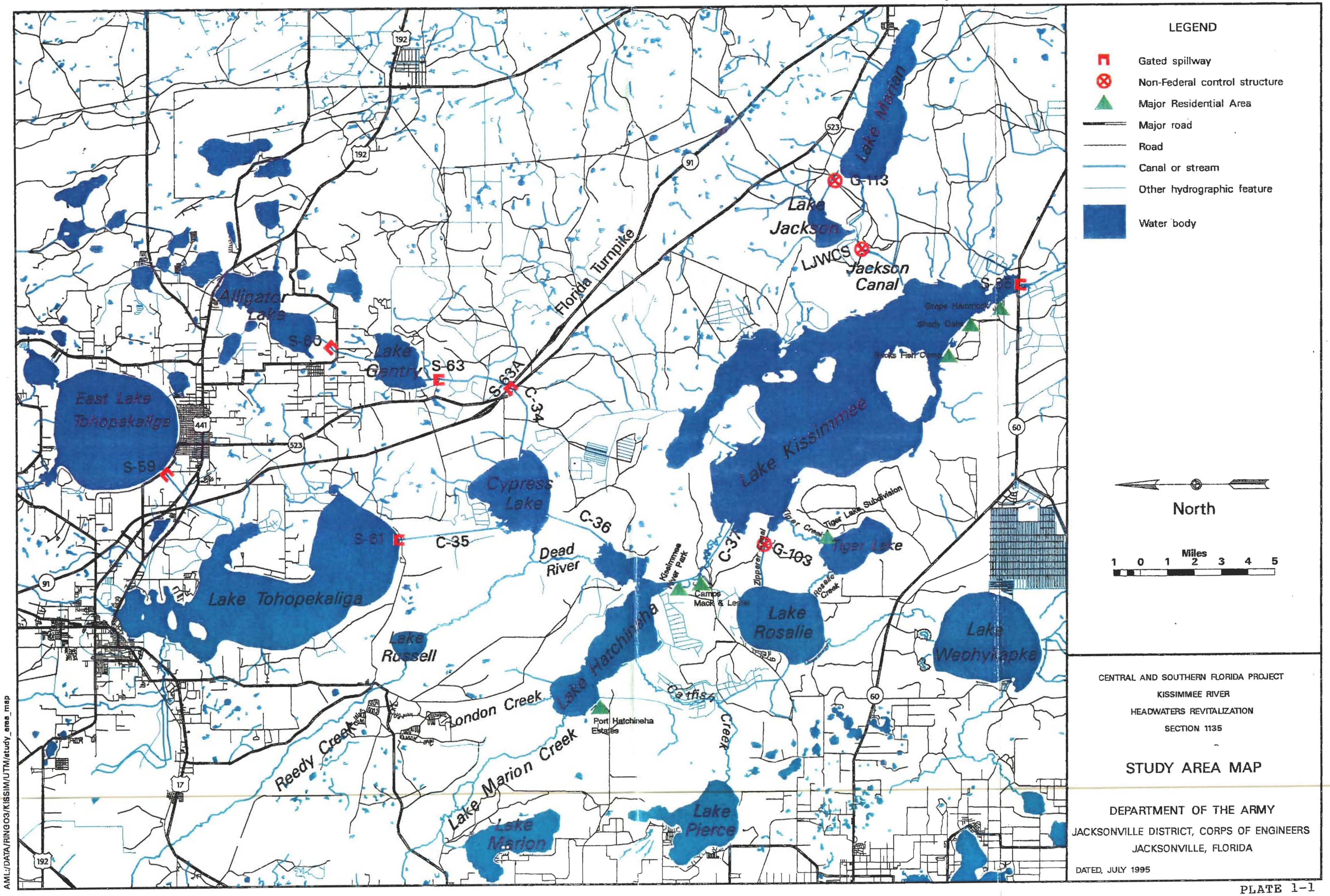

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PLATE 1-1

SECTION 2

HISTORIC CONDITION

This section provides an historic overview of the Upper Kissimmee River Basin as well as the Upper Basin's important relationships with the Lower Kissimmee River Basin.

2.1 HYDROLOGY

The Kissimmee River Basin is the largest watershed providing surface water delivery to Lake Okeechobee. The total basin encompasses 3,013 square miles. The major lakes within the 1,633 square-mile Upper Basin are Lakes Tohopekaliga and East Tohopekaliga in the upper chain of lakes, and Lakes Marion, Hatchineha, Pierce, Rosalie, Cypress, Weohyakapka, Tiger, Marian, Jackson, and Kissimmee in the lower chain of lakes. The Lower Basin includes the Kissimmee River and tributary watersheds. Plates A-1 and A-2, Appendix A, show the Upper and Lower Kissimmee Basins in their entirety.

The Upper Kissimmee Basin is characterized by numerous lakes ranging in size from a few acres to the 55 square-mile Lake Kissimmee. The total surface area of these lakes at normal water surface elevations was more than 10 percent of the total area in the Upper Basin. The normal stages and corresponding surface areas of the main lakes affected by this study, as presented in the 1956 C&SF General Design Memorandum, are provided below.

TABLE 2-1
HISTORIC LAKE STAGES AND SURFACE AREAS

LAKE	NORMAL STAGE (FT)	SURFACE AREA (SQ MILES)
CYPRESS	52.8	10.5
HATCHINEHA	51.8	18.8
KISSIMMEE	50.8	55.5
TIGER	51.0	4.8
ROSALIE	53.5	9.1

* Normal stage - stage equaled or exceeded 50 percent of time based on 1942-1954 record (mean sea level)

The headwater lakes are thought to have once been the deeper portions of a vast marsh complex. During the wet summer months and periods of heavy rainfall, natural drainage occurred by the overtopping of the upper lakes and the overflow of water across the wide shallow marshes into the lower lakes (Parker et al., 1955). Historically, drainage and land reclamation programs which were initiated as early as 1860 had a pronounced effect on land use in the headwaters by lowering water levels and water tables. Most of the broadleaf marsh and wet prairie communities that once dominated the floodplain have been drained for grazing and agriculture purposes, leaving the headwater lakes occupying only the deepest depressions of a once vast marsh complex.

Under natural conditions, the lake stages in the Kissimmee Basin fluctuated seasonally about 2 to 10 feet. The historic outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season. Discharges typically increased up to a wet season peak in October or November and declined through the dry season. (Figure 2-1).

Historically, hydrological connections between the lakes were cyclical in response to periods of high and low rainfall. Stages in Lake Kissimmee, the primary source of the Kissimmee River, historically ranged up to 56 ft NGVD and down to around 45 feet, (Figures 2-2 and 2-3). During wet periods, water levels in the lakes rose and overflowed, creating broad, marshy connections between the lakes. During dry periods, little to no surface hydrological connections existed between lakes. The low periods provided time for drying and oxidation of bottom sediments, and during high periods, fish and wildlife used the flooded vegetation for spawning and foraging.

Flows through the Upper Kissimmee Basin originated in the vicinity of Alligator Lake and flowed northward through the East Chain of Lakes to Lake Hart, then flowed southward to Lakes East Tohopekaliga, Tohopekaliga (Toho), Cypress, Hatchineha, and Kissimmee to the Kissimmee River. The natural meandering connections between the lakes were dredged during the late 1800's to early 1900's for the purposes of drainage and navigation. The historic entrance into Lake Cypress, as well as Lake Kissimmee, was actually towards the east of the present canal locations.

KISSIMMEE HISTORICAL DISCHARGES

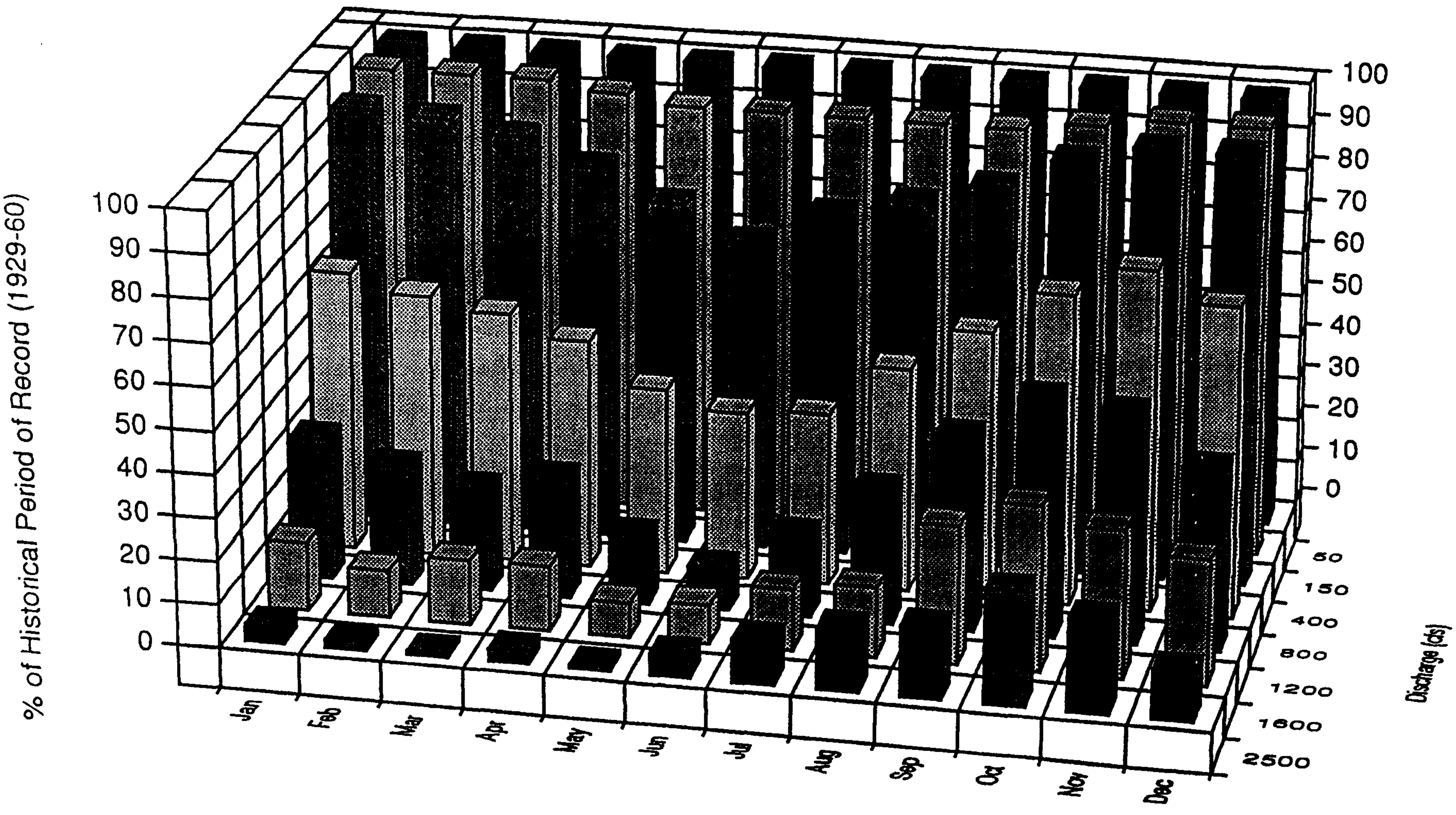


Figure 2-1

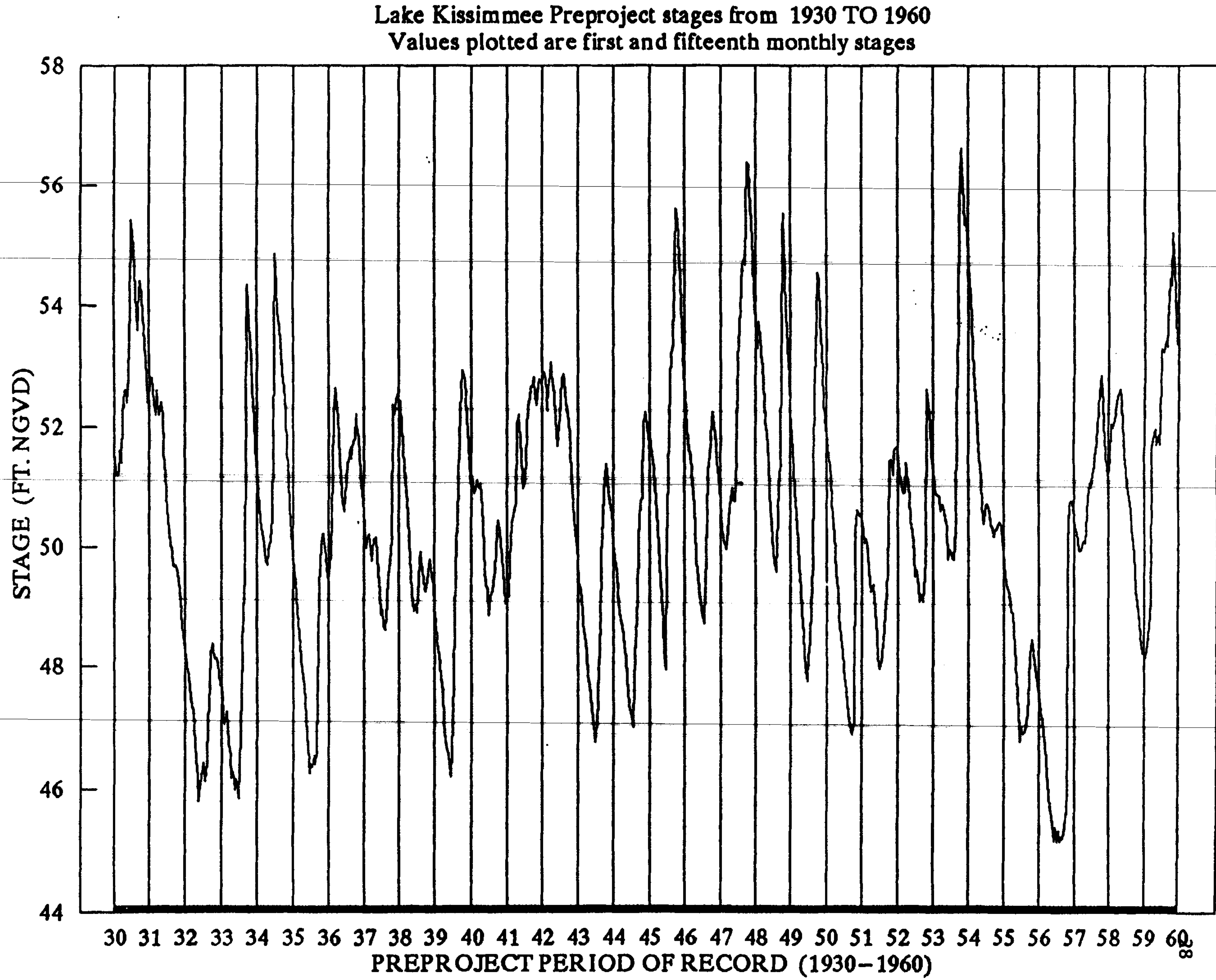
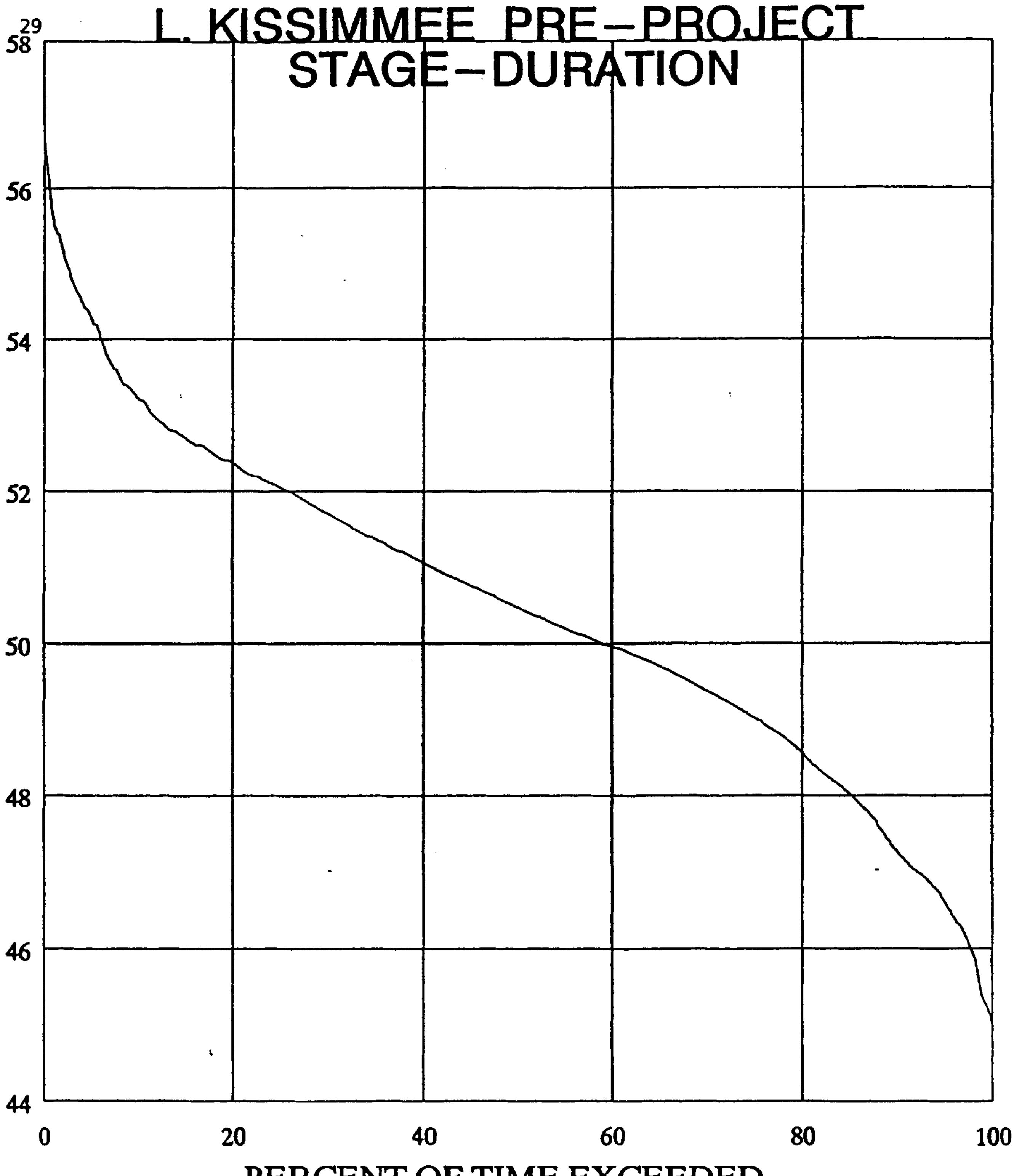

Lake Kissimmee Preproject stages from 1930 TO 1960
Values plotted are first and fifteenth monthly stages
STAGE (FT. NGVD)
58
56
54
52
50
48
46
44
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
PREPROJECT PERIOD OF RECORD (1930–1960)

Figure 2-2



LAKE KISSIMMEE STAGE DURATION PREPROJECT
PERIOD OF RECORD 13 AUG 1929 – 31 DEC 1959

Figure 2-3

Lake Tohopekaliga was connected to Lake Cypress by the Southport Canal (C-35). Lake Cypress, the collector lake for inflow from the east and west chains of lakes, normally discharges to Lake Kissimmee by way of Cypress-Hatchineha Canal (C-36), Lake Hatchineha, and Hatchineha-Kissimmee Canal (C-37). However, during flood periods considerable overflow from Cypress Lake reached Lake Kissimmee directly by overland flow through marsh areas between the two lakes. A drainage canal, known locally as the Short Canal, was constructed during the 1930's and 40's within these marsh areas but was never completed to connect Lake Cypress to Lake Kissimmee.

Several important lakes in the Upper Kissimmee River Basin are not included in the main chain of lakes, but are tributaries. Lake Marion Creek is the main tributary feeding water to Lake Hatchineha, along with flow from Lake Cypress. Lakes Marion and Pierce are both tributary to Lake Hatchineha from the west. Lake Marion has an outlet on its north side by way of Lake Marion Creek, which flows southeasterly about 8 miles to the northwest corner of Lake Hatchineha. Reedy Creek, which discharges into Lakes Cypress and Hatchineha, is the largest tributary, with a drainage area of 207 square miles. Standing water remained on low-lying lands and the marshy areas of Reedy Creek Basin most of the year at depths of as much as 3 to 4 feet. Flow from Lake Pierce enters the southwest side of Lake Hatchineha by way of Catfish Creek which flows about 7 miles east and northeast from Lake Pierce. In the area west of Lake Kissimmee, Lakes Weohyakapka, Rosalie, and Tiger form a secondary chain of lakes which discharge generally north and east to Lake Kissimmee. Lakes Marian (not to be confused with Marion) and Jackson discharge into the east side of Lake Kissimmee through Jackson Canal. Lake Marian is connected to Lake Jackson by a channel less than 2 miles long; however, during times of high water, overflow from lake Marian bypasses south of Lake Jackson and flows directly to Lake Kissimmee.

From Lake Kissimmee, the historic Kissimmee River naturally meandered approximately 103 miles within a one to two mile wide floodplain. The flood plain was about 56 miles in length and gradually sloped from an elevation of 51 feet at Lake Kissimmee to an elevation of 15 feet at Lake Okeechobee. Under historic conditions, river flows generally exceeded 250 cubic feet per second (cfs) 95 percent of the time, while overbank flooding occurred when flows exceeded 1,400 cfs in the upper reaches to 2,000 cfs in the lower reaches. The river moved very slowly, with normal river velocities averaging less than two feet per second.

2.2 NAVIGATION

With the conclusion of the Third Seminole War, in 1858, small numbers of settlers began moving into the Kissimmee Basin area. The earliest settlers were ranchers and farmers, but soon turpentine and timber industries became the major economic enterprises. As more people moved into the area, wetlands were drained to open up room for development. This movement was accelerated by the Swamp and Overflowed Land Grant Act of 1850 which encouraged development and expansion by transferring Federal lands to the State.

The reclamation project was spurred by the State's proposal to raise revenues by selling swamp and overflowed lands to interested entrepreneurs willing to drain such wetland areas for agricultural use. In the late-1800's, Hamilton Disston, an industrialist from the northeast, began a ditching and drainage project in central Florida. As part of his plan to convert some four million acres of wetlands into productive farmland, Disston connected many of the Upper Kissimmee Basin lakes and began dredging and clearing a navigable route from the Gulf of Mexico into Lake Okeechobee, along the Caloosahatchee River. As a result of this action, water levels within the Upper Kissimmee Basin dropped approximately six feet or more.

After dredging was completed by the Atlantic and Gulf Coast Canal and Okeechobee Land Company in the 1890's, navigation was possible in the upper chain of lakes from Lake Tohopekaliga through East Lake Tohopekaliga, and continuing to Lake Gentry (and possibly at times to Lake Cypress). In the nineteenth century, commerce on the Kissimmee River gained impetus with the availability of new lands from drainage and from the connection of waterbodies by canal systems.

To aid navigation along the river, in 1902 Congress authorized a Federal navigation project to create and maintain a 30 feet wide and 3 feet deep channel from the Town of Kissimmee to Fort Basinger. The length of the project was about 109 miles, including 9.4 miles in Istokpoga Creek. Figure 2-4 shows the extent of the navigation project. The development of railroads, and later highway systems, in the early and mid-twentieth century led to greatly reduced use of the river for commerce. By the 1920's, railroads had replaced most of the commercial traffic on the river. The last Federal maintenance under the Kissimmee River navigation authority was in 1927.

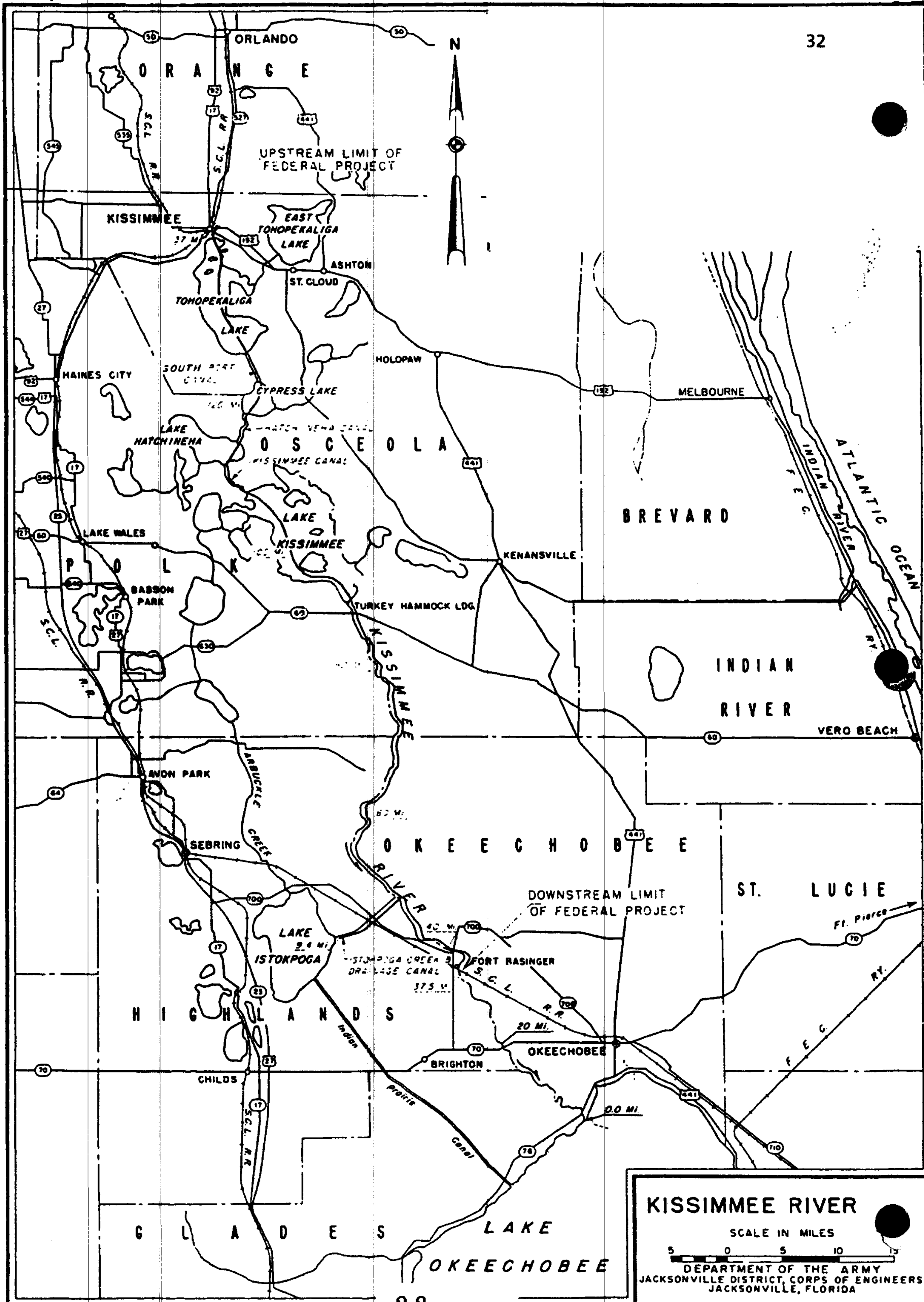

32
N
ORLANDO
O R A N G E
S.C.L. R.R.
UPSTREAM LIMIT OF FEDERAL PROJECT
KISSIMMEE
EAST TOHOPEKALIGA LAKE
ASHTON
ST. CLOUD
TOHOPEKALIGA LAKE
HOLOPAW
HAINES CITY
CYPRESS LAKE
MELBOURNE
LAKE HATCHINEHA
O S C E O L A
LAKE KISSIMMEE
BREVARD
ATLANTIC OCEAN
INDIAN RIVER
F.E.C.
LAKE WALES
P O L K
KENANSVILLE
BABSON PARK
TURKEY HAMMOCK LDG.
KISSIMMEE
INDIAN RIVER
VERO BEACH
AVON PARK
ARBUCKLE CREEK
SEBRING
O K E E C H O B E E
ST. LUCIE
DOWNSTREAM LIMIT OF FEDERAL PROJECT
RIVER
LAKE ISTOKPOGA
FORT BASINGER
Ft. Pierce
H I G H L A N D S
20 MI.
OKEECHOBEE
BRIGHTON
CHILDS
Indian Prairie Canal
0.0 MI.
G L A D E S
LAKE OKEECHOBEE
KISSIMMEE RIVER
SCALE IN MILES
5 0 5 10 15
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

Figure 2-4

2.3 NATURAL ENVIRONMENT

2.3.1 Upper Basin

Florida's cyclic rainfall pattern historically produced a wide range of water level fluctuations (Figure 2-2) in all lakes of the Upper Basin. Wildlife, waterfowl, fish, and aquatic plant populations evolved under this cyclic hydrological pattern, with periodic extreme water fluctuations playing an important role in maintaining healthy ecosystems by enhancing and maintaining habitat diversity. The wide, flat, marshy areas around some of the lakes and their interconnecting sloughs and channels were nurseries and feeding grounds for many species of fish, as well as the nesting areas of numerous wading and water birds.

The historic Kissimmee River Basin harbored a large and diverse wintering waterfowl population, including ring-necked ducks, American widgeon, northern pintail, and blue-winged teal. Five lakes (Kissimmee, Tohopekaliga, Cypress, Istokpoga, and Hatchineha) and the Kissimmee River averaged 1,442,732 waterfowl days per winter from 1949-1957. (Waterfowl days equal the average observed daily waterfowl multiplied by the number of days in the study period). Peak waterfowl populations generally occur in January and the highest peak on record was approximately 40,000 individuals (FGFWFC, 1957). Deer, turkeys, and squirrels were found in the cypress, gum, and pine forests of the Upper Basin. Overflows of the lakes during the wet season inundated the large adjacent marsh areas from three to five months on the average, and as long as ten months during wet years. Wet prairie was the most valuable of the wetland communities to waterfowl. Under historic hydrologic conditions, wet prairies were typically dry from spring through early summer, allowing annual plants such as wild millet to germinate and produce seed. Fall and early winter flooding made these wet prairies attractive feeding sites for resident and wintering waterfowl.

By incorporating the same assumptions presented by the USFWS in their 1994 Coordination Act Report (CAR), which determined the amount of existing wetlands, we determined the amount of historic wetlands that should have existed within the study area. The minimum hydrologic regime for defining wetlands is generally accepted as continuous saturation for at least 5% of the growing season. Assuming that the growing season is year-round in the study area, which equates to 18 days of continuous saturation, the USFWS determined that the present upper end of the wetlands is approximately elevation 52.0 feet. Using these same assumptions, 18 days of continuous saturation, with the historic stage hydrograph (Figure 2-3) for the period 1929 through 1959, the historic boundary of wetlands extended to elevation 54.5

NGVD. Based on the area between elevation 52.0 and 54.5, approximately 39,000 additional acres of wetlands existed between 1929 and 1960 compared to the present. Based on the historical stage versus percent exceedance relationship (Figure 2-5) for the historical period of record, the lower limit of wetlands was approximately elevation 48.0 feet. The amount of wetlands that existed prior to the flood control project was estimated to be 55,000 acres. This was estimated by adding the amount of land between the 48.0 and 52.0 foot elevations, 16,000 acres, to the area between 54.5 feet and 52.0, or 39,000 acres.

Throughout the early 1900's, canals were dredged to drain marsh areas for agriculture and development. Impacts of channelization on these wetlands have had wide-ranging ecological consequences, including loss of fish and wildlife habitat. As channelization between lakes redirected flows, the large marsh area found along the lake shore was replaced by a narrow littoral zone. Water levels were constricted within a reduced range of fluctuation. As plant habitats changed, so did the species that inhabited them. The environment, responding to altered conditions, began to change. Native vegetation was replaced by species that were suited to the drier conditions, causing fish and wildlife to move to more suitable surroundings. Water quality deteriorated as a result of stable water levels along with high nutrient inflows from urban runoff and sewage treatment plants.

2.3.2 Relationship to Lower Kissimmee River

Historic seasonal flows out of Lake Kissimmee lead to fluctuating water levels within the meandering river channel, oxbows, and natural river floodplains within the Lower Kissimmee Basin. This enhanced and maintained habitat diversity, including diverse plant communities within the river valley. Within the historic floodplain, wildlife, waterfowl, fish, and other biological components were once part of a river floodplain ecosystem. The river and floodplain were not discreet and independent ecosystems, and the ebb and flow of their life was closely interrelated with the level of water levels within their boundaries. In November, ducks and probers, such as snipe and ibis, fed in the sloughs, potholes and wet prairies in upland areas near the tree line. Many of the same populations used the potholes, oxbows, backwaters, and marshes of the floodplain in February, and the river and the deepest marshes and cypress swamps near the river in May. In the 1950's, peak populations of ducks and wading birds centered in and around Lake Okeechobee, saw the Kissimmee area as habitat where water and feeding conditions were favorable.

The historic floodplain of the Lower Basin contained approximately 44,000 acres of wetlands (USFWS, 1991). Major plant communities found within these wetlands included maidencane and beakrush wet prairies, broadleaf marsh, and woody shrub (Pierce et al., 1982). Other plant communities common on the floodplain, but not distributed extensively, included wetland hardwoods, cypress stands, oak-cabbage palm hammocks, switchgrass, sawgrass, and floating mats or tussocks (Pierce et al.,1982). Distribution and maintenance of plant communities within the floodplain wetlands depended on prolonged inundation and seasonally fluctuating water levels (Dineen et al., 1974; Toth, 1991). Besides being a popular feeding site for wintering waterfowl, the floodplain also provided flooded vegetation to be used by fish and wildlife for spawning and foraging. The floodplain supported one of the most abundant population of wading birds in the world. The number of wading birds in the Kissimmee River floodplain before channelization was estimated about 18,000 birds (USFWS, 1991).

2.4 STORMS AND FLOODS

Prolonged seasonal rainfall, coupled with limited outlet capacity, resulted in almost yearly flooding of large areas in the Kissimmee Basin. About 70 percent of the annual rainfall occurs during the rainy season, a five month period from June to October. During this time, the region is subject to tropical hurricanes which bring intense rainfall, often aggravating a flood situation already serious from heavy seasonal rainfall. Annual damages, a result of long-duration flooding, were relatively high as soaked pasture lands could not be used for farming or grazing. Substantial damages resulted from flood conditions, notably those of 1945, 1947, 1948, and 1953. PLATE 2-1 shows the areas flooded by the 1947 storm. Table 2-2 presents a summary of stage data and other pertinent information on the major floods of record in the Kissimmee Basin.

TABLE 2-2

Pertinent Historic Flood Data
for Upper Kissimmee River Basin

ITEM	SEPT. 1945	SEPT. 1947	OCT. 1948	OCT. 1953
Flooded Area (sq mi)	346	386	--	408
Peak Stage (ft)				
Alligator Lake	66.0	66.0	66.2	66.3
Lake Mary Jane	--	--	--	--
Lake Hart	65.3	63.6	64.6	64.0
E. Lake Tohopekaliga	61.8	60.8	61.5	62.0
Lake Tohopekaliga	58.3	58.5	57.6	58.6
Cypress Lake	56.4	57.4	56.3	57.2
Lake Hatchineha	56.1	56.8	56.0	56.8
Lake Kissimmee	55.7	56.7	55.7	56.7
Peak Discharge (cfs)				
Lake Kissimmee outlet	6,130	6,870	8,820	7,170
Kiss Riv near Lk Okeechobee	11,700	13,000	17,400	17,800
Estimated Actual Damages ($)	--	2,300,000	--	2,285,000
Estimated Frequency (yr) *	8	20	7	15

NOTES: * Based on volume and duration of flooding.

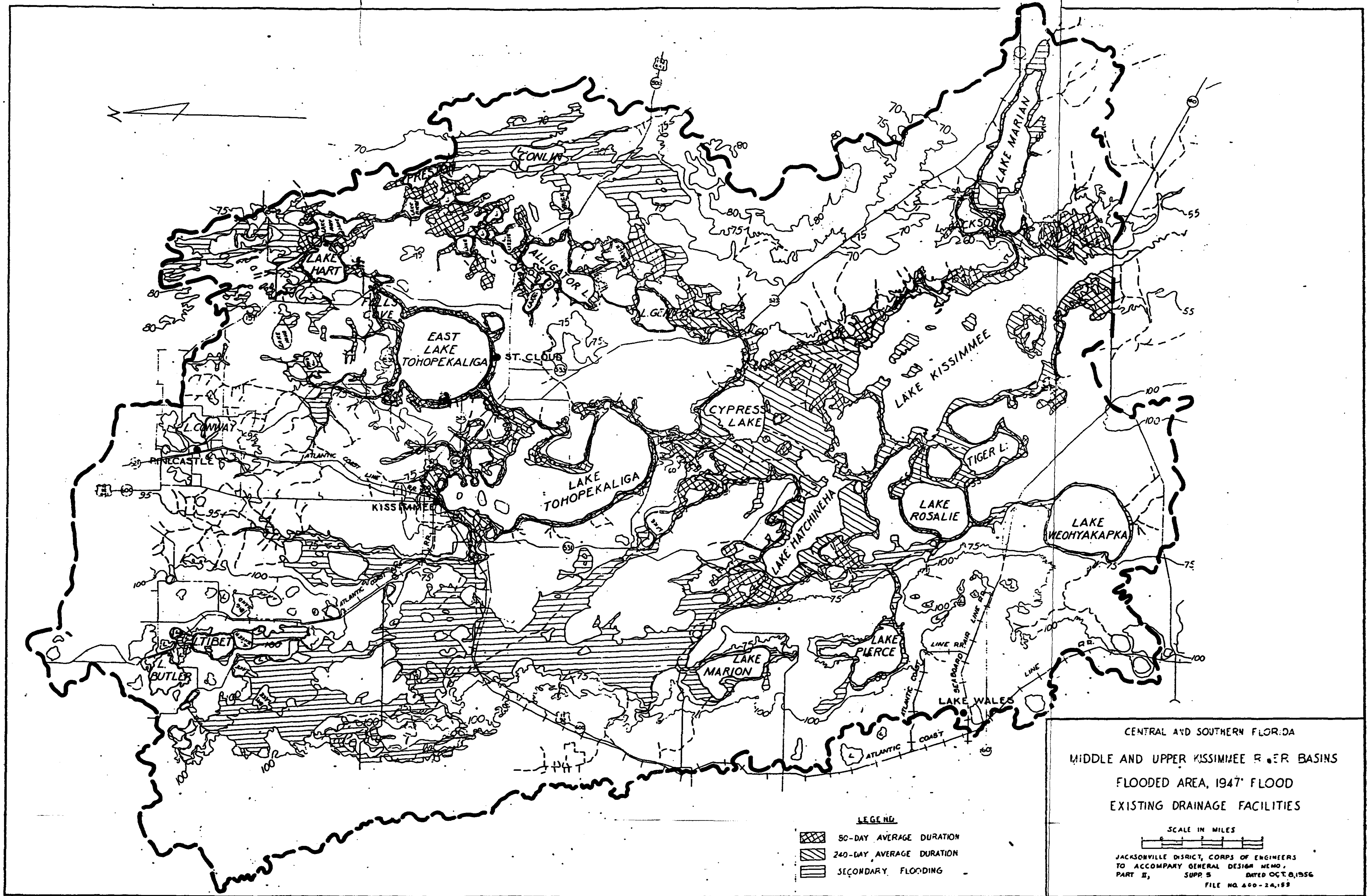

CENTRAL AND SOUTHERN FLORIDA
MIDDLE AND UPPER KISSIMMEE RIVER BASINS
FLOODED AREA, 1947 FLOOD
EXISTING DRAINAGE FACILITIES
SCALE IN MILES
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
TO ACCOMPANY GENERAL DESIGN MEMO,
PART II, SUPP. 5 DATED OCT. 8, 1956
LEGEND
50-DAY AVERAGE DURATION
240-DAY AVERAGE DURATION
SECONDARY FLOODING
LAKE MARIAN
CONLIN
PRESTON
LAKE HART
ALLIGATOR L.
L. GENEVA
EAST LAKE TOHOPEKALIGA
ST. CLOUD
LAKE KISSIMMEE
L. CONWAY
PINECASTLE
ATLANTIC COAST LINE R.R.
KISSIMMEE
LAKE TOHOPEKALIGA
CYPRESS LAKE
TIGER L.
LAKE ROSALIE
LAKE WEOHYAKAPKA
LAKE HATCHINEHA
L. TIBET
L. BUTLER
LAKE MARION
LAKE PIERCE
LAKE WALES
SEABOARD AIR LINE RR.

PLATE 2-1

SECTION 3

FLOOD CONTROL PROJECT

3.1 FLOOD CONTROL

Creation of the Everglades Drainage District by the State of Florida in 1907, and passage of the State's General Drainage Act in 1913, encouraged development in central and south Florida. Resulting development, coupled with inadequate hurricane protection, led to the loss of three thousand lives around Lake Okeechobee during storms in 1926 and 1928. In response, Congress authorized the Corps to modify the Kissimmee navigation project to include flood control. The modified plan, described in a report titled *Caloosahatchee River and Lake Okeechobee Drainage Areas,* included numerous levee and channel improvements to reduce flood damage primarily throughout the lower basin.

Settlers attempted to drain portions of the upper basin lakes to create well drained pasture and agricultural lands, but were unsuccessful. The drought of 1944-45 and the hurricane of 1947, which caused wide-spread flooding of some 600,000 acres in the Kissimmee Basin illustrated the lack of drought and flood protection. Flooding conditions in the Kissimmee River Basin were the result of runoff accumulation on the flat lands of the basin and the subsequent rise of lake levels within the Upper Basin, which remained at high levels because of poor outlet capacity. In addition to flooding from runoff, hurricane winds over Florida create problems of tide generation on the larger lakes which added to the local flooding.

Increasing population growth and developmental pressures, primarily in the Upper Basin, intensified public pressure to reduce the threat of flood damage. As a result, the State of Florida requested the Federal Government to prepare a plan for flood control for the central and southern part of the state. In response to this request, the Corps prepared a comprehensive plan for the area in 1947. Congress authorized the Corps to undertake construction of the Central and Southern Florida (C&SF) Project for flood control and other purposes in 1948. Figure 1-2 shows the features of the overall project. The C&SF Project resulted in a series of reports and design memoranda used in planning and designing the comprehensive flood control and water management system now in place in south Florida.

In 1954, Congress specifically authorized the construction of the Kissimmee River portion of the C&SF Project, which was subsequently planned and designed between 1954 and 1960. The purpose of this plan was to relieve flooding and minimize flood damages in the Kissimmee Basin. This was to be accomplished partially by flood storage in the Upper Basin lakes and partially by providing the capability to rapidly remove flood waters from the basin when necessary. Channelization of the river was selected as the means for flood damage reduction within the lower basin primarily because of the plan's cost effectiveness. The report to Congress clearly stated that complete flood protection could not be provided, but that reasonable flood protection would result from such a plan. The plan of improvement was designed to provide flood damage prevention for thirty percent of the standard project flood (SPF) (which equates to somewhere between a five to ten year level of protection depending on location). For storms greater than the 30 percent SPF, the depth and duration of flooding in the Upper Basin would be reduced by the project features. The plan of improvement, as described in the 1956 General Design Memorandum, was designed to provide the following:

a. Remove runoff from a design storm equal to 30 percent of the standard project flood from the project area between Lake Kissimmee and Lake Okeechobee.

b. Provide sufficient regulation capacity for each of the lakes in the middle and upper Kissimmee Basin to limit the rise in lake stage during the design storm (30 percent S.P.F.) to 2 feet or less.

c. Provide sufficient regulation capacity for Lake Kissimmee to prevent maximum stages resulting from occurrence of the standard project flood from exceeding those that could be expected under existing conditions. That capacity would reduce the stage and duration of all floods below the magnitude of the standard project flood.

d. Provide capacity in Kissimmee River for the design discharge from canal 41A (Lake Istokpoga regulation outlet), developed in Part II, Supplement 2 (reference 3b).

e. Provide water control for the project area by control structures to maintain, insofar as practicable, the lakes at desirable elevations, approximating the present mean stages and water levels in the canals at the optimum elevations.

f. Provide for navigation on Kissimmee River and all lakes in the middle and upper Kissimmee River Basin. Locks would be provided at each control structure on the main watercourse between East Lake Tohopekaliga and Lake Okeechobee.

g. Maintain levels in the lakes of middle and upper Kissimmee River Basin in consideration of the interests of recreation and the preservation of fishery resources.

Work in the Upper Basin was started in the early 1960's. The major lakes of the Upper Basin, which were used for water storage, were connected by channels. In most cases, these were the same channels excavated by Hamilton Disston in the 1880's, but enlarged to varying degrees under the Congressionally authorized plan. Work within the Lower Basin, which included channelization of approximately 48 miles of the river and floodplain (C-38) from Lake Kissimmee to Lake Okeechobee was initiated in 1962 and completed in 1971. Water control structures were also constructed with small boat locks, providing continuous navigation along the length of the new canal, but limited to daylight hours. Combined with Government Cut, a previously channelized section of the lower Kissimmee River (Figure 1-1), C-38 provided complete channelization of the river between Lakes Kissimmee and Okeechobee, a distance of 56 miles.

3.2 UPPER BASIN

3.2.1 Development of Plan

The flood control plan for the upper Kissimmee lakes is a combined system of flood storage capabilities and outlet discharge capacities. Lakes levels are prevented from exceeding stages represented by a seasonal plan known as a regulation schedule which represent the seasonal and monthly limits of water levels needed to obtain the flood protection designed into the project.

Under natural conditions, the lakes in the Kissimmee River Basin fluctuated seasonally through a range in stage varying from about 2 to 10 feet. The existing outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season and was released during dry periods. With the increased outlet capacities of the project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions. Table 3-1, shows the following data for Lakes Cypress, Hatchineha, and Kissimmee: (1) the historical 15 percentile, 50 percentile (median), and 85 percentile stages (based on the 24 years of record prior to institution of regulation), and (2) maximum and minimum daily stages and differences between the record extremes,

TABLE 3-1
Historic Lake Stages

	CYPRESS	HATCHINEHA	KISSIMMEE
15 Percentile (ft.msl.)	54.2	53.2	52.6
Median (ft.msl.)	52.5	51.3	50.4
85 Percentile (ft.msl.)	50.3	49.1	47.7
Maximum (ft.msl.)	57.2	56.8	56.6
Minimum (ft.msl.)	48.0	47.3	44.2
Difference (ft.)	9.2	9.5	12.4

The data shows that prior to regulation, Cypress Lake stage was about one foot higher than Lake Hatchineha stage and two feet higher than Lake Kissimmee stage. Despite the large range in extreme stages, the data shows that 70 percent of the time, under pre-regulation conditions, Cypress and Hatchineha stages fluctuated within a four foot range while Lake Kissimmee fluctuated within a five foot range.

Under the Kissimmee flood control project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions (Table 2-1). The fluctuation of Lake Cypress, Hatchineha, and Kissimmee was set within a four foot range. According to the original General Design Memorandum plan, Lakes Hatchineha and Cypress were to be regulated together between 49 to 53 feet NGVD, and independently of Lake Kissimmee by a structure (S-64) between Lakes Hatchineha and Kissimmee. Lake Kissimmee was to be regulated between 48 to 52 feet NGVD.

However, in a letter to the Chief of Engineers in 1961, the District Engineer recommended eliminating S-64 and regulating Lakes Kissimmee, Cypress, and Hatchineha between 48.5 to 52.5 feet. It was determined that Lake Kissimmee could be regulated approximately one half foot higher and Lakes Cypress and Hatchineha could be regulated one half foot lower than proposed in the General Design Memorandum (Part II, Supplement 5). The flood storage in Lakes Kissimmee, Hatchineha, and Cypress would not appreciably change with this modification. This eliminated the need for the control structure, S-64, at the outlet of Lake Hatchineha. The Chief of Engineers concurred with the elimination of S-64 from the authorized project as recommended by the Jacksonville District.

The 15 and 85 percentile stages of all three lakes prior to construction were used to represent a measure of historical high and low water conditions. The regulated minimum of 48.5 feet is about 9 inches higher than the historical low for Lake Kissimmee. For Lake Hatchineha, the regulated maximum and minimum are about 7 to 8 inches lower than the natural high and low water level. Although the regulated range of four feet reflects the natural fluctuation of Lake Cypress, the effects of regulation have shifted the lake stage regime downward by almost two feet.

3.2.2 Implementation of Upper Basin Features

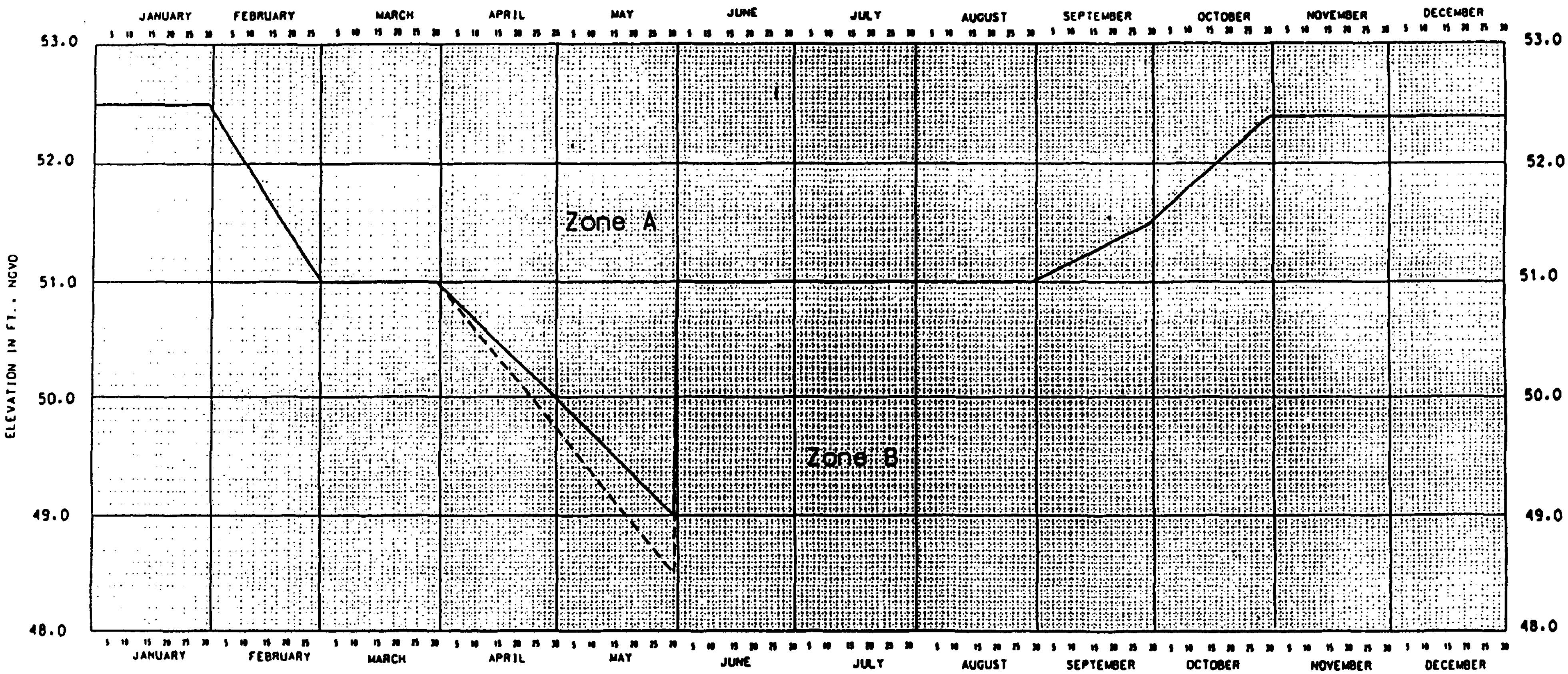
Construction within the Kissimmee Lakes took place over a 6 year period from 1964 to 1970. During this period, interim regulation schedules were adopted upon completion of individual lake outlet works, with the intention to implement permanent schedules upon completion of all works, including the Kissimmee River (C-38). Work began with East Lake Tohopekaliga and proceeded down the west chain of lakes to Lake Kissimmee. Work on the west chain of lakes through Lake Kissimmee was complete by 1965. Work then proceeded up the east chain of lakes reaching Lake Alligator by 1967. By 1970, work was completed in the east chain of lakes, from Alligator to East Lake Tohopekaliga.

Numerous efforts were made to develop permanent regulation schedules within the Upper Basin lakes, however, a decision could not be reached by the parties involved in the decision process. Each effort usually ended by recommending the current interim schedule until the results of additional studies were made. In 1975, after a comprehensive hydrologic study of the Kissimmee Basin and two public meetings, the Central and Southern Florida Flood Control District prepared a report titled, *Report to the Governing Board on Regulatory Levels for Lakes in the Upper Kissimmee Basin.* The schedules put forth in this report were approved by the Corps and implemented in 1976. In 1981, following more public meetings, the SFWMD recommended revisions to the regulation schedules, and the changes were implemented in April, 1982. The revised interim Lake Kissimmee, Hatchineha, and Cypress regulation schedule was implemented in April 1982. This schedule, which is also the current operating schedule, is shown in Figure 3-1.

3.2.3 Operation of Lake Kissimmee Regulation Schedule

Lakes Kissimmee, Hatchineha, and Cypress are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee, at the head of C-38. The lakes are currently regulated between elevations 48.5 and 52.5 feet according to the seasonally varying schedule. The present regulation schedule for flood protection of the Kissimmee River valley uses the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The design discharge of 11,000 cfs from Lake Kissimmee is restricted to a firm capacity of 3,000 cfs until flooding recedes along the lower river; usually less than two weeks. When the river recedes to a point where the Kissimmee River structures can discharge their design flow at design stages, the discharge from Lake Kissimmee is increased to 11,000 cfs. For floods less than about 10-year recurrence frequency, the inflow hydrograph into Lakes Kissimmee, Hatchineha, and Cypress has already passed the peak and has dropped to below 11,000 cfs before S-65 is opened up to the 11,000 cfs maximum discharge. Therefore, the peak stage in Lake Kissimmee would occur at the time discharge at S-65 is increased to 11,000 cfs. Before C-38 was built, the outlet capacity of Lake Kissimmee was impacted by backwater effects from the reach of Kissimmee River immediately downstream of the lake. The maximum discharge recorded from Lake Kissimmee prior to the project was 8,800 cfs and occurred during the 1948 flood at a peak stage of about 57.0 feet. Today, the 11,000 cfs outlet capacity is available any time there is a 2.5-foot head differential across S-65. During floods, the full capacity usually becomes available on a rising stage in Lake Kissimmee at about 51 feet.

LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS INTERIM REGULATION SCHEDULE



ZONE	RELEASES
A	3,000 CFS UP TO DESIGN CAPACITY(11000) WITHOUT EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FEET OF SCHEDULED STAGE FORECASTS WILL BE MADE AND RELEASES STARTED TO RETURN THE LAKE TO SCHEDULE WITHIN 15 DAYS
B	TO MAINTATIN MINIMUM FLOWS

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN
LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS

Figure 3-1

3.2.4 Physical Features

Nine water control structures and seven canals were constructed in the Upper Basin from Lake Hart to Lake Kissimmee as part of the flood control project. The structures and canals are shown in Figure 3-2 and described below.

a. Structure 57 (S-57). S-57 is located in C-30, connecting Lakes Myrtle and Mary Jane, about 6200 feet downstream from Lake Myrtle. S-57 is a double-barreled corrugated metal pipe culvert, with discharge controlled by stem operated vertical lift gates. Operation of the gates is manually controlled or by telemetry in accordance with the seasonal operational criteria.

b. Structure 58 (S-58). S-58 is located in C-32 which connects Lakes Trout and Joel, about 3200 feet downstream from Trout Lake. S-58 is a double barreled corrugated metal pipe culvert, with discharge controlled by stem operated vertical lift gates. Operation of the gates is manually controlled or by telemetry in accordance with the seasonal operational criteria.

c. Structure 59 (S-59). S-59 is located in C-31 between East Lake Tohopekaliga and Lake Tohopekaliga at the outlet of East Lake Tohopekaliga. S-59 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. Operation of the gate is manually controlled or by telemetry in accordance with seasonal operational criteria.

d. Structure 60 (S-60). S-60 is located in C-33 between Lakes Alligator and Gentry about 1,500 feet upstream from State Road and 3,700 feet downstream from Alligator Lake. S-60 is a reinforced concrete, gated spillway with discharge controlled by a stem operated, vertical lift gate. Operation of the gate is manually controlled or by telemetry in accordance with seasonal operational criteria.

e. Structure 61 (S-61). S-61 is located in C-35 at the south shore (outlet) of Lake Tohopekaliga. S-61 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate, and a reinforced concrete lock structure with two pairs of sector gates. Operation of the spillway gate is manually controlled in accordance with seasonal operational criteria.

f. Structure 62 (S-62). S-62 is located in C-29 at the outlet of Lake Hart which discharges into Lake Ajay. S-62 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. Operation of the gate is manually controlled in accordance with the seasonal operational criteria.

g. Structure 63 (S-63). S-63 is located in C-34 about 2000 feet downstream from Lake Gentry. S-63 is a reinforced concrete, gated spillway with discharge controlled by a stem operated vertical lift gate. Operation of the gate is manually controlled in accordance with the seasonal operation criteria.

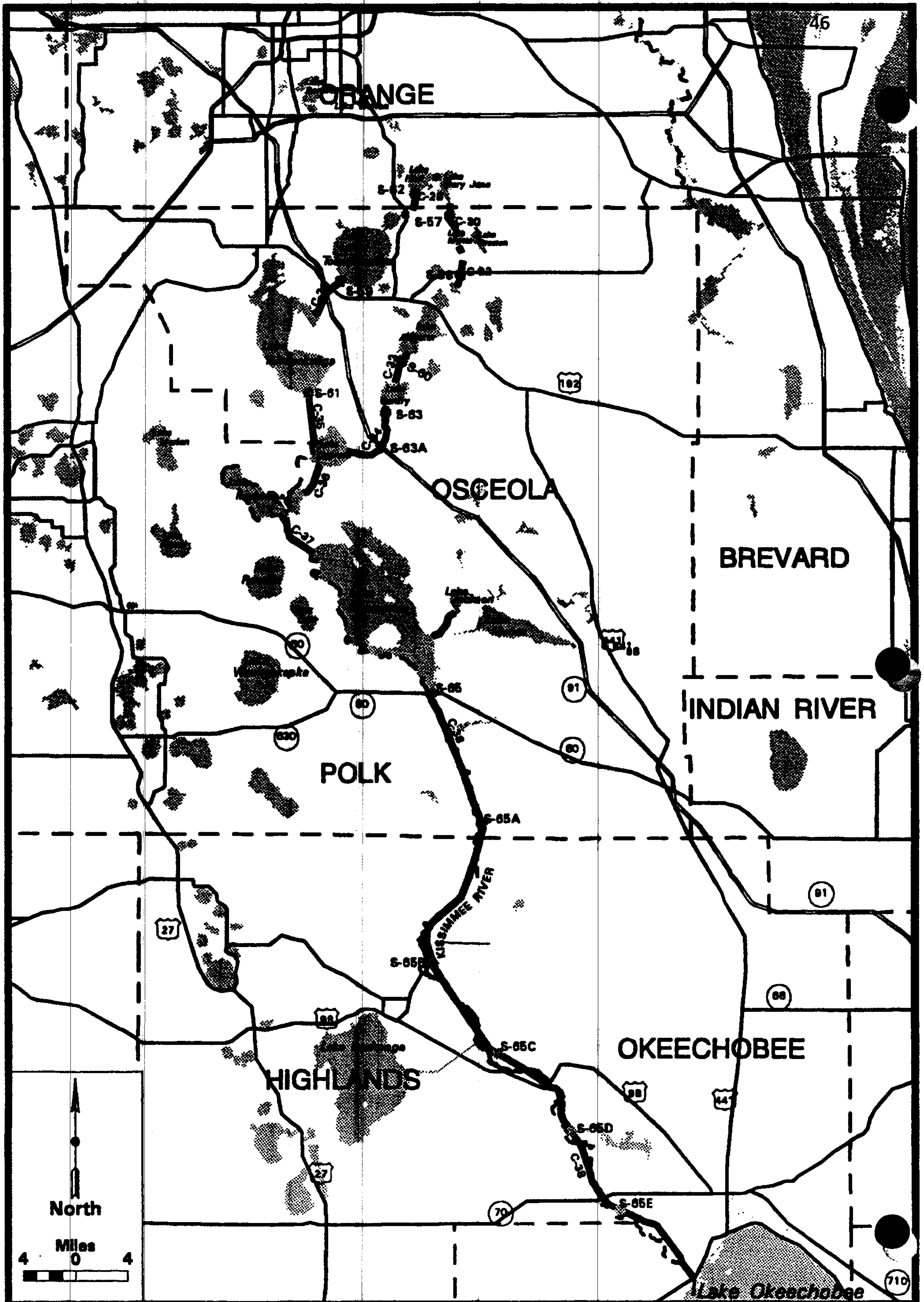
h. Structure 63A (S-63A). S-63A is located in C-34, about 2.25 miles upstream from Lake Cypress. S-63A is a reinforced concrete, gated spillway with discharge controlled by two stem operated vertical lift gates. Operation of the gates is automatically controlled in accordance with the seasonal operational criteria.

i. Structure 65 (S-65). S-65 is located at the outlet of Lake Kissimmee at the head of C-38. S-65 is a reinforced concrete, gated spillway with discharge controlled by three vertical lift gates, and a reinforced concrete lock structure with two pairs of sector gates.

3.2.5 Lower Basin (Canal 38)

Canal 38 (C-38) was designed between 1954 and 1960 and constructed between 1962 and 1971. There are six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E, each with tieback levees, that divide the river into five pools. S-65 is the outlet structure from Lake Kissimmee and uses the S.R. 60 road embankment as a tieback levee. Pool A is between S-65 and S-65A; Pool B is between S-65A and S-65B; Pool C is between S-65B and S-65C; Pool D is between S-65C and S-65D, and Pool E is between S-65D and S-65E. Structure 65E is located eight miles north of Lake Okeechobee.

The Kissimmee structures are designed to step down the 36-foot drop of the river in six-foot increments. The canal is designed to pass the outflow from Lake Kissimmee plus local inflow for a storm equal to 30 percent of the SPF. The 30 percent SPF discharge capacity at Lake Kissimmee represents a 25 percent increase over historical capacity, thus, providing flood protection to the Upper Chain of Lakes. In the lower C-38 basin, the design channel is capable of passing the twin-peaked hydrograph produced by the local inflow and the delayed peak from the upper basin. Even with higher inflow discharges, the C-38 project significantly reduced flood stages in the lower valley because of the reduction in surface friction and hydraulic conveyance provided by the canal.



KISSIMMEE RIVER PROJECT

FIGURE 3-2

SECTION 4

EXISTING CONDITION/AFFECTED ENVIRONMENT

This section provides an overview of resources that currently exist within the Upper Kissimmee River Basin. These resources will be assessed according to the potential for altering the existing condition relative to the recommended restoration measures.

4.1 GEOLOGY AND SOILS

Soils found throughout the Kissimmee River Basin are sandy with poor to moderate drainage due to organic hardpans found 1 to 2 feet below the surface. The majority of soil types found in the Upper and Lower Basin's are classified under the Smyrna-Myakka-Basinger soil association. Other predominant classifications are the Myakka-Basinger category and the Myakka-Immokalee-Basinger category. Weathering, erosion, climatic conditions, vegetation effects, and topographical locations of resident soils have resulted in the numerous differences in soil characteristics. These characteristics are undergoing continual alteration due to normal seasonal climatic conditions and longer term climatic changes.

The study area also has soils with hardpan one to two feet below the surface. Over the long period of natural evolution of these soils, organic and mineral materials leached downward and accumulated at the top of the locally prevailing water table. In the early history of the Kissimmee River Basin, there were extensive areas of wetlands. Agriculture and other land use activities over the past 100 years have drained these wetlands by surface drainage systems and by breaking up the original hardpan. As a result of this process, the high organic fraction of these original soils has been rapidly oxidized by exposure to the air and soils now act as well-drained soils, creating better drainage during high rainfall but a need for more irrigation during periods of lesser rainfall. The fresh water swamps, where the groundwater is 15 inches or less beneath the surface, were at one time under water 9 to 12 months of the year. Additional information may be found in the Geotechnical Investigations section, Appendix C, of this report.

4.2 HYDROLOGY

The Upper Kissimmee Basin encompasses approximately 1,600 square miles in Osceola, Polk, Orange Counties and includes 26 lakes, 18 of which are controlled by structures and canals operated by the SFWMD, in accordance with regulations prescribed by the Secretary of the Army. The system of water control works now in place in the Kissimmee Basin conforms closely with the general plan outlined in the 1948 report to Congress and authorized for construction in 1954. A description of the existing structures is provided in the Flood Control Project section, Section 3, of this report.

In addition to the flood control structures identified in Section 3, several locally constructed control structures are located in the Upper Basin. Lake Rosalie has a steel sheet pile weir, G-103, which partially separates Lake Rosalie from the canal connecting it with Lake Kissimmee. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges into Lake Tiger. The water levels of Lake Jackson are also controlled separately from Lake Kissimmee by a control structure on the Lake Jackson canal. The structure was recently completed by the FGFWFC and SFWMD.

The flood control plan for the upper Kissimmee lakes is a combined system of flood storage capabilities and outlet discharge capacities. Water levels in between Lakes Hatchineha, Cypress, Kissimmee and its tributary, Lake Tiger are controlled with a single outflow structure at the south end of Lake Kissimmee, S-65. Inflow into these lakes from Lake Tohopokeliga and Lake Gentry is controlled by structures S-61, S-63 and S-63A. Details of the S-65 and other structure operational criteria are described in the Water Control Plan (Appendix B).

Lake levels are prevented from exceeding stages represented by a regulation schedule designed to provide the designed level of flood protection into the project. Lakes Kissimmee, Hatchineha and Cypress are currently regulated between 48.5 to 52.5 feet NGVD according to a seasonally varying operation schedule (Figure 3-1). The schedule varies from 52.5 feet during the driest months to 51.0 feet during the wet season. The schedule is lowest in the wet season to obtain the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The schedule stage is highest during the dry season because both the probability of extreme rainfall and ground water storage in the basin are low.

Due to the flood control schedules and operation rules that are used to regulate stages in the headwater chain of lakes, discharge regimes from the Upper Basin have been greatly altered compared to historical conditions. Prior to regulation the river received continuous inflows from the Upper Basin, with lowest discharge typically occurring during the winter-spring, dry season and steadily increasing to an end of the wet season (November) peak. Since regulation, the natural seasonality of high and low flow periods has been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the lower basin. Low or no discharge is common during most of the wet season months (June-November), however the wet season discharges are required about 35 percent of the time to keep Lake Kissimmee stages from rising above schedule. Highest annual flows often occur during the dry season months (particularly February-May) as stages in the upper lakes are lowered to provide storage for flood control (Figure 4-1). Both of these changes to historical flow regimes impact the potential for restoring fish and wildlife habitat in the river and its bordering floodplain.

Flood control regulation has also reduced the range of water level fluctuations and maximum annual lake stages in the Upper Basin (Figure 4-2). The curves, based on actual daily gage values over the period, reflect a wider fluctuation in lake stage for the pre-project or unregulated period. The larger variation in the natural system was due primarily to a less efficient outlet from Lake Kissimmee in the form of the meandering Kissimmee River and the absence of the S-65 control structure operating in conjunction with an established regulation schedule. Flood and wet season stages are now reduced because of the improved outlet capacity at S-65 and the downstream conveyance of C-38 while dry season stages tend to be higher because releases from S-65 are curtailed when the lake is below schedule.

Comparison of Pre-Project and Post Project Discharges from Lake Kissimmee

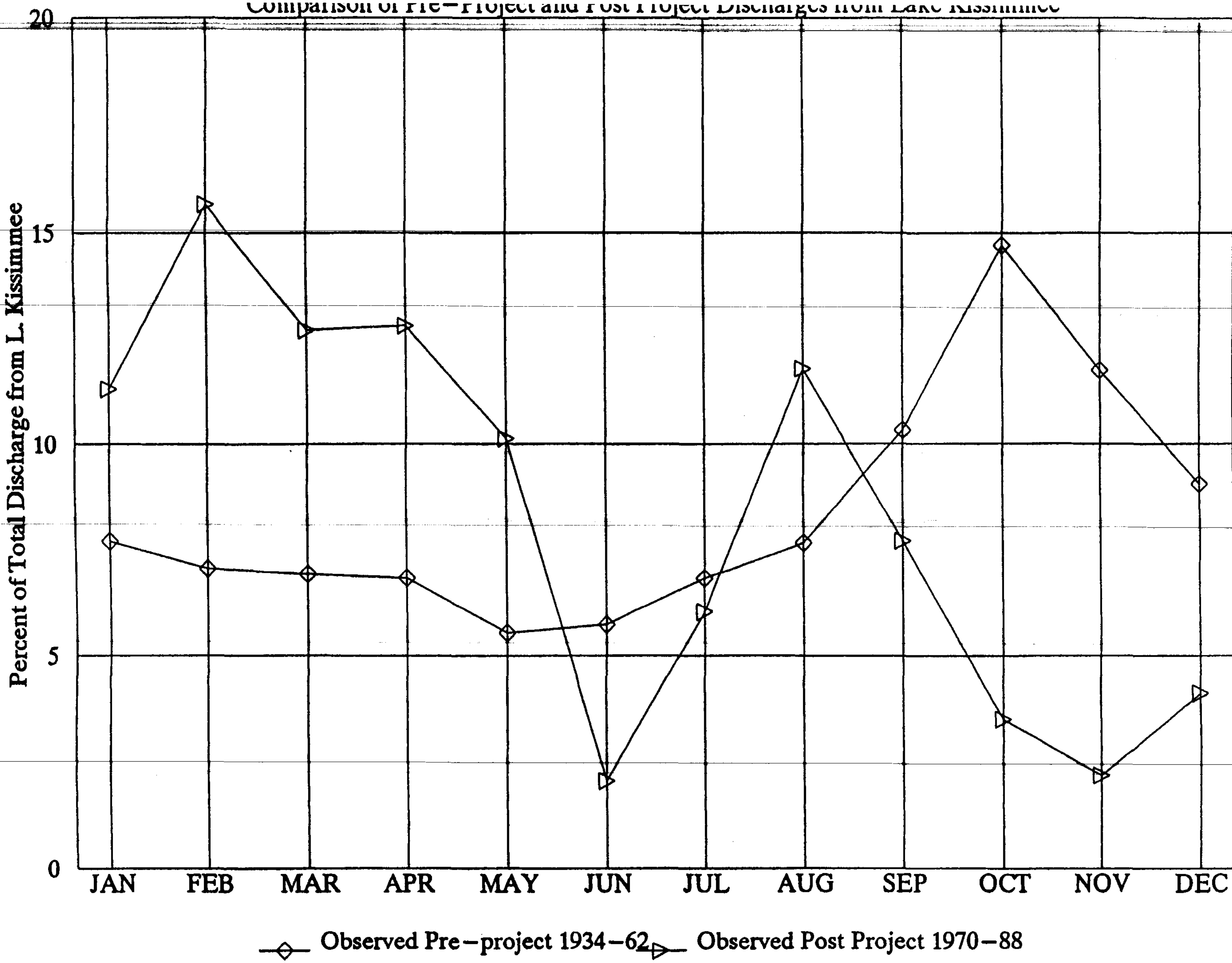


FIGURE 4-1

4-4

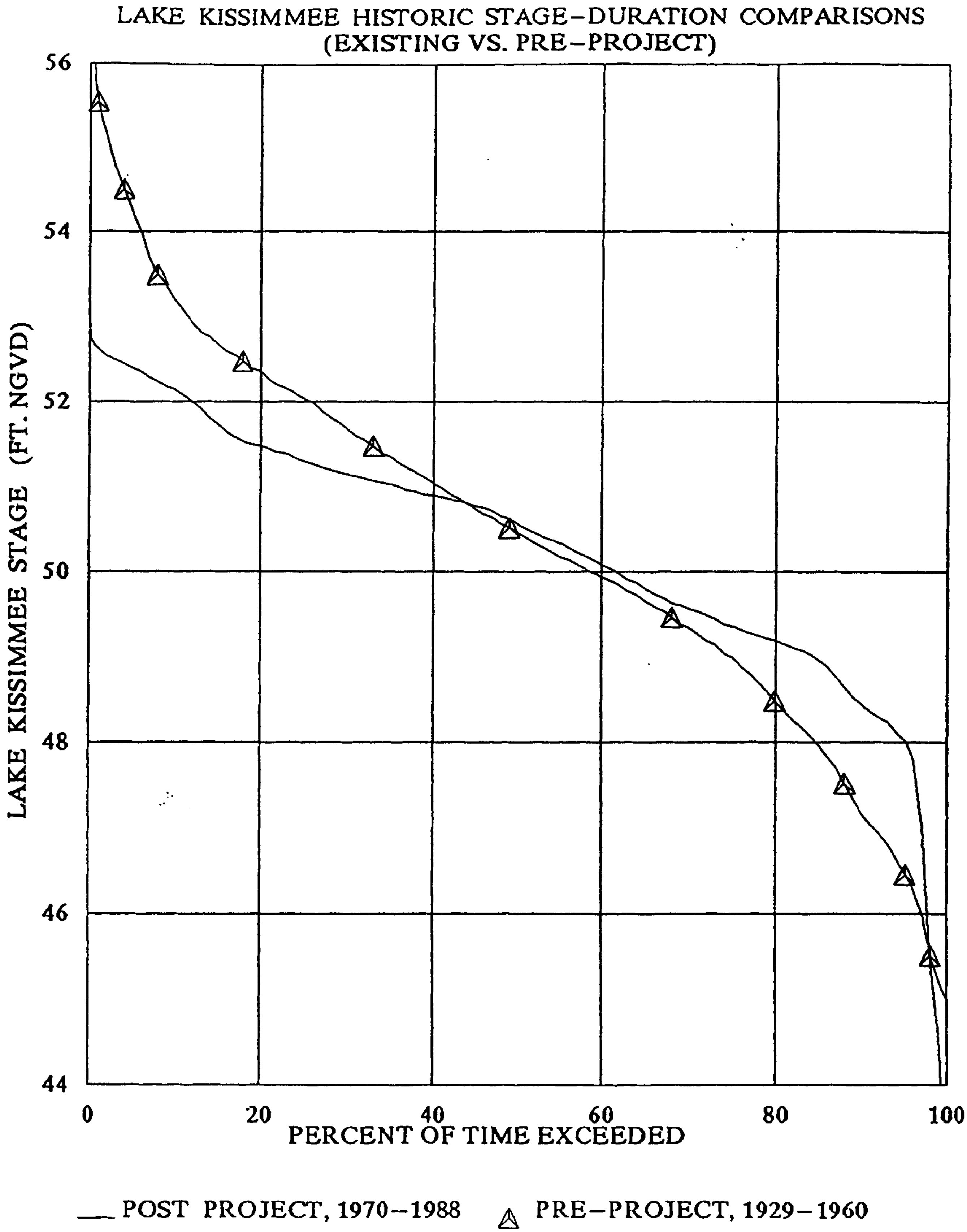

LAKE KISSIMMEE HISTORIC STAGE–DURATION COMPARISONS
(EXISTING VS. PRE–PROJECT)
LAKE KISSIMMEE STAGE (FT. NGVD)
56
54
52
50
48
46
44
0
20
40
60
80
100
PERCENT OF TIME EXCEEDED
POST PROJECT, 1970–1988
PRE–PROJECT, 1929–1960

Figure 4-2

4.3 EXISTING FLOOD LEVELS

The existing Kissimmee flood control project was not designed and constructed to provide complete flood protection for the Kissimmee Basin. The plan of improvement was designed to provide flood damage prevention for thirty percent of the standard project flood (SPF) for the Upper and Lower Basins (five to ten year flood event, depending on location). In the Upper Basin, the depth and duration of flooding would be reduced by the project features for storms greater than the 30 percent SPF.

Theoretically, floods can occur almost any time. Therefore, the probability of a specific flood stage in Lake Kissimmee is a joint probability of antecedent lake stage and rainfall. Specifically, the total probability is the integral summation of the product of all the possible combinations that would produce that stage. The more traditional approach has been to start the storm at an average lake level which is usually represented by the 1 September stage on the regulation schedule. This was the approach followed in the 1990 and 1991 feasibility reports and all prior studies of the Kissimmee River Basin. However, the capabilities of the UKISS and UNET models enabled a joint probability approach to be used for the first time during the current study for the Upper Basin flood routings (see Appendix A., Hydrology and Hydraulic Analyses).

UNET, a one-dimensional unsteady flow program, was the dynamic-routing model used to simulate flood flows and stages in a fully developed network of open channels and storage areas. Both the Corps' 1991 Feasibility Report and the 1990 SFWMD Report utilized CHANOP as the Upper Basin hydraulic routing model and DWOPER as the Lower Basin model. The current study utilizes UNET exclusively in both the Upper and Lower Basins. UNET is particularly superior to CHANOP in simulating the dynamic interplay between flow and stage for the various interconnecting lakes in the Upper Basin. Unlike CHANOP, UNET allowed the three main stem lakes (Kissimmee, Hatchineha, and Cypress) to be modeled as separate entities thereby identifying the respective headlosses between the lakes and ultimately leading to an optimization of design channel enlargements for Canals 35, 36, and 37. Due to modeling constraints and a lack of topographic information in the canals, previous studies in 1990 and 1991 had computed a common peak flood stage for the three lakes. Figure A-1 shows a schematic of the UNET models for the Upper Basin under existing and with-project conditions. Figures A-2 and A-3 show schematics of the Lower Basin UNET model. The Lower Basin model essentially consists of one reach, C-38, which extends from S-65 to S-65D.

The existing conditions flood routing model accounts for the fluctuation of starting water surface elevations on Lakes Kissimmee, Hatchineha, Cypress, and Tiger between elevations 49.0 to 51.0 feet. Although there are additional lakes in the Middle Basin, only the lakes which would potentially be impacted by a change in the Lake Kissimmee regulation schedule are included in the UNET model. However, hydrology and HEC-1 flood routings were also developed for the other major lakes (i.e., Lakes Weohyakapka, Marion, and Pierce) and input as upstream boundary hydrographs into the UNET model shown. The previous hydrologic modeling for the Upper Basin chain of lakes was included in the current UNET model as upstream boundary hydrographs at the S-61 and S-63A locations.

The fully-integrated model includes the Upper and Lower Basin UNET models joined together at S-65. S-65 is modeled as a submerged rating curve (maximum capacity of 11,000 cfs at head of 2.5 feet) which computes discharge based on headwater and tailwater; however, discharge is restricted to 3,000 cfs when tailwater exceeds elevation 49.0 feet. S-65A, S-65B, and S-65C are also modeled as submerged rating curves with their full-height tieback levees represented with cross-sections. A downstream rating curve is used to simulate outflow from the model at S-65D. Canals 35, 36, and 37 are represented with existing bottom widths and side slopes and the Lake Kissimmee SWSEL for the flood event fluctuates between elevation 49.0 to 51.0 feet. C-38 is left intact (no backfill) and Mannings "n" values of 0.03 and 0.15 used for the channel and overbanks, respectively. Peak stage results for the integrated UNET existing conditions model is shown in Table 4-1 for the Upper and Lower Basins. Peak stages shown for the Lower Basin, below S-65, are tentative at this time. The stages will be revised as new topographic information for Pools A, B, C, and D continue to be incorporated into the model when they become available.

TABLE 4-1
KISSIMMEE RIVER UPPER AND LOWER BASIN
EXISTING PEAK FLOOD STAGES (FT)

PEAK STAGE FT.	RETURN PERIOD IN YEARS				
LOCATION	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR
S-61 TW	53.91	54.53	55.96	56.77	57.22
S-63A TW	53.85	54.53	56.01	56.84	57.46
CYPRESS	53.47	54.16	55.71	56.56	57.04
HATCHINEHA	52.87	53.69	55.42	56.41	56.99
KISSIMMEE	51.77	52.41	53.96	55.13	56.18
TIGER	52.39	52.93	54.08	55.15	56.18
JACKSON	56.8	57.4	58.1	58.4	58.7
ROSALIE	56.1	56.3	56.6	56.8	57
MARIAN	61.4	61.7	62.1	62.4	62.7
S-65 TW	49.51	49.66	49.83	49.92	49.99
S-65A HW	48.04	48.14	48.59	48.87	49.02
S-65A TW	44.18	44.55	45.47	46.16	46.22
S-65B HW	42.86	43.16	44.51	45.36	45.43
S-65B TW	35.4	35.92	36.06	36.47	36.47
S-65C HW	34.35	34.85	35.12	35.61	35.61

4.4 NAVIGATION

The C&SF project works improved navigation opportunities originally provided in the Congressional Act of 1902. The waterway now provides year-round navigation from Lake Kissimmee to Lake Okeechobee with interpool navigation being limited to daylight hours only. The navigation features of the project are now part of a more extensive flood control project that has provided a broader and deeper waterway. Current usage of those waters is in the form of recreational boating. Vessel registration for 1995 in Osceola and Polk Counties show 6,370 and 24,905 recreational vessels, respectively. These two counties have over 660 commercial vessel registrations. Post-regulation invasion of the exotic hydrilla has impacted the Upper Basin lakes navigation, though, particularly in shallow water. Some small boat owners are no longer using the Kissimmee Chain due to their difficulty or inability to get through the dense mats of hydrilla.

4.5 NATURAL ENVIRONMENT

4.5.1 Vegetation

The littoral zones of the lakes are among the most significant resources in the Upper Kissimmee River Basin. The distribution of plants is a result of a history of inundation, fire, grazing, nutrient input and soils. Cypress swamp, shrub swamp or emergent fresh water swamp make up the dominant vegetation communities in the littoral zones.

Flooding stage and duration are the dominant influences on vegetation composition. Flood control regulation has impacted environmental resources in the Upper Basin. Because the range of water level fluctuations and maximum annual lake stages have been reduced (Figure 4-2), the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished. PLATE 4-1 depicts a transformation from historic littoral conditions (1958) to the post-Kissimmee flood control project conditions (1984) at Lake Hatchineha. The photographs show a definite reduction in wetland fringe from 1958 to 1984.

The lakes are general surrounded by pine flatwoods, dry and wet prairies, and cypress domes. The tributaries have swamp hardwood bottomlands adjoining them, and in the case of Reedy Creek, swamp hardwood bottomlands exist for more than 25 miles to the north.

Where the cypress swamp prevails, it exists in pure stands in peripheral parts of the lakes, with little understory vegetation. The shrub swamp is dominated by willow (Salix spp.), buttonbush (Cephalanthus occidentalis), Carolina bay (Persea sp.) and primrose willow (Ludwigia peruviana). The emergent marsh is dominated by various grasses: torpedo grass (Panicum repens), maidencane (Panicum hemitomon), and cord grass (Spartina bakeri). Smartweed (Polygonum spp.), pickerelweed (Pontederia cordata), arrowhead (Sagittaria latifolia), sawgrass (Cladium jamaicense), cattail (Typha spp.), various rushes (Juncus spp.) and sedges compete with the grasses. Deeper parts of the littoral zone contain water lily (Nymphaea odorata), spatterdock (Nuphar luteum), bulrush (Scirpus spp.), and cattail. Hydrilla (Hydrilla verticillata) is a dominant submerged aquatic plant, and American lotus (Nelumbo lutea) is locally abundant.

The zone around the present emergent marsh is largely pasture land dominated by short-growing carpet grass, with little cordgrass, and is subject to cattle grazing. Where cattle are excluded, the area is dominated by other grasses, such as torpedo grass. If the upper marsh has not been burned and cattle are excluded, it is dominated by broomsedge (Andropogon virginicus), dog fennel (Eupatorium capillifolium), sesbania (Sesbania punicea), goldenrod (Solidago fistulosa), and wax myrtle (Myrica cerifera).

The wet prairie is typically inundated about 1.5 months to 5 months each year. It is dominated by grasses and rushes, such as wiregrass (Aristida stricta), maidencane, spikerush (Eleocharis spp.), beakrush (Rhynchospora microcarpa), and cordgrass (Spartina bakeri).

Reduced or eliminated water level fluctuations has been implicated by many authors as a major cause of undesirable changes in lake and wetland communities (Perrin, 1982). Such changes involve the accelerated accumulation of unconsolidated bottom sediments, declines in dissolved oxygen, nutrient enrichment, vegetation changes in the upper littoral zone, and ultimately the reduction of fish and wildlife populations.

In six places, on the east and west shore of Lake Kissimmee, on the southwest, northwest and east shore of Lake Hatchineha, and on the northwest shore of Lake Cypress near C-35, land owners have constructed farm levees to reduce flooding of pasture land. The levees inhibit flooding of about 3,000 acres that, historically, were marsh, contiguous with the lakes during high water periods.

This reduction in the size of the littoral zone marshes has reduced the total area for recruitment of forage to the in-lake fishery and diminished the shallow, useful zone for wading bird foraging. The present day marsh zone is approximately 16,000 acres. This is approximately a 71% reduction in marsh area compared to the historical extent of wetlands surrounding these lakes.

On occasion these lakes are drawn down several feet in cooperation with the FGFWFC as a fisheries management measure to consolidate organic sediments and to permit removal of muck and debris from the littoral zones. They attempt to hold water levels down for at least 90 days, starting February 1. For Lake Kissimmee, water levels should remain below 45 feet for a minimum of 90 consecutive days for effective treatment. Extreme drawdowns were completed for Lake Tohopekaliga in 1971, 1974, and 1987, and East Lake Tohopekaliga in 1989. A drawdown of Lake Kissimmee was completed in 1977. Although it did not include mechanical removal of muck, it was still beneficial for the consolidation of organic sediment. Another drawdown is underway for Lake Kissimmee which started in late 1995 and will continue through 1996.

The purpose of this extreme drawdown will be to compact lake bottom sediments and stimulate growth of desirable aquatic vegetation. This action will increase the overall quality of fish and wildlife populations in Lake Kissimmee.

4.5.2 Fish and Wildlife

The fluctuating waters of the lake littoral zone are important for overwintering waterfowl, which utilize these lakes during migrational periods. Coots (Fulica americana), ring-necked ducks (Aythya collaris), American widgeon (Anas americana), pintails (Anas acuta) and blue-winged teal (Anas discors) are the major species (Joe Carroll, USFWS. Pers. comm., 1992). The native Florida, or mottled duck (Anas fulvigula) also breeds and is resident in the shoreline marshes. Normally, the common snipe (Gallinago gallinago) is also found in these areas in the fall and winter months.

Post-regulation waterfowl use in the Upper Basin, i.e., Lakes Kissimmee, Hatchineha and Cypress, has averaged 3,405 waterfowl days based on eight surveys between 1965 and 1980. Pre-regulation waterfowl usage, based on three surveys between 1954 and 1957, had a mean of 4,360 waterfowl days. This is a 22% decrease in waterfowl day usage since lake level regulation was imposed on the lakes (Perrin et al., 1982). Presently, i.e., 1994-1995, a mid-winter waterfowl survey by the Florida Game and Fresh Water Fish Commission (FGFWFC) on lakes Kissimmee, Cypress, Hatchineha and Tohopekaliga estimated approximately 56,402 individuals were utilizing the lakes. This would represent an increase of approximately 16,000 individuals over the historic peak of 40,000 individuals since lake level regulation has been imposed. However, in comparing the data found in Perrin et al. (1982) against the 1994-95 mid-winter survey by FGFFC this increase is attributed to the significant increase in the populations of coots on the lakes. Lake Kissimmee had a pre-regulation (1954-1957) population mean of 2,532 ducks and 959 coots during winter surveys, while the post-regulation (1965-1980) mean population had changed to 1,437 ducks and 1,203 coots. The FGFWFC found in their mid-winter survey of Lake Kissimmee that ducks numbered approximately 3,185 whereas coots had increased to 14,010. This change in species abundance from ducks to coots is exhibited on all the lakes of the Upper Basin. The changes in duck and coot populations on the lakes has occurred following implementation of regulated water level schedules. One of the main factors related to these changes would be the decrease in the zone of fluctuation surrounding the headwater lakes. The zone of fluctuation which provides important waterfowl habitat was reduced by 5,600 acres for all upper basin lakes following water level regulation (Heaney et al., 1975). Due to topographical characteristics, the reduction of high water stages had the greatest impacts upon the low lying marshes bordering Lakes Kissimmee, Hatchineha and Cypress than the other lakes of the Upper Basin. The vegetation change resulting from regulated water level schedules and construction of local farm levees has resulted in conditions that favor coot utilization over ducks.

Wading birds use the littoral zone as important feeding habitat. The great egret (Casmerodius albus), snowy egret (Egretta thula), great blue heron (Ardea herodias), tricolor heron (Egretta tricolor), and little blue heron (Egretta caerulea) are among those that benefit from the littoral zone. White ibis (Eudocimus albus) and glossy ibis (Plegadis falcinellus) also feed there. All are dependent on forage organisms produced in the littoral zone; i.e., fishes, reptiles, amphibians and invertebrates. One of the main reasons for recent declines in wading bird populations has been attributed to nesting failures due to inadequate food production (Ogden 1978). Ultimately, this lack of food production is attributed to increased marshland destruction and alteration of hydrological patterns (Kushlan and White 1977, Ogden 1978). Based on aerial surveys conducted over the upper and lower Kissimmee Basins by FGFFC from November 1978 through October 1980, wading bird population levels in the survey area seemed to reflect the degree to which wetlands habitat had been degraded. Number of species, density, and diversity of wading birds generally were lower in the Lower Basin (Kissimmee River) system than in the lake marshes of the Upper Basin.

Sport fishing constitutes the largest use of any species in the Upper Basin area (Section 4.11). The primary quarry sought by anglers on Lake Kissimmee is the largemouth bass (Micropterus salmoides). From 1987 to 1991, anglers exerted 59 percent of the total fishing effort on bass, 24 percent on black crappie (Pomoxis nigromaculatus) and 17 percent on bream (Lepomis spp.). Miscellaneous species, such as channel catfish (Ictalurus punctatus), brown bullhead (Ictalurus nebulosus) and chain pickerel (Esox niger) also were targeted. The effects of stabilized water levels, loss of littoral wetland habitat and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones. Increased rates of organic matter deposition and flocculation of decaying plant matter have reduced the food availability for fish, limiting the habitat for fish spawning and larval and juvenile fish.

The American alligator (Alligator mississippiensis) is a dominant reptile in the region. The alligator scavenges for carcasses of birds and hunts for fish in the deep water canals and ponds within the marsh zone.

Vectors in the study area include ticks, mosquitoes, biting flies and midges. These vectors may transmit Lyme's disease (ticks), encephalitis (mosquitoes and flies), and malaria (Anopheles mosquitoes); rabies is present to varying degrees among wild mammals; notably raccoons, skunks and foxes.

The eastern indigo snake (Drymarchon corais couperi) is a large, black to glossy blue-black snake. Indigo snakes prefer sandy uplands, but can be found in many kinds of habitats, including certain canal banks. Generally, it can be found using gopher tortoise burrows for shelter. The collecting of tortoises for food and gassing of burrows for rattlesnakes have diminished the population of indigo snakes.

Audubon's crested caracara (Polyborus plancus auduboni) is a raptor with opportunistic feeding habits. It feeds on both carrion and living prey. It prefers open, dry prairie and pasture and scattered cabbage palm clumps for nesting. Live oak hammocks are also often present in preferred habitat. Caracara fly over improved pasture lands and forage over shallow ponds and sloughs. The distribution of the Florida population of this subspecies was once more widespread, including all of the prairie region of central Florida, but the bird is now mostly confined to the several counties north and west of Lake Okeechobee. The Kissimmee Prairie region is the core of the present range of the species. Sightings of caracara have been reported in the project area. Nesting was also reported in the vicinity of the study area, near the edge of the floodplain.

A population of whooping cranes (Grus americana) is the subject of an experimental introduction into the Three Lakes Wildlife Management Area, east of the project. The USFWS, in cooperation with the FGFFC, is conducting the program. The population, classified as a nonessential population, is not expected to be affected by the project.

4.5.4 State Listed Species of Special Concern

The sandhill crane (Grus canadensis pratensis) is state listed as threatened (T). A characteristic species of the basin, the cranes feed in pastures adjacent to the lakes and the upper littoral zone. Nesting by resident cranes occurs in the potholes dotted throughout the Kissimmee Prairie.

Other state listed species in the study area include the American alligator, categorized as a species of special concern (SSC), the least tern (Sterna antillarum)(T), limpkin (Aramus guarauna)(SSC), snowy egret (SSC), little blue heron (SSC), and tricolored heron (SSC).

4.6 WATER QUALITY

The majority of the Upper Kissimmee Basin exhibits fair to good water quality with the exception of Lake Tohopekaliga, which is classified as having

While these vectors or hosts are likely present in the study area, there are no known public health problems related to vectors in the basin.

4.5.3 Endangered or Threatened Species

The Corps, in consultation with the USFWS (Annex D), has identified the bald eagle (Haliaeetus leucocephalus), Audubon's crested caracara (Polyborus plancus), Florida snail kite (Rostrhamus sociabilis), Florida grasshopper sparrow (Ammodramus savannarum), wood stork (Mycteria americana) and eastern indigo snake (Drymarchon corais) as occurring in the drainage basin.

The bald eagle is primarily riparian and is usually found nesting near bodies of water where it feeds on fish. Historically, the bald eagle was a common nesting species in the southeast, inhabiting areas on the coastal plain and along major lakes and rivers. Osceola County currently has 103 active bald eagle territories, concentrated in the upper Kissimmee Chain of Lakes, with a cluster of active nests on Brahma Island in Lake Kissimmee (USFWS, Annx D).

The snail (Everglade) kite, (Rosthrhamus sociabilis plumbeus) inhabits shallow, open, wetlands containing sufficient emergent vegetation to support its primary food source, the apple snail (Pomacea paludosa). Such communities are usually situated in large marshes of sawgrass, wet prairie, or cattails with scattered shrubs, small trees, or tree islands. Snail kites are opportunists that will find new areas of suitable habitat when necessary.

The wood stork (Mycteria americana) is a large wading bird, Federally listed as endangered. The wood stork's tactile feeding strategy requires a concentration of fish in receding pools, and they are particularly dependent on consistent availability of such feeding areas within range of the nesting rookeries. They have been observed feeding up to 80 miles from their nesting rookery. Relative to the project area, the nearest active wood stork colony is located west of Lake Cypress and north of Lake Hatchineha, along Reedy Creek.

The Florida grasshopper sparrow (Ammodramus savannarum floridanus) is a strictly non-migratory resident of central Florida. The Florida subspecies requires a habitat with saw palmetto and, at times, dwarf scrub oak cover, as well as grasses. The main cause of decline is considered to be conversion of native range to intensely managed, improved pasture and other uses. The subspecies finds suitable habitat where a management plan includes grazing, chopping, and fire, stimulating plant succession. The subspecies is documented as occurring in the Avon Park bombing range, close to the Kissimmee River flood plain, approximately 8 miles from Lake Kissimmee.

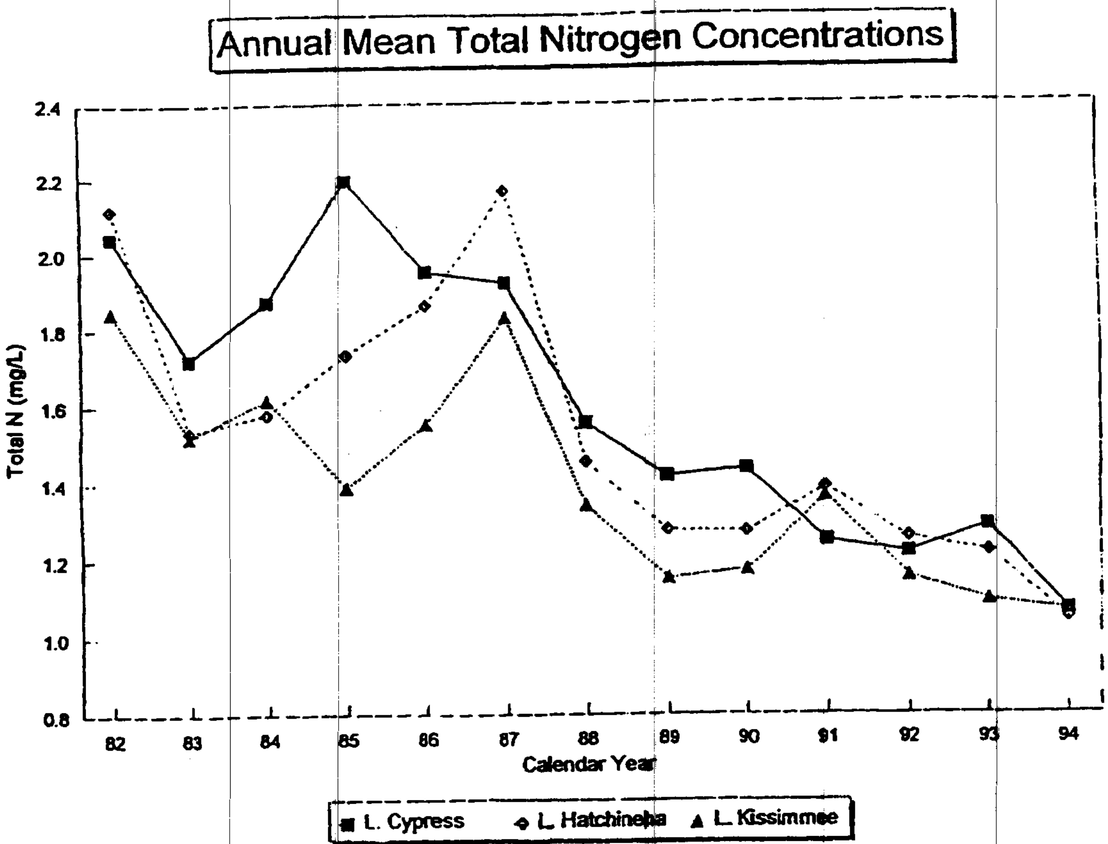
poor water quality. The other main problem areas are Shingle and Reedy Creeks. Shingle Creek and Reedy Creek have water quality problems associated with wastewater treatment plant (WWTP) effluent and urban runoff. Due to the reduction and elimination in both point and non-point source discharges water quality is improving. Lake Tohopekaliga has a history of poor water quality due to large nutrient inputs from WWTPs and non-point source urban and agricultural runoff. However, water quality in the lake is showing improvement due to reductions in WWTP discharges and lake drawdowns. The water quality downstream from Lake Tohopekaliga has suffered due to large nutrient loads leaving Lake Tohopekaliga. These areas are also showing improvements in water quality which may be a result of the reduced nutrient loads entering Lake Tohopekaliga. Water quality data for Lakes Cypress, Hatchineha and Kissimmee are presented in Figure 4-3.

4.7 AQUATIC PLANT CONTROL

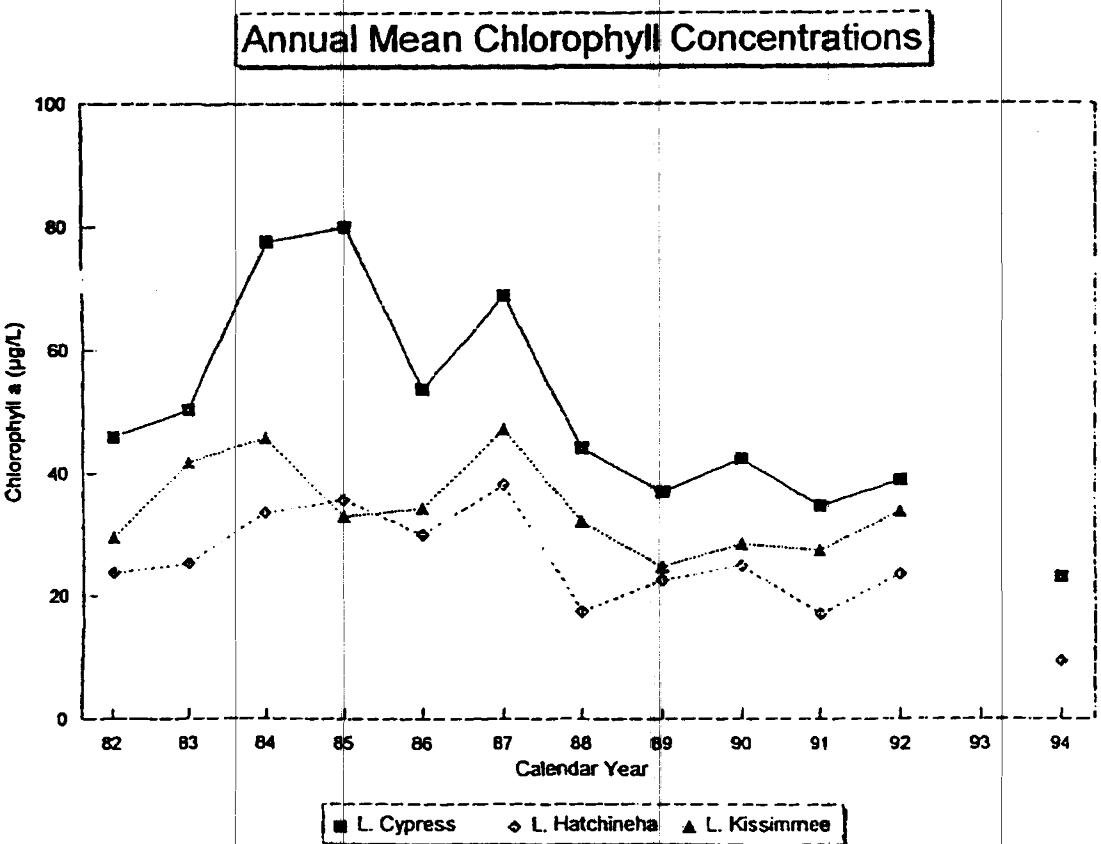
Water quality degradation by nutrients and reduced water-level fluctuation have created conditions that are favorable to foster the nuisance growths of aquatic plants, such as the American lotus (Nelumbo lotus), and cattail and exotic plants such as, hydrilla (Hydrilla verticillata), waterlettuce (Pistia stratiotes) and water hyacinth (Eichhornia crassipes). The effects of stabilizing water levels and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones and by the rapid proliferation of nuisance aquatic plants. Increased rates of peat deposition and flocculation of decaying plant matter have limited the habitat for fish spawning.

Aquatic plant control is used as an integral component of ecosystem management in the Upper Kissimmee Basin. Current aquatic plant control programs within the Kissimmee Basin include herbicide treatment and other programs coordinated with lake level manipulations used in an effort to control floating exotic species such as water hyacinth, water lettuce, and the submersed exotic hydrilla. In these lakes, approximately 6.2 million dollars were spent between 1985 and July 1994, managing over 28,000 acres of the invasive non-native aquatic plants, hydrilla, waterhyacinth, and waterlettuce.

Hydrilla, which was previously introduced into the subject area, is the most problematic submersed exotic threatening the basin's water resources. All three major lakes in the Upper Basin have experienced typical exponential growth rates since the species was first discovered (Lake Hatchineha-1983, Lake Kissimmee-1984, and Lake Cypress-1986) and this threat is expected to continue. During the time period from 1988 to 1993, a total of $4.38 million was expended for control of hydrilla on these lakes, or an average of about $730,000 per year.

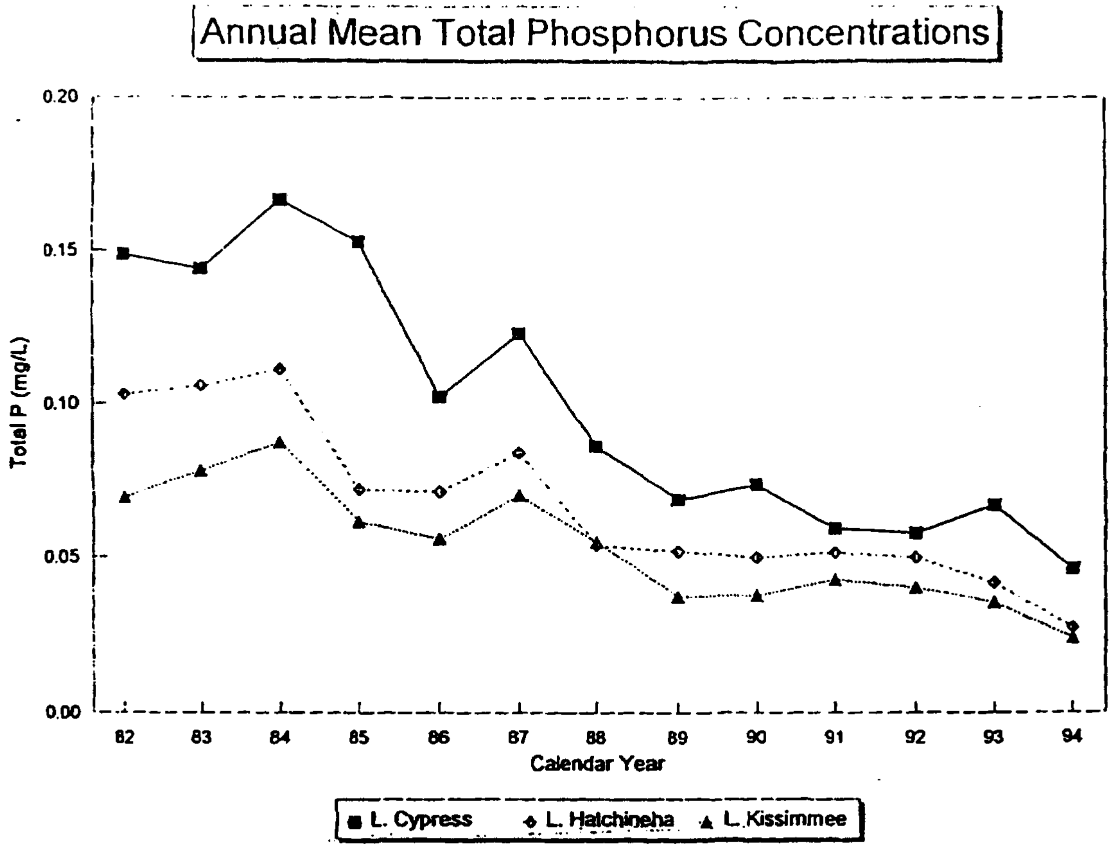


Annual Mean Total Nitrogen Concentrations
Total N (mg/L)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee



Annual Mean Chlorophyll Concentrations
Chlorophyll a (µg/L)
100
80
60
40
20
0
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

Figure 4-3


Annual Mean Total Phosphorus Concentrations
0.20
0.15
0.10
0.05
0.00
Total P (mg/L)
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

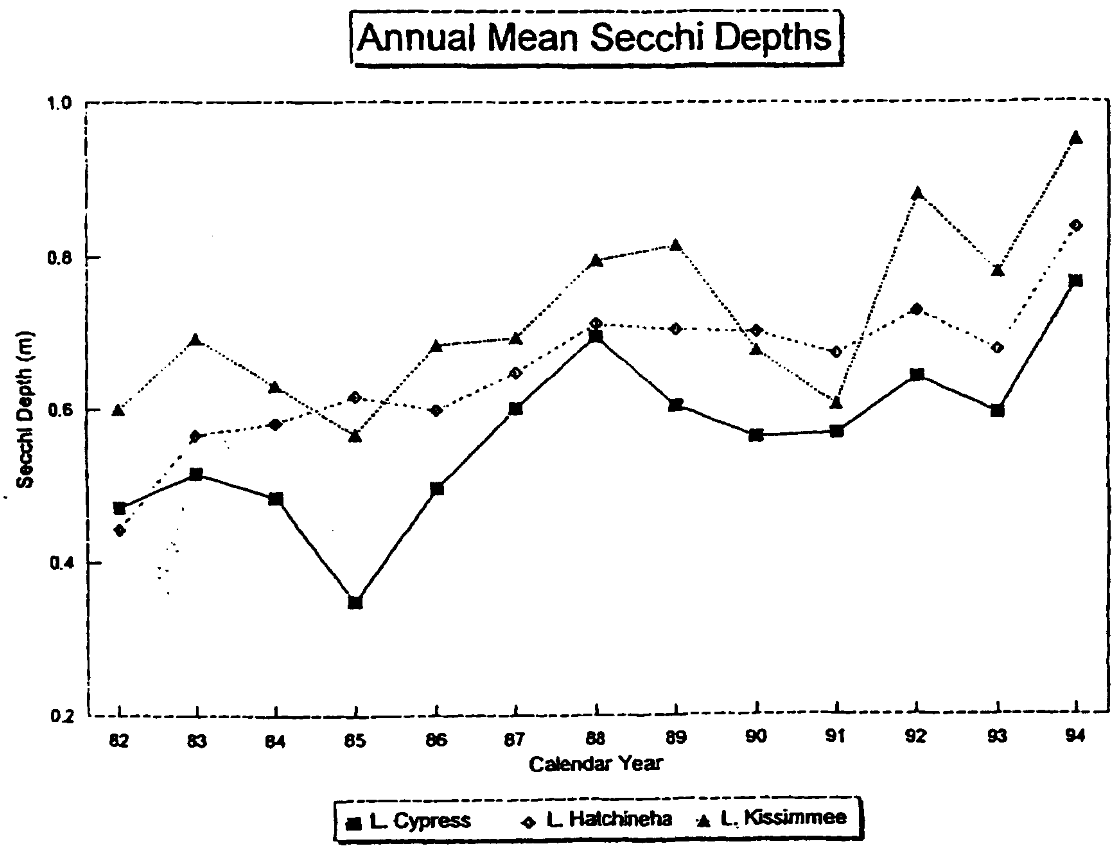

Annual Mean Secchi Depths
1.0
0.8
0.6
0.4
0.2
Secchi Depth (m)
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

Figure 4-3

4.8 HAZARDOUS, TOXIC OR RADIOACTIVE WASTES

The U.S. Army Corps of Engineers performed a HTRW Civil Works Audit in conformance with ER 1165-2-132. This audit covers property impacted by the Kissimmee River Headwaters Revitalization consisting of approximately 20,800 acres to be acquired on land bordering the affected lakes; i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger.

The record search was conducted over the period of 20 November 1994 to 3 February 1995. Several aerial photographs were reviewed for the purpose of delineating the actual property for detecting any signs that would indicate past activity that could have resulted in the existence of a current hazard. A South Florida Water Management District Environmental Audit determined that two inactive cattle dipping vats were identified on the concerned property. A phase II site investigation is required to quantify residue contaminates left by these cattle dipping vats.

A site investigation was performed February 9-10, 1995, on the properties impacted by the Kissimmee River Headwaters Revitalization Project. The properties indicated in the aerial photography consisted of fish camps and several residential areas, covered primarily with typical native marshlands vegetation. The site investigation of selected areas did not reveal hazardous, toxic or radioactive wastes. During the property acquisition, the real estate agent should pursue with the landowner if any undocumented disposal actions occurred on the property.

4.9 WATER SUPPLY

The total volume of water delivered to Lake Okeechobee from the entire Kissimmee Basin has experienced a decline in recent years due to the long-term variation in the wet/dry cycle. The majority of the flow reduction has occurred in the Upper Basin and can be seen at the gage site near S-65 where the average discharge has declined from 1,180 cfs to 664 cfs. The Lower Basin discharge, after adjusting Lake Istokpoga outflow, has remained virtually unchanged.

4.10 CLIMATE

Since 1970, the entire south Florida region has experienced an apparent change in rainfall characteristics. Average annual rainfall has been below normal in most of the twelve basins within the boundaries of the SFWMD over the period 1970-1985. The Upper and Lower Kissimmee Basins were among the basins where the reduction was most evident. The Lower Basin received below normal wet season rainfall in eleven consecutive years beginning in 1975. The reduction has been attributed to drier, shorter wet seasons, less heavy storms, and less rainfall associated with tropical storms. The Kissimmee Basin has not experienced a major tropical storm since 1969 until 1994 when Tropical Storm Gordon caused minor flooding.

4.11 POPULATION

The 1990 Census indicated that the population of Polk County was 405,382, Osceola County's was 107,728, and the population of the State of Florida was 12,937,900. Population projections from the Florida Statistical Abstract, 1993, 27th Edition, indicate that the rate of population growth in Osceola County is expected to greatly exceed that experienced by Polk County and Florida as a whole. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was development of the Kissimmee-St. Cloud area as a result of Orlando's Disney World and other area tourist attractions. Additional population and demographic data can be found in the Socio-Economics Appendix (Appendix G).

4.12 LAND USE

Cattle and citrus are historic mainstays of the basin economy. The citrus industry in the Kissimmee Basin is located principally north of Cypress Lake. Cattle ranches and sod farms dominate a large portion of the land use in the Upper Basin. Today, tourism is replacing citrus as the major economic factor in the Upper Basin.

Land uses in the Upper Basin around the perimeters of Lakes Kissimmee, Hatchineha, Cypress, Rosalie, Tiger and Jackson are primarily pasture, some agriculture, and a large amount of wetlands (PLATE 4-2). Marinas, fish camps, and various public facilities, such as boat launching sites and picnic areas, are located around the lakes. Lake Kissimmee State Park is on the extreme northwestern periphery of Lake Kissimmee. Three Lakes Wildlife Management Area and Prairie Lakes Preserve border the southeastern half of Lake Kissimmee. Small residential and commercial areas are also scattered around most of the lakes. Development is more intense upstream of Cypress Lake, particularly in the Lake Tohopekaliga - East Lake Tohopekaliga chain.

Residential developments within the project area are located primarily around Lake Kissimmee and Lake Hatchineha. The largest development is located at Hatchineha Estates on the west side of Lake Hatchineha. This area consists of approximately 300 lots with the majority of them developed. The lots are arranged along a system of canals so that each lot has water frontage. Almost all have docks or boat shelters. The other major residential areas, south to north from Lake Kissimmee to C-37, include Grape Hammock Fish Camp, Shady Oaks Fish Camp, Rocks Fish Camp, Kissimmee River Park and Camps Mack and Lester. The general location of these can be seen on the Study Area Map (see PLATE 1-1, Section 1).

Over the past twenty years, the northern portion of Osceola County, above S-61 (Lake Cypress) has become increasingly urbanized. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was the development of the Kissimmee-St. Cloud area as a result of Orlando's (Orange County) Disney World and other tourist attractions. Any increase in flood levels above S-61 created by a new project proposal would have the potential for substantial increases in flood damages to Upper Basin residential areas. For this reason, impacts by restoration project proposals were constrained to areas below S-61.

4.13 RECREATION

The three counties in which the upper Kissimmee Basin is located are in two different regions according to the State Comprehensive Outdoor Recreation Plan, published in 1989. Orange and Osceola are in Region VI; Polk is in Region VII. The large urban populations around Orlando, the Tampa Bay area, and the central coastal cities are all within a one- to two-hour drive from the project area. The main highways leading to the project area are heavily traveled and well maintained. The main constraint to access lies with the condition of the secondary service roads leading from the main highways to the upper chain of lakes and the large amount of private property which is in agricultural use around some of the lakes.

Recreation in the upper Kissimmee River basin is moderate to heavy with emphasis on Recreational Vehicle (RV) camping, general boating, and boat and bank fishing. Channelization and water control provide year-round navigable water levels for recreational boating, canoeing, and fishing. During high water conditions, airboats are able to traverse many of the marshes and flooded pastures around the chain of lakes.

Marinas, fish camps, and various public facilities such as boat launching sites and picnic areas are located around the lakes. There are six public and 14 commercial boat ramps around the upper chain of lakes which occur within the region affected by headwaters revitalization. The commercial boat ramps are associated with RV parks, marinas and fish camps located on the lakes. All but two of these commercial operations charge fees for use of their launching facilities.

Lake Kissimmee State Park encompasses over 13,000 acres along the extreme northwestern periphery of Lake Kissimmee. Lake Kissimmee State Park, located on the shores of Lakes Kissimmee, Tiger and Rosalie, offers outstanding fishing and water access, picnicking, bird watching and boating. Thirty campsites with water and electrical hookups are available. The park has 13 miles of hiking trails which offer hikers the possibility of seeing whitetail deer, bald eagles, sandhill cranes, turkeys and bobcats. Plans to rework the park boat ramp are being developed by the State.

The Three Lakes Wildlife Management Area, located in Osceola County, is an 8,200 acre tract of land adjacent to Lakes Kissimmee, Jackson and Marian. This area is traversed by the Florida Trail. Picnicking facilities are available and primitive camping is allowed at designated campsites along the trail except during established hunting seasons for the area. Camping permits are required, but these are issued at no cost to the camper. This area has a boat ramp which can provide access to the Kissimmee chain of lakes via Lake Jackson. Parking at the ramp should not be affected by higher water conditions. The access road into the site may be subject to overtopping, however.

A large number of out-of-state visitors bring their boats with them to spend the winter in this portion of the State. During their stay, they participate in fishing and boating activities in and around the interconnected chain of lakes in the Upper Kissimmee Basin. Rental boats are available at many of the fish camps and marinas found along the edge of many of the lakes. Resident boat owners intensify the use of these lakes. The combined acreage of the Upper Basin lakes, plus the miles of waterways in between, offer recreational boating and fishing unlimited opportunities for residents and visitors alike.

Heaviest boat usage occurs within the Lake Kissimmee and Lake Okeechobee areas, located at the northern and southern ends of C-38. This is most likely the result of the larger numbers of boat owners who keep their boats at marinas on these lakes, more waterfront property owners with their own moorage facilities, and more convenient access to these larger water bodies than to the river. Although fishing occurs on a year round basis, heaviest fishing use occurs during the four to five months from late fall to early spring.

Recreational fishing is the largest use of species in the lakes. Based on creel data collected by the FGFFC, effort expended to fishing in Lake Kissimmee over the five year period, 1987-1991, averaged 451,582 hours per year. The primary quarry sought by anglers on Lake Kissimmee is the largemouth bass. From 1987 to 1991, anglers exerted 59 percent of the total fishing effort on bass, 24 percent on black crappie and 17 percent on bream. Miscellaneous species, such as channel catfish, brown bullhead and chain pickerel also were targeted. The only creel survey conducted in Lakes Hatchineha and Cypress was during the spring of 1986. The total fisherman effort was 40,832 hours at Hatchineha and 18,007 hours at Lake Cypress. As a comparison, fishermen in Lake Kissimmee fished for 213,921 hours during the same spring quarter (February 21 to May 15, 1986). Lakes Rosalie and Tiger are also popular with fishermen, but no creel census on these waters were available for this report. Lake Jackson has been a popular fishing spot in the past, but aquatic vegetation problems periodically cause fishing effort to be low.

As discussed in Section 4.5, these lakes are drawn down several feet on occasion to consolidate organic sediments and to permit removal of muck and debris from the littoral zone. Water levels are lowered for several months at a time during the draw down period. During this period the major problem in affected lakes is temporary loss of navigational access due to low water.
The organized Kissimmee Boat-A-Cade utilizes the Kissimmee channel for an annual floating pilgrimage in December from the City of Kissimmee through Lake Okeechobee to the coast. The 1995 Boat-A-Cade was canceled because of the drawdown currently underway on Lake Kissimmee.

4.14 AESTHETICS

With the exception of some limited pockets of development, the majority of the Upper Kissimmee Basin is either wooded or primarily in agricultural and pasture use. Open vistas can be found around the lakes and viewed from roadways crossing the basin. This patchwork type of development allows those who use the lakes the opportunities to view a tremendous variety of wildlife from short distances away from shorelines. Large tracts of undeveloped land, used by wildlife for roosting, feeding and nesting, are interspersed along stretches of the lakes and are more extensive than the developed shorelines. Towering cypresses and other hardwoods combine with hammock vegetation to provide roosting and nesting sites for a variety of bird species. The typical mammals and reptiles associated with marsh, lake and riparian environments can be often seen by boaters on the lakes. The upper chain of lakes provides an excellent example of the contrasts between development and a more natural lacustrine environment.

4.15 CULTURAL RESOURCES

Although the Upper Kissimmee Basin has received little systematic, professional cultural resources investigation, and few historic properties are recorded, the area has the potential to contain significant cultural resources. During a recent cultural resources survey of the project area, three potentially significant prehistoric archeological sites were identified along the canals. Previous investigations have been confined to small archeological surveys in discreet project areas, designed to take into consideration the effects of specific development projects on cultural resources in compliance with the National Historic Preservation Act and other State and Federal laws. Local written histories and the collections of county historical societies provide insights into the historical development of the region and address the impacts of specific periods such as the Seminole War period and industries such as turpentining and cattle ranching as they relate to cultural resources.

The earliest widely accepted occupation of Florida, classify as the Paleoindian period, dates from approximately 10,000 B.C. to 6500 B.C. (Milanich, 1994). No Paleoindian archeological sites are recorded in the study area. During the Archaic period, ca. 6500 B.C. - ca. 1200 B.C., native groups exploited a wider range of resources than Paleoindians and probably utilized a more restricted territory. Archaic period sites become more numerous through time. The Transitional Stage, ca. 1200 B.C. - ca. 500 B.C. is characterized by changes in technology and lifestyles. A profusion of stone tool types and ceramic styles in this stage indicates increased population movement and social interaction, and a more complex political and religious community organization. The St. Johns culture begins about 500 B.C. and lasts into the historic period about A.D. 1500. Changes in ceramic technology appear to reflect variations in the degree of interaction with indigenous groups from northern Florida through time. Limited horticulture is assumed to be established by the beginning of the St. Johns, although abundant marine food resources appear to be the staple throughout the 2000 year time span.

During the early historical period, beginning with the first Spanish colonial period (1513 - 1763), European contacts were limited to the coastal areas. Native Florida tribes were decimated by European diseases and conflict, and by the 18th century, migrants from the Creek and other southeastern groups were moving into the vacated interior Florida. These migrants eventually coalesced into the Seminole tribe. The Seminoles lived in dispersed hamlets and farmed, hunted, and raised cattle. Following the Third Seminole War in 1858, the Upper Kissimmee River Basin was settled by cattle ranchers and farmers. Railroads and draining of swampland opened up the area to more homesteaders. The turpentine and timber industries made a significant economic impact on the region.

4.16 RELATION TO LOWER RIVER BASIN

One of the key findings of the planning studies that have been conducted for the Kissimmee River restoration project is that dechannelization alone, that is backfilling of C-38, is not sufficient to accomplish ecological restoration of the river/floodplain ecosystem. Based upon a review of historical U.S. Geological Survey (USGS) data, the overall volume of waters, under similar hydrologic conditions, delivered to Lake Okeechobee from the Upper Basin lakes and Lower Kissimmee basin via the completed project was found to be relatively the same as those volumes experienced under pre-project conditions. However, the timing of those water deliveries has been changed which is reflective of the current water management practices for flood control and water conservation purposes within the basin. At certain times, when required for flood protection in the Upper Basin, water is released to the Lower Basin in sudden pulses. During the post-project regulated period, no releases were made to the Lower Basin about 50 percent of the time.

These changes to historical flow regimes would have impacted biological resources, functions and values in the river and its adjacent floodplain even if the river was never channelized. Whereas historically, large portions of the floodplain were exposed to prolonged hydroperiods, the extended, post-regulation periods of no inflow from the upper basin would have kept most of the floodplain dry during the wet season months. In the SFWMD 1990 Restoration Study, a relationship was developed by linear regression between historical stages at the Fort Kissimmee gage and the discharges from Lake Kissimmee. Based upon this relationship, daily discharges from Lake Kissimmee were translated into hypothetical Lower Basin stage hydrographs and associated floodplain inundation frequencies for the regulated 18-year period of record. Results indicate the entire floodplain would have been dry greater than 70 percent of the time during the wet season, whereas approximately 80 percent of the floodplain was inundated greater than 70 percent of the time during these months prior to flood control regulation (Figure 4-4). Even during particularly wet years pulsed discharges would lead to only short-term floodplain inundation followed by rapid drainage, which generally would preclude utilization of the floodplain by fish, wading birds and waterfowl. The reduced hydrologic connectivity between the river and floodplain also would have largely eliminated nutrient and sediment filtration processes once provided by the floodplain wetlands. The seasonal shift of high flow periods from the summer/fall to late winter/spring months likely would have interfered with fish reproduction and recruitment. The spawning and reproductive habits of Kissimmee River fish species make their eggs and young vulnerable to high flows during spring months.

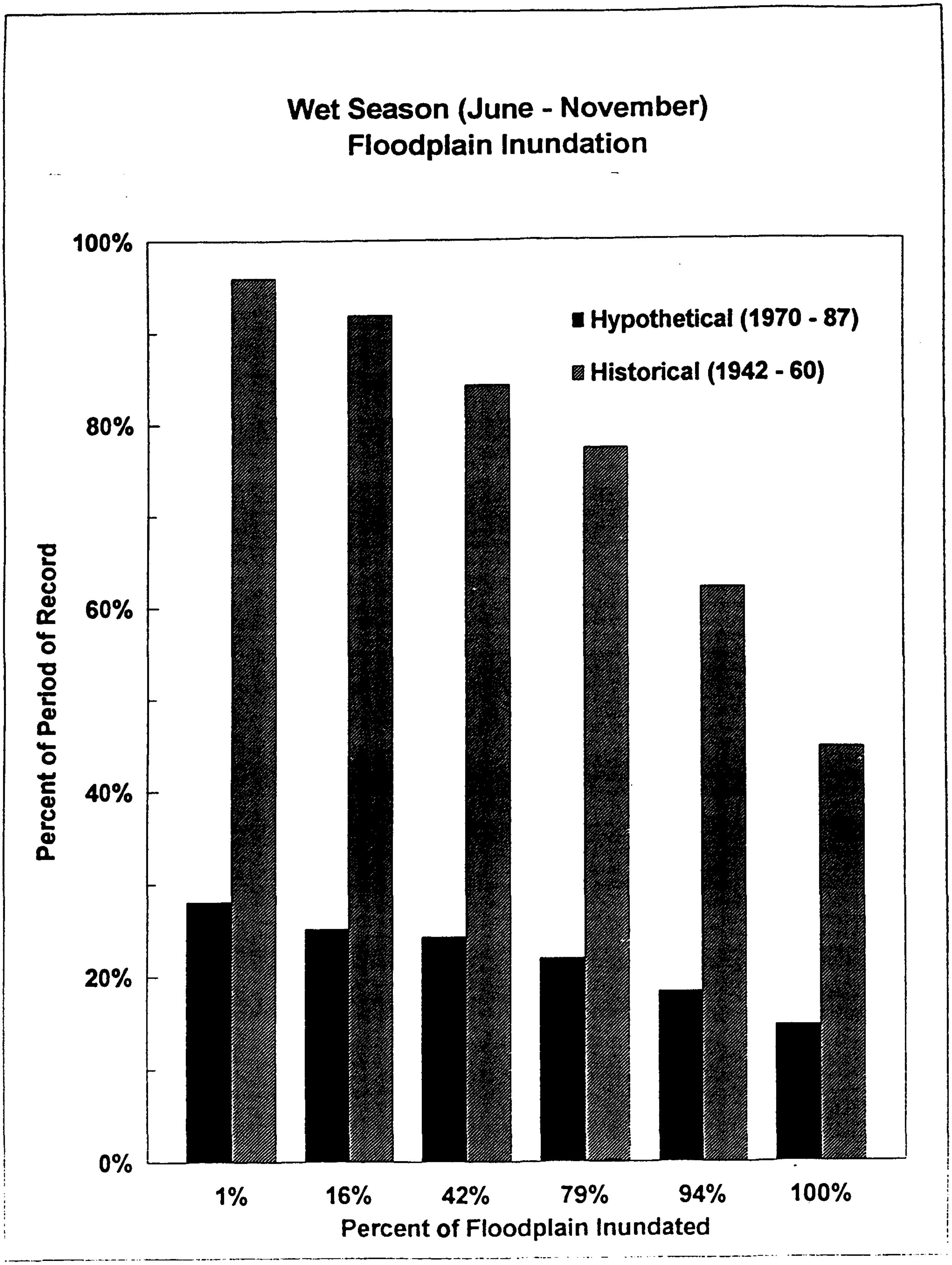
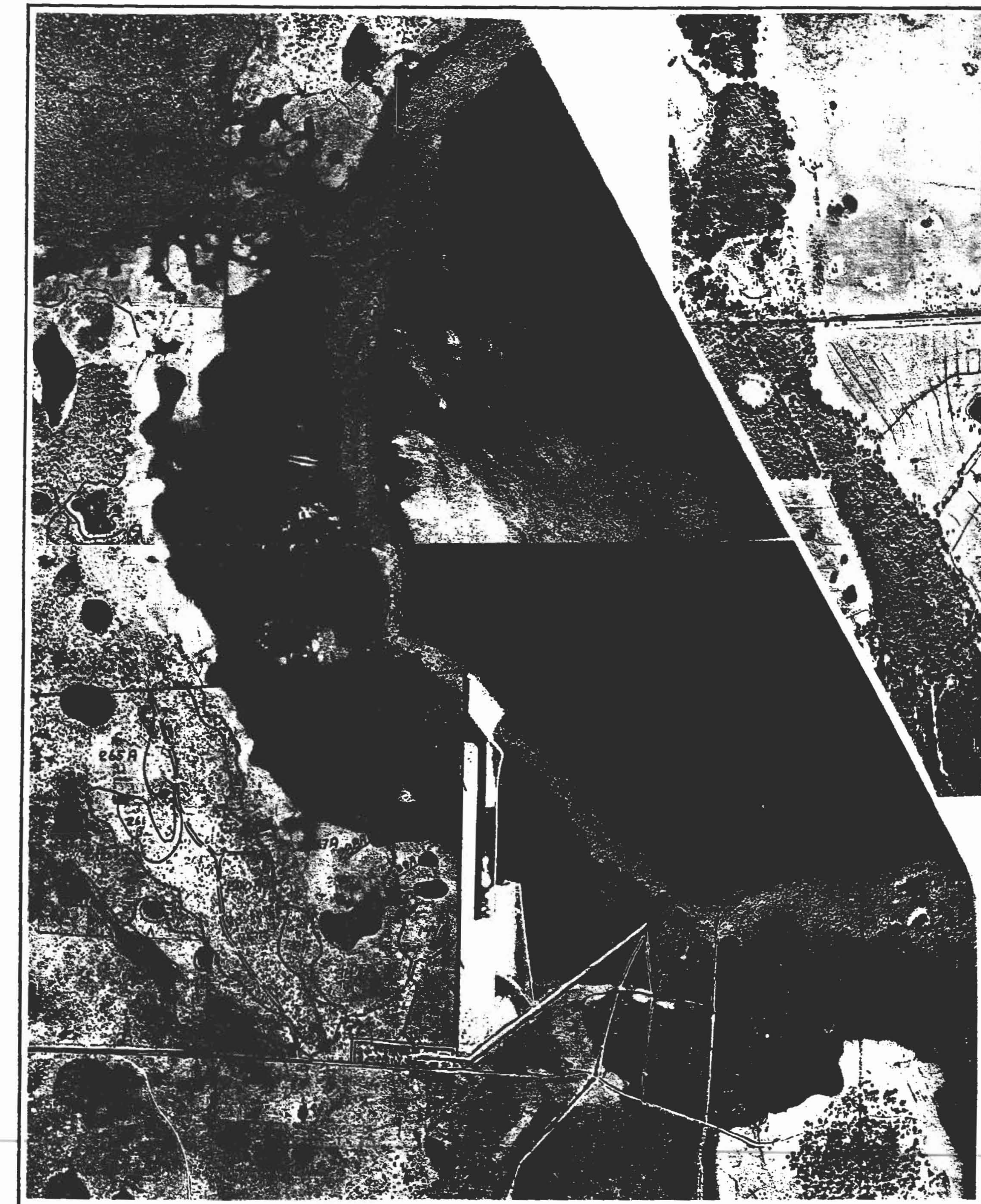
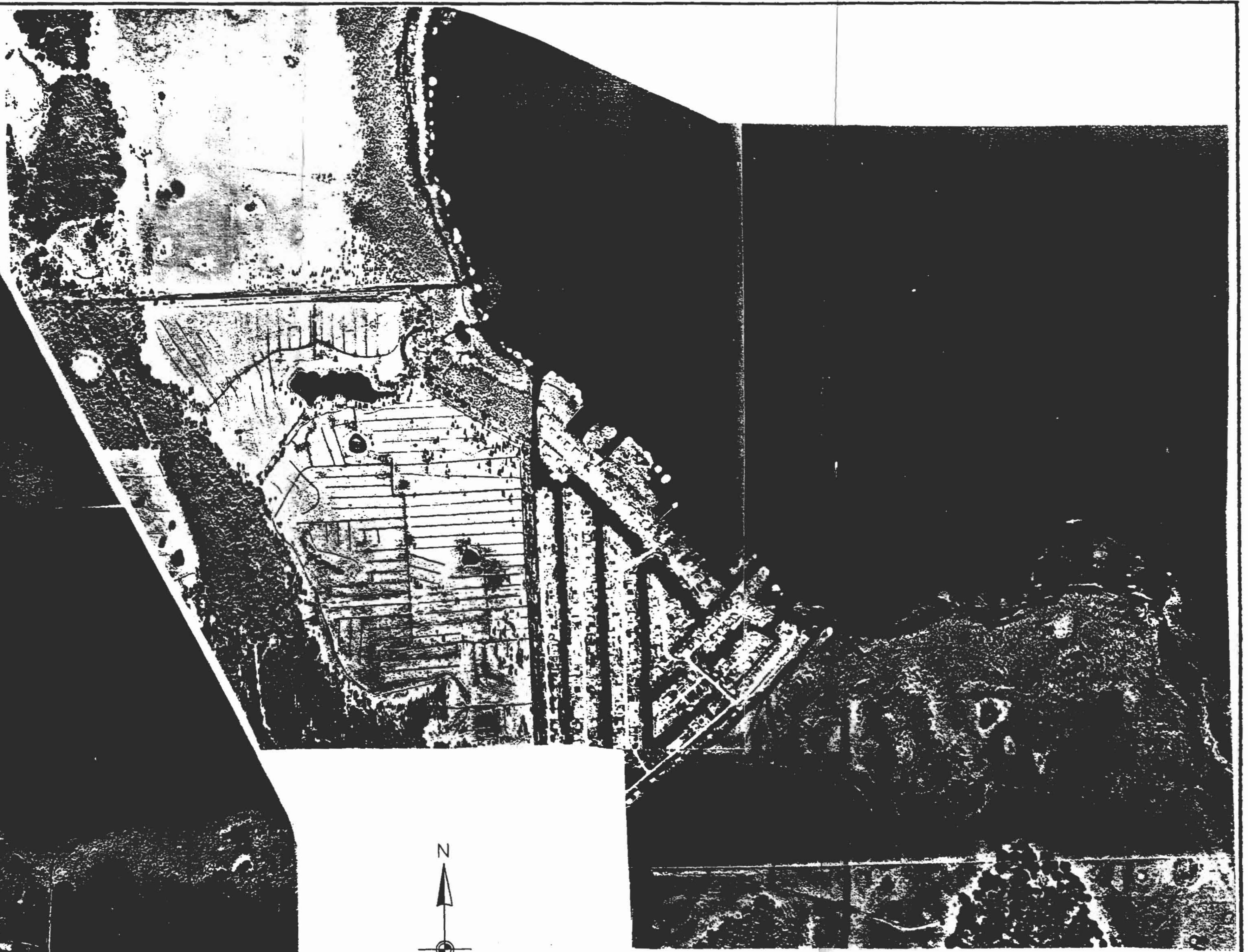

Wet Season (June - November)
Floodplain Inundation
Hypothetical (1970 - 87)
Historical (1942 - 60)
100%
80%
60%
40%
20%
0%
Percent of Period of Record
1%
16%
42%
79%
94%
100%
Percent of Floodplain Inundated

FIGURE 4-4



LAKE HATCHINEHA 1958 SHORELINE



LAKE HATCHINEHA 1984 SHORELINE

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CENTRAL AND SOUTHERN FLORIDA
KISSIMEE RIVER HEADWATERS REVITALIZATION

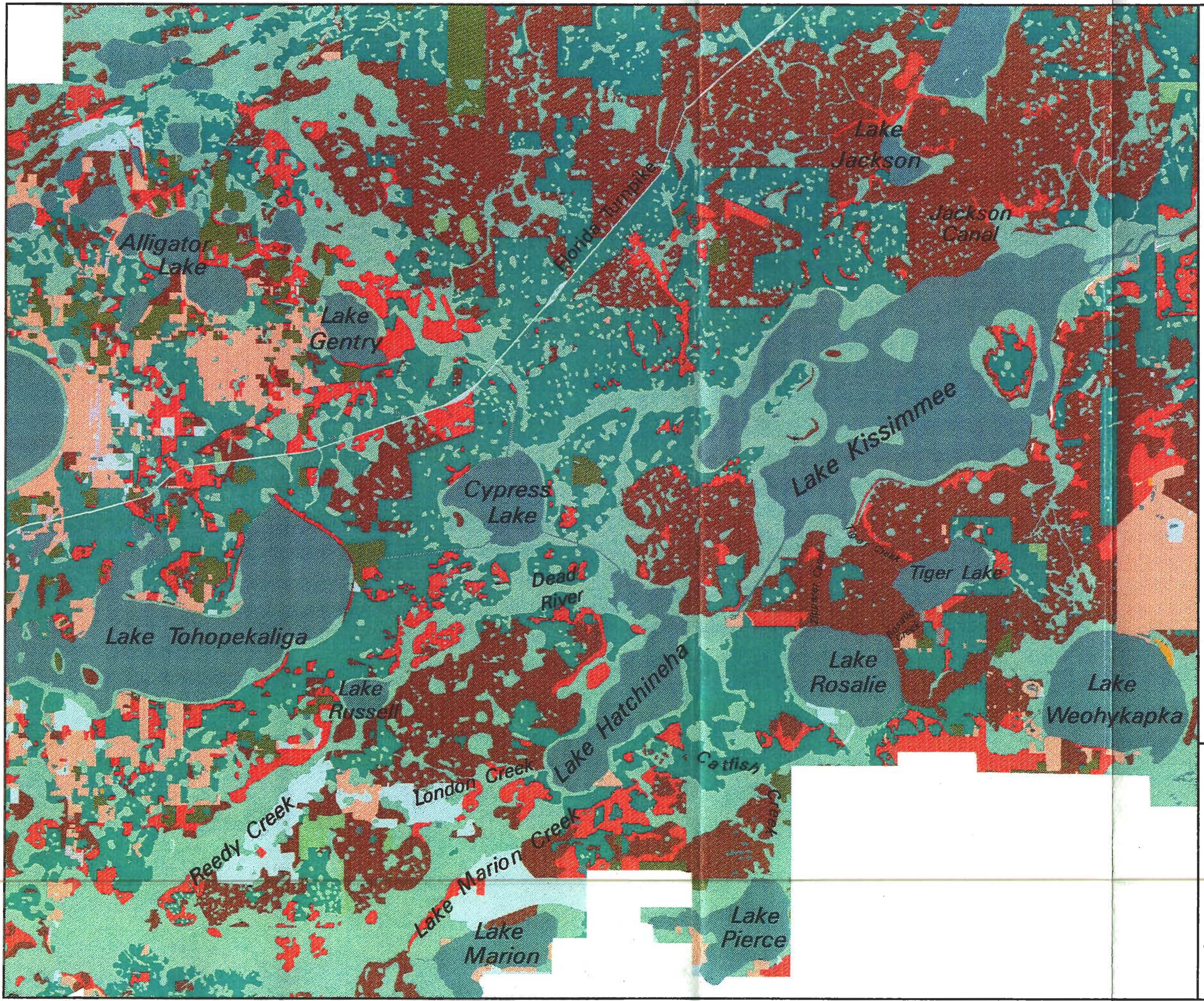
HISTORIC AND POST-FLOOD CONTROL
PROJECT LITTORAL ZONES

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

DATED: JULY 1995 D.O. FILE NO. 400-36,826

PLATE 4-1



LEGEND

- CROPLAND AG
- GROVE & NURSERY AG
- PASTURE AG
- BARREN LAND
- FOREST
- WATER
- RANGELAND
- COMMERCIAL URBAN
- INDUSTRIAL URBAN
- OTHER URBAN
- RESIDENTIAL URBAN
- WETLAND
- NO DATA FOR REGION

Summary of land use within the impacted area of the Kissimmee basin. The impacted area consists of lands having an approximate elevation between 52.5 ft. and 54.0 ft. or which have been delineated by SFWMD to be included in the inundation area.

Land use	Acres
WETLAND	3677.310
GROVE & NURSERY AG	13.726
PASTURE AG	7578.690
FOREST	636.113
RANGELAND	2328.171
WATER	42.582
RESIDENTIAL URBAN	20.702
COMMERCIAL URBAN	1.806
INDUSTRIAL URBAN	0.605
OTHER URBAN	1.700
TOTAL	14301.405

Source: South Florida Water Management District land use codes 1 and 2 for Polk and Osceola Counties, 1988.

North

Miles
1 0 1 2 3 4 5

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION

LAND USE MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, JULY 1995

PLATE 4-2

SECTION 5

FUTURE "WITHOUT PROJECT" CONDITION

This section provides a forecast of future conditions in the Kissimmee Basin, including the Upper and Lower Basin, that are likely to occur if no Federal project is implemented in Upper Kissimmee Basin. The future without project condition is synonymous with the "no action" alternative required pursuant to the National Environmental Policy Act of 1969, as amended. It is also referred to as the Base Condition in other sections of this report. In the future, without project condition (without a Headwaters Revitalization Project), the existing Kissimmee River Project for navigation and flood control would remain in place and would continue to be operated and maintained. The existing flood control features within the Upper Basin and existing operating schedules would remain intact.

5.1 KISSIMMEE RIVER PROJECT

If the Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved. Specifically, an Upper Basin project is necessary to meet two of the five hydrologic conditions (criteria) that must be reestablished to restore the Lower Basin ecosystem. These conditions are the reestablishment of continuous flow with duration and variability characteristics comparable to prechannelization records, and reestablishment of stage hydrographs that result in floodplain inundation frequencies comparable to prechannelization hydroperiods, including seasonal and long-term variability characteristics. These conditions can only be met, and Lower Basin restoration will only be successful, if an Upper Basin project is implemented. Thus, without Upper Basin modifications, a Lower Basin project would be largely ineffective and its construction would be unjustified. Therefore, the basic without project assumption is that, in the absence of the headwaters project, there will be no Kissimmee River Restoration Project, i.e., the flood control canal, C-38 would remain along with existing water control structures. Likewise, since the primary purpose of the Upper Basin project is restoration of the Lower Basin ecosystem, if for some reason the Lower Basin project is not implemented, the Upper Basin project would not be initiated as a stand alone project.

Management of the water resources within the basin would continue as presently managed, with strict adherence to current lake regulation levels and structure design discharge criteria. Continuation of these water management practices are not expected to improve the basin's ecological resources.

5.2 NATURAL ENVIRONMENT

The condition of the lakes, without the Upper Basin Revitalization Project would remain similar to the present condition. Management measures are taken to limit impacts of flood control regulation on existing natural resources. The effects of reduced range of water level fluctuations are evidenced by nuisance vegetation growth (e.g. tussocks) and accumulation of organic muck in littoral zones. Rapid proliferation of exotic plants are controlled with chemical applications coordinated with lake level manipulations. Extreme lake level drawdowns are conducted periodically to revitalize littoral wetlands by consolidating sediments and providing conditions favorable for germination of wetland plant species. These measures need to be continued to maintain existing fisheries and wildlife values. These values are below those possible in a system with a wider-range of water levels. The areas on private lands, formerly marshes contiguous with lake littoral zones, are drying behind dikes and becoming brushy pastures. These habitats will become increasingly undesirable for fish and wildlife.

Immediate environmental impacts associated with construction of flood control works within the Lower Kissimmee Basin have stabilized, however, long-term effects are expected to continue to degrade the fish and wildlife resources in the basin. Water level stabilization, continued deposition of organic matter within remnant river channels, and continuation of low dissolved oxygen levels in C-38, are likely to further degrade the natural resources in the basin.

Maintenance of stable water levels is expected to lead to continued deterioration of wetland communities and associated fish and wildlife resources within impounded portions of each pool. Stable pool stages will facilitate continued buildup of plant litter and thereby accelerate succession from a wetland to terrestrial environment. Although the rate at which this transition to a non-wetland state is occurring has not been determined, the without project condition will eventually result in a steady elimination of the existing 14,000 acres of wetlands. As the acreage of wetlands declines, there will be a coincident loss of fish and wildlife habitat, including a decrease in the estimated 3,500 wading birds and 140 waterfowl which currently utilize the floodplain. Thus, the without project condition can be expected to exacerbate the long-term decline of wading bird and waterfowl populations in the southeast.

In the absence of flow, the without project condition also will allow for continued deposition of dead plant litter, and as a result, a similar loss of wetland (open water) habitat in remnant river channels. Although these remnant channels are currently in a degraded state, they provide some fish habitat during winter and spring months, when dissolved oxygen levels are suitable. If remnant river channels are allowed to eventually fill with organic deposits, the resultant loss of open water habitat will reduce the fish carrying capacity of the system.

Degradation of remaining natural resources also could result from future developmental encroachment and/or land use modifications in the basin. Further loss of the basin's natural resources could be expected in the without project condition, unless action is taken to prevent intensive development and/or land use changes, such as conversion of more of the floodplain or tributary watersheds to improved pasture. The condition of the lakes,

5.3 CLIMATE

For planning purposes of the environmental restoration, a conservative assumption has been made that there will be a continuation of the dry period through the period of analysis. Hydrological modeling conducted during this study was based on a period of record between 1970 and 1987. A return to "normal" rain patterns would enhance restoration benefits. While this dry cycle from 1970 through 1987 was used for hydroperiod predictions for restoring ecosystem values, the entire period including all of the hurricanes was used for the flood control portion of the analysis.

5.4 POPULATION

Each of the two Counties in the Kissimmee Upper Basin study area, Osceola and Polk, are expected to continue the population growth experienced in recent years. Table 5-1 shows expected growth by county over the period of analysis. The center of regional growth is expected to remain around the Orlando area, just north of the study area in Orange County. Other major growth areas are expected to remain in the Upper Basin chain of lakes, primarily in Orange and Polk Counties.

TABLE 5-1
PROJECTED POPULATION
KISSIMMEE RIVER UPPER BASIN

COUNTY	1995	2000	2005
ORLANDO	1,426,888	1,618994	1,802,504
OSCEOLA	137,595	165,098	191,603
POLK	443,802	478,002	510,202

Source: *Florida Statistical Abstract, 1993, 27th Edition.* Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

5.5 LAND USE

In the Upper Kissimmee Basin, the expanding economic base of the Orlando area is expected to continue to place increased demands on the area's resources. Cattle ranches and orange groves will continue to give way to suburban subdivisions. Metropolitan development is rapidly moving toward the Cities of Kissimmee and St. Cloud in Osceola County. This urban development is expected to continue in the Upper Basin as the population continues to expand.

5.6 FLOOD DAMAGE REDUCTION

The existing level of flood protection in the Kissimmee Basin would be expected to be maintained under the without project condition. The current project provides flood damage prevention for thirty percent of the standard project event, or approximately between a 5 and 10 year event. Structural components in the Lower Kissimmee River Basin, C-38 and the existing water control structures, would continue to maintain water level control within that basin; prescribed regulation schedules and operation of discharge structures would maintain flood damage reduction in the Upper Basin lakes.

5.7 RECREATION

Large urban populations around Orlando, the Tampa Bay area, and the central coastal cities are all within a one to two hour drive of the Kissimmee River study area. As such, it is expected that the basin will experience increasing demand for recreational opportunities. The current, predominant recreational use in the study area is recreational boating, and fishing from both boats and adjacent banks of the basin's lakes. Both public and private recreational facilities are available, offering camping, picnicking, fishing, hiking, and boating opportunities. Demand for these types of recreational opportunities are expected to increase with greater population growth in the region.

5.8 WATER QUALITY

Water quality concerns are expected to continue to focus on two areas: (1) the nutrient content of the basin's waters and effects of those nutrients on Lake Okeechobee, and (2) low dissolved oxygen levels in C-38 and remnant channels of the Kissimmee River. Existing low dissolved oxygen levels in C-38 and remaining river remnants are expected to continue in the without project condition. Adverse ecological effects associated with low dissolved oxygen would therefore continue to degrade the basin's natural resources.

5.9 AQUATIC PLANT MANAGEMENT

The ongoing control effort which includes C-38, portions of the old Kissimmee River runs and oxbows, is expected to continue in the same magnitude as at the present time. Current funding levels are insufficient to treat all of the hydrilla present in the subject area and hydrilla can be expected to increase in coverage. The invasive nature of these plants mandates continued control to avoid adverse impacts to navigation, flood control, recreation, wildlife habitat, as well as public health and safety within the Kissimmee Basin.

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SECTION 6

NEEDS AND OPPORTUNITIES TOWARDS PLAN DEVELOPMENT

Construction of C-38 and the regulation of the Upper Basin lakes has reduced the flood threat in the Lower and Upper Kissimmee River Basin, enabling more intensive land uses to occur. However, it also led to a number of environmental impacts, such as a loss of fish and wildlife habitat.

This section discusses problems and opportunities relating to the ecological degradation of the Kissimmee Chain of Lakes and the Lower Kissimmee River Basin, through the planning process that resulted in the selection of the recommended plan for the Upper and Lower Basin restoration. Key events in the overall process are shown in Table 6-1.

A more complete discussion of the plan formulation process is included in the 1991 *Integrated Feasibility Report and Environmental Impact Statement*, which is the foundation of this report. This report is incorporated by reference and may be consulted for more detailed descriptions and explanations of the plan formulation process.

6.1 RESTORATION MOVEMENT

While the flood control project had been requested and supported by the State of Florida, there was some opposition to the project even before construction began. Concerns centered on fear of environmental damage that the project, primarily channelization, might cause. Although initially poorly organized, a grassroots movement to restore the Kissimmee River developed during project construction. Early issues in the restoration movement centered around aesthetic impacts and physical alterations caused by C-38 excavation and placement of excavated materials on the adjacent floodplain.

TABLE 6-1

KISSIMMEE RIVER RESTORATION TIMELINE

FEDERAL	STATE OF FLORIDA	SOUTH FLORIDA WATER MANAGEMENT DISTRICT
1948 Central and Southern Florida (C&SF) Project Authorized for Construction		
1954 *Kissimmee River Flood Control Project* Authorized for Construction		
1961 Construction Started		
1971 Construction Finished	1971 Governor's Conference on Water Management in South Florida Identified Environmental Concerns	
1971 U.S. Geological Survey report identified environmental concerns	1972 First Public Meeting on Environmental Concerns	
	1976 Florida's "Kissimmee River Restoration Act"	
First Corps Feasibility Report	1976 Kissimmee River Coordinating Council (KRCC) Established	
1978 Congressional Study Authority	1981 Florida's "Save Our Rivers" Program Initiated	
	1983 Governor's "Save Our Everglades" Plan Released	
	1983 KRCC Endorsed Canal Backfilling	
	1983 Governor's Executive Order-*Kissimmee River - Lake Okeechobee Everglades Coordinating Council* (KOECC) Established	SFWMD Restoration Study
1985 Final District Report Objectives: Wetlands and River Restoration Water Quality Improvement Alternatives: Partial Backfill Combined Wetlands Demonstration Project Pool Stage Manipulation Paradise Run Best Management Practices Recommendations: No Federal Action Congressional Authority of 1135	1985 Governor's "Kissimmee River Restoration Strategy" Released	1984 - 1989 Demonstration Project Construction and Monitoring 1986 - 1989 Model Study 1988 Kissimmee Restoration Symposium
Current Corps Feasibility Study 1990 WRDA 90 Study Authority 1991 Feasibility Report and EIS Objectives: Determine Federal Participation in Level II Backfilling Alternatives: Weirs Plugging Level I Backfilling Level II Backfilling Modified Level II Backfilling Recommendation: Modified Level II Backfilling Headwaters Revitalization	1990 Governor Endorsed Level II Backfilling	1990 Restoration Report Objective: Ecosystem Restoration Alternatives: Weirs Plugging Level I Backfilling Level II Backfilling Recommendation: Level II Backfilling
1992 WRDA Kissimmee River Project Authorization of Kissimmee River Restoration Authorization of Headwaters Revitalization 1994 Test Fill Construction Kissimmee River		

The interests that were to provide the drive and foundation for both progress and controversies over the Kissimmee River evolved through the early 1970's. Support for river restoration came from numerous individuals and groups, including national environmental advocate groups, which desired return of the river's ecological and aesthetic values, and saw refilling of C-38 as the means to achieve that return. Opposition to river restoration came primarily from agricultural interests, including dairy and beef cattle ranchers and farmers. Concern also was expressed by developers, homeowners and other property owners, and boaters. These groups were concerned that restoration would create an unfair hardship on them. Residents of the Upper Basin were concerned that modifications to C-38 might threaten their level of flood control. Land owners and other users along C-38 were concerned about the loss of their uses of the floodplain due to re-flooding from restoration. Boaters were concerned about the loss of the enlarged waterway.

The first steps toward restoration of the Kissimmee River occurred in 1971. The U.S. Geological Survey released a report that concluded that Lake Okeechobee was experiencing accelerated eutrophication as a result of high nutrient loading. In September 1971, one hundred and fifty experts from the fields of science, government, agriculture, and conservation participated in the Governor's Conference on Water Management in south Florida. While the conference focused on water quality problems, it requested that, *"action should be taken to restore fish resources and wildlife habitats,"* in the Kissimmee Valley.

In 1972, the Central and Southern Florida Flood Control District (now the SFWMD), conducted the first public hearing concerning possible environmental damage resulting from Kissimmee River channelization. Major public concerns were water quality and potential increased rates of eutrophication of Lake Okeechobee, and the loss of environmental values within the lower Kissimmee River Basin, specifically wetlands reduction. The Flood Control District's resulting recommendations included, among others, creation of an interdisciplinary team to help determine if additional restoration was necessary.

Throughout the mid-1970's, many debates occurred over the environmental effects of the Kissimmee River project, and what could and should be done about them. As discussed above, the earliest impetus to restore the river focused on possible effects on water quality entering Lake Okeechobee. It was believed that C-38 had acted as a conduit, speeding pollution from the urbanizing Upper Basin into Lake Okeechobee.

In 1976, after several years of public debate, the Florida Legislature passed the *"Kissimmee River Restoration Act"*. The Act created the Coordinating Council on the Restoration of the Kissimmee River and Taylor Creek-Nubbin Slough Basin (known as the Kissimmee River Coordinating Council, or KRCC).

The KRCC was charged with broad responsibilities to solve many of the region's water resources problems, including development of measures *"to minimize and ultimately remove threats to the agricultural industry, the wildlife, and the people of central and southern Florida posed by land use and water management practices"*. The KRCC was specifically directed to:

* Restore the natural seasonal water level fluctuations in the lakes of the Kissimmee River and in its natural floodplains and marshlands.

* Recreate conditions favorable to increases in production of wetland vegetation, native aquatic life, and wetland wildlife.

* Utilize the natural and free energies of the river system to the greatest extent possible.

Between 1976 and 1983, the State of Florida, through the KRCC, funded a variety of studies designed to evaluate different Kissimmee River restoration approaches. These studies improved understanding of hydrologic, biological, and water quality issues in the basin. As a result, many early hypotheses about basin conditions were validated or discarded. Especially important were clarifications of water quality issues (most Lake Okeechobee water quality problems were not originating in the Upper Basin), and establishment of restoration of lost environmental values through habitat restoration as a primary goal.

As early as April 1977, the KRCC's First Annual Report to the Florida Legislature recommended several specific projects to analyze the most effective way to deal with basin water quality problems, and presented two restoration alternatives, one calling for partial backfilling of C-38, and the other calling for creation of wetlands along the canal.

6.2 KISSIMMEE RIVER RESTORATION PLANNING STUDIES

In response to the growing concern about the effects of the Kissimmee River Flood Control Project, three major planning studies were undertaken by the Corps or the SFWMD since 1978. The studies, each with a different purpose, represented milestones in the development of the final restoration and headwaters projects. Each study, in addition to building on the previous study, also responded to new concerns and moved forward with an improved understanding of the values and complexities of environmental resources.

6.2.1 First Federal Feasibility Study (1978-1985)

The primary objectives of this study were to restore the values of specific components of the Kissimmee River and its wetlands, and to improve water quality within the river basin. More specifically, the study goals included restoration of wetland vegetation and improvement of water quality, particularly concerning nutrient levels. A wide range of plans were developed for evaluation, and these plans became the basis for current and future evaluations. Although several plans were formulated for these objectives, the study did not recommend Federal participation in solutions to these concerns because of the policies in effect at that time.

6.2.2 SFWMD Restoration Study (1984-1990)

As a result of the KRCC recommendations, the SFWMD designed and constructed a demonstration project intended to determine the feasibility of dechannelization. During the course of the demonstration project a goal of restoring the ecological integrity of the Kissimmee River was adopted. Whereas the previous Corps feasibility study had focused on component parts of the environment, primarily wetlands and water quality and how to improve each part individually, the SFWMD focused on restoration of the ecosystem as a whole by incorporating the component parts of the natural system and the interactions among them. This ecosystem approach included consideration of wetlands and water quality, as well as all of the many other elements that comprise the natural environment. However, the ecosystem approach recognized that numerous individual components collectively comprise the ecosystem and operate synergistically, making it difficult to define the relative importance of individual parts, as well as to define and address the requirements of each individual part. Furthermore, while requirements of many components are compatible, others would be in conflict, and meeting the needs of one could impact another. Therefore, the ecosystem approach looked at ways to holistically recreate more natural physical and hydrologic characteristics that would support and provide suitable conditions for the Kissimmee River plant and animal communities to again flourish.

Based on these ecological guidelines and the determinants of ecological integrity, the study concluded that the primary restoration objective was to reestablish pre-channelization hydrologic characteristics in as much of the river and floodplain ecosystem as possible, including 35 miles of river channel and 7,000 acres of floodplain that were directly impacted by construction of C-38.

This objective was further defined through five criteria that collectively measure hydrologic conditions that must be recreated in order to restore the rivers pre-channelization ecological integrity. Evaluations of performance relative to these criteria could be used to compare alternative restoration plans. The following hydrologic criteria need to be recreated to restore the ecological integrity of the Kissimmee River:

* continuous flow with duration and variability characteristics comparable to pre-channelization conditions;

* average flow velocities between 0.8 and 1.8 feet per second when flows are contained within the river banks;

* a stage-discharge relationship that results in overbank flow along most of the floodplain when discharges exceed 1,400 to 2,000 cubic feet per second;

* stage recession rates on the floodplain that typically do not exceed 1 foot per month;

* stage hydrographs that result in floodplain inundation frequencies comparable to pre-channelization hydroperiods, including seasonal and long-term variability.

By providing proper land and water conditions, the entire spectrum of the living environment will return naturally and maintain itself as it had done before C-38 was constructed. This assumption was verified by results of the demonstration project from 1984 through 1989. In order to achieve the proper water conditions, a new component of the restoration project was developed as part of the SFWMD restoration study. This Upper Basin component, entitled "Headwaters Revitalization", is a mechanism to achieve two of the five hydrologic criteria as described above; the criteria are the reestablishment of stage hydrographs and the reestablishment of continuous flows that are comparable to pre-channelization hydroperiods.

In an effort to provide conditions necessary to restore more natural flows in the Kissimmee River, the SFWMD developed a proposal to modify seasonal water storage operations in the Upper Basin (Figure 6-1). Appendix E provides documentation describing the early development of the preliminary Lake Kissimmee Regulation Schedule modification which was presented in the 1991 Federal feasibility study. The regulation schedule, which was developed by the SFWMD, was used as the base for the development of the recommended plan presented herein. This component was a critical part of the alternative evaluation process, as it was evident that the restoration of the Lower Basin hinged upon the successful implementation of the Upper Basin project.

Following additional extensive analyses, the SFWMD concluded that backfilling a long continuous reach of C-38 (Level II Backfilling Plan) was the best approach to restore the integrity of the Kissimmee River ecosystem.

6.2.3 Second Federal Feasibility Study (1990-1992)

The Congressional authority for the Corps' second feasibility study of the Kissimmee River directed that the study be based on implementing the SFWMD's Level II Backfilling Plan. Therefore, there was no need to develop new planning objectives or alternative plans.

While the SFWMD followed the common planning process in conducting its restoration study, its work addressed that agency's decision making needs and was not intended to address the full range of Federal requirements that are normally imposed on Corps water resource planning. Therefore, the second Corps feasibility study required several additional analyses to establish the extent of Federal participation in the Level II Backfilling Plan. The report also recognized that the implementation of the Headwaters Revitalization Project was critical to achieving the recommended plan's fish and wildlife restoration outputs as described in the report.

The recommended plan proposed in the Feasibility Study, referred to as the Modified Level II Backfilling plan, consisted of backfilling about 29 miles of C-38; excavating about 11.6 miles of new river channel; constructing a bypass weir and channel at S-65; shallowing and construction of weirs in the Lake Kissimmee outlet channel reach; modifications of the Pool B weirs, and S-65A and S-65E structures; construction of containment levees, bridge crossings at U.S. Highway 98 and the CSX Transportation Railroad, and new structures in Pool E; removing the existing S-65B, S-65C and S-65D structures, and local levees; and installation of navigation channel markers. About 67,843 acres of land was estimated to be acquired in fee or easement to meet restoration needs and preserve flood control in the Lower Basin. The shallowing and weir construction and modification of Pool B weirs and backfilling south of S-65D were designated as locally preferred options with no Federal participation. The study did not demonstrate sufficient Federal justification for these options. The estimated cost of the Recommended Plan was $426,885,000. Based on a 50-50 cost sharing of the total costs, less the cost of the locally preferred options, the Federal share was $139,943,000.

6.2.4 Anticipated Environmental Outputs

Based upon the preliminary recommendations for the modifications of the regulation schedule for the lakes, the expected environmental outputs of the Kissimmee River Project, the Modified Level II Backfilling plan recommended in the feasibility report, are provided below in Table 6-2. As stated before, these outputs are dependent on the successful implementation the Headwaters Revitalization component of the project. The environmental conditions within the Lower Basin waterway for the Historic or Pre-channelization river and the existing channel are provided for comparison.

TABLE 6-2
ENVIRONMENTAL OUTPUTS OF KISSIMMEE RIVER RESTORATION

Environmental Outputs	River/Flood plain ecosystem (acres)	Wetlands (acres)	HEP habitat units	Instantaneous fish biomass (pounds)	Winter water (acres)	Ducks (winter population)	Wading birds (population; excluding
Pre-channelization Conditions	48,800	35,000	339,800	81,000	------	12,500	18,000
Existing Conditions	0	14,000	123,443	3,000	27,000	140	3,500
Modified Level II Backfilling (Recommended Plan)	48,800	29,000	285,342	46,000	327,000	12,500	16,000

6.2.5 Authorized Kissimmee River Project (1992)

The 1992 Water Resources Development Act authorized the construction of the Headwaters Revitalization Project and the Kissimmee River Restoration Project (Modified Level II Backfilling Plan). Three portions of the project, if desired by the sponsor, are to be accomplished without Federal participation. Those portions, referred to as locally preferred options are: shallowing in Pool A; modification of existing weirs in Pool B; and backfilling south of S-65D. The Federal project encompasses the following components:

* Headwaters Revitalization component as detailed herein.
* Backfilling of 29 continuous miles of canal.
* Removing structures S-65B, S-65C and S-65D.
* Recreating 18 new river channels totaling approximately 11.6 miles.
* Construction of Lake Istokpoga containment levee.
* Modification of structure S-65 and S-65A.
* Grade control structure upstream of S-65E.
* Partial degradation of local farm levees and ditches within the floodplain.

6.3 BACKGROUND OF DEVELOPMENT FOR KISSIMMEE RIVER HEADWATERS REVITALIZATION COMPONENT

6.3.1 Background

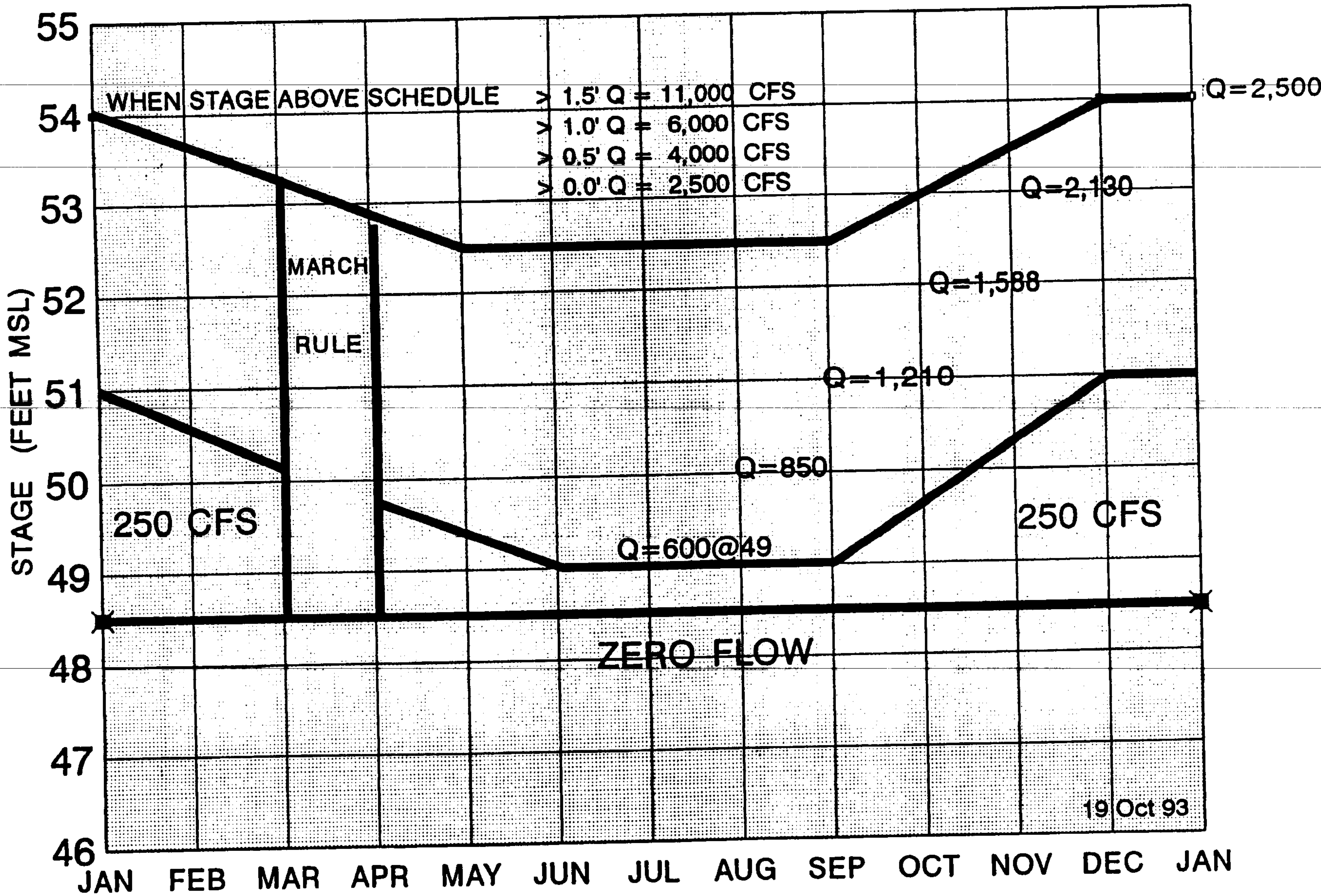
Use of regulation schedule and operation rule modifications such as those proposed in the 1991 feasibility study for achieving the integrated environmental objectives for the upper and lower Kissimmee basins (see study goal) is based upon the established premise that the basin's environmental restoration objectives will be met by reestablishing key hydrologic characteristics. Hydrologic restoration criteria for the lower basin require reestablishment of continuous inflows from the upper basin, particularly during July-October, natural seasonality of high and low inflow regimes, and a wide range of stochastic, discharge variability.

The primary criterion for achieving environmental improvements in the upper basin is to increase the maximum extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the upper basin watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationships for the headwater lakes. Figure 3-1 provides the pre-regulation and regulated lake stage frequency relationship. The flood control lake schedule has eliminated the range of peak lake stages by 2 to 3 feet. More natural rainfall-driven fluctuations would lead to higher lake stages, increasing water storage and, thereby, accommodating maintenance of continuous inflows from the Upper to Lower Basin.

6.3.2 SFWMD Development

In an effort to provide conditions necessary to restore more natural flows in the Kissimmee River, the SFWMD developed a proposal to modify seasonal water storage operations in the Upper Basin (Figure 6-1). Appendix E provides documentation describing the early development of the preliminary Lake Kissimmee Regulation Schedule modification which was presented in the 1991 Federal feasibility study. The regulation schedule, which was developed by the SFWMD, was used as the base for the development of the recommended plan presented herein.

1991 REGULATION SCHEDULE



6-10

Figure 6-1

6.3.3 Development of Lake Regulation Schedule

The design of the proposed regulation schedule was based on 3 criteria: (1) to eliminate the on again/off again or pulsing effect of the existing regulation schedule, (2) to provide more natural seasonal distributions of water releases, and (3) to increase the frequency and extent of high water fluctuations. Under natural conditions, the lake surface had a range of fluctuation of approximately 6 feet 75 percent or more of the time. The current regulation schedule is regulated over a 4 foot range. The on again/off again pulsing affect was to be corrected by zoned discharges.

In order to provide more natural flow conditions, the seasonal water storage had to be increased. Based on a sensitivity study that was conducted by the SFWMD team, approximately 100,000 acre-feet of additional water storage was required to provide for longer durations and seasonal variability of flow to the lower river basin. The top water surface elevation of 54 feet was developed by determining the increase in elevation, starting from the top of the existing lake regulation schedule or 52.5 feet which would provide the storage requirements of approximately 100,000 acre-feet. (See Plate 6-1, Storage - Elevation and Area - Elevation Relations, C&SF, Part II, Kissimmee River Basin and Related Areas, Suppl. 5, GDM, dated Oct 8, 1956). The total storage for lakes Kissimmee, Hatchineha and Cypress at 52.5 feet is 440,000 acre-feet. The storage available at 54 feet is 545,000 acre-feet. The difference is approximately 100,000 acre-feet. The upper limit of water levels or increased storage capability was also controlled by flood protection constraints. The stage corresponding to 30 percent of the Standard Project Flood (design flood elevation) under natural conditions at Lake Kissimmee was 54 feet.

The top of the proposed schedule was lowered to 52.5 feet during the wet season to allow for additional flood control storage. The scheduled drop during the wet season also corresponds to the top of the existing regulation schedule or 52.5 feet. If the top of the schedule was lowered below 52.5 feet, say to 52 feet, changes in the desired stage durations in the Upper and Lower Basin would occur. The idea was to allow for more availability of water throughout the year for the lower river restoration project. If the top of the lake schedule was lowered below 52.5 feet, we might over discharge to the river too early, especially during a normal to dry wet season. Additionally, stages in the Upper Basin lakes would be driven lower for a longer period of time.

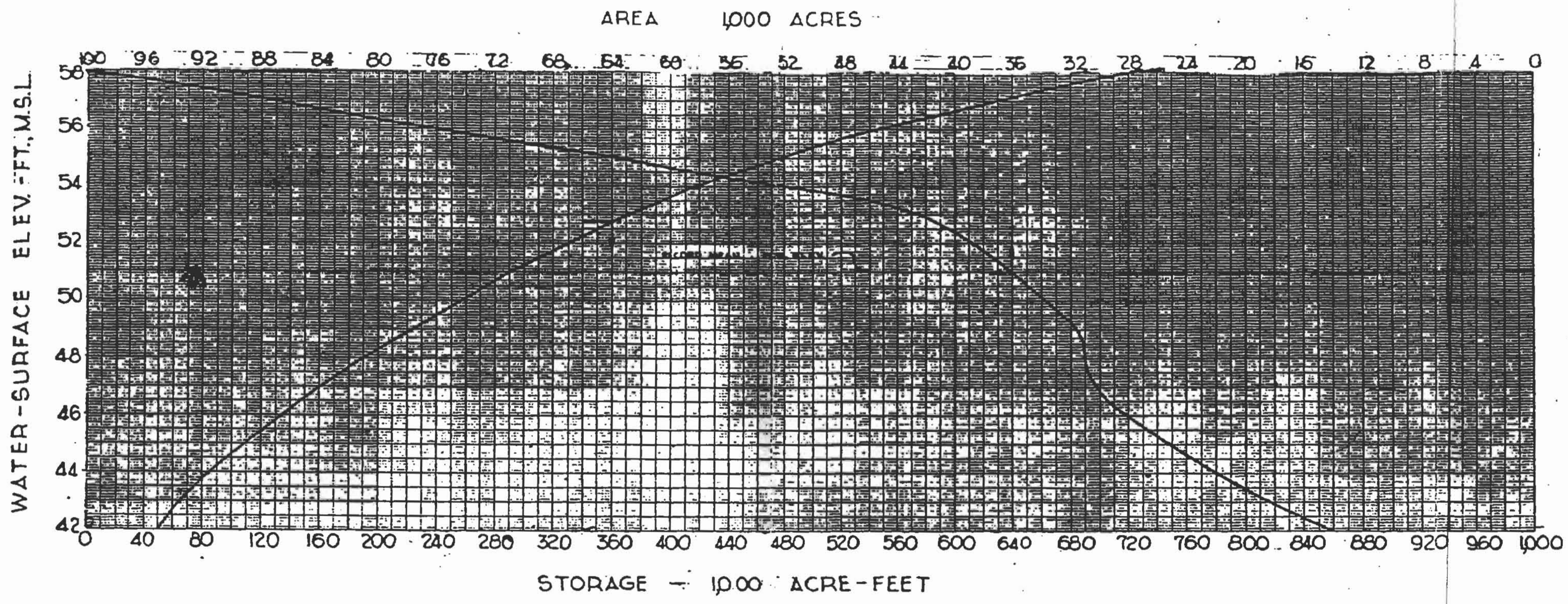


FIG. 1 LAKE KISSIMMEE

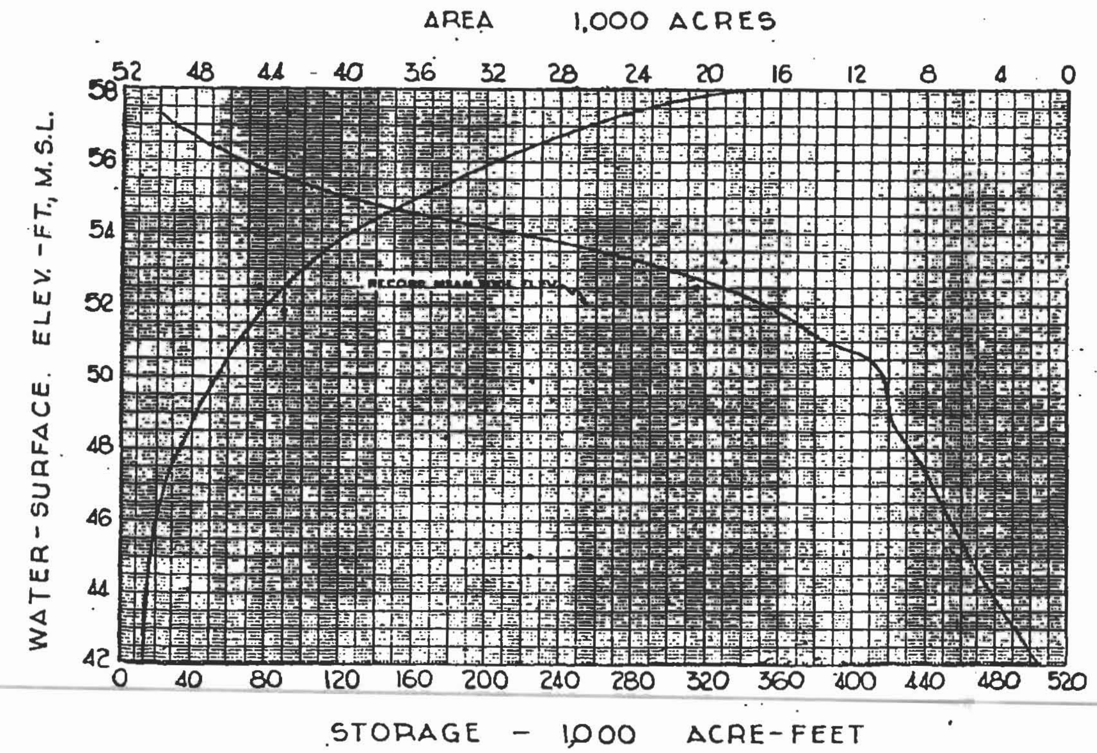


FIG. 2 LAKES CYPRESS & HATCHINEHA

CENTRAL AND SOUTHERN FLORIDA
MIDDLE KISSIMMEE RIVER BASIN
STORAGE-ELEVATION AND AREA-ELEVATION RELATIONS
SCALES AS SHOWN
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
TO ACCOMPANY GENERAL DESIGN MEMO.,
PART II, SUPP. 5 DATED OCT. 8, 1956
FILE NO. 400-24,153

SECTION 7

DEVELOPMENT OF PROJECT MODIFICATION

7.1 PLANNING PROCESS

7.1.1 Federal Objective

The Water Resources Development Act (WRDA) of 1992 authorizes the Assistant Secretary of the Army to construct the Headwaters Revitalization Project in accordance with a report prepared under Section 1135 based on the benefits derived for the environmental restoration of the Kissimmee River. The Headwaters Revitalization Project is unique in that a larger project, the Kissimmee River Restoration Project, relies upon the successful implementation of the Headwaters element.

Historically, the Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. In accordance with Section 1135 guidance and the 1992 authorization, the objective of the project modification is to improve the quality of the environment by the restoration or improvement of degraded habitats to their natural integrity, productivity, stability, and biological diversity. Furthermore, based on Section 907 of the 1986 WRDA, environmental benefits attributable to projects with the purpose of improving the Nation's environment were deemed to be at least equal to the costs of providing such projects. Because of the environmental nature of this project, an analyses in support of an NED Plan was not conducted for this study. An environmental restoration plan is presented which maintains the flood damage prevention for the study area.

7.1.2 Federal Policy

It is the policy of the Corps of Engineers to consider in the planning process all practicable and relevant alternatives applicable to sound water resources management. No one alternative is to be pre-judged superior to any other. The fundamental goal is to develop, define, and recommend a solution that has public and institutional support, that is engineeringly feasible and cost effective, and environmentally acceptable.

The plan that reasonably maximizes our project environmental goals, consistent with the Federal objective, is the goal of the Federal plan formulation and analysis process. In addition, the most cost effective way of constructing the authorized project is determined. Only modifications that could potentially optimize the cost and benefits of the authorized project were considered. Federal planning concerns other than environmental enhancement include environmental protection, human safety, social well being, and cultural and historic resources. Modifications to the authorized project were formulated in consideration of these four criteria:

(1) Completeness. The extent to which a given modification of the authorized project provides and accounts for all necessary investments or other actions to ensure the realization of environmental benefits.

(2) Effectiveness. The extent to which a given modification of the authorized project contributes to a solution to the degradation of the environment and achieves protection from flood induced storm damages.

(3) Efficiency. The extent to which a given modification of the authorized project is the most cost effective means of protecting the Nation's environment.

(4) Acceptability. The viability of a given modification to the authorized project and its acceptance by the non-federal project sponsor, state entities, and the public, and compatibility with existing laws, regulations, and public policies.

The Corps' policy usually requires an incremental cost analysis to be performed for all plans recommending Federal participation in a water resources development project for fish and wildlife restoration projects. The purpose of such analyses is to assure that all features of the Recommended Plan are justified based on both monetary (dollars) and non-monetary (environmental quality) factors. Incremental analysis requires that fish and wildlife resources be inventoried and grouped into resource categories as meaningful indicators of their relative significance from a national, regional and local perspective. Planning objectives are developed to reflect specific problems and opportunities to be addressed during the study.

Planning objectives of the Headwaters Revitalization study were developed based upon the 1991 feasibility study and by the 1992 project authorization. The authorization noted that the Upper Basin project was justified based on the Lower Basin benefits. Thus the primary purpose of the Upper Basin project is to provide the necessary discharges to obtain the environmental benefits for the Kissimmee River Restoration project. Modification of the existing Lake Kissimmee regulation schedule is the only alternative which achieves this objective.

In this instance, the objective of the study is to determine the most cost effective, justified means to restore degraded ecological conditions (expressed in fish and wildlife habitat quality) of the Kissimmee River. While a quantitative environmental incremental analysis cannot be performed for this project due to the lack of separable environmental project features, a modified qualitative analysis is provided which describes potential for increases in environmental performance for various lake regulation schedules. Likewise, the plan formulation process will be provided to clarify the process for developing the measures for maintaining the required levels of flood protection in the Upper Kissimmee Basin.

7.1.3 Environmental Compliance

The Final Environmental Impact Statement (FEIS) for the Kissimmee River, Florida Environmental Restoration project was completed in December 1991 (USAED, Jacksonville). The Supplement to the Final EIS is integrated into this project modification report and will be coordinated with the appropriate local, State, and Federal agencies in the fall of 1995. The results of this coordination will be contained in the Final Supplement to the FEIS integrated within this report. This document describes the environmental impacts of the authorized project modifications and summarizes compliance with the Federal statutes and regulations.

The Corps considers and seeks to balance the environmental and development needs of the Nation in full compliance with NEPA and other authorities provided by Congress and the Executive Branch. Alternative means of meeting competing demands generated by human water resource needs are examined and their environmental values examined fully, along with the economic, engineering, and social factors. Significant environmental resources and values that would likely be impacted, favorable as well as adversely, by alternatives being considered are identified early in the planning process. All plans are formulated to avoid, to the fullest extent practicable, any adverse impact on significant resources.

7.2 PLAN FORMULATION

7.2.1 Kissimmee River Restoration

Feasibility studies for the authorized Kissimmee River Project were completed in 1991 (USAED, Jacksonville). An assortment of alternatives were examined as possible solutions for the restoration of the degraded Kissimmee River ecosystem (see Section 6, Needs and Opportunities). Detailed analyses of these plans were developed based on an assortment of evaluation accounts, including social, environmental, and economic impacts. As a result of this and earlier studies, mainly the SFWMD 1990 Kissimmee River Report, the Modified Level II Backfill Plan met the Federal objectives of river restoration in the most economically efficient and environmentally acceptable manner.

The Headwaters project is an authorized component of the larger Kissimmee River Project. Specific project outputs of the Headwaters component were tied directly to the outputs of the Kissimmee River Restoration Project as detailed in the 1991 Federal feasibility study.
As such, plan development for the Headwaters study, presented herein, was centered around the development of a modified Lake Kissimmee regulation schedule and operational criteria which would first achieve the environmental benefits associated with the restoration of the lower Kissimmee River and as documented in the 1991 feasibility report. The plan that achieves Lower Basin outputs can then be modified to improve environmental conditions within the Upper Basin.

The Headwaters Revitalization Project was formulated to produce hydrologic characteristics that are critical to successful ecosystem restoration. in the Lower Basin. Hydrological, hydraulic, and ecological analyses of alternative Lower Basin restoration plans by the SFWMD (1990) produced evidence that the combination of backfill in the Lower Basin and Headwaters Revitalization would reestablish continuous flow and stage characteristics that are needed to achieve river restoration objectives. Maintenance of continuous flows would produce the physical aeration and mixing that is needed to restore favorable dissolved oxygen regimes in the restored river channel. Reestablished discharge characteristics from Lake Kissimmee also would improve habitat diversity in the 56 miles of restored river channel, and provide water that is necessary to restore about 50 square miles of river floodplain wetlands and associated fish and wildlife values.

If a Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved. Thus, without Upper Basin modifications, a Lower Basin project would be largely ineffective and its construction would be unjustified. Therefore, modification of the Lake Kissimmee regulation schedule was presented as a necessary component of river restoration.

7.2.2 Project Goal

WRDA 1992 authorizes the Secretary of the Army to construct the Headwaters Revitalization project and other project modifications based on the benefits derived for the environmental restoration of the Kissimmee River basin. Based on WRDA 1992, the Headwaters Revitalization is justified on the merits of the Lower Basin project. Therefore, the objective of the Headwaters Revitalization Project must first recognize the primary goal of Kissimmee River restoration.

To be consistent with guidance concerning Section 1135, the emphasis of the proposed modifications in the Upper Kissimmee Basin should be to restore or otherwise improve degraded habitats to their natural integrity, productivity, stability, and biological diversity. Therefore, based on Section 1135 guidance and WRDA 1992, the District established a goal for the Headwaters Revitalization Project. The primary project goal was to reestablish discharges to the Lower Basin that are necessary to restore the ecological integrity of the Kissimmee River while optimizing environmental improvements to the Kissimmee Upper Basin.

7.2.3 Development of Planning Objectives

A plan formulation objective was established for the Headwaters Revitalization study during the Kissimmee feasibility phase and subsequent review conferences. In January 1993, representatives from the Corps, including the Jacksonville District, South Atlantic Division, and Chief of Engineer's office met with the SFWMD in a special Review Conference to discuss policy and procedural issues regarding the study. The following planning objectives were established to address the requirements of the Upper Basin project and to serve as guidelines for the formulation and evaluation of alternative plans:

(a) provide necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits intended for Kissimmee River restoration;

(b) increase the quantity and quality of the wetland habitat in the Upper basin lake littoral zones to benefit fish and wildlife; and

(c) provide increased potential for recovery of several endangered and threatened species, while not jeopardizing any listed species.

7.2.4 Environmental Planning Objectives

Water levels in Lakes Kissimmee, Cypress, and Hatchineha have been maintained within a narrow range of fluctuations relative to the natural conditions. Because of existing structural limitations and limited real estate interests, it is not possible to allow water levels to exceed the top of the regulation schedule (elevation 52.5 feet, NGVD) without flood control releases from the lakes. This resulted in substantial loss of good quality peripheral marsh habitat around the lakes.

The regulation schedule for Lakes Kissimmee, Cypress, and Hatchineha requires that water levels be drawn down in advance of the wet (hurricane) season and that water levels be allowed to rise prior to the dry season. Consequently, discharges to the lower basin are generally limited during the wet season and extended periods of no flow are common as water is being stored in the upper lakes. Discharges increase during the dry season as water levels in the lakes are being drawn down. Also, when water levels rise above the regulation schedule (dry season or wet season), flood control discharges are required. Following flood releases, it is common for discharges to decline rapidly. The existing project has caused substantial alteration of the seasonal flow patterns, increased the frequency of low or no flow conditions, and has created the existence of harmful pulse like discharges.

The proposed project would result in hydrologic alterations that would provide environmental benefits in both the Upper and Lower basins. The recommended plan would increase the range of water level fluctuations in the Upper Basin. As a result, there would be an increase in the size and quality of the peripheral marshes for the benefit of fish and wildlife. Environmental benefits in the Lower Basin would result by reestablishment of more natural timing of discharges from the Upper basin. The U.S. Fish and Wildlife Service has determined that Headwaters Revitalization will benefit the endangered bald eagle, snail kite, and wood stork. The increased storage capacity and expanded littoral zone would result in expanded riparian and wetland feeding habitat and increased food supply for the eagle, kite and wood stork.

7.2.5 Plan Coordination

In the interest of interagency coordination for planning studies and trying to avoid issues arising very late in the planning process, the appropriate Federal and state agencies were invited to participate in the planning and review process for the development of the recommended plan detailed herein. Jacksonville District, SFWMD, USFWS, and Florida Game and Freshwater Fish Commission (FGFWFC) personnel met periodically to develop and review the alternative Lake Kissimmee regulation schedules. On January 24, 1995, an in-progress review conference was held in the Jacksonville District with the SFWMD, USFWS, FGFWFC, and Jacksonville District personnel in attendance. The meeting was held to discuss the final selection of alternative regulation schedules and to resolve project related issues.

On September 20, 1994, a Planning Conference was held in the Jacksonville District to present details of the project recommendations to the South Atlantic Division office. The purpose of the conference was plan coordination and to provide a forum for resolution of any project conflicts with District higher authority. Based on the results of the conference, there were no conflicts with the Jacksonville District's approach to plan development.

7.3 PLANNING SCOPE AND CONSTRAINTS

The study area for the Headwaters project was confined within the hydrologic limits of Lake Kissimmee, Lake Hatchineha, Lake Cypress and Lake Tiger. The remaining Upper Basin lakes bordering these lakes are separated from the Kissimmee chain-of-lakes by water control structures. Originally, Lake Jackson was included within the study area, but the recent completion of the Lake Jackson control structure by the Florida Game and Freshwater Fish Commission between Lake Jackson and Lake Kissimmee allows regulation of Lake Jackson apart from Lake Kissimmee. Therefore, Lake Jackson was removed from the study area.

Based on the 1992 authorization, there are certain limitations which must be considered in evaluating any plan for possible implementation. The January 1993 project review conference, (see Section 7.2.3), provided additional guidance on developing project constraints and helped to define the limits of the study planning evaluations. The following planning constraints were established to serve as guidelines for formulating and evaluating alternative plans.

(a) maintain the existing level of flood protection in the Headwater Lakes;

(b) avoid any adverse impact to existing flood protection upstream of C-34 and C-35 (Lake Gentry and Lake Tohopekaliga, respectively);

(c) insure continuous flow in the Kissimmee River with duration and variability characteristics comparable to pre-channelization records; and

(d) reestablish water schedules that result in floodplain inundation frequencies and recession rates comparable to pre-channelization hydroperiods.

(e) avoid impacts to existing Federal navigation project

One exception to normal evaluation requirements, was that traditional economic benefit-cost analysis would not be required for this environmental restoration project in accordance to the authorized project purposes. While an economic benefit cost analysis was not conducted for this project, economic and social impacts as a result of increased water levels were documented (see Appendix G). Instead of the traditional economic benefit-cost analysis, a combination of methods for measuring environmental improvements were used in determining the impacts of the final array of alternatives. This evaluation included comparison of historical flows, prediction of wetlands, and a prediction of habitat units by HSI models.

7.4 DEVELOPMENT OF PROJECT MODIFICATION

7.4.1 Establishment of the Recommended Project Modification

Detailed analyses were conducted on proposed modifications to the existing flood control project. Additive alternative measures which did not fully address the planning objectives were either not considered or not retained for further evaluation analysis. Planning objectives discussed earlier were the basis for the selection of alternative plans used for development of intermediate level of analysis.

Modifications of the existing Lake Kissimmee regulation schedule were considered for meeting the stated Kissimmee River environmental goals and objectives. Variations of lake stage-discharge schemes or operational criteria were analyzed to optimize project environmental outputs for the Upper and Lower Basins. Once the optimum schedule was selected, multiple combinations of structural and non-structural flood control options were investigated to determine the most effective method of maintaining the existing level of flood protection. Finally, various measures of land acquisition were considered as part of the plan to obtain environmental benefits and provide for flood storage in the Upper Basin.

The possible solutions considered in the first step of project formulation are listed below. The considered alternative plans are: (a) "no action," i.e., leaving the existing Upper Basin works in place and operating with the present schedules, and (b) water schedule and structure modifications to achieve the restoration objectives for the Kissimmee River while optimizing fish and wildlife benefits in the Upper Basin. The development and evaluation of alternative lake regulation schedules are discussed in Section 7.5 and Appendix F of the report. Separable measures considered in combination with the recommended alternative regulation plan included enlargement of interconnecting canals and outlet structures, levee breaching combinations, and various combinations of land acquisition measures. The alternative of taking no action must be included throughout the planning process. The "No Action" plan is developed to allow comparisons with the proposed authorized project.

7.4.2 NO ACTION Plan

Plan Description. Because Kissimmee River restoration is dependent upon the implementation of a Headwaters project, this alternative assumes that the authorized Kissimmee Restoration Project will not be implemented. No solutions or remedial measures, for example river backfilling, would be implemented or constructed in either the Upper or Lower Basins. While the existing level of flood protection in the Kissimmee chain of lakes would not be altered, opportunities for expansion of the existing lake littoral zones would not be pursued. Likewise, the ecosystem of the river valley would continue to degrade. The existing and forecast resource conditions without project construction of the authorized project are described in more detail in the "Existing" and "Future Without Project" condition sections, Section 4 and 5, of the report. This alternative does not fulfill the stated objectives for the river or the Upper Basin lakes.

Implementation Responsibilities. There would be no Federal responsibility in the implementation of this alternative. This alternative plan is considered in relation to the effects of construction of the authorized project.

Local Sponsor's Views. The local sponsor has indicated in numerous letters a commitment to implementation of the overall restoration project and, therefore, the NO ACTION PLAN is unacceptable.

7.4.3 The 1991 Feasibility Report Headwaters Revitalization Plan (Regulation Schedule Alternative RS1, RS1-A, RS1-B) -

The 1991 Feasibility Report and Environmental Impact Statement provided a recommendation consisting of specific changes to the existing Lake Kissimmee regulation schedule and operating rules for the restoration of the Kissimmee River. The upper level of the preliminary schedule would be increased from elevation 52.5 feet to elevation 54.0 feet, and the schedule would be zoned to provide varying discharges based on season and water levels. The revised schedule would seasonally reflood land between elevations 52.5 and 54.0 feet in Lakes Kissimmee, Hatchineha, and Cypress. It was expected that flood damage reduction afforded by the existing Kissimmee River Flood Control Project could be maintained with implementation of a zoned schedule. The revised schedule would increase seasonal water storage capacity by 100,000 acre-feet, according to studies by the SFWMD. Figure 6-1 shows the alternative Lake Kissimmee regulation schedule presented in the 1991 report. The plan also consisted of channel enlargements, modification of existing water control structures, and land acquisition. The plan was developed primarily for river floodplain restoration. Upper Basin benefits or potential degradation of the Upper Basin environment were not evaluated in detail.

7.4.4 Modification of the Existing Lake Regulation Schedule Operational Rules (Regulation Schedule Alternative RS2) -

Modifications of the operating rules of the existing flood control regulation schedule were also considered. Historic discharge characteristics were added below the top of the schedule where normally a no flow regime exists. This alternative was dropped as a potential plan during the early screening of alternative regulation schedules, see Section 7.5 and Appendix F, based on its inability to provide required discharges for river restoration.

7.4.5 Addition of Bypass Channel with Fixed Weir Lake Kissimmee outlet (Regulation Schedule Alternative RS5) -

The SFWMD study proposed a by-pass spillway as the primary spillway to discharge at a rate that closely approximates the pre-project stage-discharge rating for lake stages above the crest elevation of 51.0 feet. A lake regulation schedule option which calls for the addition of a fixed weir and bypass channel around the S-65 outlet structure was considered to provide the operational requirements of the proposed schedule. The weir elevation would be set at an elevation to pass the minimum flows of 250 cfs when stages are above the elevation of the weir. Discharges above the weir were based on the rating curve, Figure A-2, from the 1991 feasibility report proposed bypass weir at S-65. This alternative was dropped as a potential plan during the early screening of alternative regulation schedules, see Section 7.5 and Appendix F, based on its inability to meet the required discharges for river restoration.

7.4.6 Modification of the Operation Rules of the Proposed 1991 Lake Kissimmee Regulation Schedule -

Modification of the Upper Chain of Lakes' regulation schedule proposed in the 1991 feasibility report would restore the ability to simulate the historic seasonal flow from Lake Kissimmee to the Lower Basin, and provide higher fluctuations of water levels in the lakes. Eighteen modifications of the 1991 regulation schedule were developed and evaluated based on their ability of achieving the 1991 schedule discharge requirements and improving Upper Basin lake stages.

7.4.7 Structural Flood Control Measures -

Based on the requirements of the existing authorization, any new project proposal must maintain the existing level of flood protection. Because project impacts on residences and structural improvements could significantly increase if the frequency of water levels were raised above 54.0 feet, a decision was made by the Jacksonville District that the maximum extent of project related hydrologic impacts will be held at the 54.0 foot elevation. The criteria for acceptability in the Upper Basin was to have no increase in the peak flood stage above 54.0 feet for any flood frequency. Because of the planned acquisition of lands below 54.0 feet, any increases in peak flood stages below 54.0 feet would be acceptable. Potential flood impacts above 54.0 feet would be addressed through an engineering solution (i.e. their will be no flood induced impacts above 54.0 feet and no additional land requirements above 54.0 feet). Modification of the lake regulation wet season rule curve and reduction of the backfill length would not meet the authorized environmental outputs and were subsequently eliminated.

a. Enlarge C-34, C-35, C-36, C-37, and Replace S-61 - If water levels in Lake Kissimmee are increased, additional land interest and structural modifications may be required to maintain the existing flood protection north of Lake Cypress. These canals could be enlarged to flatten the flood profile through the upper lakes and prevent increasing flood stages. By enlarging canals C-34, C-35, C-36, C-37, the tailwaters of Lakes Tohopekaliga and Gentry could be reduced to prevent the need for structural modifications or real estate acquisition upstream of Lake Cypress. Canal bottom-widths from 20 feet to 160 feet were tested. The need to replace S-61 to further reduce the impact on tailwater at Lake Tohopekaliga was also considered.

Evaluation of whether deepening the canals would be a viable alternative to widening for flood control purposes was also considered. Based on the hydraulic performance of a deepened channel option, the deepening option was not carried forward in the plan development stage.

b. S-65 Structure Modification or Addition of Bypass Spillway and Gate Extensions - Modifications to the existing S-65 structure could be needed to provide larger discharge capacity because of the higher stages in Lake Kissimmee and to overcome the discharge capacity affected by higher tailwater elevations below S-65. Several versions of these measures were tested. Various enlargement options at S-65 were tested in conjunction with the various canal configurations and simulated floods up to the Standard Project Flood.

c. Alignment Option for Canal Widening - Alternative options for the widening of C-34, C-35, C36 and C-37 were considered. Potential acres of wetlands affected on the either the right or left side of the canals were provided by the USFWS. Based on this information, alignment options which reduce the environmental impacts were considered.

d. Create a Canal Using the Alignment of Short Canal - Excavation of a canal along the alignment of Short Canal, a shallow drainage canal between Cypress Lake and Lake Kissimmee, could reduce the amount that C-36 and C-37 would have to be enlarged. Short Canal, however, is now little more than a depression through a marsh. Because enlargement would require extensive excavation and removal of excavated material away from the marsh at considerable expense, this alternative was dropped from further consideration.

7.4.8 Additional Structural Plans

a. Removal of S-65A - The study addressed the removal of S65A as an alternative for eliminating the additional land requirements in Pool A in the Kissimmee River and for reducing or eliminating any structural improvements at S-65. A preliminary assessment of the S65A removal alternative, both financial and hydrologic, was initiated in order to determine the viability of the proposal. Because of the combination of high costs associated with the S65A removal option, potential negative environmental and navigational impacts associated with river overdrainage and the desirability of the operational flexibility of the gated spillway structure, it was recommended that the removal of S65A not be considered as a project feature. The S-65A option is discussed further in the flood control design section, Section 7.7, of this report.

b. Increase Flow-ways Between Tributary Lakes and Lake Kissimmee - Increasing the regulation schedule of Lake Kissimmee will effect runoff from the tributary lakes. Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small, mildly meandering natural stream which flows through a flat, swampy expanse of marshes over a distance of 9,000 feet. Since Lake Tiger and Lake Kissimmee are at approximately the same natural ground elevation and are hydraulically connected by Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Effects could be mitigated by acquisition of real estate interests, or by structural modifications to improve conveyance. In order to eliminate the need to acquire real estate interest around the Lake Tiger by increasing Lake Kissimmee's regulation schedule, an option was considered for improving the flow-way between the lake and Lake Kissimmee to permit additional water storage.

c. Addition of Weir or Flap Gated Culverts and Pump Station between Lake Tiger and Lake Kissimmee - This alternative included channel widening options, the addition of weirs or culverts with flap gates and pump station alternatives between Lakes Kissimmee and Tiger in order to avoid acquisition of lands around Lake Tiger. Based on the analyses, there were no feasible structural alternative for reducing or eliminating the requirement of land acquisition at Lake Tiger. The analysis is described in more detail in the Flood Control Design Optimization section.

d. Addition of a New Water Control Structure - The Florida Game and Freshwater Fish Commission requested that a water control structure at the northern end of C-36 to regulate Lake Cypress at levels closer to the historic conditions be considered. The alternative was considered, but it was expected that the added structure and the loss of initial storage in Lake Cypress would have an adverse impact on flood stages upstream of the proposed structure and that it may interfere with the required operational criteria for the river restoration project. Since monitoring and evaluation of operation criteria will be an ongoing process after implementation of the Kissimmee River Project, the Jacksonville District proposes to defer any investigation of a new control structure.

7.4.9 Land Acquisition Requirements - Acquire Property Rights in Fee Verses Easement

The environmental benefits achieved, in both the Upper and Lower Basin, by modifying the regulation schedule would be affected by how the land is used with the project. A range of real estate acquisition possibilities were evaluated for securing various levels of land use controls over the floodplain around the headwater lakes. Acquisition of real estate interests in fee simple versus easement rights were compared with potential fish and wildlife benefits and project requirements for flood control storage. It was recognized that agricultural uses compatible with seasonal flooding, such as cattle grazing, might also be compatible with, or beneficial to, fish and wildlife uses. With the U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission, we considered the beneficial uses of grazing and fire as part of a wildlife management plan for the Headwaters.

If the land is acquired in fee, which would be a higher cost than if the land were acquired in easement, the use of the land acquired in fee would be limited to project purposes and would not be disturbed in such a way that could be damaging to the environment. If the land is acquired in a lesser easement, the environmental benefits may not be fully achieved, nor would we have the flexibility to modify or deviate from the proposed lake regulation schedule for future environmental or flood control purposes.

7.5 EVALUATION OF LAKE KISSIMMEE REGULATION SCHEDULE ALTERNATIVES

7.5.1 Development of Alternatives

The 1991 feasibility study demonstrated that discharges required to accomplish ecological restoration of the lower basin could be provided by modifying the flood control regulation schedule and operation rules for the lower group of headwater lakes (i.e., Kissimmee, Hatchineha, and Cypress). The proposed modifications (Figure 6-1) provided required inflow regimes for the lower basin restoration, including relatively continuous discharges, with rates that varied with lake stages. These modifications to the operation rules, along with proposed provisions to raise the upper level of the regulation schedule to 52.5 during May-September and between 52.5-54 ft during the remaining months of the year, also have the potential for increasing the range and temporal dynamics of water level fluctuations in the lakes. An associated expansion of littoral wetlands and increased quality and productivity of littoral habitat surrounding the lakes was suggested, but not rigorously evaluated.

The first component of plan formulation for the Headwaters study was centered around the development of a Lake Kissimmee regulation schedule which would meet or exceed the environmental benefits which were attributed to the restoration of the lower Kissimmee River as shown in the 1991 authorizing document. Key components of the regulation schedule and operation rule modifications in the 1991 feasibility study were used as a template for developing alternative Upper Basin water management schemes for meeting the restoration criteria and environmental objectives of the river and headwater lakes. However, the potential for modifying the Upper Basin regulation schedule and operation rules was limited by flood control and navigation constraints, which establish an upper and lower envelop for lake stages and discharge manipulations.

Between August 1993 and November 1993, the SFWMD and the Corps developed 21 alternative lake regulation schedules (Table 7-1 and Figures 7-1). During this iterative design process, an interagency environmental team, consisting of the USFWS, the Florida Game and Freshwater Fish Commission, the SFWMD and the Corps members reviewed and screened the alternatives based on their conformance to project related goals for the Lower and Upper Basins. Appendix F provides a detailed explanation of the process which lead to the development and evaluation of the 21 alternative schedules.

TABLE 7-1 REGULATION SCHEDULE ALTERNATIVES (See Figures in Appendix F.)	
ALTERNATIVE	**OPERATION RULES**
RS1 (SFWMD 1990 AND 1991 FEASIBILITY STUDY SCHEDULE)	Three discharge zones bounded by an upper flood control regulation zone when lake stages exceed 52.5-54 ft and a lower no discharge zone when lake stages are < 48.5 ft. Within this envelop no discharges are made during March; during other months discharges either vary according to the historic (pre-regulation) stage-discharge relationship or are maintained at 250 cfs, depending upon lake stages.
RS1-A	Same as RS1 with slight modifications to historic stage-discharge rating curve.
RS1-B	Same as RS1 without March no discharge zone.
RS2	Same discharge zones as RS1-B except upper flood control regulation zone is bounded by existing regulation schedule elevations.
RS3	Same as RS1-B with slightly higher flood control envelop during May.
RS4	Same as RS3 except 250 cfs zone changed to 400 cfs zone.
RS5	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 250 cfs when lake stages are < 51.68 ft or unregulated flow as lake stages overtop a weir with a fixed crest of 51.68 ft.
RS6	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 150 cfs when lake stages are < 49 ft or vary according to a new outlet rating curve (RC-A rating curve from Appendix F).
RS7	Same as RS6 with the addition of a 400 cfs discharge zone when lake stages fall within designated ranges during November-May.
RS8	Same as RS6 with a different stage-discharge rating curve (RC-B rating curve from Appendix F).
RS9	Same as RS6 with the addition of a 400 cfs discharge zone that occurs at different lake stages than the RS7 400 cfs discharge zone

TABLE 7-1
REGULATION SCHEDULE ALTERNATIVES
(See Figures in Appendix F.)

ALTERNATIVE	OPERATION RULES
RS9-A	Same as RS9 with a modification to the 400 cfs discharge zone
RS9-B	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A
RS9-C	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A and RS9-B
RS9-D (T400C150RR in USFWS CAR)	Same as RS9-C with elimination of 400 cfs discharge zone during November-December
RS10	Same as RS9-A with historical stage-discharge rating curve.
RS10-A	Same as RS9-B with historical stage-discharge rating curve.
RS10-B	Same as RS9-C with historical stage-discharge rating curve.
RS10-C	Same as RS9-D with historical stage-discharge rating curve.
RS11	Same as RS9-C and RS10-B with RS8 stage-discharge rating curve during January-June and historical stage-discharge rating curve during July-December.
RS11-A (T1000HISRR in USFWS CAR)	Same as RS11 with elimination of 400 cfs discharge zone during November-December.

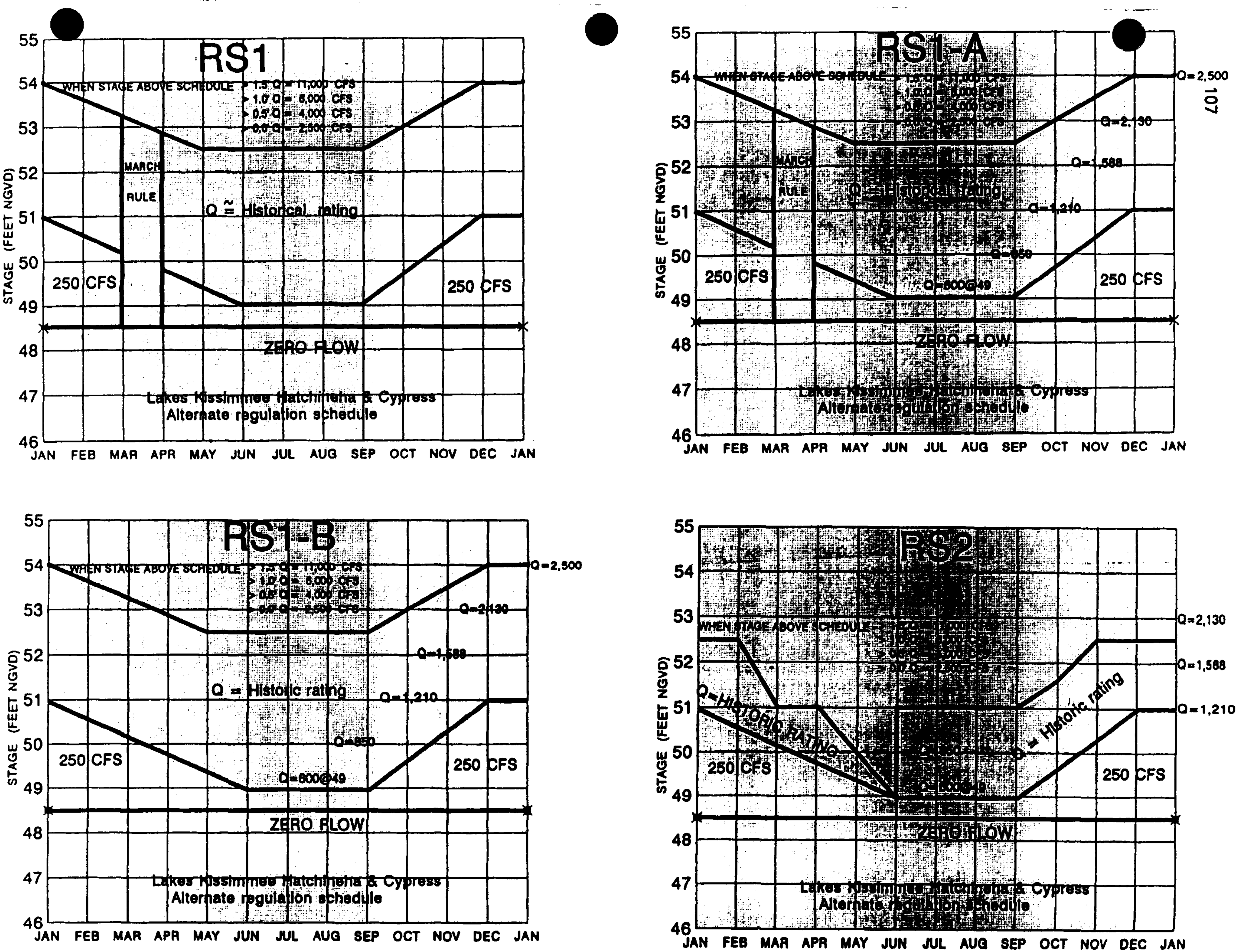
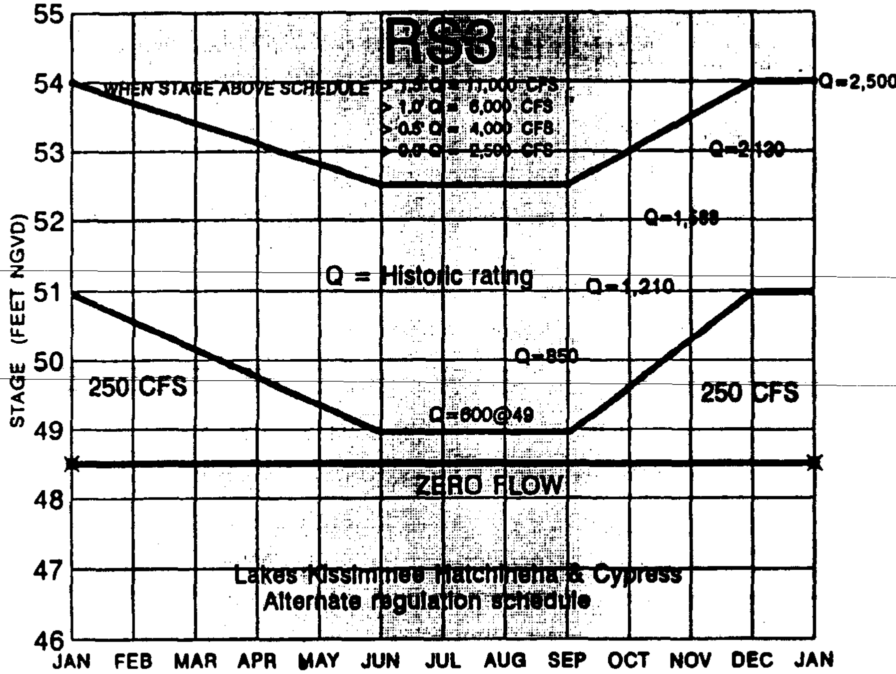
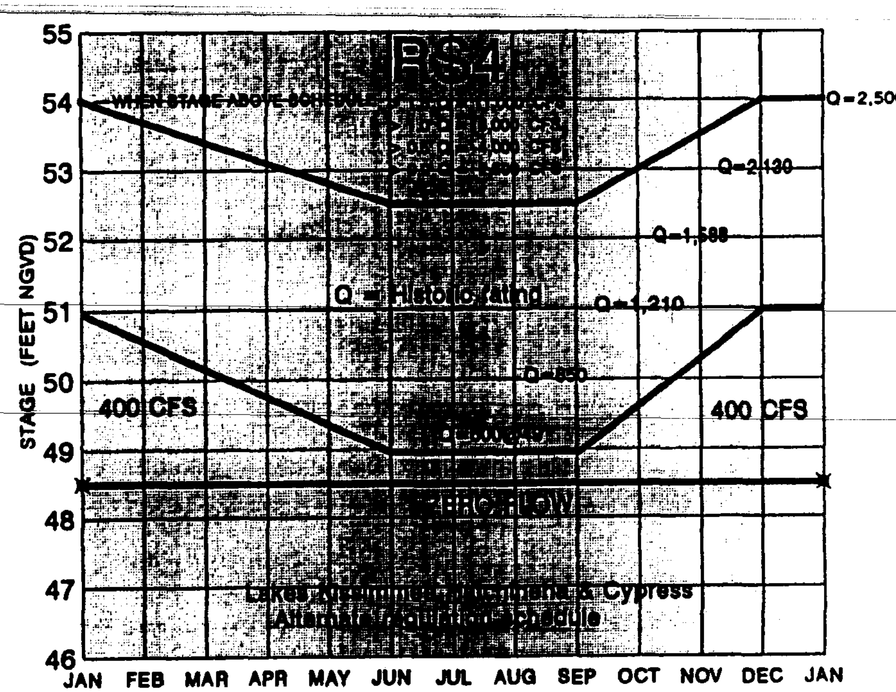
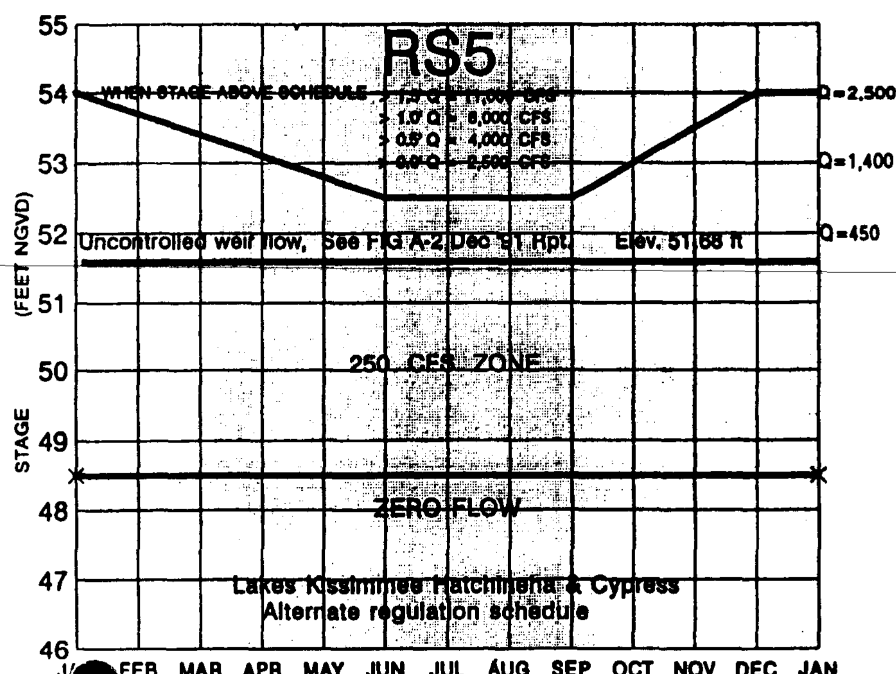

RS1
WHEN STAGE ABOVE SCHEDULE > 1.5 Q = 11,000 CFS
> 1.0 Q = 6,000 CFS
> 0.5 Q = 4,000 CFS
> 0.0 Q = 2,500 CFS
MARCH
RULE
Q ≅ Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
RS1-A
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
MARCH
RULE
Q = Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS1-B
WHEN STAGE ABOVE SCHEDULE > 1.5 Q = 11,000 CFS
> 1.0 Q = 6,000 CFS
> 0.5 Q = 4,000 CFS
> 0.0 Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS2
WHEN STAGE ABOVE SCHEDULE
Q=2,130
Q=1,588
Q=1,210
Q=HISTORIC RATING
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule

FIGURE 7-1(a)


RS3
WHEN STAGE ABOVE SCHEDULE
> 1.0 Q = 6,000 CFS
> 0.5 Q = 4,000 CFS
Q=2,500
Q=2,130
Q=1,588
Q = Historic rating
Q=1,210
Q=850
250 CFS
250 CFS
Q=600@49
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS4
Q=2,500
Q=2,130
Q=1,588
Q=1,210
400 CFS
400 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS5
WHEN STAGE ABOVE SCHEDULE
> 1.0 Q = 6,000 CFS
> 0.5 Q = 4,000 CFS
Q=2,500
Q=1,400
Q=450
Uncontrolled weir flow, See FIG A-2 Dec 91 Rpt. Elev. 51.68 ft
250 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

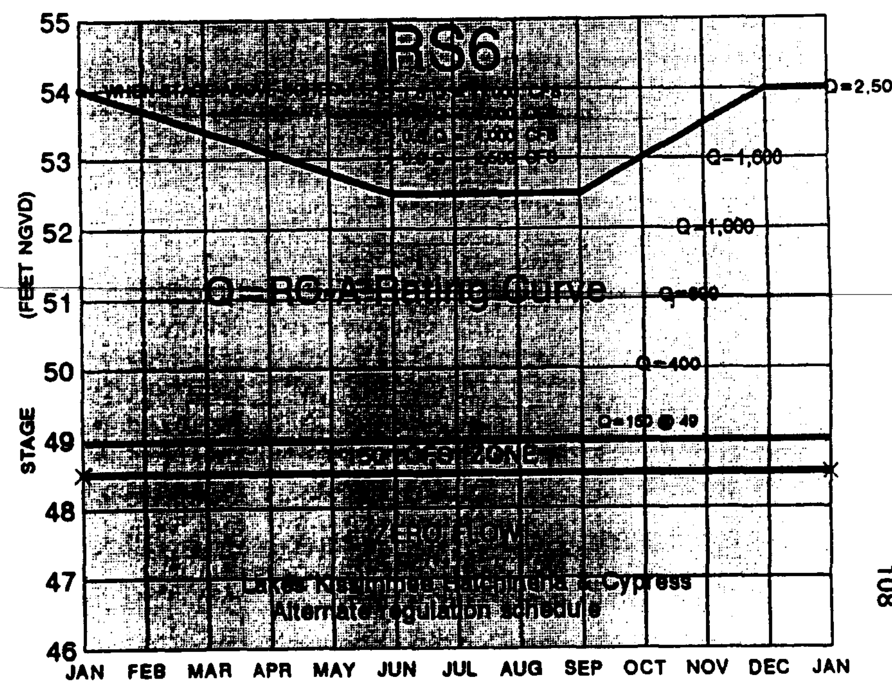
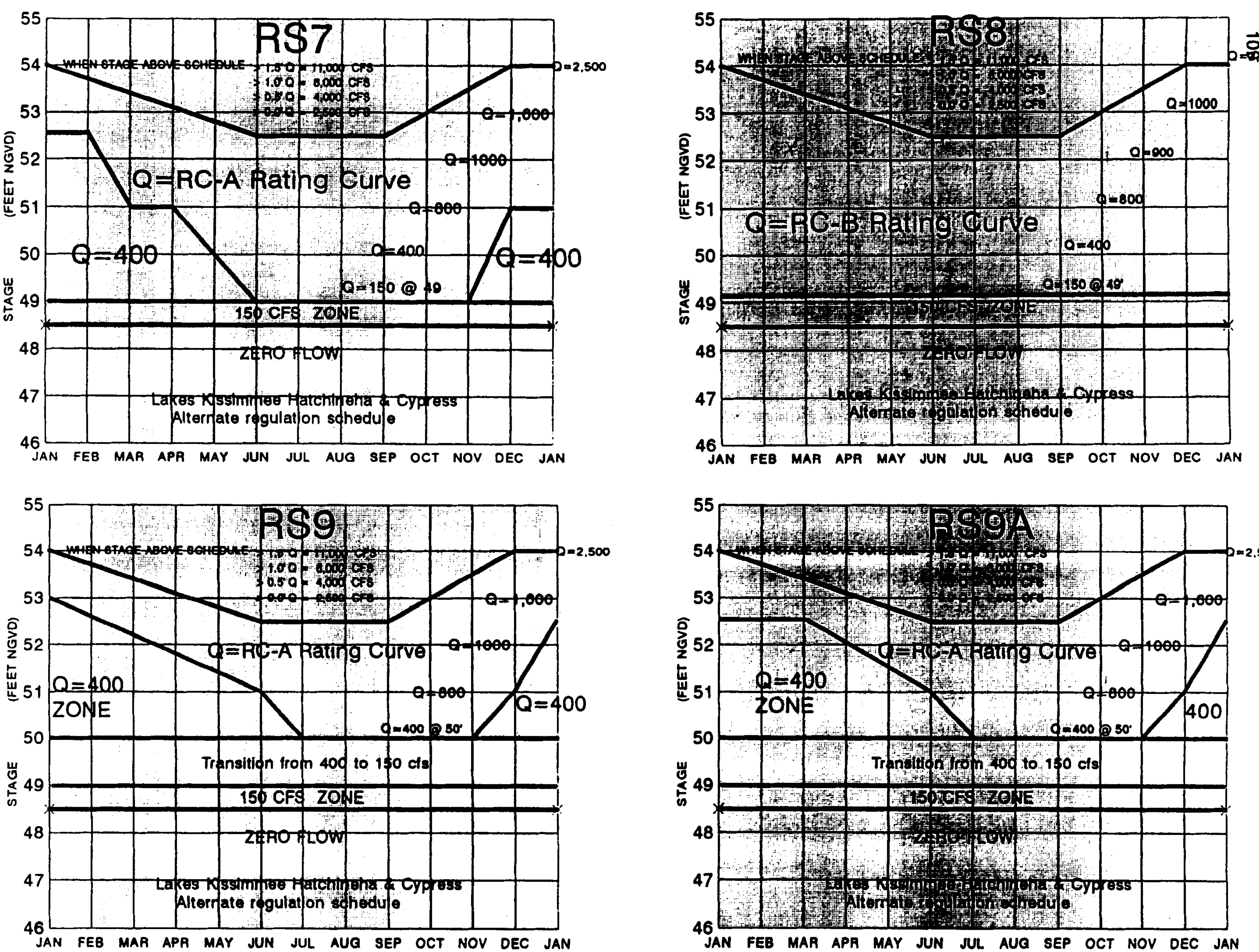
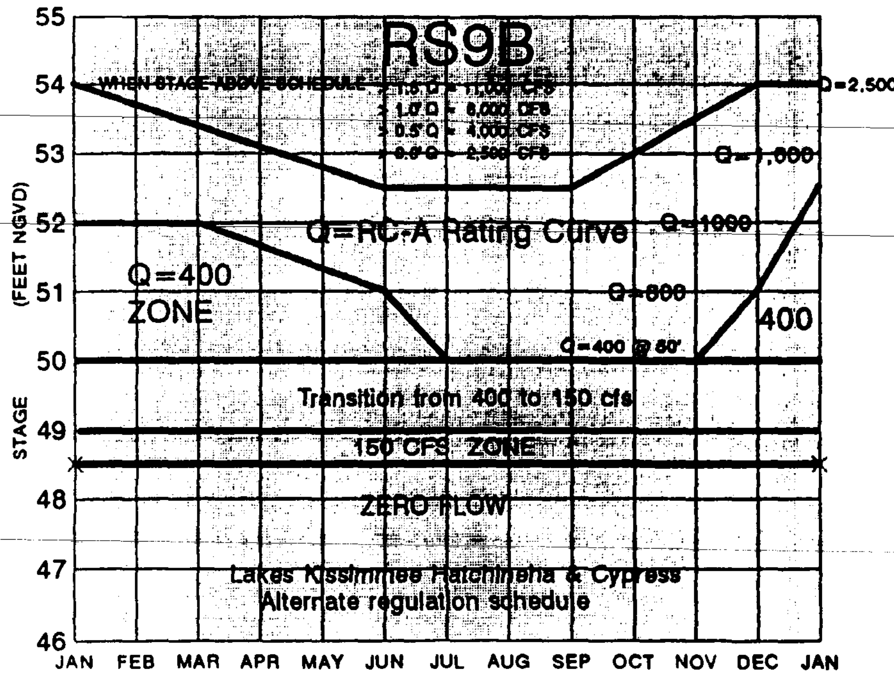

RS6
Q=2,500
Q=1,600
Q=1,000
Q=400
Q=150 @ 49
ZERO FLOW
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(b)



RS7
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=RC-A Rating Curve
Q=800
Q=400
Q=400
Q=400
Q=150 @ 49
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
RS8
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=1000
Q=900
Q=800
Q=RC-B Rating Curve
Q=400
Q=150 @ 49'
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS9
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=RC-A Rating Curve
Q=800
Q=400 ZONE
Q=400
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS9A
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=1,600
Q=1000
Q=RC-A Rating Curve
Q=800
Q=400 ZONE
400
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule

FIGURE 7-1(c)


RS9B
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=RC-A Rating Curve
Q=1000
Q=400
ZONE
Q=800
400
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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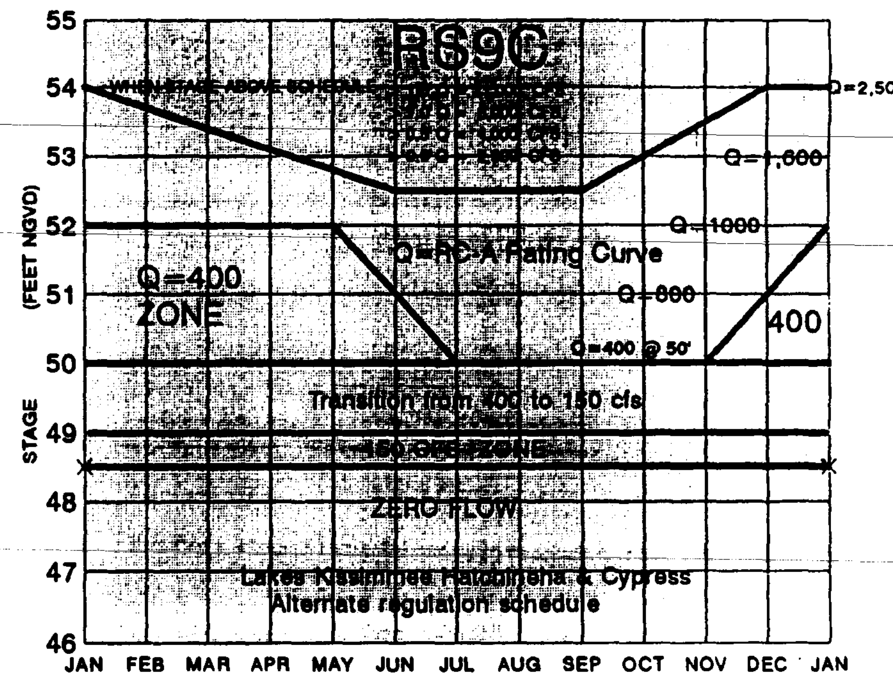
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9C
Q=2,500
Q=1000
Q=RC-A Rating Curve
Q=400
ZONE
Q=800
400
Q=400 @ 50'
Transition from 400 to 150 cfs
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

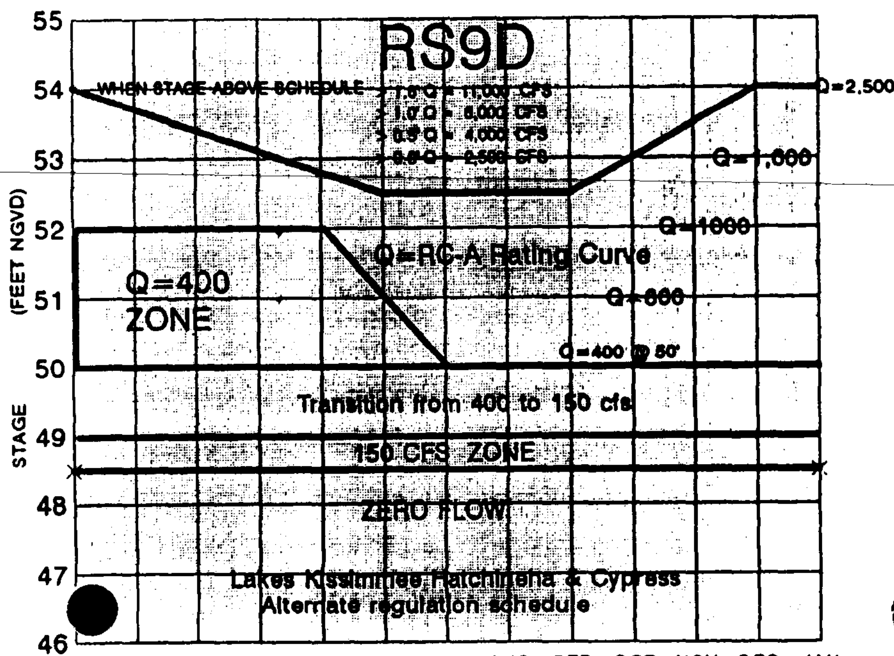
RS9D
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=1000
Q=RC-A Rating Curve
Q=400
ZONE
Q=800
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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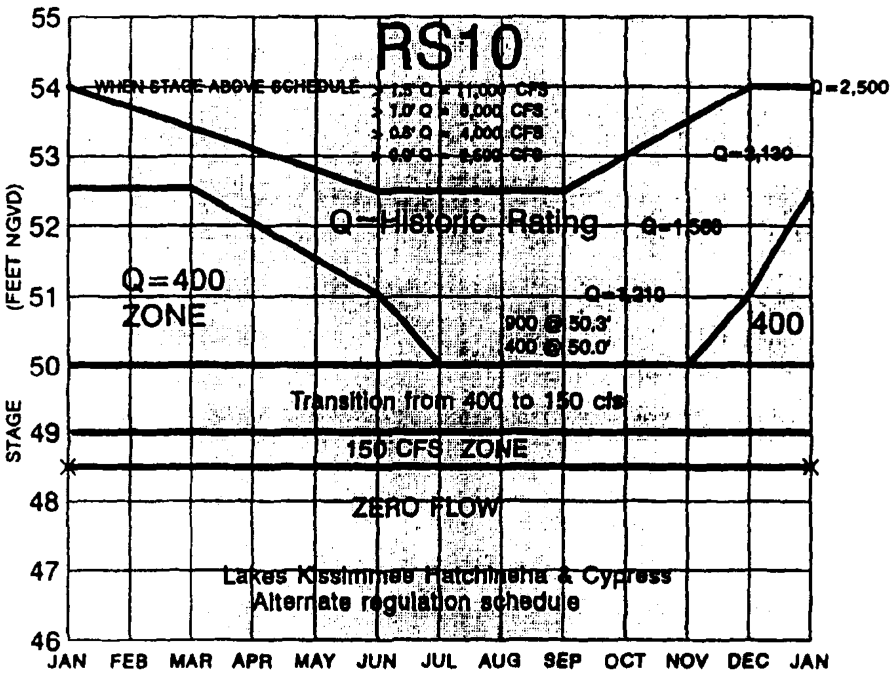
FIGURE 7-1(d)


RS10
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,500
Q=400
ZONE
Q=1,210
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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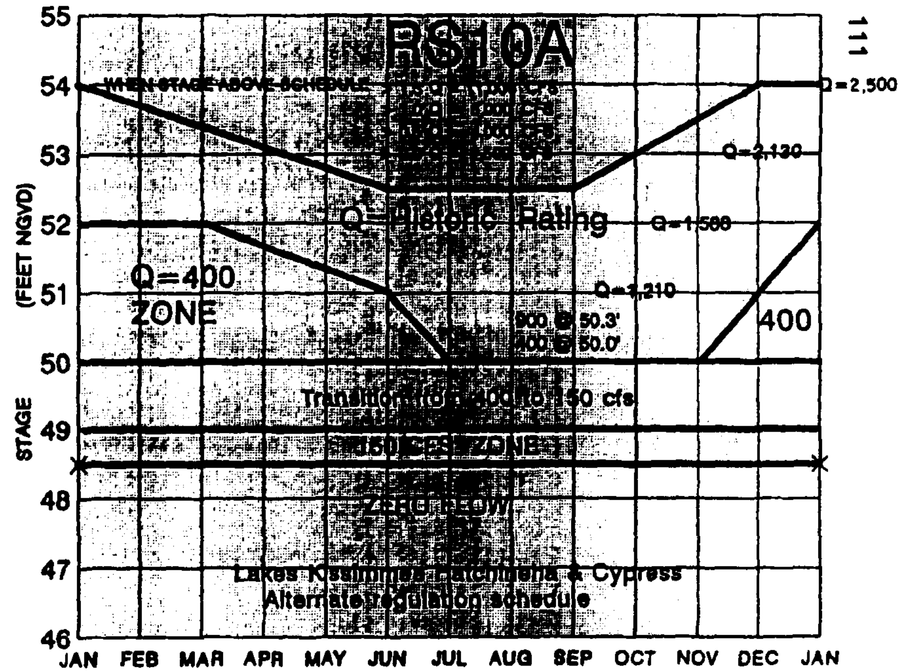
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10A
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,500
Q=400
ZONE
Q=1,210
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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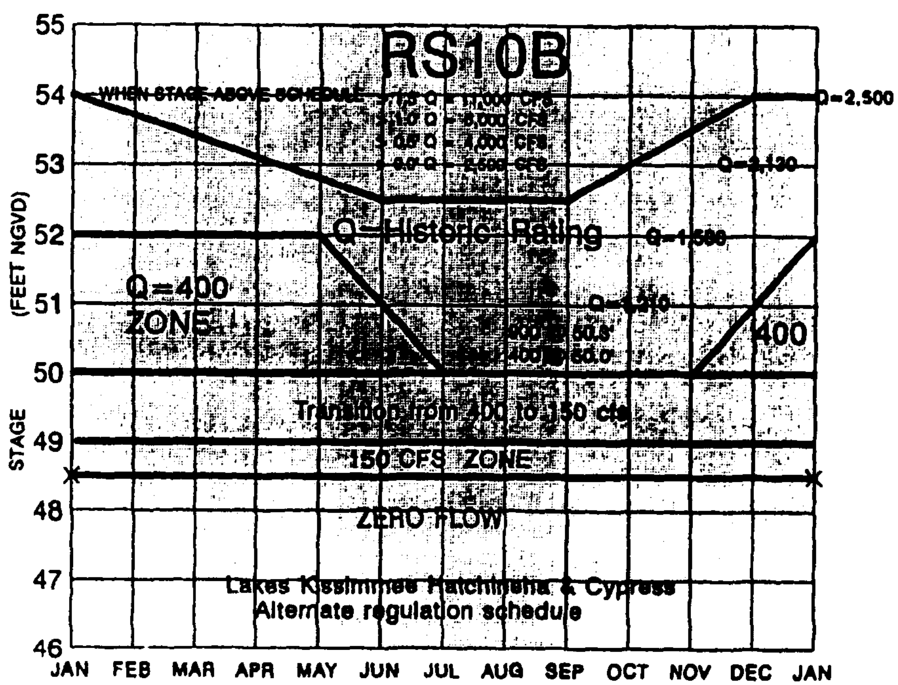
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10B
WHEN STAGE ABOVE SCHEDULE
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,500
Q=400
ZONE
Q=1,210
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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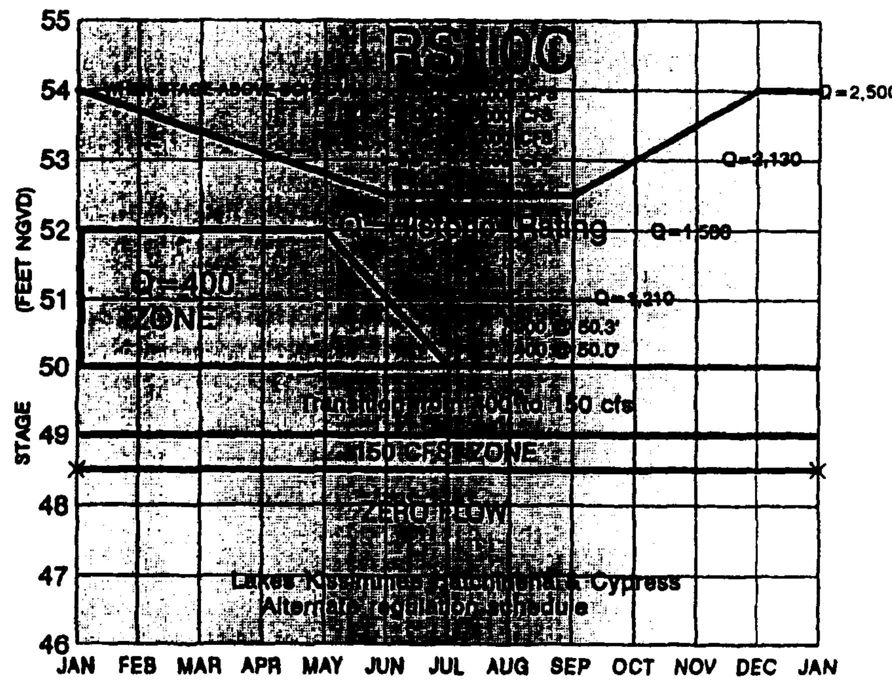
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10C
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,500
Q=400
ZONE
Q=1,210
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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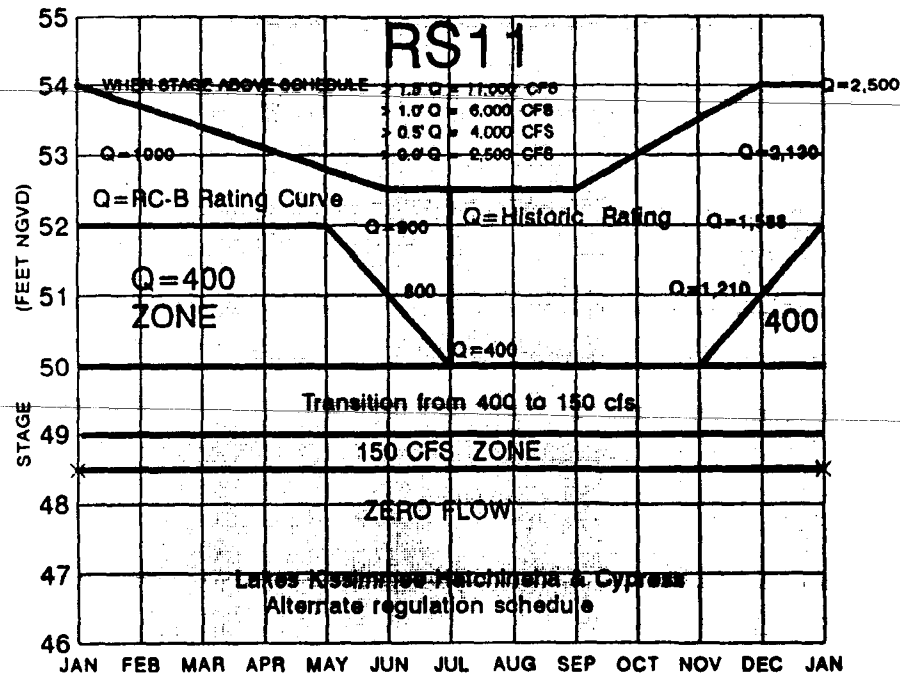
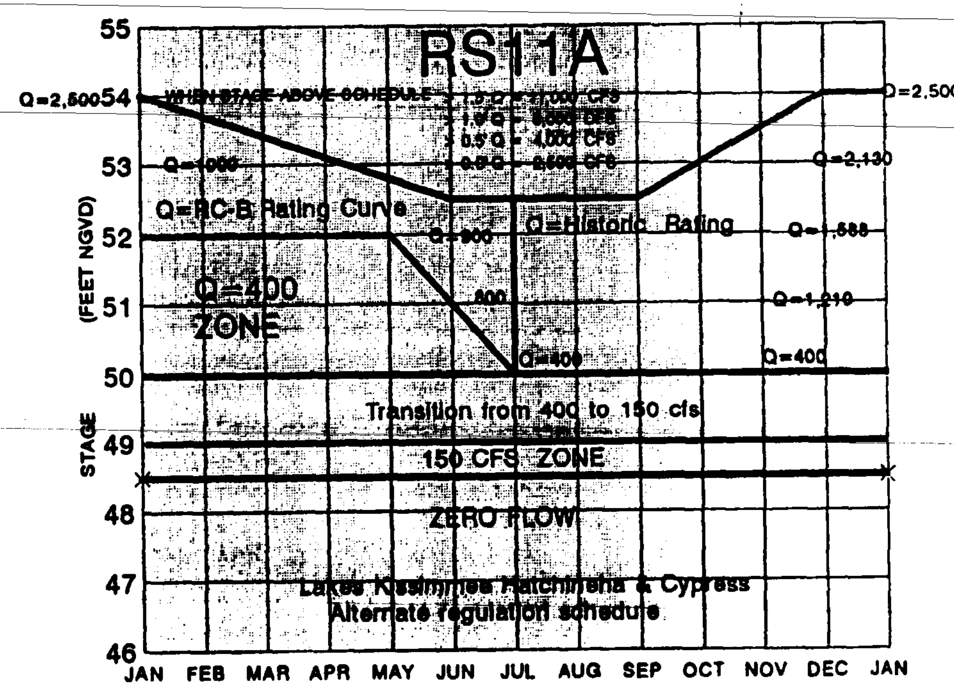
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(e)





7-22

FIGURE 7-1(f)

Initial alternatives were developed and improved through the addition or variation of one or several discharge zones. Upper level discharge zones were developed based on the historic rating curve in order to provide opportunities to achieve historic flow patterns. Because modelling outputs suggested the potential for overdrainage of Upper Basin lakes when historic discharges were used, two reduced stage-discharge rating curves, RC-A and RC-B, were developed as alternatives (see Figure C3, Appendix F for rating curves). In order to avoid reduction of higher water levels in the lakes, schedules were eventually modified by inserting a transitional zone with discharges between 400 cfs and 150 cfs. Minimum discharges of 150 cfs were incorporated within the schedules during low lake level periods.

7.5.2 Evaluation Process

The hydrologic performance of these alternatives was modeled over a 18-year, (1970-87) post-channelization simulation period, using a modified version of a continuous simulation model (Fan, 1986) for the upper chain of lakes (UKISS model). Environmental analyses of the alternatives focused on comparisons of their simulated hydrologic performance with the established restoration criteria. Lower Basin environmental requirements were based upon the simulated discharge regimes of the alternatives. Simulated Lake Kissimmee outflows for each alternative were compared to discharge characteristics of the RS1 schedule, because the 1991 feasibility study demonstrated that the hydrologic performance of this schedule met the criteria for restoration of the lower basin ecosystem and was used as a basis for the restoration project's authorization.

New alternatives were considered acceptable if their simulated discharge characteristics equalled or exceeded the hydrologic performance of the RS1 schedule. Comparisons were based upon monthly discharge exceedence data (i.e., discharges that were exceeded during various percentages of the simulation period). The continuous flow criteria was evaluated by determining monthly discharges that were exceeded during 90 percent of the simulation period. The degree to which the alternatives reestablished discharge variability and natural seasonal distributions of high and low flow periods was evaluated by monthly discharges that were exceeded during 10, 25, 50, and 75 percent of the simulation period. These percentages were chosen to represent magnitudes of discharges that could be expected during low (discharge exceeded during 75% of simulation period), average (discharge exceeded during 50% of simulation period), high (discharge exceeded during 25% of simulation period) and peak (discharges exceeded during 10% of simulation period) flow periods.

Upper Basin environmental analyses were based upon comparisons of observed and simulated stage duration curves for the post-channelization period. During the 1934-60 period of record, Lake Kissimmee stages exceeded 54 ft approximately 7 percent of the time and were less than 48.5 ft approximately 19 percent of the time. Because frequencies of lake stages between 49.6 ft and 50.8 ft were similar for the observed post-regulation period and historical period, and the primary environmental objective for the Upper Basin is to reestablish littoral wetlands that were drained by lowered lake stages, Upper Basin analyses focussed on the degree to which the alternatives increased frequencies of lake stages between 50.8 and 54 ft.

7.5.3 Initial Screening of Alternatives

Initial screening of the hydrologic performance of each alternative indicated that nine schedules failed to meet the minimum requirements of the Upper or Lower Basin restoration criteria. Five alternatives, the RS1, RS1-A, RS1-B, RS3, and RS4 schedules, were eliminated because simulations indicated these alternatives would result in Upper Basin water levels that would be consistently lower than stages produced by the existing regulation schedule. The RS2, RS5, RS6, and RS8 alternatives were eliminated because their discharge characteristics during average flow periods were inadequate for Lower Basin restoration. Simulations indicate that 50 percent of the time the RS2 and RS5 schedules would produce inflows of only 250 cfs. The RS6 and RS8 alternatives produced higher discharges, but were less than 600 cfs during most months, including much of the wet season. Based upon Lower Basin stage and Upper Basin discharge relationships, inflows produced by these schedules would consistently inundate only 50 percent or less of the river's floodplain. Table 7-2 summarizes the screening process for the first 8 regulation schedule options. The RS7 alternative was the only alternative that met both the Upper and Lower Basin objectives.

TABLE 7-2
INITIAL SCREENING OF ALTERNATIVES

OPTION	ACHIEVE LOWER BASIN FLOODPLAIN INUNDATION	LAKE KISSIMMEE STAGE ABOVE OBSERVED PERIOD (1970-88)	MAINTAIN FOR NEXT PHASE OF REVIEW
RS1	ACHIEVED	POOR	NO
RS1-A	ACHIEVED	POOR	NO
RS1-B	ACHIEVED	POOR	NO
RS2	NOT MET	POOR	NO
RS3	ACHIEVED	POOR	NO
RS4	ACHIEVED	POOR	NO
RS5	NOT MET	POOR	NO
RS6	NOT MET	FAIR	NO
RS7	ACHIEVED	FAIR	YES
RS8	NOT MET	GOOD	NO

7.5.4 Intermediate Development of Alternatives

The RS9, RS10, and RS11 series of alternatives were developed through sequential modifications of the RS7 schedule. Modifications involved adjustments of the location of the 400 cfs discharge zones and changes to the upper zone discharge rating curve. The main difference in the RS9 schedules is the addition of a 400 to 150 cfs transition zone from the 50 foot to 49 foot lake stages. The RS10 series also include the 400 cfs transition zone, but uses the historic rating curve above the 50 foot stage instead of the RC-A rating curve. RS11 and RS11A include the 400 cfs transition zone below 50 feet, but incorporate a combination of the Historic and RC-B rating curves in the upper discharge zones.

RS7, RS9, RS9-A through D, RS10, RS10-A through C, RS11, RS11-A produced discharge regimes that met the Lower Basin restoration criteria and improved upon the hydrologic performance of the RS1 schedule. Compared to the RS1 schedule, these alternatives had lower frequencies of no flow periods, increased the magnitude of low flows during wet season months and average flows during dry season months, and redistributed average and high flow volumes in a more natural seasonal pattern.

The simulated effects of these 12 schedules on lake stages were compared to observed lake stage frequencies between 1970-88. The schedules were grouped into three separate classes based upon their characteristics of stage/discharge over the period of record. Alternatives RS10, RS10-A, RS10-B, and RS10-C resulted in frequencies of lake stages > 51.5 feet that were similar to that produced by the current regulation schedule, but significantly lower frequencies of stages between 49.5-51.5 feet. Alternatives RS7, RS11, and RS11-A resulted in slightly higher frequencies of stages >52.5 feet and lower frequencies of stages between 50-51 feet than the current schedule. Alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D produced the greatest increase in frequencies of lake stages >51 feet, and had frequencies of stages between 49-51 feet similar to observed frequencies of these stages during the 1970-88 simulation period.

During an interagency meeting in November 1994, the last two schedules, RS9-D and RS11-A, were selected to be evaluated further by the USFWS. While the hydrologic performance of the RS9 type schedules would be similar for both the Upper and Lower Basins, the RS9-D has less operation constraints. Because this alternative does not have a zone that limits discharges to 400 cfs when lake stages are between 50-52 feet during November-December, it would produce more natural inflows to lower basin during these months. Therefore, the RS9-D was selected for its overall performance for both the Upper and Lower Basins. The RS11-A schedule was selected based on its potential to increase the upper end of the Upper Basin wetlands. Table 7-3 summarizes the selection of the final two alternatives.

TABLE 7-3
EVALUATION OF INTERMEDIATE ALTERNATIVES

OPTION	ACHIEVE LOWER BASIN FLOODPLAIN INUNDATION	FREQUENCY OF LAKE KISS STAGE ABOVE 52.5 FEET (1970-88)	LAKE STAGE ABOVE OBSERVED 49-51 FT (1970-88)	MAINTAIN FOR FINAL PHASE OF REVIEW
RS7	ACHIEVED	GOOD	POOR	NO
RS9	ACHIEVED	FAIR	GOOD	NO
RS9A	ACHIEVED	FAIR	GOOD	NO
RS9B	ACHIEVED	FAIR	GOOD	NO
RS9C	GOOD	FAIR	BEST	NO
RS9D	BEST	FAIR	BEST	YES
RS10	ACHIEVED	POOR	POOR	NO
RS10A	ACHIEVED	POOR	POOR	NO
RS10B	ACHIEVED	POOR	POOR	NO
RS10C	ACHIEVED	POOR	POOR	NO
RS11	ACHIEVED	GOOD	POOR	NO
RS11A	ACHIEVED	BEST	POOR	YES

7.5.5 Detailed Evaluation and Selection of Final Plan

The USFWS conducted detailed analyses of the final two alternatives, RS9-D and RS11-A, based on the addition of several new evaluation criteria. (Note: USFWS Coordination Act Report calls the alternatives by their original model designation; RS9-D is 400C150RR, and RS11-A is T1000HISRR). The stage-exceedence curves used in the initial screening of alternatives only indicated the percent of time over the period of record that a certain water level would be exceeded; it did not indicate the duration of each occurrence. The average duration of flooding and drying events was judged to be more significant, because it correlates better with the suitability of flooded areas as wildlife habitat and with the beneficial effects of routine low water levels. For this reason, seven criteria were developed for comparing the final alternatives. Three quantitative criteria were developed for evaluating the Upper Basin outputs. Four criteria were used for measuring the performance of the alternatives in achieving river restoration. The seven criteria are:

* average duration, in days, of water levels greater than 52.5 feet, the present regulated maximum of the lakes;

* average duration of water levels lower than 49 feet;

* coefficient of variation of the daily records over the 18 period of record - provides a measure of overall variability of water levels from the mean;

* average duration (days) with greater than 90 percent floodplain inundation in the wet season (June 1 - Oct 31);

* average duration (days) less than 200 cfs flow at S-65, in wet season;

* average duration (days) with greater than 25 percent floodplain inundation, Jan 1 - May 31;

* average duration (days) less than 200 cfs flow at S-65, Jan 1 - May 31.

A formula was devised to provide an overall ranking of the final two alternatives and to compare these alternatives with the period of record. The overall ranking (R) equals the weighting factor (W) for each criterion times the individual ranking value (r) for each criterion, summed across the 7 criteria:

$$R = W_{c1} x r_{c1} + W_{c2} x r_{c2} + \ldots \; W_{c7} x r_{c7}$$

The individual ranking value (r) for each criterion is a value from 0 to 1, based on the range of values observed for the alternatives and the observed values in the reference periods of record. For criteria 1, 2, 3, 4, and 6, high values are more desirable, and r is calculated as follows:

$$r = \frac{X}{X_{max}}$$

where X_{max} is the highest value for each criterion among the alternatives or the period of record.

For criteria 5 and 7, lower values are more desirable, and r is calculated as follows:

$$r = 1 - \frac{X}{X_{max}}$$

Evaluation team members assigned weighing factors, based on the following premises that account for institutional priorities. The preliminary review of water regulation schedules was based on evaluation of the timing and volume of discharges to the Kissimmee River. Although lower basin criteria was included in the final selection of the preferred schedule, it was decided that greater weight should be given to the factors relating to the Headwater lakes, that is, higher water levels and greater water level fluctuation. For the Lower Basin criteria, delivery of water to the Kissimmee River during the wet season months was considered more important than providing floodplain inundation and avoidance of low flow in the dry season.

Therefore, among the 7 criteria, the average number of days with water levels above 52.5 feet (criterion 1) and the overall variability in water levels (criterion 3) were considered most important to the evaluation for the Chain of Lakes, and were assigned a weighting factor of 2. The effects on the Lower Basin during the dry season (criteria 6 and 7) were considered relatively less important, and were assigned a weighting of 0.5. The other three criteria (2, 4, and 5) were considered to be intermediate in importance, and were assigned a weighting factor of 1.

Table 7-4 provides the ranking of the final two schedules as detailed by the USFWS in their 1994 Coordination Act Report. The RS9-D alternative rated higher than the RS11-A schedule for 5 of the 7 criteria. Although the average duration of water levels above 52.5 feet, criteria 1, is lower for RS9-D, the RS9-D schedule produces the greatest increase in frequencies of stages above 51 feet. A comparison of the observed period of record and the RS9-D stage and percent of time exceedence relationship is provided in Figure 7-2. On January 24, 1994, an Interagency Review Conference was held in the Jacksonville District for the project to discuss the results of the Service's community-level evaluation of the final alternatives. Based on the performance of the schedules, a joint decision was made by the group that the RS9-D regulation schedule was the best alternative for achieving the integrated environmental restoration objectives of the Upper and Lower Basins. Subsequently, the USFWS used individual species models on the preferred alternative to determine the potential for habitat improvements within the Upper Kissimmee Basin.

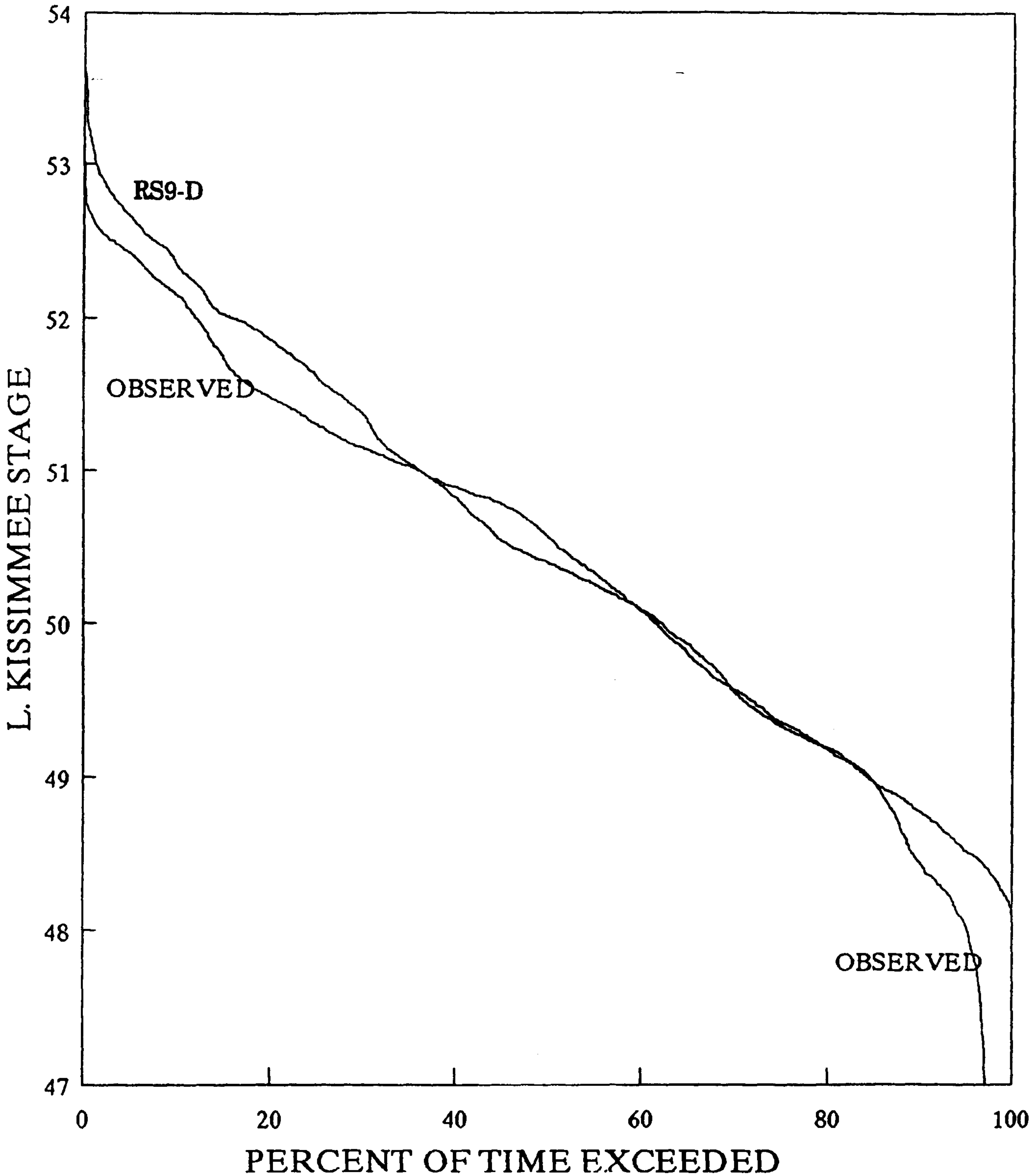
TABLE 7–4
RANKING OF THE FINAL TWO LAKE SCHEDULE ALTERNATIVES

CRITERIA	WT FACTOR (W)	"HISTORIC"			"OBSERVED"			"RS9D"			"RS11–A"		
		OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)
1	2	64.30	1.000	2.000	4.90	0.076	0.152	23.30	0.362	0.725	24.90	0.387	0.774
2	1	87.50	1.000	1.000	38.70	0.442	0.442	85.30	0.975	0.975	63.10	0.721	0.721
3	2	4.35	1.000	2.000	3.08	0.708	1.416	2.60	0.598	1.195	2.57	0.591	1.182
4	1	76.50	0.990	0.990	31.00	0.401	0.401	77.30	1.000	1.000	70.80	0.916	0.916
5	1	50.30	0.108	0.108	56.40	0.000	0.000	38.20	0.323	0.323	52.50	0.069	0.069
6	0.5	114.90	1.000	0.500	50.30	0.438	0.219	102.90	0.896	0.448	80.70	0.702	0.351
7	0.5	4.00	0.956	0.478	41.40	0.542	0.271	90.40	0.000	0.000	71.90	0.205	0.102
TOTAL SCORE				7.076			2.902			4.665			4.116

NOTES:

1 CRITERION 1 = AVE duration (days) water levels exceed 52.5 ft (Positively correlated, with weighting factor = 2)
CRITERION 2 = AVE duration (days) water levels below 49 ft. (Positively correlated, with weighting factor = 1)
CRITERION 3 = Coefficient of variation of water levels over 18–year period. (Positively correlated, with weighting factor = 2)
CRITERION 4 = AVE duration (days) with greater than 90% floodplain inundation in the wet season (June 1 – Oct 31) (Positively correlated, with weighting factor = 1)
CRITERION 5 = AVE duration (days) with less than 200 cfs flow at S–65, in the wet season. (Inversely correlated, with weighting factor = 1)
CRITERION 6 = AVE duration (days) with greater than 25% floodplain inundation, Jan 1 – May 31. (Positively correlated, with weighting factor = 0.5)
CRITERION 7 = AVE duration (days) with less than 200 cfs flow at S–65, Jan 1 – May 31. (Inversely correlated, with weighting factor = 0.5)

2 NOTE: (r) = individual ranking value
3 NOTE: HISTORIC PERIOD (1939–42; 1945–58)
4 NOTE: OBSERVED (1970–1988)
5 NOTE: REFER TO TEXT FOR EXPLANATION OF CRITERIA AND THE CALCULATION OF THE TOTAL SCORE



RS9-D
15 Nov 93

FIGURE 7-2

7.6 ENVIRONMENTAL RESTORATION ANALYSIS OF THE RECOMMENDED LAKE REGULATION SCHEDULE

7.6.1 Wetland Restoration

In their 1994 report, the USFWS conducted an analysis to determine the extent of additional acreage of wetlands that would be restored by higher water levels in Lakes Kissimmee, Hatchineha, and Cypress once the recommended schedule was implemented. According to the Service's report, the waterward edge of the marsh around the lake shores should not change as a result of the proposed project because of the predominance of highly tolerant wetland plants at the waters edge. The minimum hydrologic regime for determining wetlands is generally accepted as continuous saturation for at least 5 percent of the growing season. Assuming that the growing season is year-round in the study area (the most rigorous standard), this equates to 18 days of continuous saturation.

All durations were derived from model simulations over an 18 year, post-channelization (1970-87) period. The model has been calibrated for stage, but underestimated discharge during the simulation period by approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990).
As a result of using a drier period of the historical hydrological record, the wetland outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits then the simulation model predicted. The observed 1970-1988 period had an average duration of 18.2 days saturation at an elevation of 52.19 feet. While the RS9-D alternative provided an average duration of 19.25 days saturation at 52.87 feet. The Service generalized the findings of the hydrologic analyses and assumed that the present upper end of wetlands is approximately 52 feet and the with project upper end of wetlands would be 52.5 feet. Based on the Service's evaluation, the revised lake regulation schedule would restore about 5,939 acres of additional littoral marsh relative to the present condition excluding the breaching of local farm levees. If all three of the local farm levees, which were identified by the USFWS, adjacent to the shorelines of Lakes Kissimmee, Hatchineha, and Cypress are breached about 7,236 of acres of marsh would be restored.

7.6.2 Fish and Wildlife Habitat Modelling

As a cooperating agency with the U.S. Army Corps of Engineers in this study, the U.S. Fish and Wildlife Service (USFWS) gathered data and constructed models of the habitat requirements (species models) of representative faunal species in the Upper Basin (Annex D). The models were used with a grid-cell-based Geographical Information System (GIS) to quantitatively evaluate the final alternative lake regulation schedule. As a result of using a drier period of the historical hydrological record (see Paragraph 7.6.1), the habitat unit outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits then the simulation model predicted. Evaluation species were those listed below:

1. Snail kite (Federally endangered)
2. Florida sandhill crane (State threatened)
3. Bald eagle (Federally endangered)
4. Audubon's crested caracara (Federally threatened)
5. Wood stork (Federally endangered)
6. Florida mottled duck (resident game species)
7. Snowy egret (State species of special concern)
8. Largemouth bass (sport fish species)
9. Great egret (widely ranging, opportunistic predator)
10. Ring-necked duck (migratory game species)

Table 7-5 presents the results of the species models in terms of habitat units for the recommended lake regulation schedule. The total reflects that local farm levees surrounding the effected lakes will be breached to hydrologically connect the existing wetlands with the lakes and allow additional restoration. Section 7.6.3 presents an analysis which demonstrates the cost effectiveness of breaching the local farm levees to obtain the full potential for environmental benefit in the Upper Basin.

TABLE 7-5
HABITAT UNITS (ACRES X HSI)
FOR EXITING AND RECOMMENDED PLAN

SPECIES	WITHOUT PROJECT	WITH PROJECT	CHANGE
FLORIDA DUCK	6,755	9,119	2,364
RING-NECK DUCK	11,516	15,015	3,499
SNAIL KITE	659	839	180
GREAT EGRET	17,619	21,509	3,890
SNOWY EGRET	13,943	16,501	2,558
WOOD STORK	16,491	18,353	1,862
LARGEMOUTH BASS	38,174	38,937	763
BALD EAGLE	31,827	32,102	275
SANDHILL CRANE	63,452	63,208	(244)
CRESTED CARACARA	41,486	41,618	132
ALL SPECIES	241,923	257,201	15,278

7.6.3 Levee Breaching Cost Effectiveness Analysis

Lands up to the 54 foot elevation will be periodically reflooded with the implementation of the recommended lake regulation schedule. Throughout Lakes Kissimmee, Hatchineha and Cypress, several farm levees were constructed adjacent to the lakes by land owners prior to implementation of the flood control project. Plate 8-1, Project Plan Plate, shows the location of five local farm levees which are within the influence of the proposed regulation schedule. Three were identified by the USFWS in their Coordination Act Report. Two more where identified later in the study. These levees have encroached upon the historic lake littoral zone, separating the large, historic, lake bottom marshes from the lakes. In each case, either drainage canals or pump stations are in place to drain surface water run-off into the adjacent lake.

Because the levees encroach within the boundaries of the storage requirements of the proposed lake regulation schedule, e.g. 54 feet, and the levees would not provide adequate protection for lands behind the levees, lands located behind levees will be inundated as part of the project requirements. Lands located behind farm levees are not beyond the impacted areas of the proposed regulation schedule and are not considered as separable project areas. For this reason, an incremental analysis was not possible or appropriate for determining the justification for reflooding these lands. While a quantitative environmental incremental analysis cannot be performed for this project due to the lack of separable project environmental features, a modified qualitative analysis was done which describes the potential for increases in environmental performance for the recommended lake regulation schedules.

Lands behind all of the levees, are required as part of the water storage needs for the restoration of the Lower Kissimmee River Basin and would provide additional areas for environmental enhancement in the Upper Basin. A sixth levee, referred to as the Exposition levee, located along the western shore of Lake Hatchineha, was also identified, but was found to be adequate for protection against a 10 year or project level flood based on a geotechnical investigation performed by the Jacksonville District. Approximately 220 acres of land would need to be acquired if we use the land for project environmental and storage purposes. Because the cost of acquiring the land located behind the levee and degrading the levee, $451,000, was considered too high compared to the limited storage and environmental benefit, the District recommended not to acquire lands located behind the Exposition levee.

Since these levees would provide a hindrance against the hydrologic influence of the proposed lake regulation schedule, the removal of these levees would provide the full storage capacity required for maintenance of the existing project flood control project and for Kissimmee River environmental restoration. The removal or partial removal of locally constructed levees would enhance the hydroperiod on the interior portions of the property presently being protected by the levees, allowing for expansion of the lake littoral zone in the Upper Basin. Breaching of the levees was considered as a more viable alternative to degradation of the entire levee. The breach was estimated based on providing a minimum of 100 foot gaps at approximately every one thousand feet along the levee alignment. This alternative would be less expensive than degrading the entire levee, and would provide areas for upland habitat to remain.

An analysis was performed to demonstrate the cost effectiveness of degrading five local farm levees located adjacent to Lakes Cypress, Hatchineha, and Kissimmee. Table 7-6 describes the levees and the analysis based on the value of wetlands expected for degrading the levee and on the expected Habitat value outputs as detailed by the USFWS in their Coordination Act Report. Out of the ten species modelled by the USFWS, only five showed significant changes after the project is implemented. These five species, the Florida Duck, Great Egret, Snowy Egret, Wood Stork, and the Bald Eagle, were selected for the cost effectiveness analysis. Degrading the five local levees is recommended to improve project storage capability for the Lower Basin restoration and for increasing the level of environmental enhancement in the Upper Basin. Breaching of the levees would restore an additional 1,350 acres of marsh. The total additional littoral marsh added relative to the existing condition would be 5,939 acres.

TABLE 7-6
COST EFFECTIVENESS OF BREACHING LOCAL FARM LEVEES

							ADDITIONAL BENEFITS IF LEVEES BREACHED			
LOCAL FARM LEVEES	LENGTH (FT)	LANDS BETWEEN 52.5 & 54 FT (ACRES)	PROJECT STORAGE (ACRE-FT)	LAND REQUIRED FOR PROJT STORAGE	COST OF LAND ($1,000's)	COST TO GAP LEVEE ($1,000's)	ADDED WETLANDS PRODUCED (ACRES)	ADDED HABITAT (IN HABITAT UNITS)	TOTAL PROJECT COST	LOCAL LEVEE PROJECT RECOMMENDATIONS
LAKE CYPRESS										
1 BRONSON	13,000	700	1,110	YES	$674	$26	166	210	$700	GAP LEVEE
LAKE HATCHINEHA										
2 SPARKS CANDLER	15,000	500	810	YES	$707	$26	31	39	$733	GAP LEVEE
3 ROLLING MEADOWS	22,000	1,826	2,550	YES	$5,480	$30	1028	1511	$5,510	GAP LEVEE
LAKE KISSIMMEE										
4 OVERSTREET	14,000	171	525	YES	$274	$22	103	180	$296	GAP LEVEE
5 OASIS	2,500	205	375	YES	$256	$10	22	38	$266	GAP LEVEE

7.7 FLOOD CONTROL DESIGN OPTIMIZATION

The structural components of the recommended plan were not formulated as a measure for achieving a given level of project environmental outputs. The structural components of the plan are required to maintain the existing level of flood protection in the Upper Basin. They were not proposed as additional options for obtaining additional project environmental outputs, but necessary features of the recommended plan.

Based on our January 21, 1994, Review Conference which was held in the Jacksonville District with the South Florida Water Management District, a decision was made by the Jacksonville District to limit project induced flood impacts to the top of the proposed new Lake Kissimmee regulation schedule or 54 feet. This decision was established based on the requirements from the project authorization that is, to limit or reduce the potential for project induced flood damages on adjacent residential areas. Potential increases in post-project flood stages above 54 feet were addressed through proposed structural modifications of the existing flood control canals and outlet structure at Lake Kissimmee.

Hydrologic analyses were undertaken to define the limits of flood impacts in the Upper Basin chain of lakes. Once these impacts were developed, modelling efforts were continued to define a project design which would meet our recommended flood control constraints. The flood control design was constrained by the top of the proposed lake regulation schedule or 54.0 feet NGVD. Based on this design constraint, our modelling indicates that there will be no project induced flood impacts above the 54 foot contour. Furthermore, these flood impacts will not extend beyond the boundaries of the S-61 and S-63A control structures due to the extensive amount of residential development that is presently located and expanding in north Osceola County.

7.7.1 Design and Hydrologic Modelling Methodology

The primary purpose of the rainfall runoff modeling in this study was to analyze and compare the hydrologic effects of the existing and proposed new regulation schedules, to insure that the Kissimmee project continues to function, and to maintain the same level of flood protection in the Upper Kissimmee Basin as it was originally designed for all lands above 54.0 feet elevation.

The existing flood control project is designed to convey a 30 percent SPF (approximately a 7-year event) flood event within the C-38 canal, which translates to approximately an 11,000 cfs peak flowing in Pool A. The local sponsor currently owns the lands necessary to withstand the 11,000 cfs flow in Pool A at a design headwater of elevation 46.3 feet at S-65A (translates to about elevation 49.5 feet at S-65 tailwater). S-65 is operated such that the total discharge at S-65A (S-65 releases plus local inflow into Pool A) does not exceed 11,000 cfs and therefore maintains flood stages within available sponsor-owned lands. Under the with-project conditions, backwater effects from the restored river section in Pool B under a 30 percent SPF flow translates to a peak stage at the S-65 tailwater of about elevation 52 feet. Any attempt to maintain a tailwater comparable to existing conditions would require the reduction of S-65 releases to less than 5,000 cfs, which in turn would lead to an unacceptable rise in the Lake Kissimmee and Upper Basin lake stages. Therefore, in order to maintain the existing level of flood protection upstream of S-65, S-65 must be operated to make full available discharges to the Lower Basin. This was the operating criteria that was used for all flood control alternatives described in this section.

The Upper and Lower Kissimmee basins were analyzed as a fully-integrated hydraulic system with the Corp's one-dimensional unsteady flow routing model, UNET. UNET provides the analytical tool for designing the structural modifications (i.e., improved canals, increased structural capacity) necessary to maintain existing flood control criteria upstream of S-65 for the recommended project. Appendix A, Hydrology and Hydraulic Analyses, provides a detailed documentation of the modelling effort and the optimization of the flood control design features.

With the combined capabilities of the UKISS and UNET models, the study allowed flood control features to be designed through a coincident frequency approach whereby flood stages are considered to result from the joint probabilities of starting water surface elevation and rainfall frequency. The starting water surface elevations for flood events vary according to the stage-duration relationship generated by the UKISS period of record routing model. The joint probability approach provided a statistical basis for the flood control project and resulted in design optimization and cost reduction of certain project features. The alternatives which were considered for flood control design optimization are described below:

a. **Alternative 1 (With backfill and new regulation schedule)** is the condition of restoration of the Kissimmee River and installation of the new schedule without any other structural modifications.

b. **Alternative 2 (With backfill, new schedule, and enlarged canals)** is the same as Alternative 1 but with enlargement of the canals C-36 and C-37 connecting Lakes Kissimmee, Hatchineha, and Cypress. The plan for C-36 calls for an increase in canal width from 48 feet to 60 feet. C-37 will be widened from 70 feet to 90 feet. Enlargement of the canals C-34 and C-35 was found to be not necessary in order to maintain the current level of flood protection.

c. Alternative 3 (Plan 2) is the same as Alternative 2 but with an increase of 33 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 4-bay structure.

d. Alternative 4 (Plan 1) is the same as Alternative 2 but with an increase of 67 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 5-bay structure.

7.7.2 Optimization of Flood Control Design for Upper Basin

For each of the six locations (Kissimmee, Tiger, Hatchineha, Cypress, S-61 tailwater, and S-63A tailwater) shown to be affected by the regulation change, stage frequency relationships were examined for the four alternatives. Table 7-7 shows peak flood stages for the Existing Conditions and the four alternatives described in Section 7.7.1 using the proposed regulation schedule. Figures A-10 through A-21 of the Hydrology and Hydraulics Appendix also show plots of the stage-frequency curves for existing conditions and the four alternatives using the proposed regulation schedule. Review of the stage-frequency table and stage-frequency curves leads to several conclusions:

1. Alternative 1 satisfied the stage-frequency criteria for Lake Kissimmee, however, the increased stages at the upstream locations, S-61, S-63A and Lake Cypress made it necessary to improve downstream conveyance by enlarging canals C-36 and C-37.

2. Alternative 2 satisfied the stage-frequency criteria for Lakes Cypress and Hatchineha, but the improved downstream conveyance increased the level of flood stages in Lake Kissimmee above elevation 54 feet for the 25-year frequency storm.

3. Alternative 3 (S-65: 4-bay) does not restrict stage impacts on Lake Kissimmee to below elevation 54 feet for the 25-year frequency storm.

4. Alternative 4 (S-65: 5-bay) limits stage impacts at all six locations to elevation 54 feet or below (see 5. below). Alternative 4 is the recommended flood control design solution.

5. Although the S-61 and S-63A tailwater locations show minor stage impacts (0.1 feet) above elevation 54 for the recommended plan, maintenance dredging of Canals 35 and 34 to their as-built templates will eliminate these impacts.

TABLE 7-7
PEAK STAGES FOR ALTERNATIVES
FOR OPTIMIZATION OF UPPER BASIN FLOOD CONTROL DESIGN

PEAK STAGE (EL. FT)	EXIST CONDI-TIONS	ALT. #1	VS. EX.	ALT. #2	VS. EX.	ALT. #3	VS. EX.	*ALT #4	VS. EX.
5-YEAR FREQ									
S-61 TAILWATER	53.91	54.53	0.6	54.11	0.2	54.05	0.1	54.01	0.1
S-63A TAILWTER	53.85	54.49	0.6	54.03	0.2	54.01	0.2	53.98	0.1
CYPRESS	53.47	54.15	0.7	53.67	0.2	53.63	0.2	53.58	0.1
HATCHINEHA	52.87	53.82	1.0	53.39	0.5	53.35	0.5	53.3	0.4
KISSIMMEE	51.77	52.73	1.0	52.83	1.1	52.83	1.1	52.77	1.0
TIGER	52.39	52.99	0.6	53.03	0.6	52.99	0.6	52.99	0.6
JACKSON	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
ROSALIE	56.1	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0
MARIAN	61.4	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0
10-YEAR FREQ									
S-61 TAILWATER	54.53	54.96	0.4	54.47	-0.1	54.47	-0.1	54.38	-0.1
S-63A TAILWTER	54.53	54.94	0.4	54.50	-0.0	54.49	-0.0	54.43	-0.1
CYPRESS	54.16	54.62	0.5	54.09	-0.1	54.09	-0.1	53.99	-0.2
HATCHINEHA	53.69	54.29	0.6	53.85	0.2	53.85	0.2	53.74	0.1
KISSIMMEE	52.41	53.09	0.7	53.29	0.9	53.29	0.9	53.17	0.8
TIGER	52.93	53.35	0.4	53.46	0.5	53.44	0.5	53.37	0.4
JACKSON	57.4	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0
ROSALIE	56.3	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0
MARIAN	61.7	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0

1. Alternative 1. - Proposed Regulation Schedule with no structural modifications.
2. Alternative 2. - Proposed Regulation Schedule with enlarging canals C-36 and C-37.
3. Alternative 3. (Plan 2) - Proposed Regulation Schedule with enlarging canals C-36 and C-37 and increasing S-65 outlet from 3 to 4 bays.

*4. Alternative 4. (Plan 1) - The Recommended Plan - Proposed Regulation Schedule with enlarging canals C-36 and C-37 and increasing S-65 outlet from 3 to 5 bays.

TABLE 7-7 (continued)
PEAK STAGES FOR DESIGN ALTERNATIVES
FOR OPTIMIZATION OF UPPER BASIN FLOOD CONTROL DESIGN

PEAK STAGE (EL. FT)	EXIST CONDI-TIONS	ALT. #1	VS. EX.	ALT. #2	VS. EX.	ALT. #3	VS. EX.	ALT. #4	VS. EX.
25-YEAR FREQ									
S-61 TAILWATER	55.96	55.91	-0.0	55.35	-0.6	55.33	-0.6	55.22	-0.7
S-63A TAILWATR	56.01	55.92	-0.1	55.37	-0.6	55.36	-0.6	55.27	-0.7
CYPRESS	55.71	55.59	-0.1	55	-0.7	54.98	-0.7	54.88	-0.8
HATCHINEHA	55.42	55.3	-0.1	54.85	-0.6	54.82	-0.6	54.68	-0.7
KISSIMMEE	53.96	53.79	-0.2	54.21	0.3	54.14	0.2	53.95	0.0
TIGER	54.08	53.96	-0.1	54.25	0.2	54.2	0.1	54.05	0.0
JACKSON	58.1	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0
ROSALIE	56.6	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0
MARIAN	62.1	62.1	0.0	62.1	0.0	62.1	0.0	62.1	0.0
50-YEAR FREQ									
S-61 TAILWATER	56.77	56.45	-0.3	55.88	-0.9	55.79	-1.0	55.44	-1.3
S-63A TAILWATR	56.84	56.45	-0.4	55.89	-1.0	55.82	-1.0	55.5	-1.3
CYPRESS	56.56	56.19	-0.4	55.58	-1.0	55.5	-1.1	55.12	-1.4
HATCHINEHA	56.41	55.94	-0.5	55.49	-0.9	55.39	-1.0	54.93	-1.5
KISSIMMEE	55.13	54.34	-0.8	54.88	-0.3	54.68	-0.5	54.08	-1.0
TIGER	55.15	54.44	-0.7	54.88	-0.3	54.71	-0.4	54.23	-0.9
JACKSON	58.4	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0
ROSALIE	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
MARIAN	62.4	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0

7.7.3 S65A REMOVAL OPTION

The removal of S65A was considered by the 1985 Kissimmee River Final Feasibility Report, the SFWMD's 1990 "Kissimmee River Restoration Alternative Plan Evaluation and Preliminary Design Report" and the 1991 Kissimmee River Restoration Feasibility Study. The option was never pursued because of the uncertainty of the potential overdrainage of the Pool A floodplain. The current combined Upper and Lower Basin UNET modelling indicates that flood stages will be higher in Pool A of the Kissimmee River than originally modelled for the 1991 feasibility study. The S65A removal option resurfaced for this study as a possible measure for reducing the additional land requirements in the Kissimmee River Pool A and for reducing or eliminating any structural improvements at S-65.

The UNET model was used to assess the potential overdrainage problem arising from the removal of S65A. Flood flows, average daily flows and low flow conditions out of S65 were modelled to determine the range of potential stage impacts in Pool A.

The removal of S65A appears to lower Lake Kissimmee and Pool A stages during the extreme flood flows (25 year and larger). Lower stages during average daily flow conditions indicate possible overdrainage of the Pool A floodplain. Water levels in Pool A could be lowered as much as 2 to 5 feet, depending on the average daily flows. The lower stages would likely overdrain the surrounding floodplain and adjacent tributaries resulting in a reduction in available groundwater. As such, the projected environmental outputs of the authorized recommended plan will be reduced. Potential environmental and navigational impacts would necessitate implementation of engineering and/or mitigation measures to reduce or avoid project induced damages.

Based on the U. S. Fish and Wildlife Service's 1991 Coordination Act Report, maintaining the gated spillway structure could provide the operational flexibility desired for the accomplishment of pool stage fluctuation and a flow-through impounded marsh in the Pool A area. The marsh feature would add approximately 3,214 acres of wetlands to Pool A. Based on a preliminary UNET model evaluation, the removal of S65A does not remove the requirement to increase the outlet capacity at S65. The model indicates that the S65A removal alternative would result in a net increase in flood stages above 54 feet. Therefore, the S65 structure would have to be modified to compensate for the increase in flood stages.

In order to determine the cost effectiveness of the S65A removal alternative, cost estimates were developed for comparison to the recommended plan. Annual operation and maintenance costs were not included in the comparison. The cost of the S65 structural improvements including the additional land requirements in Pool A (above 1991 feasibility levels) were compared with the option of S65A removal and tieback levee degradation. Table 7-8 summarized the S65A analysis. The cost of the recommended S65 structural improvements is approximately $3.0 million. The cost to provide the S65A removal option, excluding overdrainage or environmental mitigation measures, is approximately $3.7 million. Additive measures, whether levee impoundments or small weirs in the tributary areas to hold water levels up in Pool A, would increase the cost further. Therefore, this option was not considered further.

TABLE 7-8
COST COMPARISON OF RECOMMENDED S65 IMPROVEMENTS AND S65A REMOVAL ALTERNATIVE

ITEM	COST OF RECOMMENDED PLAN	COST OF S65A REMOVAL
S65 MODIFICATIONS	$3,000,000	$2,000,000
LANDS	$ 365,000	UNKNOWN
REMOVE S65A AND TIEBACK LEVEES		$1,105,000
CONTROL WEIR		$ 620,000
ENVIRONMENTAL MITIGATION MEASURES		UNKNOWN
TOTALS	$3,365,000	$3,725,000

1. S65A ESTIMATE BASED ON UPDATED COST TO REMOVE S65B.
2. WEIR COSTS BASED ON UPDATED COST FROM 1990 SFWMD KISSIMMEE RIVER REPORT.

7.7.4 Tributary Impact Analyses of Recommended Flood Control Plan

Lakes Jackson, Tiger, and Rosalie and are connected directly to Lake Kissimmee either through natural tributaries or man-made canals. Hydraulic analyses were conducted to determine if and to what extent an increase in the Lake Kissimmee regulation schedule would impact the flood stages in the three lakes and tributaries.

a. Lake Jackson - Lake Jackson is connected to Lake Kissimmee through Jackson Canal, a man-made canal approximately 2.75 miles in length. The Lake Jackson Water Control Structure (LJWCS), installed in 1994, was designed to maintain Lake Jackson at a higher stage (elevation 53.5 feet) in order to improve the aquatic habitat of the lake. Although the peak stages in Lake Jackson increased after the LJWCS was installed, these impacts are attributable to the structure itself and to the higher regulation schedule for Lake Jackson. These locations are sufficiently elevated to remain unaffected by the changes in the Lake Kissimmee regulation schedule and S-65 capacity. Stage impacts resulting from the increased Lake Kissimmee regulation schedule were limited to river mile 6.0 to 6.5 along Jackson Canal and would be on the magnitude of only 0.1 feet. Lake Kissimmee is considered to be at river mile 5.25 and LJWCS at river mile 7.5.

b. Lake Tiger - Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small, mildly meandering natural stream which flows through a flat, swampy expanse of marshes over a distance of 9,000 feet. Since Lake Tiger and Lake Kissimmee are at essentially the same natural ground elevation and since no water control structure is currently installed on Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Under normal stage and flow conditions, the head loss through Tiger Creek generally results in Lake Tiger exhibiting a 0.1 to 0.5 feet higher water stage than Lake Kissimmee. The head loss may increase to over 1 foot in the early phases of a flood when discharges through Tiger Creek are high and the Lake Kissimmee stage is still relatively low (i.e., less than elevation 51 feet). However, as the stage in Lake Kissimmee rises due to a larger flood event and approaches or exceeds 54 feet, the head difference between the two lakes is reduced to 0.1 feet or less. Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, outside of isolating Lake Tiger and installing a substantial pump station, there is no structural measure to insure that the Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. The Lake Tiger evaluation is described in the following paragraphs.

Several structural alternatives and combinations of the alternatives were considered and evaluated for construction at the Tiger Creek location to reduce flood stages in Lake Tiger. Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, the only structural alternative to reduce with-project flood stages below Lake Kissimmee is isolating Lake Tiger and installing a substantial pump station.

Sizing of the pump station based on the critical 25-year flood frequency indicate that a 1650 cfs capacity pump station would be required at the Tiger Creek outlet of Lake Tiger. A preliminary cost estimate for a 1650 cfs pump station was prepared. Estimated cost is $10,647,000. The estimated cost of land acquisition at Lake Tiger, including the costs of lands, administration, and contingencies is $3,000,000. Additional costs associated with the station superstructure, inlet and outlet channels, culverts and tieback levees extending to high ground would escalate the total cost of the pump station even higher. Furthermore, annual operating and maintenance costs as well as environmental mitigation are additional considerations making the pumping option even less attractive.

Therefore, the flood control solution for Lake Tiger must be similar to that already recommended for Lake Kissimmee, which is a combination of implementing Plan 1 (C-36 and C-37 improvements, S-65 enlargement) and acquiring interest in lands to elevation 54 feet around Lake Tiger.
Project lands lying between the 52.5 foot contour and the 54 foot contour would need to be acquired based on a flowage easement. A perpetual flowage easement is being recommended over fee acquisition due to the limited post-project environmental benefits within the Lake Tiger littoral zone.

TABLE 7-9
ELIMINATION OF LAKE TIGER TRIBUTARY IMPACTS

ALTERNATIVE MEASURE	PLAN 1	PLAN 2
1. FLOWAGE EASEMENT AROUND LAKE TIGER	$3,000,000	NO COSTS
2. INSTALL 1650 CFS PUMP STATION BETWEEN LAKE TIGER AND KISSIMMEE	NO COSTS	$10,647,000
3. INSTALL CULVERTS AND TIEBACK LEVEES	NO COSTS	NOT ESTIMATED
TOTAL COSTS	$3,000,000	$10,647,000 +

c. Lake Rosalie - Lake Rosalie is connected to Lake Kissimmee through Zipperer Canal, a man-made canal about 2.0 miles in length. G-113, a SFWMD weir structure is installed in the canal about 1.6 miles downstream from Lake Rosalie and maintains Lake Rosalie at a higher stage, normally between elevation 54.0 to 54.5 feet. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges at a natural sill elevation of 50 feet downstream to Lake Tiger. The weir will prevent any backwater effects due to an increased Lake Kissimmee regulation schedule from impacting stages in Lake Rosalie.

7.8 UPPER BASIN FLOOD CONTROL DESIGN

The plan developed in Section 7.7 was designed to meet the requirements of maintaining the existing level of flood in the Upper Basin. The plan calls for widening the flood control canals C-36 and C-37 by 12 and 20 feet, respectively and increasing the outlet capacity of water control structure S-65 by 2 bays. There will be no project induced flood damages above elevation 54 feet around those lands surrounding Lakes, Cypress, Hatchineha, Kissimmee and Tiger. Lands in the Upper Basin above the S-61 and S63A water control structures will not be impacted by the recommended project. Therefore, the existing level of flood protection provided by the current flood control project will be maintained. Table 7-10 provides a comparison of the existing flood stages based on the existing conditions with the flood stages expected with the proposed lake regulation schedule and accompanying flood control measures. Based on the Table 7-10, the project will have no impact on flood stages above 54-foot elevation during severe or catastrophic events, for example, the 50 or 100 year storm events. In fact, based on the results of the hydrologic modelling, areas surrounding Lakes Cypress, Hatchineha, Kissimmee and Tiger should expect an increase in the level of flood protection based on the reduction of the 100-year flood stage.

TABLE 7-10
KISSIMMEE RIVER UPPER BASIN
EXISTING VERSUS PROJECT PEAK FLOOD STAGE COMPARISON (FT)

PEAK STAGE (FT)	RETURN PERIOD OF FLOOD EVENT IN YEARS									
	5-YEAR FREQ		10-YEAR FREQ		25-YEAR FREQ		50-YEAR FREQ		100-YEAR FREQ	
	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND	PLAN
S-61 TAILWATER	53.91	54.01	54.53	54.38	55.96	55.22	56.77	55.44	57.22	55.86
S-63A TAILWATER	53.85	53.98	54.53	54.43	56.01	55.27	56.84	55.5	57.46	55.89
CYPRESS	53.47	53.58	54.16	53.99	55.71	54.88	56.56	55.12	57.04	55.57
HATCHINEHA	52.87	53.3	53.69	53.74	55.42	54.68	56.41	54.93	56.99	55.44
KISSIMMEE	51.77	52.77	52.41	53.17	53.96	53.95	55.13	54.08	56.18	54.58
TIGER	52.39	52.99	52.93	53.37	54.08	54.05	55.15	54.23	56.18	54.69
JACKSON	56.8	56.8	57.4	57.4	58.1	58.1	58.4	58.4	58.7	58.7
ROSALIE	56.1	56.1	56.3	56.3	56.6	56.6	56.8	56.8	57	57
MARIAN	61.4	61.4	61.7	61.7	62.1	62.1	62.4	62.4	62.7	62.7

7.9 EVALUATION OF REAL ESTATE REQUIREMENTS

7.9.1 Development of Project Real Estate Requirements

As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be periodically flooded. This will require acquisition of land to insure the minimum project requirements are obtained. Land acquired under the provisions of a flowage easement will generally not address the requirements of the Headwaters Revitalization Project. To achieve project environmental goals and to assure that flexibility is available to operate the regulation schedule, as necessary, to achieve the greatest environmental benefits without impacting flood control, it was determined that adequate interests in lands should be acquired to provide for flexibility in post project hydrology and to assure the full realization of fish and wildlife project potentials.

The environmental benefits achieved by modifying the regulation schedule may be affected by how the acquired land is used. If the land is acquired through minimal flowage easements, the land will be available for use by land owners during dry periods. The availability of project lands to land owners for farming and other uses could greatly reduce the environmental potential for the project. Undeveloped lands between the 52.5 foot and the 54 foot contour will require restrictions of detrimental activities, operations and structures to insure that the full project environmental objectives of the Kissimmee Headwaters Revitalization Project are met. Fee is required in agricultural areas where land uses would be detrimental to the environmental benefits being achieved for this project. The restrictions required to achieve the environmental goals would prohibit fertilizing, chopping, mowing, weeding, and cultivating practices which would render the lands unusable for highest and best use which is agricultural.

Environmental resource agencies have stated the desire to increase the duration of flooding at the 54 foot elevation. The Fish and Wildlife Coordination Act Report dated April 1994 and cover letter dated June 30, 1994, from U. S. Department of the Interior, recommends operational flexibility to increase periods of inundation between the 52.5 and 54-foot contours to increase environmental benefits. Coordination with Fish and Wildlife and the South Florida Water Management District Environmental biologists resulted in a determination by the Corps of Engineers that it will be beneficial to extend duration of water storage at the 54 foot regulation schedule when this can be accomplished without detrimental impacts to flood control. This will increase wetlands and provide even greater environmental benefits in the Upper Basin.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation. The evaluation of alternative schedules will be an ongoing process after implementation of the Headwaters Revitalization Project and the Kissimmee River Restoration. Given the uncertainties of the simulations resulting from incomplete model calibration (i.e., underestimated discharge) and the relatively dry simulation period, it may be possible to modify the schedule to maintain higher lake stages for longer durations and still provide the necessary inflows to achieve restoration of the river/floodplain ecosystem. By increasing the depth to 54 feet for a longer period of time, wetlands will be restored to higher elevations than the simulations indicate. Alternatively, minor adjustments may be required to facilitate restoration of the river.

Based on the requirements of Draft Chapter 12, ER 405-1-12, and Draft Interim EC 1105-2-206, which provides guidance on acquisition of lands for environmental project modifications, fee title will be required for all lands needed to support implementation and operation of a project modification. A standard flowage easement does not provide for the restrictions of land use detrimental to the environmental aspects of the upper and lower basins. As such, the majority of lands necessary for the Kissimmee River Headwaters Revitalization Project will be acquired in fee. Justification for fee title acquisition will be for the purposes of insuring that all project environmental benefits can be obtained for the Kissimmee River Project, while including the expansion of the Upper Basin littoral zone and the restoration of the lower Kissimmee River valley, and to provide the required flood storage necessary for limiting flood induced damages to below the 54 foot contour. For this reason, project lands will be acquired in fee to insure the achievement of project environmental goals. Therefore, acquisition in fee will be required for obtaining the necessary rights to periodically reflood lands, achieving optimal environmental benefits and for insuring future operational flexibility.

Approximately 5,986 acres of land below 52.5 feet NGVD, located between Lakes Cypress and Kissimmee were previously made available for the existing Flood Control Project by Perpetual Flowage Easements. These lands are now required in fee to support the operational flexibility of the schedule and environmental restoration purposes of the project. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These lands have been determined not to be subject to navigational servitude as they are not hydrologically connected to the lakes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the water storage requirements and to comply with environmental restoration of the project. The valuation will be for the difference between the value of interest previously provided and the value of the required fee estate.

Exceptions to fee acquisition should only be pursued in a few areas where it would be more advantageous to the government to obtain a restrictive flowage easement. These areas include, but are not limited to; existing mitigation project lands, highly developed subdivisions, and lands surrounding Lake Tiger.

7.9.2 Justification for Real Estate Interests Less Than Fee in Residential Areas

Perpetual Conservation and Flowage and Perpetual Inundation easements are recommended only where fee acquisition is not required to provide maximum environmental benefits. These areas include residential areas, State of Florida Trustee of the Internal Improvement Funds (T.I.I.F.) lands, and mitigation lands owned by the Celebration for Disney, Inc. The Perpetual Conservation/Flowage easements are recommended in densely populated areas to prohibit activities on easement lands that would be detrimental to or interfere with the Federal project.

(1) A perpetual conservation/flowage easements is recommended in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park). The portion of Three Lakes Management Area that is within the project and consists of 1,261.51 acres and is owned in fee by the State of Florida. Lake Kissimmee State Park is also owned in fee by the State of Florida and contains approximately 472.20 acres within the project area. It has been determined based on conclusions in the Attorney's Opinion dated January 1996, that Perpetual Conservation and Flowage Easement are recommended for acquisition in these areas. Existing uses of the lands and management practices by the Trustees of the Internal Improvement Fund (State of Florida) are not available for flood control nor environmental benefits between the 52.5 and 54.0 foot contours.

(2) The lands north of Lake Hatchineha known as Celebration lands (Walker Ranch) are owned by the Celebration Company a subsidiary of the Disney Corporation as mitigation lands for other lands of the Celebration Company and other subsidiaries of the Disney Corporation. The conditions of a Department of the Army permit and Department of Environmental Protection Permit issued December 1992, required the Celebration Company to purchase these lands in fee for mitigation purposes. The lands are to be managed by the Nature Conservatory, a non-profit corporation with fee title being conveyed to the Nature Conservatory in stages. The permit also required the Celebration Company to convey a Perpetual Conservation Easement to the State, South Florida Water Management District, Florida Game and Freshwater Fish Commission, and the Nature Conservation. The Celebration

Company conveyed a perpetual conservation easement to the Nature Conservatory, the SFWMD, the FGFWFC and the State of Florida Department of Environmental Regulation. This easement restricts the use of the property for environmental purposes. The additional right to flood, flow and store water on the property for flood control purposes is required for the Kissimmee Headwater Revitalization Project; therefore, a Perpetual Flowage Easement is recommended for the Celebration lands.

(3) The acquisition of a perpetual flowage easements is recommended for lands surrounding Lake Tiger where environmental benefits will be minimal or not realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. These lesser estates have been coordinated with Fish and Wildlife to assure that they would not be detrimental to environmental purposes.

(4) Land requirements are also necessary in areas where ground water elevation will impact septic tanks in isolated areas requiring Water Inundation Easements (see Section 8, Recommended Plan).

7.9.3 Acquisition of Lands Behind Local Farm Levees

The acquisition of lands behind five local farm levees surrounding Lakes Kissimmee, Hatchineha and Cypress is recommended for obtaining needed water storage in the Upper Basin and to obtain the requirements for both Upper and Lower Basin environmental restoration. The lands are not a separable element of the hydrologic influences of the proposed lake regulation schedule. The levees have encroached upon the historic marsh littoral zone of the subject lakes partially impeding the designed hydrologic influences of the proposed lake regulation schedule up to the 54 foot elevation. Furthermore, the existing levee systems would be inadequate to protect lands behind the levee from the project induced inundation. Section 7.6.3 describes the additional Upper Basin environmental benefit for breaching the five levees. Plate 8-1, Project Plan Plate, shows the location of the levees.

A sixth levee, referred to as the Exposition levee, located along the western shore of Lake Hatchineha was also evaluated. Approximately 220 acres of land would need to be acquired if we use the land for project environmental and storage purposes. Jacksonville District performed a geotechnical investigation of the levee and found the levee to be adequate for protection against a 10 year or project level flood. Because the cost of acquiring the land located behind the levee and degrading the levee, $451,000, was considered too high compared to the limited storage and environmental benefit, the District recommended not to acquire lands located behind the Exposition levee.

SECTION 8

THE RECOMMENDED PLAN

8.1 RECOMMENDED PLAN HEADWATERS REVITALIZATION PROJECT

Based on the performance of the alternatives, the recommended plan for the Headwaters Revitalization Project includes the following features:

* Modification of the existing Lake Kissimmee regulation schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee Lake littoral zones. (see Figure 3-1 for details).

* Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress, and Lake Tiger (PLATE 8-1, Project Area Map).

* Widening of upper basin flood control canals, C-36 and C-37. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding.

* Increase outlet capacity at water control structure S-65. Modifications to the existing S-65 structure will be needed to reduce flood stages in Lake Kissimmee and to provide adequate discharge capacity.

* Degradation of local levees. Reflooding of lands up to the 54 foot elevation will be partially impeded by local farm levees that have been constructed within the historic lake littoral zone. Breaching of five local levees is recommended for obtaining the water storage required for achieving Lower Basin and Upper Basin restoration. Approximately 1 mile of levee sections or about 60,000 cubic yards will be degraded by backfilling adjacent borrow ditches. The five levees are located on the east and southwest side of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

8.2 MODIFICATION OF LAKE KISSIMMEE REGULATION SCHEDULE

Modifications to the existing Lake Kissimmee regulation schedule are necessary to meet two of the five hydrologic conditions (criteria) that must be reestablished to restore the Lower Basin ecosystem. These conditions are the reestablishment of continuous flow with duration and variability characteristics comparable to prechannelization records; and reestablishment of stage hydrographs that result in floodplain inundation frequencies comparable to prechannelization hydroperiods, including seasonal and long-term variability characteristics. Increasing the upper level of lake regulation will provide an opportunity to expand the littoral zone of the upper Kissimmee basin lakes. Modification of the regulation schedule for the Upper Chain of Lakes will provide both greater, and more natural fluctuations of water levels in the lakes enhancing the peripheral marsh habitats. The beneficial effects include expansion of lake littoral zones up to approximately 14,000 acres and increased spatial and temporal dynamics produced by long term fluctuations in seasonal water levels. These dynamics are expected to increase the overall quality and productivity of littoral habitat, and create significant area of wetlands.

The upper level of the recommended lake regulation schedule will increase from elevation 52.5 feet to elevation 54.0 feet, and the schedule will be zoned to provide for a variable discharge scheme based on season and water level conditions. Even though the upper end of the schedule was expanded, the lake stages will not fluctuate within the entire 5.5 foot range every year. During wet years the upper end of the zone will be used, while the lower end will be used in dry years. The proposed schedule will seasonally reflood lands between elevations 52.5 and 54.0 feet in Lakes Kissimmee, Hatchineha, Cypress, and Tiger increasing the seasonal water storage capacity by about 100,000 acre-feet. Figure 8-1 provides a description of the recommended lake regulation schedule and operation rules.

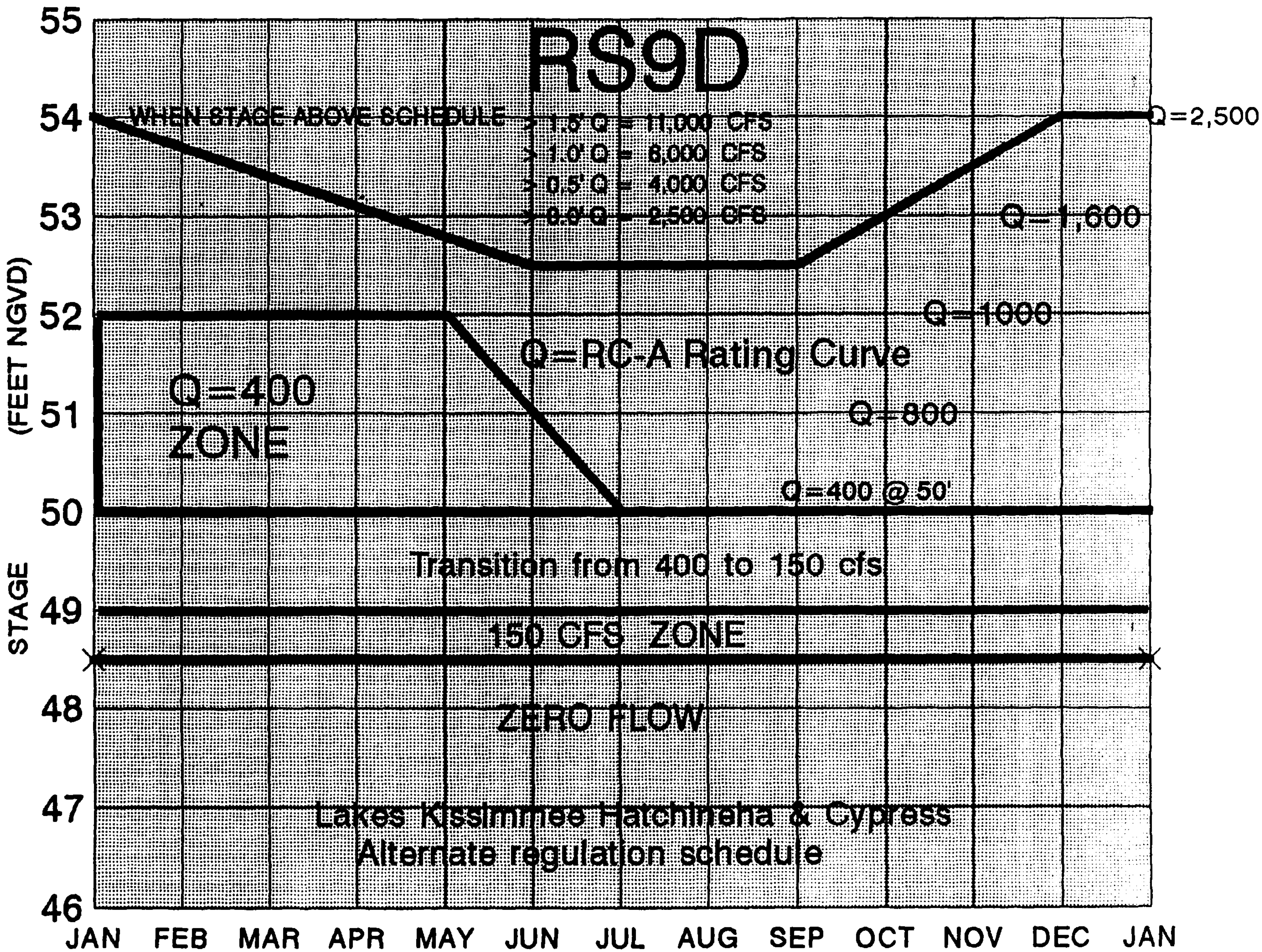

RS9D
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=RC-A Rating Curve
Q=400
ZONE
Q=800
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 8-1

8.3 LAND ACQUISITION

The environmental benefits achieved by modifying the regulation schedule may be affected by how the land is used with the project. If the land is acquired through minimal flowage easements, the land will be available for use by land owners during dry periods. The availability of project lands to land owners for farming and other uses could greatly reduce the environmental potential for the project. For this reason, project lands will be acquired in fee to insure the achievement of project environmental goals. Therefore, acquisition in fee will be required for obtaining the necessary rights to periodically reflood lands, achieving optimal environmental benefits and for insuring future operational flexibility. The operational flexibility to store water to the revised regulation schedule of 54.0 on an "as needed" basis requires acquisition of land in fee to insure the minimum project requirements are obtained. As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be flooded when necessary to obtain water storage required to meet Lower Basin and Upper Basin requirements.

Reflooded lands affected by the lake regulation schedule below elevation 54.0 feet will have to be acquired to insure that the minimum project requirements are obtained. Approximately 20,800 acres of affected lands surrounding Lakes Kissimmee, Tiger, Hatchineha, and Cypress will be acquired based on achieving the full potential of project purposes. Approximately 5,986 acres of this land, located below 52.5 feet elevation between Lakes Cypress and Kissimmee, were previously required and made available for the existing flood control project. These lands are now required in fee to allow the operational flexibility to meet the storage requirements in the Upper and Lower Basin for environmental restoration. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These areas were inundated when the lake stage was raised up to 52.5 feet and were, therefore, required previously for flood control purposes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the environmental restoration project. The valuation will be for the difference between the value of flowage easement previously provided and the value of the required fee estate. Appendix H, Real Estate Supplement provides a detailed description of land requirements. Lands surrounding Lake Jackson and Lake Rosalie will not be required for project purposes.

Lands located below 54.0 feet behind local farm levees will be flooded and additional environmental benefits achieved. Lands will be acquired in fee in these areas except for lands north of Lake Hatchineha known as Celebration lands owned by the Disney Corporation as mitigation lands for Disney World.

The interest in these lands will be a Perpetual Conservation and Flowage Easement.

The following estates are required: fee title; fee title with reservations of riparian rights as well as grazing (beef cattle only); fee title with reservations of riparian rights as well as road access in several parcels; a perpetual flowage easement over the Celebration lands; perpetual conservation/flowage easements in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park); perpetual conservation/ flowage easements with the right to prohibit, remove or fill septic systems in Hatchineha Estates; Water Inundation Easements; and perpetual flowage easements surrounding Lake Tiger where environmental benefits will not be realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. Land acquisition of approximately 20,800 acres bordering the four lakes impacted by the increased storage and restoration will be required.

8.4 ENGINEERING ALTERNATIVES FOR IMPACTED RESIDENTIAL SEPTIC SYSTEMS

8.4.1 Septic System Impacts

All of the homes and businesses in the lakeside study area use septic tanks with drain fields to dispose of their sewage. Most are individual on-site below-ground installations with both the tank and the drain field below the general ground level. There are a few cluster systems in place where the effluent from several sources is disposed of in a common drain field. There are also a few mounded drain fields in the area.

To function properly, typical septic systems should have the discharge pipe invert at least two feet lower than the top of the septic tank and resting on at least six inches of gravel. The gravel layer should be at least one foot above the "seasonal high water table". If the lake elevation is increased to 54 feet MSL for part of the year, it would likely cause septic systems whose tanks/drain fields are too low to malfunction. This would create an intolerable health hazard as untreated sewage would be discharged to the Kissimmee.

Based on the criteria developed by the Corps and the SFWMD, septic systems with a top of tank elevation of 56 feet or lower would be considered impacted under the operation of the modified lake regulation schedule. This is based on application of the vertical clearance requirement of 3.5 feet from the seasonal high water level. The seasonal high water level was taken to be the maximum scheduled lake elevation during the wet season, or 52.5 feet. All septic tanks located with top of tank below the 56-foot elevation must be replaced with mounded septic tanks or if onsite cure is not possible, be acquired in fee. An engineering analysis was completed by the Jacksonville District of several alternatives.

Mounded systems are proposed as replacements in those areas where basic criteria for their use can be met. The criteria are: sufficient land to site a mounded system; mound could be sited with at least five-foot setbacks from property lines; and mound could be sited at least 150 feet from delineated bodies of water. The proposed repair methods are as follows:

1. <u>On-site mounded system</u>: The repair for an impacted lot will require installation of a four-foot diameter manhole, a dosing pump station, and a raised mound. This repair is feasible if the raised 34'x44' mound can be sited on the lot and maintain 150-foot setbacks from water courses.

2. <u>Off-site mounded system</u>: In situations where the site did not meet setback requirements from bodies of water or the lot was too small, the raised mound could be sited on a vacant lot.

3. <u>Cluster Systems</u>: When several adjacent lots are too close to a water body or lot sizes are too small, a remote cluster system can be used. In this design, a mounded system is located off-site with a dosing pump station. Sewage effluent from two to six residences would be pumped to this central dosing pump station.

Table 8-1 describes the number of likely impacted systems and the possibility for using mounded systems in different locations. Parcels in areas where an onsite cure is permittable and feasible (mounded septic tanks) were appraised using the Water Inundation Easement. Parcels which cannot be cured would be acquired in fee.

TABLE 8-1
SEPTIC SYSTEM IMPACTS

Fish Camps	Total Lots	Estimated Total Lots Impacted by Lake Operation Over 52.5 feet	Can Be Corrected by On-Site Mounded System	Can Be Corrected by Off-Site Mounded Systems	Off-site Cluster System (No. of lots)	Sewered Lots
Shady Oaks	107	85	58	8	7(19)	0
Rocks Fish	116	77	49	2	9(26)	0
Grape Hammock	127	12	4	0	2(8)	0
Hatchineha Estates[1]	306	61	0	0		61
The Oasis	6	6	0	0	1(6)	0

[1]Note the only method of correction is to connect the impacted lots to a sewer system.

8.4.2 Hatchineha Estates

There are approximately 306 lots in Hatchineha Estates with an estimate of 61 impacted with no means of an onsite cure. This subdivision consists of waterfront lots situated on man-made canals, and 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed. These septic systems do not meet current permitting criteria, but were "grandfathered" in for zoning purposes because they were built long before the zoning laws were developed. For purposes of the project cost estimate, these parcels were appraised in fee acquisition.

The non-Federal sponsor has indicated a preference to construct a sewer system in lieu of acquisition. Construction of a sewer treatment system was determined to be a feasible alternative to land acquisition for Hatchineha Estates based on a cost comparison. If constructed, the construction of the facilities will be a non-Federal responsibility. A perpetual conservation/flowage easement with the right to prohibit existing and future septic tanks, and the right to fill and remove exiting septic tanks, as well as a release will be acquired from landowners required to participate in the hookup to the recommended sewer treatment plant.

The estimated construction cost including construction, supervision and inspection and contingencies is $2,834,000 for the residences impacted versus estimated real estate costs of acquisition, 91-646 relocation, administration and contingencies totalling $9,260,000. The construction cost estimate is based on a Jacksonville District Corps of Engineers analysis. The sponsor will receive credit for fee acquisition if the sewer treatment system is not implemented. The project sponsor may receive LERRD's credit as a "cost to cure", if the sewer treatment system is implemented. The maximum will be set at the Corps estimate for construction of the sewer treatment plant .

8.5 ENLARGE FLOOD CONTROL CANALS

A design constraint was placed on the restoration objective to insure that the same level of flood protection was maintained in the Upper Kissimmee Basin once the project was implemented. Additionally, the proposed regulation schedule would not adversely impact existing flood protection upstream of C-34 and C-35 (i.e., Lakes Gentry and Tohopekaliga, respectively).

Hydrologic modelling was completed to detail the affects of the proposed Lake Kissimmee Regulation Schedule. Based on the results of the model, flood stages would be substantially increased at Kissimmee, Hatchineha, and Cypress. By enlarging canals C-36 and C-37, flood impacts in Lake Hatchineha and Cypress were reduced to levels below the 54 foot elevation. The canal enlargements also reduced the tailwaters at S-61 and S-63A such that the flood impacts from the proposed Lake Kissimmee regulation schedule did not extend upstream of the spillways (i.e., into Lakes Tohopekaliga and Gentry, respectively). Modifications to canals C-34 and C-35 were not found to be necessary. However, excess shoal material presently existing within the canals should be removed.

C-36 will be widened from 48 feet to 60 feet, requiring the excavation and disposal of 125,000 cubic yards of material. Widening and disposal will be performed on the canal's west bank in order to avoid impacts to existing cypress trees on the eastern bank. Canal widening would increase the canal's discharge capacity by about 15 percent for a 10-year event. Likewise, C-37 will be widened from 70 feet to 90 feet, requiring the excavation and disposal of approximately 330,000 cubic yards of material. Canal widening would be performed on the canal's east side only. C-37 widening would increase the canal's discharge capacity by about 20 percent for a 10-year event. All dredged material will be placed on the existing canal spoil areas within the adjacent right-of-ways. Typically, the cut sections will be excavated on a 1 vertical to 2.5 horizontal slope.

In addition to these design quantities, approximately 700,000 cubic yards of excess shoal material will need to be removed in area canals. Canals C-35, C-36 and C-37 will require the removal of 170,000 cubic yards, 160,000 cubic yards, and 373,000 cubic yards, respectively, of shoal material. The costs of removing the excess material will be included as part of the sponsor's responsibility for operation and maintenance.

8.6 STRUCTURE S-65 MODIFICATIONS

In order to maintain the existing level of flood protection above 54 feet the outlet capacity of the existing S-65 gated spillway structure will be increased by about 66 percent. The increase in outlet capacity will be provided by the addition of two concrete bays on the east side of the existing three bay structure. The discharge capacity will be increased from a maximum of 11,000 cfs to about 18,000 cfs. In addition to the structural modification, the existing entrance and exit channels to the structure will be enlarged to realign with the new structure configuration. The modified channel will be designed to reduce scour and provide adequate getaway capacity from the structure.

Although the S-65 discharge capacity will be increased by 66 percent, the probability of ever being able to discharge 18,000 cfs for an extended period is remote. Under a relatively small flood, the amount of inflow to the lake and the insufficient head differential across S-65 (because of tailwater elevation) will result in sustained maximum discharges of less than 11,000 cfs. It will not be until larger floods, when Lake Kissimmee approaches elevation 54 feet and continues to rise, that the advantage of the increased outlet capacity will be realized. Only under an extreme or nearly catastrophic event would there be sufficient head across the structure (i.e. Lake Kissimmee stages greater than 56 feet) to discharge 18,000 cfs to the Lower Basin.

8.7 DEGRADE LOCAL LEVEES

The breaching of locally constructed levees and dikes will increase the hydroperiod on interior portions of land presently being protected by levees. In order to insure adequate project water storage requirements, project design integrity, and to increase Upper Basin project environmental outputs, five local farm levees (spoil mounds) within the project area have been designated for degradation.

Levees will be degraded by pushing the mounded fill back into the adjacent borrow source ditches. The earth will be graded to the extent necessary to restore the area to its natural ground elevation. No offsite disposal areas will be required for the operation. The levees will be breached in a series of 1 hundred foot gaps without substantially impeding the flow of flood waters landward of the levees. Gaps will be spaced at approximately 1,000 foot intervals. Gap spacing will be optimized to correspond with degrading low lying areas first and to avoid areas with large trees. Tree lined areas will remain intact to maintain patches of upland habitat.

8.8 SUMMARY OF RECOMMENDED PLAN COMPONENTS

A summary of the recommended plan features is provided in Table 8-2 below. The table includes all project features necessary for implementation of the Headwaters Revitalization component of the Kissimmee River Project.

TABLE 8-2
SUMMARY OF RECOMMENDED PLAN FEATURES

PROJECT FEATURE	PURPOSE	LOCATION OF BENEFIT
1. Modified Lake Kissimmee Regulation Schedule and Operation Rules	Kissimmee River restoration and expansion of Upper Basin littoral wetlands	Upper and Lower Kissimmee Basin
2. Acquisition of 20,800 acres of land bordering Lakes Kissimmee, Hatchineha and Cypress	Environmental restoration, Flood Control, Operational Flexibility	Upper and Lower Basin
3. Widen Canals C-36 and C-37	Flood Control	Upper Basin
4. Increase Outlet capacity of Lake Kissimmee water control structure, S-65	Flood Control	Upper Basin
5. Breaching of five local farm levees	Flood Control Storage, Environmental Restoration	Upper and Lower Basin
6. Construction of Hatchineha Estates Package Sewage Treatment Facility	Mitigation for flood impacts	Upper Basin

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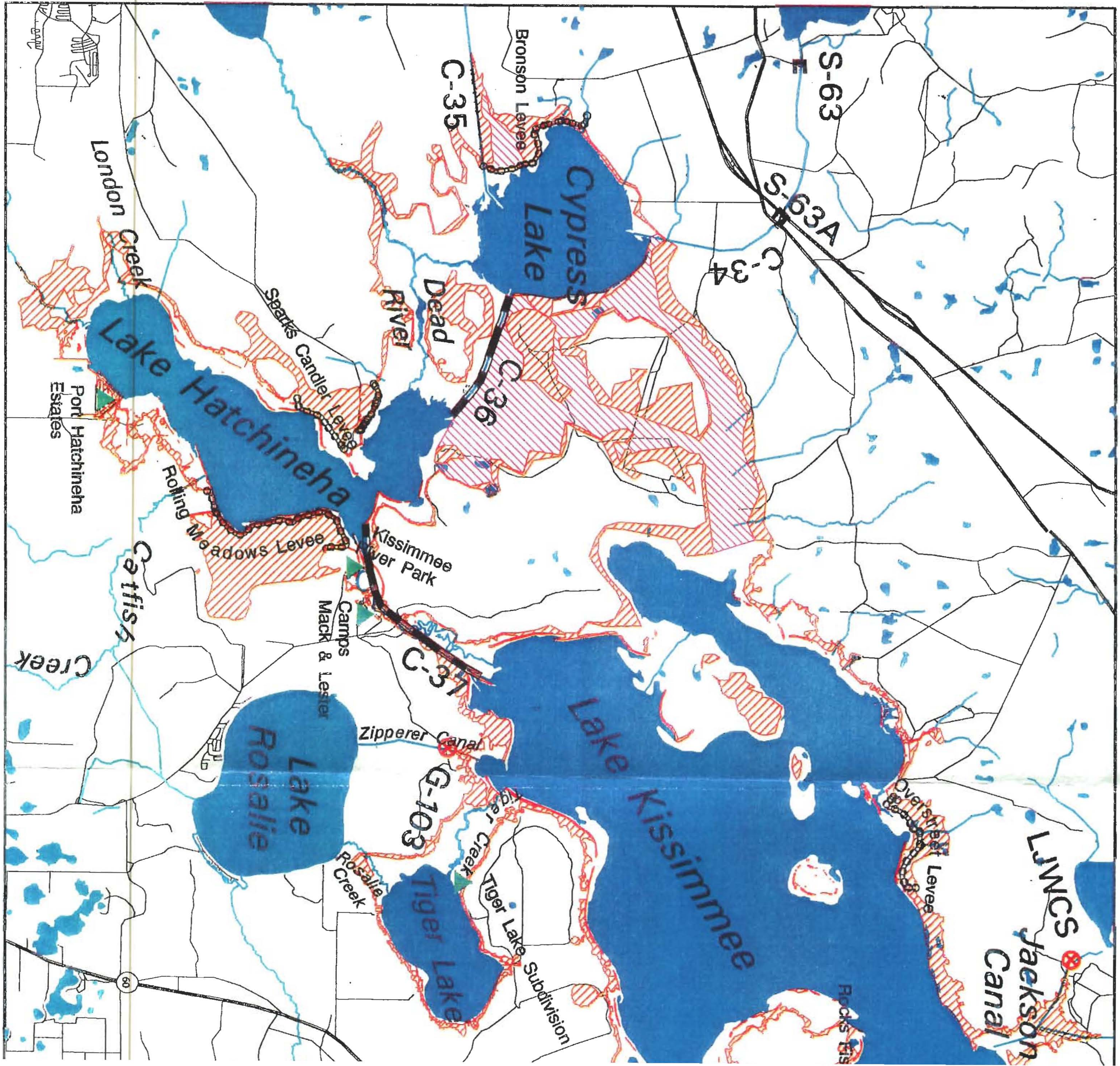


SECTION 9

EVALUATION OF ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

9.1 EFFECTS ON LOWER BASIN

Hydrological, hydraulic, and ecological analyses of alternative restoration plans by the SFWMD (Toth, 1991; US Army Corps of Engineers, 1991) produced evidence that the combination of backfill in the Lower Basin and restored flow from the Upper Basin would provide the necessary conditions to restore the ecological integrity of the river/floodplain ecosystem. Wetland plant communities would become reestablished on reflooded former spoil sites and drained sections of floodplain. The recommended plan was determined to be the best plan to achieve the desired effects in the Lower Basin while meeting the needs of the Upper Basin, i.e., flood control and navigation.

Discharges provided by the recommended modifications to the Lake Kissimmee regulation schedule and operation rules will be an integral component of the restoration of ecological integrity within the Lower Basin ecosystem. As described in the 1991 Feasibility Study, specific Lower Basin environmental benefits linked to restored inflow characteristics include:

(1) maintenance of favorable river channel dissolved oxygen regimes during summer and fall months;

(2) provision of non-disruptive river flows for fish species during their spring reproductive period;

(3) restoration of temporal and spatial aspects of river channel habitat heterogeneity;

(4) reestablishment of the full range of physical, chemical and biological interactions between the river and floodplain;

(5) reestablishment of 26,500 acres of wetlands with a complete complement of functional values, including, nutrient and sediment filtration processes, a productive food web and feeding, reproductive, nursery and refuge habitat for fish, wading birds and waterfowl.

By providing for a more natural seasonal distribution of high and low flow periods and less frequent no flow periods, the recommended plan will result in environmental benefits in the lower basin that will at least equal and probably exceed the environmental outputs documented for the preliminary schedule modifications that were described in the 1991 Feasibility Study. Figure 9-1 compares the simulated monthly Lake Kissimmee discharge characteristics (based on percentage of total volume) for the proposed regulation schedule against the historic or pre-project period from 1934 to 1962, and the post-regulation (1970-88) period. The proposed schedule redistributes average and high flow volumes in a more natural seasonal pattern similar to the pre-project conditions. The percentage of discharges during the wet season are shown higher in the proposed project compared to the pre-project conditions because of the flood control restraints.

Restoration of the structure and function of the river's floodplain wetlands requires reestablishment of historical floodplain inundation characteristics and recession rates. Based on the dechannelization of the Kissimmee River, the historic Lake Kissimmee discharge/ Fort Kissimmee stage relationships were used to generate expected stage hydrographs and associated floodplain inundation from 15-day moving averages of simulated daily discharges from the headwater lakes, Figure 9-2. Figure 9-2 shows that even during the relatively dry simulation period, the new regulation schedule and operation rules produced inundation frequencies comparable to the historical period over 80 percent of the floodplain.

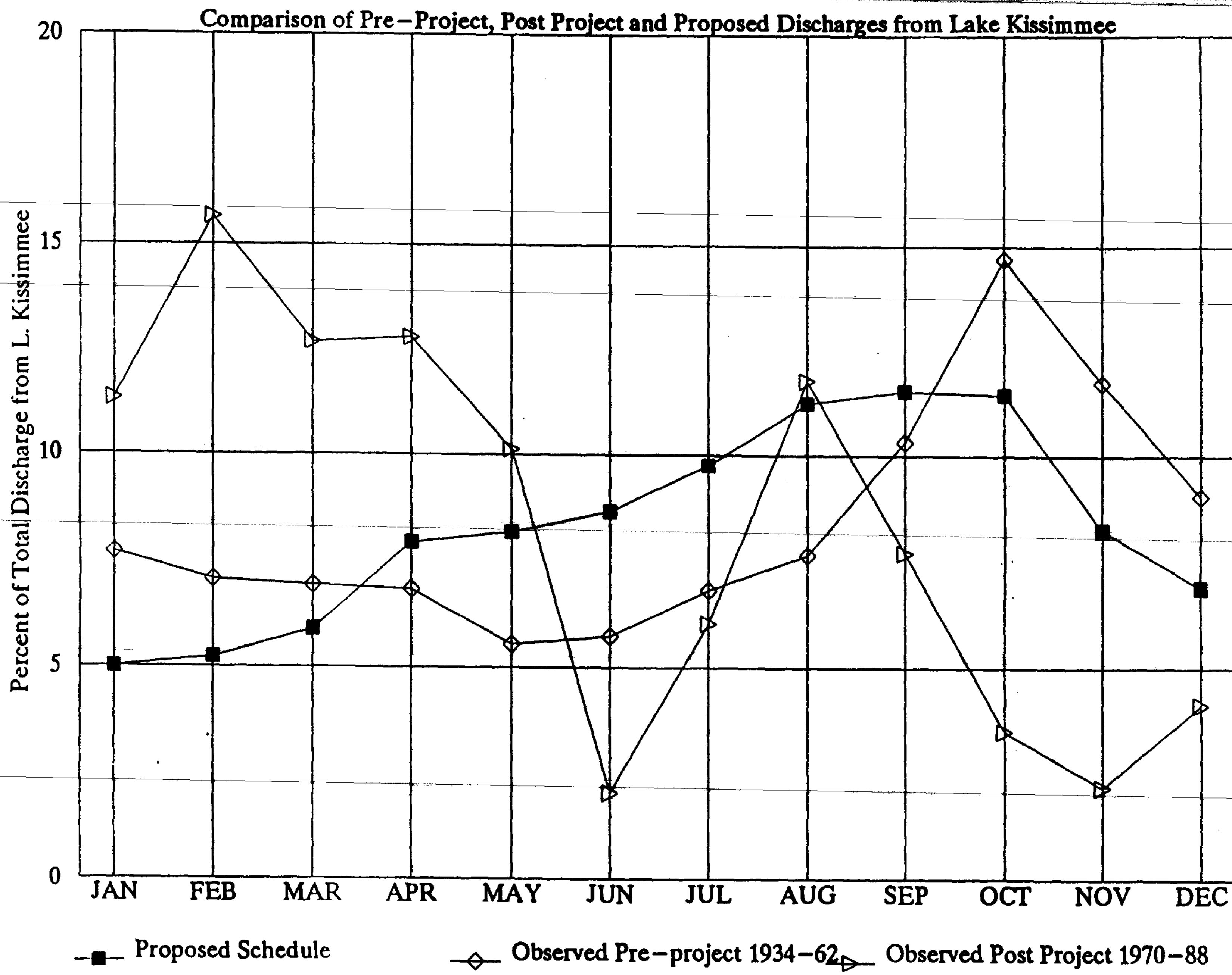
Restoration of the altered physical and hydrologic determinants of ecological integrity, through backfilling and the other features and operation of the modified plan, will lead to reestablishment of the natural structure and functioning of the Kissimmee River ecosystem. This, in turn, will lead to reestablishment of most of the fish and wildlife and other biological attributes of the pre-channelization ecosystem. The plan will reestablish the ecological integrity of the Kissimmee River by restoring the river's pre-channelization form and more natural hydroperiod and flow discharge characteristics over about fifty square miles of the river and floodplain ecosystem in the Lower Basin. The restored ecosystem will include 56 continuous miles of rejuvenated or recreated river channel, which will provide flow over reestablished flood plain wetlands. Levees, disposal piles, and other obstructions to movements of water, energy and biological components will be removed; and biological, chemical, and hydrological interactions between the river and its floodplain will be reestablished. Restoration of physical form and hydrologic conditions will lead to reestablishment of the dynamic food webs, habitat heterogeneity, water quality, energy flow, and other complex physical, chemical, and biological interrelationships and processes that supported the historic ecosystem's high levels of resilience, and allowed for persistence of highly diverse biological communities. As a result, most of the diverse communities that historically constituted the Kissimmee River ecosystem will redevelop. Tables 9-1 and 9-2 summarize the expected environmental outputs for the Lower Basin based on implementing the proposed lake regulation schedule with the Kissimmee River restoration project. The Jacksonville District is currently revising the Lower Basin hydrologic model based on new topographic data. While the Lower Basin plan has not significantly changed, the results of the current modeling will be included in future FDM's and environment outputs and real estate requirements will be verified.

TABLE 9-1
PHYSICAL CHARACTERISTICS OF LOWER BASIN

Physical Characteristics	Historic Condition	Existing Condition	Recommended Plan
length of river, canal, and oxbows (miles)	103 river (continuous) 8 canal 0 oxbows	0 river 56 canal 68 oxbows	56 river (continuous) 22 canal 13 oxbows
depth of river, canal, and oxbows (feet)	2-8 river when within bank; 4 average	30 canal 1-6 oxbows 0-8 river remnants	30 canal 1-6 oxbows 2-8 river
top width of river, canal, and oxbows (feet)	50-300 river	225-425 canal 25-100 oxbows	225-425 canal 25-100 oxbows 50-300 river
SPF flooded area (acres)	-	38,292	69,461

TABLE 9-2
ENVIRONMENTAL OUTPUTS FOR LOWER BASIN

Environmental Outputs	Historic Condition	Existing Condition	Without Project Condition	Recommended Plan
River/Flood plain ecosystem (acres)	48,800	0	0	48,800
wetlands (acres)	35,000	14,000 (impounded)	14,000 (impounded)	26,500
HEP habitat units	339,799	123,443	< 123,443	250,789
Instantaneous fish biomass (lbs)	81,000	3,000	3,000	46,000
winter water (acre-days)	unknown	27,000	27,000	327,000
ducks (winter population)	12,500	140	140	12,500
wading birds (population; excluding cattle egrets)	18,000	3,500	< 3,500	18,000



Comparison of Pre-Project, Post Project and Proposed Discharges from Lake Kissimmee
Percent of Total Discharge from L. Kissimmee
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Proposed Schedule
Observed Pre-project 1934-62
Observed Post Project 1970-88

FIGURE 9-1

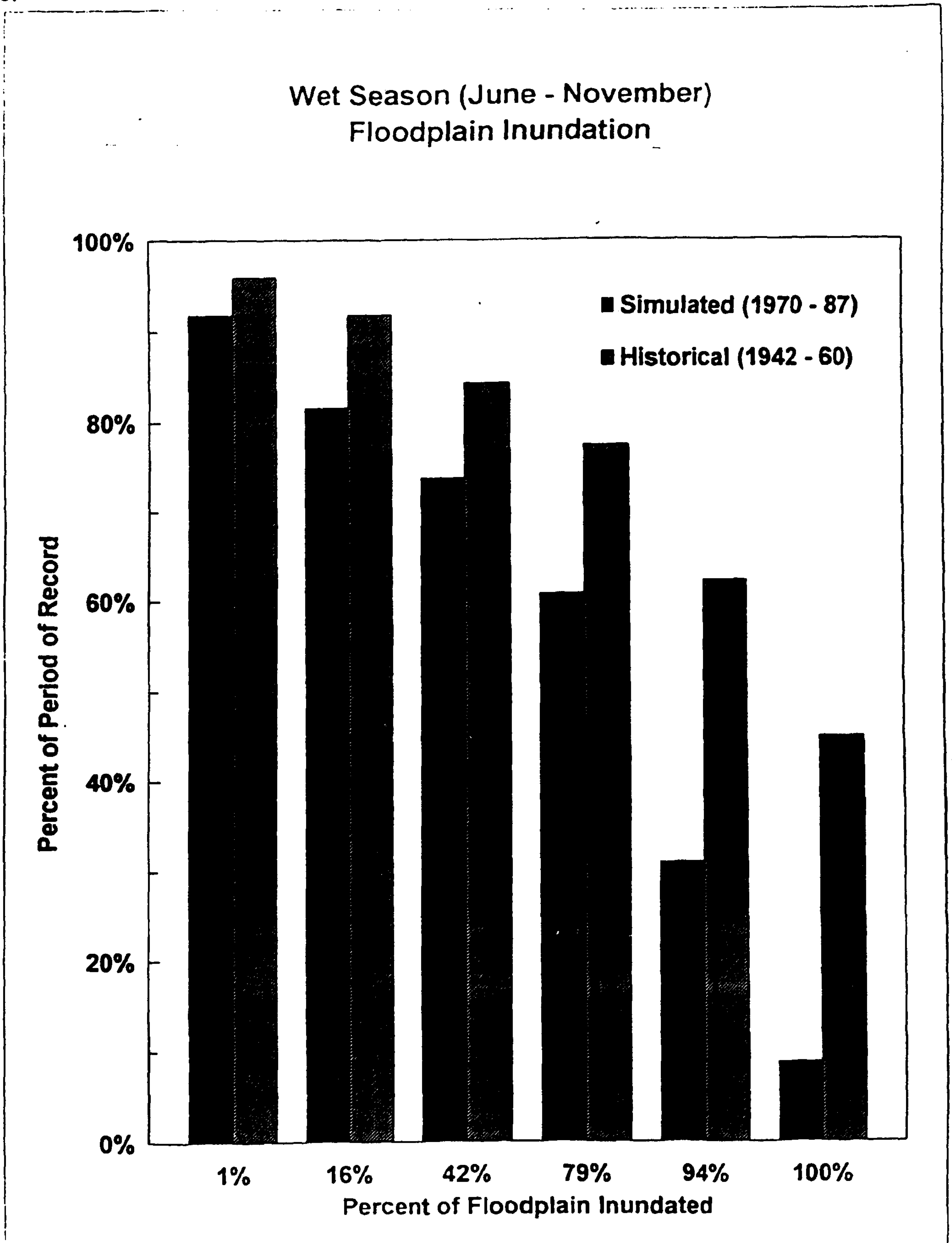

Wet Season (June - November)
Floodplain Inundation
Simulated (1970 - 87)
Historical (1942 - 60)
100%
80%
60%
40%
20%
0%
Percent of Period of Record
1%
16%
42%
79%
94%
100%
Percent of Floodplain Inundated

FIGURE 9-2

9.2 EFFECTS IN THE UPPER BASIN

9.2.1 Effects of Lake Level Regulation

In the Upper Basin, a water schedule operated according to the recommended plan, RS9-D (see Figure 8-1, Section 8), would result in greater frequency of high-water stages, compared to the existing schedule (see Section 3, Figure 3-1). During normally wet months (e.g., August-September), water levels under the recommended schedule would range from 0.5 to 1.0 foot higher than they do now, up to 20 percent of the time, and they would drop about 0.5 foot lower about 60 percent of the time. During normally dry months (e.g. April-May), the recommended schedule would produce up to 2 feet higher water levels up to 40 percent of the time, but could allow as much as 2.5 feet lower levels 60 percent of the time. A wider range between high water levels and low water levels would characterize the recommended schedule.

Modification of the Lake Kissimmee Regulation schedule would provide greater fluctuations of water levels in the lakes. The beneficial effects include expansion of lake littoral wetlands and increased spatial and temporal dynamics produced by long term fluctuations in seasonal water levels. These dynamics are expected to increase the overall quality and productivity of littoral habitat, and create significant area of wetlands. Table 9-3 summarizes the benefits for the Kissimmee Upper Basin.

TABLE 9-3
ENVIRONMENTAL OUTPUTS FOR UPPER BASIN

Environmental Outputs	Historic Condition	Existing Condition	Without Project Condition	Recommended Plan
Littoral Zone (acres)	20,000	16,000	16,000	20,000
Wetlands/Flood storage (acres)	55,000	16,000 (impounded)	16,000 (impounded)	30,000
HEP habitat units	-	241,923	241,923	257,201

All HEP habitat units were derived from model simulations over an 18 year, post-channelization (1970-87) period. The model was calibrated for stage, but appeared to underestimate discharge during the simulation period by approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990). As a result of using a drier period of the historical hydrological record the habitat unit outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits than the simulation model predicted.

9.2.2 Cultural Resources

Effects to historic and prehistoric archeological sites and standing structures, engineering structures and architectural features will be evaluated during on-going and future cultural resources investigations. Effects from the proposed project are anticipated to come from channel widening and construction.

It has been determined that modifications to the S-65 structure will have no effects on historic properties. Assessments will be made of the architectural and historic significance of residential and commercial structures to be affected by the project. An archeological survey is being undertaken along the C-36 and C-37 canals. One potentially significant prehistoric archeological site has bee identified.

In consultation with the State Historic Preservation Officer (SHPO), the Corps will apply the criteria of effect and adverse effect (36 CFR 800.9) for historic properties that meet the criteria of eligibility to the National Register of Historic Places. For those historic properties which will be adversely affected, mitigation plans will be developed by the Corps, in consultation with the SHPO and the Advisory Council on Historic Preservation, to mitigate adverse effects. The Corps will implement the mitigation plans prior to initiating any ground disturbing activities. Collections from cultural resources investigations will be curated in repositories meeting the standards established by the Corps and the National Park Service.

9.2.3 Water Quality

Water quality impacts of the proposed project will be limited to increased turbidity during dredging, filling, and construction activities associated with widening of the C-36 and C-37 canals, degradation of the local farm levees, and construction from the enlargement of the S-65 structure. However, the suspended material from these activities will settle quickly after construction ceases and the turbidity will return to normal in a very short time.

The increased area of marshlands inundation resulting from project implementation will result in improvement in overall water quality due to the wetlands acting as filters. The low water velocities in the expanded littoral zone will allow suspended material to settle rapidly and wetland vegetation will physically trap particulates and absorb nutrients as water flows through the inundated areas. Other contaminants such as pesticides and petroleum products will also be removed by the filtering action of increased wetland contact and decomposed by chemical and biological processes in the littoral zone.

The increased area of littoral wetland inundation resulting from project implementation may result in improvement in overall water quality due to increase sediment and nutrient filtration. Other contaminants such as pesticides and petroleum products will also be removed by the filtering action of increased wetland contact and decomposed by chemical and biological processes in the littoral zone.

9.2.4 Vegetation

Aquatic plants, as a result of water quality degradation by nutrients and water level stabilization, have flourished in the Upper Basin lakes. The effects of stabilized water levels and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones and by the rapid proliferation of nuisance aquatic plants. Increased rates of peat deposition and flocculation of decaying plant matter limit fish spawning. Increasing the range of fluctuation from 4 feet to 5.5 feet will restore some of the natural fluctuation and essentially remove some of the effects of over-stabilization. It is expected that this increase in fluctuation will aid the control of aquatic plants, reduce attendant costs of control and generally improve the open water habitat of these lakes for fish and wildlife. Increased seasonal fluctuation would allow for more frequent and greater natural removal of organic sediments from the lakes through oxidation and wind erosion over dried lake bottom sediments during low water levels.

Widening of the C-36 and C-37 canals will directly impact approximately 10 and 19 acres, respectively, of a mixture of fresh water marsh and upland grass vegetation along the backside of the levees. The C-36 canal will be widened to the west and the dredged material will be placed within the right-of-way of the west levee. The C-37 canal will be widened to the east and the dredged material will be placed within the right-of-way of the east levee. Erosion control measures will be implemented along the new levees until they become stabilized with vegetation.

Implementation of the recommended lake regulation schedule and degradation of the local farm levees would increase the amount of littoral wetlands by 7,236 acres. Approximately 5,019 acres of the total acreage restored would be converted to high quality wetlands from present-day grasslands (3,663 acres) and shrub/brushland (1,356 acres). The remaining 2,217 acres would be converted to moderate quality wetlands from what is now classified as dry prairie (1,616 acres), pineland (369 acres), or barren areas (231 acres). For a detailed explanation of how these acreage were calculated refer to the USFWS Coordination Act Report, date April 1994 (Annex D). The overall result of the recommended lake regulation schedule would be to increase the total amount of wetlands that meet the criteria of continuous saturation for at least 5% of the growing season, with the assumption that the growing season is year-round in the study area, to 23,236 acres (16,000 existing plus 7,236) or a 45% increase in wetlands subject to seasonal flooding over what currently exists.

Increasing the range of water level fluctuation from 4 feet to 5.5 feet will restore some of the natural fluctuation and remove some of the negative impacts of over-stabilization. Increased seasonal fluctuation would allow for more frequent and greater natural removal of organic sediments from the lakes through oxidation and wind erosion over dried lake bottom sediments during low water levels.

Widening of the C-36 and C-37 canals will directly impact approximately 10 and 19 acres, respectively, of a mixture of fresh water marsh and upland grass vegetation along the backside of the levees.

Implementation of the recommended lake regulation schedule and degradation of the local farm levees would increase the amount of littoral wetlands by 7,236 acres. Approximately 5,019 acres of the total acreage restored would be converted to high quality wetlands from present-day grasslands (3,663 acres) and shrub/brushland (1,356 acres). The remaining 2,217 acres would be converted to moderate quality wetlands from what is now classified as dry prairie (1,616 acres), pineland (369 acres), or barren areas (231 acres). For a detailed explanation of how these acreages were calculated refer to the USFWS Coordination Act Report, date April 1994 (Annex D). The overall result of the recommended lake regulation schedule would be to increase the total amount of littoral wetlands by 45% or to 23,236 acres (16,000 existing plus 7,236).

9.2.5 Fish and Wildlife

Ecological benefits to the Upper Basin include expected expansion of the littoral zones by up to 14,300 acres between 52.5 feet and 54.0 feet, and associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress and Tiger. This expanded littoral zone would include the 7,236 acres of seasonally flooded wetlands described in Section 8.2.4, and the additional wetlands between elevation 52.5 and elevation 54.0, which are needed for flood storage. Total wetlands surrounding the lakes would increase to 30,300 acres or 55% of the historical wetlands before lake level regulation was imposed for flood control. Additional benefits are expected because of increased spatial and temporal dynamics produced by long-term fluctuations of seasonal water levels. The entire, regulated, potential fluctuation zone of 5.5 feet (vertically) would not be inundated every year. In wet years, the zone could be flooded to its upper end, while in dry years only the lower end of the zone might be inundated. These added dynamics, introducing instability and diversity into the system, are expected to increase the overall quality and productivity of the littoral habitat. The USFWS conducted an evaluation model for wading birds against the different lake regulation schedules. The results of the evaluation are contained in the Final Fish and Wildlife Coordination Act Report. The USFWS concluded that the RS9-D lake regulation schedule would benefit the wading birds evaluated and would be neutral to the rest of the evaluation species.

Ecological benefits to the Upper Basin include the potential to expand the littoral zone by up to 14,300 acres between 52.5 feet and 54.0 feet, with associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress and Tiger. This expanded littoral zone would include the 7,236 acres of seasonally flooded wetlands described in Section 8.2.4, and the additional wetlands between elevation 52.5 and elevation 54.0, which are needed for flood storage. Total wetlands surrounding the lakes would increase to 30,300 acres or 55% of the historical wetlands before lake level regulation was imposed for flood control. Additional benefits are expected because of increased spatial and temporal dynamics produced by long-term fluctuations of seasonal water levels. The entire, regulated, potential fluctuation zone of 5.5 feet (vertically) would not be inundated every year. In wet years, the zone could be flooded to its upper end, while in dry years only the lower end of the zone might be inundated. These added dynamics, introducing instability and diversity into the system, are expected to increase the overall quality and productivity of the littoral habitat. The USFWS conducted an evaluation model for wading birds against the different lake regulation schedules. The results of the evaluation are contained in the Final Fish and Wildlife Coordination Act Report. The USFWS concluded that the RS9-D lake regulation schedule would benefit the wading birds evaluated and would be neutral to the rest of the evaluation species.

9.2.6 Endangered or Threatened Species

The following is a summary of impacts anticipated from the proposed project:

* Bald Eagle - The project will increase feeding areas for bald eagles, and would beneficially affect the bald eagle by providing new foraging habitat that could accommodate more nesting.

* Snail Kite - The project will increase feeding areas for snail kites, and would beneficially affect the snail kite by providing new foraging habitat that could accommodate more nesting. However, it is recognized that the new lake regulation schedule will allow greater lake fluctuations than the existing schedule. This fluctuation along with the potential for future extreme drawdowns for aquatic weed control and fisheries management could adversely effect the species if these activities are not coordinated in a timely manner. The recommended lake regulation schedule may also have the additional benefit of reducing the need for future extreme drawdowns as a result of greater lake level fluctuations.

* Wood Stork - The project will increase feeding areas for wood storks, and would beneficially affect the wood stork by providing new foraging habitat that could accommodate more nesting.

* Florida Grasshopper Sparrow - The project is not likely to adversely effect the Florida grasshopper sparrow. The sparrow is normally found at higher elevations in dwarf scrub oak and palmetto grassland which will be unaffected by the changes in the lake regulation schedule.

* Eastern Indigo Snake - The project, i.e., adjusted lake regulation and restoration of the littoral zone, is not likely to effect the indigo snake. However, construction activities along the canal banks during the widening of the C-36 & C-37 canals and the degrading of the local levees could adversely effect the species. To assist in the protection of the species that may be found during earth work activities the USFWS has provided conservation recommendations. These recommendations include that all construction personnel involved in this project be informed of the possible presence of the indigo snake in the area, its recognition, and the possible civil and criminal penalties resulting from the unauthorized take (harming, harassing, killing, or collection) of a listed species.

* Audubon's Crested Caracara - The project will result in the loss of 5,510 acres of potential foraging habitat, i.e., 1,616 acres of dry prairie, 231 acres of barren ground, and 3,663 acres of grassland, unimproved pasture, and sod farms. The USFWS concurs with the Corps that this loss of possible foraging habitat is insignificant and would not adversely effect the species.

The following is a summary of effects anticipated from the proposed project:

* Bald Eagle - The project will increase feeding areas for bald eagles, and would beneficially affect the bald eagle by providing new foraging habitat that could accommodate more nesting.

* Snail Kite - The project will increase feeding areas for snail kites, and would beneficially affect the snail kite by providing new foraging habitat that could accommodate more nesting.

* Wood Stork - The project will increase feeding areas for wood storks, and would beneficially affect the wood stork by providing new foraging habitat that could accommodate more nesting.

* Florida Grasshopper Sparrow - The project is not likely to adversely effect the Florida grasshopper sparrow. The sparrow is normally found at higher elevations in dwarf scrub oak and palmetto grassland which will be unaffected by the changes in the lake regulation schedule.

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* Audubon's Crested Caracara - The project will result in the loss of 5,510 acres of potential foraging habitat, i.e., 1,616 acres of dry prairie, 231 acres of barren ground, and 3,663 acres of grassland, unimproved pasture, and sod farms. The USFWS concurs with the Corps that this loss of possible foraging habitat is insignificant and would not adversely effect the species.

9.2.7 State Listed Species of Special Concern

The sandhill crane was one of the evaluation species used by the USFWS for this project, and is listed by the State of Florida as threatened. The snowy egret, another evaluation species, is listed as a species of special concern. Based on the evaluation modelling, the USFWS predicted a likely benefit for the snowy egret, and no significant effect on the sandhill crane.

Other species of special concern that occur in the study area are: gopher tortoise, osprey, burrowing owl, limpkin, little blue heron, and tricolored heron. Based on the USFWS modelling of effects on wading birds, the Service anticipates that the last three species are likely to benefit from the project, because they are wetland or wetland-dependent wading birds. The Corps does not anticipate a significant adverse effect to the other State listed species of special concern.

9.2.8 Hazardous, Toxic, or Radioactive Wastes

The U.S. Army Corps of Engineers performed a HTRW Civil Works Audit in conformance with ER 1165-2-132. This audit covers property impacted by the Kissimmee River Headwaters Revitalization consisting of approximately 20,800 acres to be acquired on land bordering the affected lakes; i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger. The nature of the work involved is such that contamination by HTRW is unlikely, and the probability of contamination by HTRW is considered negligible. Contractors will be advised that they should use caution with fuel containers and tanks and that they will be held liable for accidental spills. However, if additional HTRW contamination is found during land acquisition activities, remediation to Florida DEP regulator levels will be required before project implementation.

The relocation of electrical structures (Appendix D) such as generators, step-up transformers and other similar items, have been evaluated. The proper execution of this relocation does not pose a hazardous and toxic waste concern because there are no underground storage tanks (UST's) at the site. An aboveground storage tank (AST) provides liquid natural gas (LNG) fuel to the generator. Federal Law requires that abandoned equipment or other debris left behind during site relocations be free of contamination. PCB's have been phased out from Corps of Engineers projects. In recent years, Corps of Engineers scopes of work have included in the project specifications requirements for contractors to remove all hazardous wastes generated during construction. The hazardous wastes generated would be disposed of in a proper manner.

After a comprehensive environmental assessment, the potential for HTRW contamination still exists, even if the assessment included discussions with the sponsor, aerial photography, interviews and site visits. The environmental assessment was conducted without field sampling and chemical constituent analysis. Since no sample analysis was performed, undocumented buried sites may go undetected. The Jacksonville District is performing environmental audits on each tract being procured. Real estate will continue to coordinate with the Sponsor, regarding the environmental assessment and the applicability of CERCLA. These lands will be cleaned prior to certification of lands by the landowner or sponsor at no expense to the Government. The sponsor is preparing a Remediation Plan to be completed by mid-January.
During the property acquisition, the real estate agent should pursue with the landowner if any undocumented disposal actions occurred on the property.

9.2.9 Land Use

In the Upper Kissimmee Basin, the expanding economic base of the Orlando area is expected to continue to place increased demands on the areas resources. Cattle ranches and orange groves will continue to give way to suburban subdivisions. Metropolitan development is rapidly moving towards the cities of Kissimmee and St. Cloud in Osceola County. This urban development is expected to continue in the Upper Basin as the population continues to expand.

The proposed Kissimmee Headwaters project would acquire either as easements or in fee approximately 20,800 acres (includes 14,300 acres between 52.5 feet and 54.0 feet, 5,986 acres below 52.5 feet and other lands above 54.0 feet). Approximately 7,578 acres are in unimproved pasture, and approximately 4,008 acres are in sod production or other agricultural crops. These lands are behind locally constructed dikes which will be breached so that they are hydrologically connected to the lakes. The connections will convert the land from its present use to littoral wetlands.

The conversion of these lands has been coordinated with the Soil Conservation Service (SCS) to determine if any are classified as prime or unique. By letter dated April 18, 1995, the SCS concluded that there are 202 acres of unique farmlands in the project area, based on soil potential, that will be directly impacted by recommended lake regulation schedule.

9.2.10 Navigation Impacts

Potential problems areas are most likely to occur at extreme high water above 53.0 feet NGVD and extreme low water below 48.5 feet NGVD. The extreme high water condition is the top of the lowest boat ramps in the impacted area. The extreme low water condition comes from interview information obtained during field investigation. Based on an investigation to determine the net impacts of the proposed regulation schedule (Appendix J., Navigation Impacts Study), the proposed lake regulation schedule should have minimal adverse impacts on navigation when compared to the observed period of flood control regulation (1970-88). Those impacts that do occur would occur during extreme high water conditions above lake levels of 53 feet NGVD.

The estimated impacts involve ramps and covered boat slips. Lake Cypress has a public boat ramp impacted during high waters. Usable alternative boat ramps are available for access. They are within a 30 minute drive from the impacted boat ramp. High water impacts occur at lake levels exceeding 53 feet. Based on an analysis of the stage-exceedance relationship for the proposed regulation schedule, the ramp on Lake Cypress could have 21 more days of high water impacts with the proposed schedule than the observed period of record. About 20 covered slips in Lake Hatchineha and C-37 would have a net impact of 2 days a year with the proposed schedule. Such an impact appears minor with the availability of alternative berthing.

Navigational impacts to Lake Kissimmee with the proposed schedule could involve overtopping a public boat ramp, isolating a private commercial boat ramp, and raising water levels sufficiently to impact about five covered slips. The boat ramp impacts are estimated to occur about 5 days a year on Lake Kissimmee during high water above 53 feet. The private commercial boat ramp could experience inundation of the public access (paved road) with high water which would make it unusable for boating. Covered slips on the southwest side of the lake could experience less impacts but have alternative berthing options to minimize the problem.

9.2.11 Recreation

Fishing and other recreational experiences, i.e., birding, water sports, duck hunting, etc., will not be affected by the proposed lake regulation schedule. Boating and fishing will continue to increase in direct relation to an increase in population in the market area. Use demand on existing facilities will increase as well. Hunting may increase more than these other activities since some lands being acquired by the local sponsor for the project may be made available for this purpose. The wider range of water level regulation, from the present range of 3.5 feet to the proposed range of 5.5 feet, will increase the areas available for boating and fishing during high water conditions. Only during low water conditions would any effects be noticed by boaters and anglers, and these will not be significant or of long duration.

9.2.12 Effects on Aesthetics

The natural aesthetic quality of the Upper Kissimmee Basin will not be affected by the proposed lake regulation schedule. The expansion of the littoral zones and associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress, Tiger, and Jackson will have positive benefits by providing the potential for increased utilization of the area by fish and wildlife, which increases the opportunity for the public to enjoy a positive aesthetic experience.

9.2.13 Vectors

The project should have no effect on vectors related to the cattle population in the headwaters basin. Ticks will continue to be carried in the wild animal populations. No significant incidence of Lyme's disease is recorded for the Upper Kissimmee Basin, and the project is unlikely to produce a significant change in this condition. Mosquitoes and biting flies spend part of their life-cycle in standing water, and the project will increase the area of standing or slow moving water. Concurrently, increased populations of mosquito fish (Gambusia) and other insectivorous fishes, as well as insectivorous insects and spiders, are expected in the restored littoral zone. Swallows, swifts, and bats will take their toll on flying insects. The net effect is expected to be a dynamic balance, very similar to existing conditions. The Upper Kissimmee Basin has a sparse human population, and no human health problems related to vectors are expected.

9.2.14 Effects on Aquatic Plant Control Program

It is expected that the increase in lake level fluctuation, i.e., during normally wet months (e.g., August-September), water levels under the recommended schedule would range from 0.5 to 1.0 foot higher than they do now, up to 20 percent of the time, and they would drop about 0.5 foot lower about 60 percent of the time. During normally dry months (e.g. April-May), the recommended schedule would produce up to 2 feet higher water levels up to 40 percent of the time, but could allow as much as 2.5 feet lower levels 60 percent of the time. This fluctuation will aid the control of aquatic plants, reduce the attendant costs of control, and generally improve the open water habitat of the lakes for fish and wildlife.

While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. Water control plan flexibility for the maintenance of the ongoing aquatic plant management program and for extreme drawdowns will be referenced in the Water Control Plan for the lakes. The extreme drawdowns will be coordinated with the USFWS, FGFWFC, SFWMD and the USACOE's aquatic plant control program. However, with greater fluctuating water levels, extreme drawdowns may not be needed as frequently.

9.2.15 Air Quality

The short term impact from emissions by construction equipment associated with the Upper Kissimmee River Restoration Project will not significantly impact air quality. Osceola County is an attainment area and the Department of Environmental Protection does not regulate mobile emission sources in attainment areas. Air pollution associated with the creation of airborne particles will be effectively controlled through the use of watering or other dust suppression alternatives. No permits are required for this project.

9.2.16 Noise Pollution Effects

The short term impact of noise by construction equipment associated with the Upper Kissimmee River Restoration Project will not significantly impact the surrounding area. All construction equipment will be maintained to minimize noise intrusion to the surrounding environment.

9.2.17 Social-Economic Effects

Successful implementation of the Kissimmee River Restoration Project is dependent on successfully completing work on the lakes in the Upper Basin and modifying the regulation schedule in order to be able to store more water for release as needed. This would require increasing the authorized lake elevations by 1.5 feet more than current conditions. Approximately 20,800 acres would need to be acquired for flowage rights. Lakeside residences and businesses would be impacted by having some outbuildings and other facilities subject to inundation. These would be floodproofed by being elevated. No primary structures would be flooded. However, all septic systems with top-of-tank elevation at or below 56 feet would have to be replaced with mounded systems or with centralized package systems (see Section 8.4, Septic System Impacts).

The Project Modification Report was coordinated with the South Florida Water Management District who has held public meetings with landowners potentially being impacted by the implementation of the project. It has also been coordinated with other agencies, including the Fish and Wildlife Service. The attitudes of the landowners in the upper basin have been varied. The residents are generally receptive, with several expressing concerns for the detrimental impacts to their land use. In areas where less restrictive easements could be utilized without detrimental impact to the environmental benefits, the non-standard estates were developed to meet the needs of the public as well as the landowners.

Flooding range land would reduce cattle production by an estimated $200,000 to $400,000, annually. Approximately $25,000 per year in taxes on undeveloped land will be lost to the counties. Marinas and fish camps may be stressed by changes to their properties required by the increase in lake levels. Options exercised by owners to adjust to changed conditions are problematic. If individual businesses close, they will be replaced at some time by a similar business if the demand for the service is great enough. No residences or occupants will be displaced if mounded septic systems or centralized package sewage systems are installed. Project construction, floodproofing, and septic system replacement will generate an estimated 80-160 man-year of direct employment. Induced employment could range from 300-680 man-years. Because of the large construction work force, relatively unskilled nature of much of the work, and relatively high unemployment in Polk County, no large influx of workers is anticipated. Construction payrolls will help the local economy, particularly the retail sector. Effects may be well dispersed throughout Polk, Osceola, and Orange Counties.

No impact is foreseen on police, fire, emergency services, schools, hospitals, or other institutions in the region as a result of the project. Project activities may act as a catalyst to increase community cohesion. Exposure to flooding from the lakes will be reduced slightly because of higher discharge capacity with no change in the 100 year flood stages. Public Health would benefit if either mounded septic systems or centralized sewage treatment plants are installed. Property values and aesthetics would be better served by the centralized systems.

A complete social impact assessment for the Upper Kissimmee Basin Project can be found in Appendix G.

9.3 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The comparatively short project construction period will produce several unavoidable effects, such as increases in turbidity, disruption of habitat, and other resources, as previously described. Such immediate adverse effects will be avoided where possible, and where unavoidable, mitigated to the extent possible. In the long term, restoration of physical form and hydrologic conditions will lead to reestablishment of the dynamic food webs, habitat heterogeneity, water quality, energy flow, and other complex physical, chemical, biological interrelationships and processes that support the historic ecosystem's high levels of resilience, and allowed for persistence of highly diverse biological communities. As a result, most of the diverse communities that historically constituted the Upper Kissimmee Basin ecosystem will redevelop, and the restored littoral zone ecosystem can be expected to again support populations of many fish and wildlife species.

9.4 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Construction and ongoing operation and maintenance will require the expense of time and resources, such as labor, energy, and project materials, purchased with the Federal and sponsor's financial contributions. Once used, these resources could not be recovered.

In a larger sense, the Upper Kissimmee River Basin restoration represents a recovery - a practicable reversal and retrieval - of natural resources that had been lost or degraded with the commitment of lands and improvements for the flood control project over twenty years ago. Although it is not possible with existing constraints to fully restore an identical pre-channelization littoral zone ecosystem around the lakes, the restoration project will provide more natural conditions that will facilitate the reestablishment and long-term maintenance of a full range of physical, chemical, and biological characteristics necessary for a resilient ecosystem.

9.5 CUMULATIVE EFFECTS

The Upper Kissimmee River Basin is the headwaters origin of the unique and complex regional ecosystem of central and southern Florida that extends from the Upper Kissimmee chain of lakes through Lake Okeechobee and culminates in the Everglades at the southern tip of the State. The Kissimmee Basin is a critical link in that overall system, providing both hydrological and ecological inputs. Restoration of the Upper Kissimmee Basin will ensure that the larger system can function in a more natural manner, reflecting its historic values. The beneficial environmental effects of restoration will make important contributions to many significant resources which require cumulative efforts to preserve their values, including:

* restoration of Atlantic flyway habitat of critical concern as recognized by the international North American Waterfowl Management Program;

* improvement of the quality of Kissimmee River waters will benefit the clean up of Lake Okeechobee;

* increased wading bird populations will assist wading bird recovery in the southeast landscape.

Restoration of the Upper Kissimmee River Basin littoral wetlands also will make contributions to both the State's environmental protection and conservation objectives, such as the Save Our River's Program, as well as National environmental goals, such as the long-term goal to increase the quality and quantity of the Nation's wetlands, as established in Section 307 of the Water Resources Development Act of 1990.

9.6 SUSTAINABLE DEVELOPMENT

Restoration of the wetlands and fish and wildlife values of the Upper Kissimmee River Basin will be accomplished in a manner that is compatible with the original, traditional project purposes of navigation (authorized in 1902) and flood control (authorized in 1954). The canals and related structures that have successfully fulfilled these purposes for many years will be replaced, by a modified project that will not only continue to meet navigation and flood control needs, but will make a significant contribution to the Nation's environment. The project will serve the full range of the water resource needs, both providing developmental services and sustaining environmental values in the central and southern Florida region.

SECTION 10

COMPLIANCE WITH ENVIRONMENTAL STATUTES

10.1 *National Environmental Policy Act of 1969*, as amended.

Environmental information on the project has been compiled and the draft Supplemental Environmental Impact Statement (SEIS), Kissimmee River Headwaters Study, dated September 1995, has been prepared as a supplement to the Final Environmental Impact Statement (FEIS), Central and Southern Florida Project, Environmental Restoration of the Kissimmee River, Florida, dated December 1991. A systematic interdisciplinary approach to planning has been utilized; alternatives have been studied, developed, and described; and ecological information has been developed and utilized. This integrated feasibility report and draft SEIS will be circulated prior to finalization in accordance with the National Environmental Policy Act.

10.2 *Archeological and Historic Preservation Act*, as amended.

The study is in full compliance at this stage. Cultural resources investigations have and will preserve historic and archeological data that would otherwise be lost as a result of this project. The cost of preservation of archeological and historic data will not exceed one percent of the total estimated Federal appropriation required for construction of this project.

10.3 *Clean Air Act*, as amended.

Coordination on December 14, 1994, with the Department of Environmental Protection, Air Quality Division determined the proposed project is in partial compliance with the Clean Air Act. No permits will be required for this project. Full compliance will be achieved with receipt of comments on the final SEIS from the U.S. Environmental Protection Agency.

10.4 *Clean Water Act (Federal Water Pollution Control Act)*, as amended.

The study is in partial compliance. Full compliance will be achieved with issuance of a Section 401 permit from the State of Florida. A Section 404(b) Evaluation is included in this report as Annex B.

10.5 *Coastal Zone Management Act of 1972*, as amended.

The study is in partial compliance at this time. Full compliance will be achieved with receipt of comments from the State Clearinghouse. A federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as Annex C.

10.6 *Endangered Species Act of 1973*, as amended.

Formal consultation was initiated on December 3, 1993 and completed on March 28, 1994. This project was fully coordinated under the Endangered Species Act; therefore, this project is in full compliance with the Act.

10.7 *Estuary Protection Act*.

This act is not applicable, since no estuaries will be affected by this project.

10.8 *Federal Water Project Recreation Act*, as amended.

The project is in full compliance at this stage. The effects of the proposed action on outdoor recreation have been considered. Continued recreation planning will be performed during project engineering and design.

10.9 *Fish and Wildlife Coordination Act*, as amended.

In response to the requirements of this Act, the Jacksonville District has and will continue to maintain continuous coordination with the USFWS during all stages of the planning and construction process. On June 30, 1994, the USFWS submitted a final Fish and Wildlife Coordination Act Report, which is included in this report as Appendix G.

* <u>Recommendation #1</u> - Lands up to the 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. These actions will realized the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risk during storm events. Among the evaluation species, the Florida duck, great egret snowy egret, and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from this action. Direct hydrological connection of the wetlands with the lakes would increase the flow of nutrients and promote movement of aquatic animals; the wetlands behind the levees are now

generally isolated from the lakes. Acquisition of the area behind the levees would also ensure that existing wetlands behind the levees are not pumped dry by more intensive agricultural practices on private lands.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #1. Lands up to 54 feet in elevation located behind the local levees at Lakes Hatchineha, Kissimmee, and Cypress will be acquired and these levees will be breached to hydrologically connect existing wetlands with the lakes.

* Recommendation #2 - Periodic extreme drawdowns should be superimposed on the normal regulation schedule and should be referenced in the operational notes for the schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. Field research has demonstrated substantial increases in the yield of the sport fishery for several years after an extreme drawdown. The periodic reduction in density of vegetation in the littoral zone is also beneficial to the ecosystem as a whole. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #2. While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. Water control plan flexibility for the maintenance of the ongoing aquatic plant management program and for extreme drawdowns will be referenced in the Water Control Plan for the lakes. The extreme drawdowns will be coordinated with the USFWS, FGFWFC, SFWMD and the USACOE's aquatic plant control program. However, with greater fluctuating water levels, extreme drawdowns may not be needed as frequently.

* Recommendation #3 - Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for losses of wetlands. The Corps should investigate redirecting flow to the remnant river run adjacent to C-37. After widening the canals, the banks should be replanted with cypress trees, and a littoral shelf should constructed and planted with desirable aquatic plants such as bulrush.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #3. Placement of spoil material excavated during widening of C-36 and C-37 has been coordinated with the USFWS. The material will be confined to the existing spoil banks within the right-of-way.

* Recommendation #4 - The Corps should develop an aquatic plant management plan, including funding projections, to address control of Hydrilla, floating plants, and tussocks in the lakes.

The U.S. Army Corps of Engineers does not concurs with USFWS's recommendation #4. Aquatic plant management for the lakes is out of the scope of this project. The USACOE and its partner the State of Florida have an active aquatic plant management program.

* Recommendation #5 - The Interagency Review Team used to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #5. The evaluation of alternative schedules will be an ongoing process after implementation of the Headwaters Revitalization Project and the Kissimmee River Restoration. Given the uncertainties of the simulations resulting from incomplete model calibration (i.e., underestimated discharge) and the relatively dry simulation period, it may be possible to modify the schedule to maintain higher lake stages for longer durations and still provide the necessary inflows to achieve restoration of the river/floodplain ecosystem. Alternatively, minor adjustments may be required to facilitate restoration of the river.

* Recommendation #6 - The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that a separate regulation at levels higher than

Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

The U.S. Army Corps of Engineers does not concur with USFWS's recommendation #6. The alternative was considered, but it was expected that the added structure and the loss of initial storage in Lake Cypress would have an adverse impact on flood stages upstream of the proposed structure and that it may interfere with the required operational criteria for the river restoration project. Since monitoring and evaluation of operation criteria will be an ongoing process after implementation of the Kissimmee River Project, the Jacksonville District proposes to defer any investigation of a new control structure.

* Recommendation #7 - The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a restoration project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #7. The Corps will continue to support the authorized plan for the Kissimmee River Restoration.

10.10 *Land and Water Conservation Fund Act of 1965*, as amended.

The study is in full compliance. No funding under this act is involved. No properties affected by this act are involved in the recommended project area.

10.11 *Marine Protection, Research, and Sanctuaries Act of 1972*, as amended.

Ocean disposal of dredged material is not proposed.

10.12 *National Historic Preservation Act of 1966*, as amended.

The study is in partial compliance at this stage. Consultation with the Florida State Historic Preservation Officer (SHPO) has been initiated. Cultural resources investigations are ongoing to determine effects to historic properties. When completed, results will be coordinated with the SHPO and the Advisory Council on Historic Preservation.

10.13 *Coastal Barrier Resources Act.*

The study area is not in a designated CBRA unit.

10.14 *Rivers and Harbors Appropriation Act of 1899.*

The study is in full compliance. The proposed work would not obstruct navigable waters of the United States.

10.15 *Wild and Scenic Rivers Act of 1968*, as amended.

The study is in full compliance. No rivers designated under the Act are in the study area.

10.16 *Resource Conservation and Recovery Act of 1976.*

This law has been determined to be not applicable as there are no items regulated under this act either being disposed of or affected by this project.

10.17 *Toxic Substances Control Act of 1976.*

This law has been determined to be not applicable as there are no items regulated under this act either being disposed of or affected by this project.

10.18 *Executive Order 11988, Flood Plain Management.*

The study is in full compliance. The considered alternatives support avoidance of development in the flood plain, continue to reduce hazards and risks associated with floods and to minimize the impact of floods on human safety, health and welfare, and restores and preserves the natural and beneficial values of the base flood plain.

10.19 *Executive Order 11990, Protection of Wetlands.*

The study is in full compliance. By nature of the project, it involves work in wetlands, and no practicable alternative to working in wetlands exists. Losses and degradation to the beneficial values of wetlands are minimized, and such values are preserved and enhanced. The public has been involved in early planning.

10.20 *Executive Order 12114, Environmental Effects Abroad of Major Federal Actions.*

This executive order is not applicable to this study.

SECTION 11

PLAN IMPLEMENTATION

The recommended restoration plan for the Upper Basin is basically an expansion of the Kissimmee River Modified Level II Backfilling Plan (or "Recommended Plan") as presented in the Corps second feasibility study of the Kissimmee River Environmental Restoration. The entire Headwaters project results from the necessity for an alternate lake regulation schedule to compensate for the new flow requirements of the restored Kissimmee River, while maintaining the existing level of flood protection within the Upper Basin. Additionally, optimization of environmental outputs throughout the project area was a vital consideration during the planning of the project. The suggested plan, shown in PLATE 8-1, Section 8, consists of construction components, real estate requirements, ecological monitoring, and operations and maintenance for the completed project.

11.1 CONSTRUCTION COMPONENTS

Included within the construction components portion of the plan are discussions of the following: dredging of canals C-35, C-36, and C-37 to include both maintenance and new work excavation; breaching of five locally built levees; structural additions to the existing gated spillway S-65; structural integrity analysis of existing spillways S-63 & S-61; adding a steel sheet pile wall to an existing embankment; removal and relocation of various mechanical and structural items in conjunction with the S-65 modifications; placement of mechanical equipment within the additional spillway structure; addition, replacement, or removal of various electrical and power components associated with the structural changes; and finally, relocation of utility and telephone lines.

11.1.1 Canal Dredging

Following the change in lake regulation schedule and subsequent analysis of potential flood conditions, it was determined that dredging of three canals is necessary in order to achieve sufficient flow and storage capacities between the lakes. Three canals C-35, C36, and C-37 are required to be excavated for maintenance and widening purposes. A total of 1,158,000 cubic yards, 703,000 cubic yards of maintenance material and 455,000 cubic yards of new work will be removed from the canals. The non-Federal sponsor, the SFWMD, will be responsible for any existing maintenance requirements needed for the flood control canals. Because of lower volume requirements between Lake Cypress and Lake Hatchineha, it was determined that C-35 would require removal of excess shoal material only. Spoil material will be placed on existing spoil mounds to either side of the canals. Typical canal sections are shown in PLATE D-1 of **Appendix D**. A brief description of each canal is as follows:

C-35 - Begins at spillway and lock structure S-61 on the southern tip of Lake Tohopekaliga and extends approximately 3.6 miles south to Lake Cypress. Lake Cypress has no control structures regulating flow to or from the lake. An estimated 170,000 cubic yards of shoal material is to be removed from the canal.

C-36 - Covers nearly 2.5 miles from Lake Cypress south to the northeast portion of Lake Hatchineha. The canal will be dredged to elevation 31.3 feet and widened to 60 feet from the original 48 feet. The estimated total volume of material for removal is 285,000 cubic yards (160,000 maintenance & 125,000 new work).

C-37 - Runs between Lake Hatchineha and Lake Kissimmee for a distance of roughly 3.9 miles. The canal design specifies widening from 70 feet to 90 feet and deepening to average elevation of 26.8 feet. An estimated 703,000 cubic yards of material (373,000 maintenance & 330,000 new work) is required to be removed from the canal and placed into a spoil location on the east bank of the canal.

The material taken from each canal will be placed to one side of the canal only, and will begin at a distance of approximately 25 feet from the top of the canal and will continue to no further than 15 feet inside the right-of-way line. The disposal areas were previously used for spoil placement from the original canal construction and are estimated to have sufficient capacity for this project. Spoil mounds currently exist on both sides of the canals, but only one side of each canal will be used, and this is the side to which the widening will occur. During construction, attempts will be made to minimize impacts to the vegetated regions that have developed along the canals since their construction. Visual inspections prior to dredging will identify any vegetation that might be impacted. Stabilization of the spoil mounds will be accomplished through grass seeding.

11.1.2 Local Levees

Five levees, which were designed and built by local property owners, are planned for partial destruction to allow for unobstructed flooding of the lands behind the levees. The levees - Lake Kissimmee Levee, Cypress Lake Levee, Sparks Chandler Levee, Rolling Meadows Levee, and Oasis Levee are to have a series of breaches cut in them which will permit lake levels above the 52.5 feet elevation to inundate the newly accessed regions and achieve the desired lake capacities. The breaches will occur approximately every 1,000 feet and will be 100 feet in length (see Plate D-2). Approximately 75,000 cubic yards of material will be graded to existing ground elevations at about 50 feet NGVD. The material cut from the levees will be placed and graded within the original borrow canals on either side of the levees.

11.1.3 Structural Modifications to S-65

In order to achieve a historical flow output from Lake Kissimmee into the Kissimmee River (currently C-38) of the Lower Basin, an additional two bay spillway structure is proposed for construction. The new structure, identified as S-65X, will be placed immediately adjacent to S-65 to the east, and will be of the same design specifications as S-65. The combination of structures S-65 and S-65X will be better able to balance the adjusted upstream lake levels and downstream flow releases following implementation of the new Upper Basin lake regulation schedule. Furthermore, the new spillway will permit the expected discharge rate to closely correspond to the prechannalization stage-discharge rating for lake Kissimmee.

Relocation of the spillway operators generator house, antenna tower and guy wires will be required during construction of the S-65 addition. The new locations of these items will be identified during plans and specifications. Minor modifications to the upstream and downstream wingwalls of S-65 are necessary in order to tie them into new spillway. The existing safety barriers will be extended to incorporate both S-65 and S-65X. A cofferdam will be constructed at the S-65X location for dewatering purposes. A stability analysis was done on S-65X, S-61, and S-63 by placing various loading conditions on the structures to see they responded (PLATES S-6 though S-9). The structures were analyzed for overturning and flotation stability, and the uplifting forces that would cause overturning or sliding were assumed to occur over the entire base of the structure. The stability results can be found in **Appendix D**. The vertical lift gates are to be 27 ft. wide by 14.2 ft high and will be of the same design specifications as the existing gate structure. A steel sheet pile retaining wall will be added to stabilize an embankment to the east side of the spillway near the operator's dwelling. Several loading conditions were incorporated into the analysis of the retaining wall.

11.1.4 Mechanical Modifications to S-65

The project's mechanical design consists mainly of additions within the new spillway structure, S-65X, with minor modifications. No modifications are anticipated for the existing structure as design analysis revealed that it would continue to operate adequately under the modified conditions, although it was evident that it may be deficient in some areas based on current standards. The mechanical equipment to be used for the new spillway will include horizontal hydraulic cylinders as part of the hoisting units to raise each vertical lift gate. The cylinders will be operated by a motor-driven hydraulic power unit. Commercial power will be used to operate the gate hoist, and a gas generator will serve as a backup. The general design of the gate operation machinery is comparable to the original design. Other items that require mechanical manipulation include the lawn sprinkler system which will need to be replaced, the aboveground and underground storage tanks will have to be relocated, and the generator house and its contents must also be moved prior to construction. For details of these items, see Appendix D., Design and Cost Estimates.

11.1.5 Electrical Modifications to S-65

Local power will service the new gated spillway, as it does with the existing spillway. For the combined S-65 and S-65X structures, the current service will be upgraded from 200 to 300 amps, resulting in necessary modifications to the manual transfer switch, the step up transformer, and associated equipment. A control center will be added to the control building and will house the electronic relay and transfer controls. Push button controls are provided for the manual operation of the gates, and they will be located in both the structure and the control house. The lighting, wiring, and grounding details are discussed in **Appendix D.**

Relocation or removal of various existing electrical components will be required during construction. Peace River Corporation, the local electric company that will serve the electricity, will do the power line relocation work. The local telephone company, General Telephone Company, will provide telephone line relocation at no cost.

11.2 REAL ESTATE

11.2.1 Lands and Easements

Lands needed for the purpose of ecosystem restoration and flood control will be acquired in fee or easement to ensure that they will continue to be available solely for that purpose over the life of the project. This will require acquisition in fee of flood plain acreage from the 52.5 feet to 54.0 feet elevation around the four impacted lakes (Kissimmee, Cypress, Hatchineha, and Tiger). The total land acquisition area up to 54.0 feet is approximately 20,800 acres. Approximately, 5,986 acres of these lands are below the 52.5 feet elevation that were previously utilized under flowage easements, but must now be purchased in fee to support the environmental effort. A large tract of land, lying to the north of Lake Hatchineha, falls below the 54' elevation, but will not be acquired in fee because it is owned by the Disney Corporation as mitigation property. For this land a Perpetual Conservation Easement is currently in effect. The additional right to flood, flow and store water on the property is required for project purposes, therefore a Pertual Flowage Easement is recommended for this property. For Lake Tiger, perpetual flowage easements are necessary due to the minimal environmental benefits anticipated from the project.

All construction areas and disposal areas for the project are located with existing right-of-ways or in proposed acquisition limits, and therefore, land easements will not be required for construction purposes. If necessary, temporary road access easements will be obtained for the canal dredging and disposal operations.

11.2.2 Relocation Assistance (*Public Law 91-646*)

Preliminary estimates identified 123 residences and 8 commercial buildings which will be acquired. Relocation assistance will be provided to affected owners in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

11.2.3 Construction Relocations

The only structural relocations necessary for the project are 61 septic systems located within the Hatchineha Estates and Grape Hammock. All septic tanks located below the 56 feet elevation must be relocated to higher ground or replaced with aboveground tanks. In the event the tanks cannot be replaced with aboveground tanks, the land parcels containing tanks will be acquired in fee. Those parcels in which the tanks can be replaced with aboveground tanks will require a Water Inundation Easement. The sponsor has the option of installing a sewer system instead of acquiring the parcels. A sewer system would require only Water Inundation Easements for all of the parcels and would be the least expensive of the alternatives. The sponsor will be given credit for the least cost option.

11.3 MONITORING

Monitoring programs will be conducted during construction and following construction. These programs are intended to evaluate the success of the project and to check both areas of success and uncertainty. Based on the results of the monitoring studies, refinements and adjustments can be made to the long-term operations and management of the regulation schedule. Further justification for each of the monitoring programs is given in the following sections.

11.3.1 Vegetative Monitoring

Plant communities should be monitored to evaluate the Project's success in restoring former wetlands around the lakes. This monitoring should focus on lands Surrounding Lakes Kissimmee, Tiger, Cypress, and Hatchineha up to the 54 feet elevation. The study's goal would be to document changes in vegetation patterns around these lakes and compare them with the predictions of the Fish and Wildlife Coordination Act Report on the Kissimmee Headwaters Revitalization Project. That report estimates that the new schedule will help restore over 7,000 acres of marsh.

Vegetation community types within the submergent and littoral zones will be mapped using aerial photography and ground truthing. Because certain wetland species are present already in some of these areas, quantitative methods should be developed to assess changes in species composition. These methods will be detailed in the Restoration Evaluation Report as prepared by the sponsor.

The aerial photography will be infrared color photos with 60 percent forward overlap at a scale of 1:8,400. The flight lines will generously cover the perimeters of the lakes as well as and all other impacted areas within the Upper Basin. Surveys would be conducted every two to three years. The first survey would be done in 1995 to document conditions existing before the 1995-96 extreme drawdown of Lake Kissimmee and before the implementation of the new regulation schedule in 1997. The next survey would be conducted in 1997, one year after the Lake Kissimmee drawdown. This would be followed by more surveys in the years 2000 and 2003, at which time the need for further monitoring would be determined.

To aide with the comparison between present and future wetland conditions, some regions between the 52 foot and 53 foot elevations will have temporary ground transects established. The areas selected for placement of transects will reside within regions expected to have moderate to significant vegetative changes. The regions of high impact were previously recognized during the 1994 Fish and Wildlife Coordination Act Report, which depicted all anticipated wetland increases between the 52 and 54 foot contours. The transects will be identified, and marked and surveyed prior to the commencement of the project and are to be maintained throughout the monitoring study.

11.3.2 Mercury Study

The bioaccumulation of organic mercury in fish and wildlife has become an important ecological and health issue in Florida. With regard to the Headwaters Revitalization Project, there is some public concern that the expanded lake stage regulation schedule could increase mercury mobilization and subsequent bioaccumulation in predatory fish and wildlife. According to some sources, periodic drying and flooding of wetlands and croplands can promote the methylation of mercury in the soil. Soil disturbances and wetland creation also have a potential to mobilize mercury. However, the production of high levels of methylmercury is usually restricted to water bodies with organic sediments, low productivity, and slight acidity.

Because of the eutrophic nature of the headwater lakes and the predominance of sandy soils, there is no compelling evidence to suggest that the revitalization project could cause a mercury problem in the headwater lakes. Yet, little information exists from the region to form a conclusive judgement. Although data on existing levels of mercury contamination in fish from the region are available, further field research would help in predicting the effect of lake stage changes on fish tissue concentrations.

Therefore, to obtain field data useful for predicting future conditions, soil samples would be collected from the lands around Lakes Cypress, Hatchineha, Kissimmee, and Tiger that will be reinundated under the new Lake regulation schedule. From the analysis of mercury concentrations in these soils, future rates of methylmercury production in these reinundated areas could be estimated. Once these rates are calculated, the potential change in fish methylmercury concentrations could be approximated with more certainty.

In addition to the soil sampling, samples of fish, water and sediment would be taken from Lake Kissimmee to document current conditions. This sampling would be done before and after the extreme drawdown of the lake in 1996 in an effort to distinguish any drawdown effects from subsequent effects of the modified stage regulation schedule.

Sampling would begin in the summer of 1995 and would be repeated over several more years. Lake Kissimmee would be sampled again in 1997 (one year after the drawdown) and every two years thereafter until 2003 so that trends can be examined. The soils around the headwater lakes would be sample again in 1999 and 2003 (two and six years after stage regulation schedule modification).

11.3.3 Water Quality

Some monitoring will be expected due to localized increases in turbidity during construction. An accurate evaluation of turbidity impacts will be required. Best management practices would ensure that turbidity is kept to a minimum by the placement of turbidity barriers during canal dredging. Therefore, no inordinate amounts of suspended solids are expected to occur within the canals or lakes downstream during or following construction.

11.3.4 Hydraulic Monitoring

Water level monitoring locations will be established in Lakes Kissimmee, Hatchineha, Cypress, and Tiger in order to better manage future operations in the Upper Basin. More gage locations will avoid existing problems with wind setup in the lakes which can cause erroneous estimates of average lake stage. Lake regulation schedules are based on stages of hypothetically flat lake surfaces; therefore, average lake stages are preferable for use in daily operations. The gages will also verify or refute the accuracy of the hydrological models, which are based on historical data and show expected lake stage durations for an average calendar year.

Monitoring within the Lower Basin (below S-65) will provide valuable hydraulic data that will aid in the management and operation of the Upper Basin regulation schedule. The same is true for the Upper Basin data which will assist with future analysis of the Lower Basin operations. Other hydrologic monitoring ongoing in the basin will continue. Rainfall gages presently located at S-65 structures will relocated during construction.

11.3.5 Stability Monitoring

While the constructed features of this project will be subjected to normal inspections, including quality assurance (quality control) and "as-built" comparisons to specifications, some long-term monitoring is necessary for some of the construction features of the project. Features normally submerged and subjected to erosional forces will be monitored to determine stability. Concerns include armoring, unprotected soil in abutment areas, and gross stability of slopes and structural mass. Also, revegetated areas will be monitored for survivability of plants and overall coverage for erosion protection.

11.4 OPERATION, MAINTENANCE, AND MANAGEMENT

11.4.1 Water Management

Water Control and Operations and Maintenance Manuals will be prepared and provided to the non-Federal Sponsor prior to final turnover of the project. During construction, interim water control plans will be prepared to ensure that project objectives are safely accomplished. Long term study of the effects that the proposed regulation schedule has on the Upper and Lower Basins will govern the adjustments to the schedule that may be necessary.

11.4.2 Land Management

Land management practices for the lands acquired for restoration shall be consistent with project purposes. As previously discussed, restoration will occur by allowing the system to return to as near a natural state as hydrologically possible, while maintaining the new discharge rates. However, some land management practices, including prescribed burning, limited livestock grazing, and fencing and posting to prevent trespassing, may be necessary.

11.4.3 Aquatic Plant Control

The primary goal of aquatic plant control in the Kissimmee River Basin is restriction of the hydrilla plant and various other non-native floating plant species such as waterlettuce, water hyacinth and floating mats of vegetation called tussocks. Hydrilla is considered to be highly intrusive to littoral aquatic regions. It is also very problematic for boaters and water control structures. The growth rate of hydrilla and other non-native plant species within the lake system is significant, and measures to control these plants must be continued and expanded if necessary.

The potentially lower lake stages in the winter, as evidenced in the stage hydrographs from H&H Branch, could provide optimal conditions for the chemical (fluridone) removal of the exotic hydrilla plant. Because the hydrilla eradication requires low water levels over a multi-week period, the lower winter lake elevations would grant an ideal time frame for this task when necessary. It is currently unknown as to whether the newly inundated areas will provide suitable or unfit habitat for the nuisance plants. Initial thoughts are that increased water surface area will allow the exotics to increase their coverage proportionally. To verify the extent to which the exotic plant species have either flourished or diminished under the new lake regulation schedule, aerial photography and ground truthing methods will be utilized on a predetermined schedule (see 11.3.1 Vegetative Monitoring).

11.4.4 Structures

The only structure of the completed project that will require routine inspection is the S-65 spillway addition. This structure, in addition to the existing S-65 structure, will be operated in accordance with the operation manuals described above. The maintenance of the structures includes activities such as periodic inspection and maintenance of mechanical and electrical equipment; sand blasting and painting gates; and ensuring inlet and outlet channels are clear of snags.

11.4.5 Navigation

Following completion of the project, the hydraulic characteristics of the lakes will change slightly, resulting in minimal impacts to navigation within the lakes and channels. The new lake regulation schedule could potentially limit access to and from certain portions of the lakes.

Types of maintenance for the navigational channel include clearing snags and sandbars, maintaining a navigational markers system, and providing advisories to navigators on water conditions such as flood stages, currents, bridge clearance, and drought and draft clearances. Maintenance of disturbed areas will be limited to the degree necessary to meet minimal navigation needs to limit influences to the natural environmental progression of the lake system.

11.5 PROJECT IMPLEMENTATION

11.5.1 Project Management Plan

A Project Management Plan is being prepared for the Kissimmee River, Project, including the Lower and Upper Basin projects, to identify specific tasks to be accomplished during the next preconstruction engineering and design (PED) phase, and to identify specific contracts and construction management activities for the construction phase.

11.5.2 Construction Sequencing

The implementation plan and schedule will be refined during later preconstruction engineering and design studies. It is intended that the Headwaters Project be at or near completion, with a fully operational S-65, prior to construction in the Lower Kissimmee Basin. The lake elevations will likely fluctuate for a while depending on the weather patterns and the outflow requirements at S-65. It is anticipated that the Upper Basin will have stabilized by beginning of construction on C-38. Construction is expected to begin at the end of FY 96 and continue for two years, although the availability of real estate may affect the schedule to some degree. At this time, the construction is expected to proceed generally as follows:

* Real estate must be provided by the sponsor prior to each separable phase of construction, including land acquisitions (both fee title and easement purchases) and relocations of houses, septic systems, other structures, utilities, and recreational facilities. Construction of the Hatchineha Estates Sewer Treatment Facility (see Section 8, Recommended Plan) should be completed.

* Monitoring network sites will be established prior to construction. Prior to any change in lake stages, an evaluation of existing vegetative communities and wildlife habitats must be accomplished. This evaluation will include vegetation mapping in the form of aerial photography and ground surveys (see 11.3.1 Vegetative Monitoring).

* The sequence of construction, including the change in regulation schedule, will generally be as follows:

1. All construction and non-construction relocations must be accomplished prior to the construction phase.

2. Most of the construction work can occur concurrently, with the exception of the implementation of the new regulation schedule, which will be the final portion of the Headwaters Project.
3. Canal dredging, levee degradation, and structural modifications can be performed through single or multiple contracts.

11.5.3 Environmental Protection During Construction

Corps construction contract specifications include environmental protection requirements. These requirements cover prevention of environmental pollution and damage as a result of construction operations under the contract. Environmental pollution and damage are defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants. Staging, storage and vehicle routes and parking areas are subject to advanced planning and approval by the Corps and local sponsor. The transportation and storage of petroleum products for use during construction is regulated by existing laws and by Corps regulations and practice.

Within 20 calendar days after the date of the notice of award of a contract, the construction contractor is required to submit an environmental protection plan. The contractor cannot proceed with construction until the plan is approved. The environmental protection plan includes the following:

* A list of Federal, State and local laws, regulations, and permit requirements concerning environmental protection and pollution control and abatement that are applicable to the contractor's proposed operations, and the requirements imposed by those laws, regulations, and permits.

* Methods for protection of features to be preserved within authorized work areas. The contractor shall prepare a listing of methods to protect resources needing protection, including: trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, and historical, archeological and cultural resources.

* Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The contractor shall provide written assurance that immediate corrective action will be taken to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the environmental protection plan.

* Permit or license and the location of the solid waste disposal area.

* Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of materials.

* Environmental monitoring plans for the job site, including land, water, air and noise monitoring.

* Methods of protecting surface and ground water during construction activities. Special measures shall be specifically addressed and shall include reduction of turbidity and aeration of discharge prior to waters being released into the canal.

* Oil and fuel spill contingency plan.

* Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or non-use. The plan would include measures for marking the limits of use areas.

* Plan for any dewatering activities associated with borrow areas.

The above minimum environmental protection procedures are expected to completely prevent avoidable environmental damage during construction. Since the Kissimmee Basin surface and subsurface groundwater are separated from the underlying deep aquifer by impervious geological strata, the potential for pollution of groundwater used for human consumption is not a concern. Typical spill contingency plans and measures are intended to contain, absorb and remove pollutants from the ecosystem for disposal in previously identified approved disposal areas.

11.6 COST ESTIMATE

11.6.1 Investment Costs

11.6.1.1 Initial Costs

The total estimated cost of the Headwaters Project is $78,356,300 at January 1996 price levels. The M-Cases detailed cost breakdown is shown in Appendix D. A summary of project costs is shown in Table 11-1. The costs of channels and canals does not reflect the cost to remove approximately 703,000 cubic yards of spoil material from C-35, C-36 and C-37 (see Section 11.1.1, Canal Dredging). The estimated cost to remove this maintenance dredging quantity, $1.4 million, is a non-Federal responsibility.

Table 11-1
Project Cost Estimate

FEATURE ACCOUNT	PROJECT COST
01 - Lands, Damages, Relocations Assistance	$ 71,566,600
02 - Construction Relocations	$ 83,224
06 - Fish and Wildlife Monitoring	$ 838,738
09 - Channels and Canals	$ 1,721,159
11 - Levees and Floodwalls	$ 102,548
15 - Floodway Control-Diversion Structure	$ 3,022,742
30 - Planning, Engineering, and Design	$ 545,380
31 - Construction Management (S&I)	$ 475,920
TOTAL FOR HEADWATERS PROJECT	**$ 78,356,300**

11.6.1.2 Interest Costs

The computation of interest during construction (IDC) is based on scheduled construction expenditures (structures, canal, levees, relocations). Calculation of IDC assumes equal construction expenditures in each month of the 2 year construction period. It is assumed that environmental benefits will be realized during the construction period, specifically after the new regulation schedule is implemented. At 7.625 percent the IDC for the Headwaters plan is $ 455,471 (annually = $ 35,634).

11.6.2 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Costs

Annual operation and maintenance costs were estimated for the components of the Headwaters Project. Replacement costs at 25 years were calculated for the structural and mechanical equipment contained in the S-65 additional spillway structure. The total estimated OMRR&R costs over the life of the Headwaters Project were estimated at $ 5,000 annually.

11.6.3 Project Annual Costs

Total investment costs (initial + IDC) were converted to annual costs using an interest rate of 7.625 percent and a project life of 50 years to compute interest and amortization. Annual operation and maintenance costs were then added to the annualized total investment costs to determine the average total project annual cost, which is $ 6,170,800 for the Headwaters Project.

11.7 COST SHARING

Responsibilities for implementing the Headwaters Project will be shared by the Corps of Engineers, on behalf of the Federal government, and the local sponsor. The Corps will design the project and administer construction contracts to build the project. The local sponsor will be involved in the project design and will in the design and construction costs; furnish necessary lands, easements, rights of way, relocation, and disposal sites (collectively referred to as LERRD); and operate and maintain the completed project.

Based on the project authorization, the local sponsor shall contribute 50 percent of total project costs. The local sponsor contributions are to be in accordance with the provisions of the Project Cooperation Agreement between the sponsor and the Federal government. The Local Sponsor is providing for and will receive credit for all LERRD's (lands, easements, rights-of-way, relocations and including suitable borrow and dredged or excavated disposal areas) determined by the Government to be necessary for construction, operation, and maintenance of the project. Furthermore, the Government has determined that the Local Sponsor shall receive credit for approved in-kind services or services requested by the Government for completion of the project. For the Headwaters Revitalization component, the sponsor will be allowed credit for their effort on completing the Upper Basin Residential Impact Evaluation and completed and continuing SFWMD staff support for the Upper Basin study and project. The affording of such credit shall be subject to an inspection as appropriate by the Government to verify that the work was accomplished in a satisfactory manner and is suitable for inclusion in the project. The actual amount of credit shall be subject to an audit to determine the reasonableness, allocability, and allowability of costs in accordance with the Project Cooperation Agreement.

Table 11-2 contains an estimated apportionment of project costs between the Federal government and the local sponsor based on the project cost sharing provisions, excluding costs for the Local Sponsor's in-kind services. The Government will reimburse the Local Sponsor for that portion of the contributions which exceeds 50 percent of the total project costs. Because the estimated value of the LERRD provided by the sponsor, $71,566,600, exceeds 50 percent of the total project costs, $78,356,300, the table demonstrates that all the construction costs will be born by the Government. The Federal share of the total project cost is approximately $39,178,150. The sponsor's (SFWMD) share is $ 39,178,150. The sponsor will be expected to bear 100 percent of all OMRR&R expenses after the project is completed.

TABLE 11-2
Cost Apportionment of Headwaters Revitalization Plan

ITEM	FEDERAL $ (USACE)	SPONSOR $ (SFWMD)	TOTAL $
Construction and Monitoring	$ 6,789,700		$ 6,789,700
Real Estate Costs	$ 32,388,450	$ 39,178,150	$ 71,566,600
TOTAL	**$ 39,178,150**	**$ 39,178,150**	**$ 78,356,300**

Table 11-3 below shows a preliminary cost estimate comparison for the Headwaters Revitalization Project. The estimate details current project cost against those developed in the 1991 Feasibility Study for the Kissimmee River Restoration. Many of the differences in the two estimates can be attributed to changes in design, real estate, and monitoring requirements since the original plan formulation.

TABLE 11-3
Headwaters Revitalization Project
Preliminary Cost Estimate Comparison

FEATURE ACCOUNT	1991 REPORT	1995 REPORT
01 - Lands and Damages	$ 74,776,000	$ 71,566,600
02 - Construction Relocations		$ 83,224
06 - Fish & Wildlife Monitoring	$ 180,000	$ 838,738
09 - Channels and Canals	$ 12,652,000	$ 1,721,159
11 - Levees and Floodwalls		$ 102,548
15 - Flood Control Diversion Struc.		$ 3,022,742
30 - Planning, Engineering, Design	$ 2,796,000	$ 545,380
31 - Construction Management (S&I)	$ 886,000	$ 475,920
TOTAL	**$ 91,290,000**	**$ 78,356,300**

11.8 FINANCIAL ANALYSIS

The non-Federal sponsor, the SFWMD, has the capability to provide the required local cooperation for the Headwaters Project. A financial analysis was previously conducted for the Kissimmee River Restoration Project to assess the SFWMD's capability to financially participate in the Headwaters Project. The SFWMD provided a statement of financial capability prior to the execution of the Project Cooperation Agreement for the Kissimmee River Project.

11.9 LOCAL COOPERATION

The project's non-Federal sponsor must provide its share of project costs, including LERRD and cash for construction and later OMRR&R costs, as described above. LERRD are to be furnished to the Federal government prior to the advertisement of any construction contract which involves those LERRD. In providing LERRD, the sponsor must comply with the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended. The sponsor is also required to pay all costs, if any, that are associated with locally preferred features of the Headwaters Plan.

A project may be initiated only after the sponsor has entered into a binding Project Cooperation Agreement (PCA) with the Department of the Army, which is normally negotiated during the preconstruction engineering and design phase. On March 22, 1994, a PCA was executed between the Department of the Army and the South Florida Water Management District for the Kissimmee River Project. This agreement successfully combined the two authorized construction components, the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project into one project. The PCA assigned Federal and non-Federal responsibilities, which, includes the following items of local cooperation:

a. The Local Sponsor shall contribute 50 percent of total project costs.

b. The Local Sponsor shall provide all lands, easements, rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

c. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project related betterments, except for damages due to the fault or negligence of the Goverment or the Government's contractors.

d. Operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

e. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

g. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA.

h. Provide 100 percent of the costs to remove excess spoil material from the flood control canals, C-35, C-36 and C-37.

11.10 SPONSOR VIEWS

The SFWMD developed and recommended the Level II Backfilling Plan upon which the Recommended Plan for the Lower Basin is based. The Headwaters Revitalization is directly linked to the Recommended Plan; the Recommended Plan cannot succeed without first implementing the Headwaters Plan. As the non-Federal sponsor of this feasibility study, the SFWMD has worked very closely in partnership with the Corps to ensure that the study and this report fairly and accurately reflected their views. On November 19, 1991, the SFWMD provided a Letter of Intent which indicated their strong support for the Recommended Plan (which included the Headwaters Revitalization Plan) and their desire to continue discussions to develop a cost sharing formula acceptable to the State of Florida and the Federal Government. The non-Federal sponsor agrees to assume responsibility for the removal of the excess spoil material from the flood control canals, C-35, C-36 and C-37.

SECTION 12

PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

This section describes the public involvement activities conducted by the Corps and the SFWMD in conjunction with the Headwaters Revitalization component of the Kissimmee River Restoration project.

12.1 PUBLIC INVOLVEMENT PROGRAM

Extensive public involvement activities have been integral to all work since the existing Kissimmee River project was completed in 1972. Complete descriptions of the public involvement programs that preceded the 1992 Kissimmee River feasibility study are available in the following documents:

* *Central and Southern Florida, Kissimmee River, Florida, Final Feasibility Report and Environmental Impact Statement, Appendix F.* (Jacksonville District, U.S. Army Corps of Engineers. September 1985.) - Appendix F, Public Involvement, Views and Responses, describes public involvement during the Corps' first Federal Feasibility study of the Kissimmee River, covering the period 1978 - 1985.

* *Kissimmee River Restoration, Alternative Plan Evaluation and Preliminary Design Report, Appendix B.* (SFWMD. June 1990.) - Appendix B, Public Input Survey/Questionnaire Results, summarizes the results of a June 1989 public opinion survey concerning restoration of the Kissimmee River.

* Letter of July 9, 1991, SFWMD to Jacksonville District, U.S. Army Corps of Engineers, subject: "Public Involvement Appendix and Monitoring Program, Kissimmee River Restoration Feasibility Study" - An enclosure to the letter describes public involvement since the project was completed, particularly during the SFWMD restoration study from 1984-1990.

* *Central and Southern Florida, Kissimmee River, Florida, Final Integrated Feasibility Report and Environmental Impact Statement Section 11 and Annex A* (Jacksonville District, U.S. Army Corps of Engineers. March 1992.) -Section 11, Public Involvement, Review and Consultation, describes public involvement during the Corps' Final Federal Feasibility study of the Kissimmee River, covering the period 1990 - 1992. Annex A, Public views and comments, includes the public comments received during the review process. Since the authorization of the Kissimmee River Restoration Project, the

SFWMD has continued to have public meetings to provide progress reports to the local community and governments.

12.2 REVIEW CONFERENCES

Six review conferences involving various study interests were conducted during the Kissimmee River Restoration feasibility study to review work and decide courses of action related to specific policy and technical issues. Subsequently, the Headwaters Revitalization component of the restoration project has undergone checkpoint conferences and a review conference on the Draft Project Modification Report. These conferences were:

* **Special Resolution Conference (SRC),** February 6-7, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Office of the Assistant Secretary of the Army for Civil Works, and the Corps met to resolve policy and procedural issues regarding the Kissimmee River Section 1135 proposal and the feasibility study authorized by the Water Resources Development Act of 1990.

* **Interagency Environmental Planning Conference**, April 10, 1991, Jacksonville, Florida, and April 11-12, 1991, River Ranch, Florida. Representatives of the SFWMD, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps met to discuss technical aspects of the project's environmental analyses.

* **Hydrology and Hydraulics Technical Review Conference,** May 15-16, 1991, River Ranch, Florida, and May 20-22, 1991, Berkeley, California. Representatives of the SFWMD and the Corps met to discuss technical aspects of project hydrology and hydraulics, including a demonstration of the Kissimmee River Pool B physical model at the University of California at Berkeley.

* **Checkpoint Conference**, June 20, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Assistant Secretary of the Army for Civil Works, and the Corps met to review study progress in implementing guidance developed during the Special Resolution Conference.

* **Meeting of the Scientific Advisory Panel for Environmental Monitoring of Kissimmee River Restoration**, July 16-18, 1991, River Ranch, Florida. Representatives of the SFWMD, the Florida Department of Natural Resources, the Florida Department of Environmental Regulation, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps met to better define monitoring of project environmental effects.

* **Feasibility Review Conference,** September 5-6, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Assistant Secretary of the Army for Civil Works, the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission, the Florida Department of Natural Resources, and the Corps met to provide the sponsor with as much assurance as possible about the Army position of the study recommendations, to facilitate Federal agency review, and to obtain Washington-level commitment to the recommendations.

* Kissimmee River Headwaters Revitalization, In-Progress Review Conference, January 1994, Jacksonville, Florida. Representatives of the SFWMD, the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission and the Corps met to discuss issues and evaluation procedures for Headwaters Revitalization component of the Kissimmee River Project.

* Kissimmee River Headwaters Revitalization, Draft Project Modification Report, Review Conference, October 26, 1995. Representatives of the SFWMD, the Assistant Secretary of the Army, and the Corps met to discuss the draft report and recommendations for the Kissimmee Headwaters Revitalization Project.

12.3 CONTINUING COORDINATION

Continuing coordination has been maintained in two special areas of the study. First, frequent communication has been maintained with the SFWMD, as the study's non-Federal cost sharing partner, on day-to-day progress and general questions concerning the previous restoration study. The sponsor has generously provided assistance in attending meetings, writing draft materials, and other activities in accordance with the Project Cooperation Agreement.

Second, continuing coordination was maintained with various experts in biological sciences representing interested environmental agencies, including the SFWMD, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps in conducting environmental studies, such as the habitat evaluation procedures analysis and forecasting future environmental conditions. Coordination has occurred over a series of meetings and through frequent exchanges of correspondence and conversations among the involved experts. Results of this coordination are documented in the Fish and Wildlife Coordination Act Report in Annex E.

12.4 SCOPING

Scoping was accomplished in accordance with the requirements of the Council on Environmental Quality's regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA) of 1969, as amended (40 CFR 1501.7).

12.5 OTHER REQUIRED COORDINATION

In addition to the scoping required by NEPA, coordination required by other Federal laws and regulations has been conducted with the following agencies:

* U.S. Fish and Wildlife Service - A final Fish and Wildlife Coordination Act Report has been prepared and is included at Annex E.

* Florida Game and Fresh Water Fish Commission - Commission representatives participated with the U.S. Fish and Wildlife Service in preparing the Coordination Act Report.

* Florida State Historic Officer (SHPO) - Coordination has been ongoing with the SHPO in accordance with the Advisory Council on Historic Preservation's procedures.

12.6 REVIEW OF THE DRAFT INTEGRATED PROJECT MODIFICATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The draft integrated report and environmental impact statement will be sent to numerous local, State and Federal agencies and private interest groups for review and comment in accordance with the Council on Environmental Quality's NEPA regulations and related Corps guidance. Comments received during the review will be considered in preparing the final study documents, and will be considered by subsequent reviewers and decision makers in the Washington level Federal review process.

12.6.1 Report and EIS Recipients

The following agencies, groups and individuals will be sent copies of the draft integrated project modification report and EIS.

Federal Agencies

Department of Agriculture
Department of the Air Force
U.S. Department of Commerce
U.S. Fish and Wildlife Service
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Environmental Protection Agency
Federal Emergency Management Agency
Advisory Council on Historic Preservation

State and Local Government

Florida State Clearinghouse
Florida Office of Planning and Budgeting
Florida Division of Historical Resources - SHPO
Florida Department of Environmental Regulation
Florida Department of Transportation
Florida Game and Fresh Water Fish Commission
South Florida Water Management District
Osceola County
Polk County
Okeechobee County

Groups

Miccosukee Tribe of Indians of Florida
Dairy Farmers, Inc.
State Wetland Managers Association
National Audubon Society
Florida Audubon Society
Environmental Defense Fund
Izaak Walton League of America, Inc.
Florida Wildlife Federation
Florida Defenders of the Environment
The Wilderness Society
Sierra Club, Florida Chapter
1000 Friends of Florida
Nature Conservancy, Florida Chapter
Florida Lake Management Society
Okeechobee Homeowners Association

River Acres Homeowners Association
Chain of Lakes Property Owners, Inc.

Individuals

A list of individuals who will receive the draft integrated report and EIS is on file in the Jacksonville District at the address shown on the cover page of this document.

12.7 PUBLIC MEETINGS

Three public meetings were conducted during the draft report review period to provide all members of the public with an opportunity to better understand and discuss the results of the Corps' 1991 feasibility study. These meetings were held as follows:

October 1, 1991, at the Okeechobee Civic Center.

October 2, 1991, at the Kissimmee City Hall.

October 3, 1991, at the Sebring City Hall.

The meeting in Kissimmee was attended by about 60 people. Many of the speakers expressed concern about the Headwaters Revitalization project and its effect on flood control and navigation. Specifically, there was concern about the results of regulation schedules for the Kissimmee group of lakes and the backfilling in the Lower Basin and the affect to the existing level of flood control. Navigation interests were opposed to the project due to the possible impact to navigation. There was also a concern that some of the larger boats would not be able to navigate the meandering river. A number of speakers also expressed concern about the cost of the recommended plan. Representatives of environmental groups expressed support for the recommended plan.

The meeting in Sebring was attended by about 45 people. Many of the speakers were concerned about the effect on property owners. Specifically, they feel properties needed for the Recommended Plan would be acquired at a token of their values, and the State may claim properties without compensation. Agricultural representatives were concerned about the effects on agriculture in the study area. A number of speakers were concerned about the cost of the project. Navigation interests were opposed to the project due to the possible impact on navigation. A concern was expressed that the regulation schedules for the Kissimmee group of lakes would adversely effect the existing level of flood protection. Fishermen spoke out against the project stating that since the demonstration project, the fishing resources has declined substantially. Individuals from surrounding communities expressed support for the recommended plan.

In addition to the three public meetings for the Kissimmee River Restoration Project, public meetings for the Kissimmee River Headwaters Revitalization Project will be held within the local areas prior to the finalization of the Project Modification Report. The meetings will be held to discuss details of the plan and potential impacts of the project. Public concerns and comments from the meetings will be documented in the Final report.

SECTION 13

RECOMMENDATIONS

I recommend that the Central and Southern Florida Project be modified to allow for the Headwaters Revitalization Project, described in the chapter of this report entitled "The Recommended Plan", be implemented as a Federal project with such modifications thereof as in the discretion of the Chief of Engineers may be advisable. The total estimated cost of the recommended plan is $78,356,300. The estimated Federal cost is $38,356,300 and the estimated non-Federal cost is $78,356,300.

I also recommend that the non-Federal sponsor be authorized credit for the value of lands, easements, rights-of-way, relocations, and disposal areas provided for Headwaters Revitalization Project.

The above recommendations are made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army to perform the following items of local cooperation:

a. Contribute 50 percent of total project costs.

b. Provide all lands, easements, rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

c. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project related betterments, except for damages due to the fault or negligence of the Goverment or the Government's contractors.

d. Operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

e. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

g. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA.

h. Provide 100 percent of the costs to remove excess spoil material from the flood control canals, C-35, C-36 and C-37.

The report states that the Headwaters Revitalization Project will be completed, or nearly so, with a fully operational modified Lake Kissimmee outlet structure prior to implementing construction for the Lower Basin project. If, for any reason, the Lower Basin project is not constructed, the Headwaters Revitalization Project will not be initiated as a stand alone project.

TERRY L. RICE
Colonel, Corps of Engineers
Commanding

SECTION 14

LIST OF PREPARERS

The people who were primarily responsible for contributing to preparing this Environmental Impact Statement are listed in Table 14-1.

TABLE 14-1

KISSIMMEE RIVER RESTORATION
LIST OF PREPARERS

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING DOCUMENT
Peter Besrutschko	Environmental Engineer	20 years experience chemical, petro and environmental engineering	Hazardous and Toxic Waste Assessment
Annon I. Bozeman, Jr	Outdoor Recreation Planner	15 years recreation design, construction and development	Aesthetics and Recreation
Brian Brodehl	Civil Engineer	2 years civil engineering	Report preparation
David L. McCullough	Archeology	13 years environmental and cultural resources assessment	Cultural Resources evaluation, coordination
Sheri Miller	Student Environmental Engineer	1 year water resources/ project management	Report preparation
Robert Pace	Biology	USFWS, Vero Beach	Fish and Wildlife Coordination Act Report, Planning Partner
William Porter	Ecologist	15 years environmental planning	EIS preparation
Glenn R. Schuster, P.E.	Environmental Engineer/Biologist	18 years environmental engineering	Water quality assessment
Michael A. Smith, P.E.	Civil Engineer	9 years water resources planning, Corps of Engineers	Report-EIS preparation: study manager
Patricia Strayer	Civil Engineer	South Florida Water Management District	Report Review
Louis A. Toth	Aquatic Ecology	South Florida Water Management District	Report Review and Ecosystem assessment of alternatives

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ANNEX B

SECTION 404(b)(1) EVALUATION

KISSIMMEE HEADWATERS REVITALIZATION PROJECT
OSCEOLA AND POLK COUNTIES, FLORIDA

1. Project Description

a. Location. The proposed Kissimmee Headwaters Revitalization Project is located in Osceola County, Florida.

b. General Description. The proposed work consists of Modification of the existing Lake Kissimmee regulation schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee lake littoral zones; Acquisition of approximately 20,800 acres of land bordering the affected lakes, i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger; Widening of Upper Basin flood control canals, C-36 and C-37. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding; Increase outlet capacity at water control structure S-65. Modifications to the existing S-65 structure will be needed to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity; Degradation of local levees. Breaching of local levees is recommended for obtaining the water storage required for meeting lower basin hydrology and to expand the range of upper basin restoration. Approximately 1 mile of levee sections or about 60,000 cubic yards will be degraded by backfilling nearby borrow ditches. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

c. Authority and Purpose. Section 1135 of Public Law 99-662 (Water Resources Development Act of 1986) authorizes the Chief of Engineers in cooperation with non-Federal interests to consider measures for restoring environmental values at authorized Federal projects. This study was conceived under that authority. Subsequently, the Water Resources Development Act of 1992 authorized the Assistant Secretary of the Army to construct the Headwaters Revitalization Project in accordance with a report prepared under Section 1135, based on the benefits derived for the environmental restoration of the Kissimmee River (Lower Basin). Consistently with the above-cited authorities, the U.S. Army Corps of Engineers and the State of Florida, with the U.S. Fish and Wildlife Service as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of lakes in the Upper Kissimmee River Basin. The present study objective is (a) to formulate a plan to optimize environmental improvements to the Upper Kissimmee Basin (b) while reestablishing discharges to the Lower Basin that are necessary to that basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida). Environmental optimization in the upper basin requires reestablishment of lake-level fluctuations with higher levels approximating 54.0 feet NGVD. Restoration in the Lower Basin requires (a) continuous but varied flow in the river channel and (b) flood plain inundation frequencies and recession rates comparable to pre-channelization periods.

d. <u>General Description of Dredged or Fill Material</u>.

(1) <u>General Characteristics of Material</u>. The fill material for this project will come from the canal and adjacent levee which consists of native soils.

(2) <u>Quantity of Material</u>. Unknown - will be determined during detailed design.

(3) <u>Source of Material</u>. West bank of C-37, East bank of C-37, and five local levees. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

e. <u>Description of the proposed Discharge Site</u>.

(1) <u>Location</u>. West bank of C-36 on top of and behind the existing levee, East bank of C-37 on top of and behind the existing levee, and backfilling adjacent borrow ditches associated with the five local levees. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

(2) Size. Approximately 29 acres of freshwater wetlands will be filled by the project.

(3) Type of Site. The project site consists freshwater marsh and grasslands.

(4) Type of Habitat. The habitat consists of freshwater marsh and grass covered levees.

(5) Timing and Duration of Discharge. Eight (8) months.

f. Description of Disposal Method. Fill material will be placed with a dragline.

2. Factual Determination

a. Physical Substrate Determination.

(1) Substrate Elevation and Slope. The area to be filled ranges in elevation from 50-56 foot National Geodetic Vertical Datum of 1929. Fill areas are relative flat.

(2) Sediment Type. Soil in the fill areas is predominately Smyrna-Myakka-Basinger association

(3) Dredge/Fill Material Movement. The fill material will be sloped and stabilized, and should not be subject to erosion.

(4) Physical Effects on Benthos. Benthic organisms within the fill areas would be lost as a result of placement of the fill.

b. Water Circulation, Fluctuation and Salinity Determination.

(1) Water. Standing water or moist soil will be replaced by fill material.

(2) Current Patterns and Circulation. Circulation to adjacent wetlands will be enhanced by breaching of the local levees and reestablihing connection to the lakes.

(3) Normal Water Level Fluctuations and Salinity Gradients. Normal water level fluctuations and salinity gradients will be maintained by proposed project.

c. Suspended Particulate/Turbidity Determinations.

(1) Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site. Temporary impacts may result from the placement of fill during construction. Any increase in turbidity will be confined to the vicinity of the activity and would not be expected to continue after construction.

(2) Effects on the Chemical and Physical Properties of the Water Column. No fill will be placed in open water.

(a) Light Penetration. The project will not change existing conditions.

(b) Dissolved Oxygen. The project will not change existing conditions.

(c) Toxic Metals, Organics, and Pathogens. No toxic metals, organics, or pathogens will be released by the project.

(d) Aesthetics. The project will not change existing conditions.

(3) Effects on Biota.

(a) Primary Productivity and Photosynthesis. Temporary impacts may result from the placement of fill during widening of C-36 and C-37. Breaching of the local levees will provide enhanced wetland function for the areas behind these levees,i.e., approximately 740 acres for Lake Cypress, approximately 2,200 acres for Lake Hatchineha, and approximately 600 acres for Lake Kissimmee, via reconnection with the lakes.

(b) Suspension/Filter Feeders. There will be no long-term adverse impact to suspension/filter feeders.

(c) Sight Feeders. There will be no long-term adverse impact to sight feeders.

d. Contaminant Determinations. Deposited fill material will not introduce, relocate, or increase contaminants.

e. Aquatic Ecosystem and Organism Determinations.

(1) Endangered and Threatened Species. There will be no impacts on any threatened or endangered species or on critical habitat of any threatened or endangered species. The eastern indigo snake may occur in the project area during the time construction takes place. Protective measures as outlined in the USFWS Biological Opinion will be utilized to protect the indigo snake during construction. Management activities associated with the lakes, i.e., extreme drawdowns, will need to be coordinated with the U.S. Fish and Wildlife Service so that these actions do not adversely impact the snail kite.

(2) Hardbottom Habitat. No hardbottom habitat exists in the project area.

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination. The fill material will not cause unacceptable changes in the mixing zone specified in the Water Quality Certification in relation to: depth, current velocity, direction and variability, degree of turbulence, stratification, or ambient concentrations of constituents.

(2) Determination of Compliance with Applicable Water Quality Standards. Because of the inert nature of the fill material state water quality standards will not be violated.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supplies. No municipal or private water supplies will be impacted by the implementation of the project.

(b) Recreational and Commercial Fisheries. Recreational and commercial fisheries will not be impacted by the disposal of dredged material in the project area.

(c) Water Related Recreation. Water related recreation will be preserved and enhanced by the proposed project.

(d) Aesthetics. Approximately 29 acres of wetlands will be converted to levee, i.e., C-36 approximately 10 acres and C-37 approximately 19 acres, by the project.

(e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The construction of the Kissimmee Headwaters Revitalization Project will not effect any parks, national or historic monuments, national seashores, wilderness areas, research sites, or similar preserves.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. There will be no cumulative impacts that result in a major impairment of water quality of the existing aquatic ecosystem as a result of the placement of fill at the project site.

3. Findings of Compliance or Non-compliance with the Restrictions on Discharge.

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.

c. The discharge of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violations of any applicable State water quality standards for Class III waters. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The disposal of fill material in the project area will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

e. The placement of fill material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, ~~aesthetic~~, ~~and~~ economic values will not occur.

f. On the basis of the guidelines, the proposed disposal site for the discharge of dredged material is specified as complying with the requirements of these guidelines.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX C

COASTAL ZONE CONSISTENCY EVALUATION

ANNEX C

FLORIDA COASTAL ZONE CONSISTENCY PROGRAM CONSISTENCY DETERMINATION

KISSIMMEE HEADWATERS REVITALIZATION PROJECT
OSCEOLA AND POLK COUNTIES, FLORIDA

1. Chapter 161, Beach and Shore Preservation.

The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

Response: No work is proposed seaward of the line of mean high water therefore, this Chapter would not apply.

2. Chapters 186 and 187, State and Regional Planning.

These chapters establish the State Comprehensive Plan which sets goals that articulate a strategic vision of the State's future. Its purpose is to define in a broad sense goals and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

Response: The proposed project has been coordinated with the state and no adverse comments were received.

3. Chapter 252, Disaster Preparation, Response and Mitigation.

This chapter creates a state emergency management agency, with the authority to provide for the common defense; to protect the public peace, health and safety; and to preserve the lives and property of the people of Florida.

Response. This statute is not applicable to the project.

4. Chapter 253, State Lands.

This chapter governs the management of submerged state lands and resources within state lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; dredged material disposal islands; and artificial reefs.

Response: The proposed Kissimmee Headwaters Revitalization Project will impact approximately 29 acres of wetlands. However, this project will accomplish the following restoration goals: (1) restore approximately 14,000 acres of lake littoral zone bordering the affected lakes, i.e., Lake Cypress, Lake Hatchineha and Lake Kissimmee, (2) hydraulically reconnect approximately 2,650 acres behind local farm levees, which will enhance the wetland functions of these areas, and (3) reestablishing discharges to the lower basin that are necessary to the basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida).

5. Chapters 253, 259, 260, and 375, Land Acquisition.

These chapters authorize the State to acquire land to protect environmentally sensitive areas.

Response: The South Florida Water Management District, the local sponsor of this project, is acquiring all the lands needed for the project.

6. Chapter 258, State Parks and Aquatic Preserves.

This chapter authorizes the State to manage State parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park property, natural resources, and park programs management or operations.

Response: The proposed Kissimmee Headwaters Revitalization Project would not directly or indirectly adversely impact any State Parks or Aquatic Preserves. However, the restoration of the upper and lower basins of the Kissimmee River would have a positive impact on State lands within the basins therefore, would be consistent with this chapter.

7. Chapter 267, Historic Preservation.

This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

Response: The study has been coordinated with the Florida State Historic Preservation Officer. Historic preservation compliance will be completed to meet all responsibilities under Chapter 267.

8. Chapter 288, Economic Development and Tourism.

This chapter directs the State to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

Response: Contribution from the study area to the State's tourism economy will not be compromised by project implementation. The project would be compatible with tourism for this area and could potentially contribute to overall growth and development of the area therefore, would be consistent with the goals of this chapter.

9. Chapters 334 and 339, Public Transportation.

This chapter authorizes the planning and development of a safe, balanced and efficient transportation system.

Response: The proposed project would not impact the existing public transportation system of the area and therefore, would be consistent with the goals of this chapter.

10. Chapter 370, Saltwater Living Resources.

This chapter directs the State to preserve, manage and protect the marine, crustacean, shell and anadromous fishery resources in State waters; to protect and enhance the marine and estuarine environment; to regulate fishermen and vessels of the State engaged in the taking of such resources within or without State waters; to issue licenses for the taking and processing of products of fisheries; to secure and maintain statistical records of the catch of each such species; and to conduct scientific and economic studies and research.

Response: The proposed Kissimmee Headwaters Revitalization Project does not effect saltwater living resources.

11. Chapter 372, Living Land and Freshwater Resources.

This chapter establishes the Game and Fresh Water Fish Commission and directs it to manage freshwater aquatic life and wild animal life and their habitats to perpetuate a diversity of species with densities and distribution which provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

Response. The proposed Kissimmee Headwaters Revitalization Project has been coordinated with the US Fish and Wildlife Service for compliance with Section 7 of the Endangered Species Act. The eastern indigo snake listed by the USFWS as endangered may occur in the project area therefore, protective measures will be included in the construction contract. The proposed project will directly impact approximately 29 acres of wetlands. However, this project will accomplish the following restoration goals: (1) restore approximately 14,000 acres of lake littoral zone bordering the affected lakes, i.e., Lake Cypress, Lake Hatchineha and Lake Kissimmee, (2) hydraulically reconnect approximately 2,650 acres behind local farm levees, which will enhance the wetland functions of these areas, and (3) reestablishing discharges to the lower basin that are necessary to the basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida).

12. Chapter 373, Water Resources.

This chapter provides the authority to regulate the withdrawal, diversion, storage and consumption of water.

Response. This project does not involve water resources as described by this chapter therefore, this chapter is not applicable.

13. Chapter 376, Pollutant Spill Prevention and Control.

This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

Response. This project does not involve the transportation or discharging of pollutants, this chapter is not applicable.

14. Chapter 377, Oil and Gas Exploration and Production.

This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

Response: This project does not involve the exploration, drilling or production of gas, oil or petroleum product and therefore this chapter does not apply.

15. Chapter 380, Environmental Land and Water Management.

This chapter establishes criteria and procedures to assure that local land development decisions include consideration of the regional impacts of proposed large-scale development.

Response: This project does not involve land development as described by this chapter therefore, this chapter is not applicable.

16. Chapter 388, Arthropod Control.

This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the State.

Response: The project would not further the propagation of mosquitoes or other pest arthropods.

17. Chapter 403, Environmental Control.

This chapter authorizes the regulation of pollution of the air and waters of the State by the Department of Environmental Protection.

Response: An application for Water Quality Certification will be submitted to DEP for the proposed Kissimmee Headwaters Revitalization Project. A Supplemental Environmental Impact Statement of project impacts has also been prepared and will be reviewed by the appropriate resource agencies including DEP, Therefore, the project is complying with the intent of this chapter.

18. Chapter 582. Soil and Water Conservation.

This chapter establishes policy for the conservation of the State's soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both on site or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

Response: The proposed project would directly impact approximately 202 acres of unique farmland, which is defined by the Farmland Protection Policy Act. The proposed project has been coordinated under the Farmland Protection Policy Act with the U.S. Department of Agriculture, Natural Resources Conservation Service. Project construction will include appropriate erosion control plans and measures to ensure compliance.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX D

FISH AND WILDLIFE COORDINATION ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

June 30, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Attn: Planning Division

Re: Kissimmee Headwater Lakes Revitalization Project

Dear Colonel Salt:

Pursuant to a Scope of Work, the Chief of your Planning Division requested the U.S. Fish and Wildlife Service (Service) provide a Fish and Wildlife Coordination Act (FWCA) Report on the Kissimmee Headwater Lakes Revitalization Project. This project is integral with the plan to restore the Kissimmee River (Canal 38). Both components of this study were authorized by Section 1135 of the Water Resources Development Act of 1986. This FWCA Report is submitted pursuant to our Fiscal Year 1993 Transfer Funding agreement and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

The Kissimmee Headwater Lakes Revitalization provides the necessary storage and discharge characteristics to restore flow to the Kissimmee River, while also providing partial restoration of ecosystems in the Headwater Lakes.

To achieve the full potential for restoration of wetlands in the Headwater Lakes Revitalization Project, the Service recommends that the three major levees along the shores of Lakes Kissimmee, Hatchineha and Cypress be breached. The local sponsor, the South Florida Water Management District, will need to acquire all lands behind these three levees that lie below the 54-foot topographic contour in addition to the lands already targeted for acquisition.

Although the selected water regulation schedule is the best we can identify after a series of iterative evaluation of model outputs, it should not be considered as immutable. After several years of operation, the cooperating agencies should re-evaluate the operational rules, particularly to determine if longer periods of inundation between the 52.5 and 54-foot topographic contours can be realized without increasing risk of flood damages. Corps hydrologists have recently suggested lowering the upper controlling elevation of the selected 400C150RR schedule from 52.5 feet to 52 feet. Our analysis indicates that any further reduction of high water levels from the currently selected plan would virtually eliminate all currently projected benefits to wetlands and wetland-dependent wildlife in the upper basin. We strongly urge the Corps not to reduce the duration of water levels above 52.5 feet below those modelled for the 400C150RR alternative.

As a possible future refinement of the project, we also recommend that we study the feasibility of constructing a water control structure/lock at the northern end of Canal 36 (south of Lake Cypress). This structure would allow separate water regulation of Lake Cypress, which presently has water levels severely below historic conditions.

The Service also recommends that the Federal government take action to restore the Kissimmee River by backfilling Canal 38 to the fullest extent possible to achieve restoration of the river's original functions and values. This will mitigate damages caused by the channelization of the river. We also continue to strongly recommend that the Paradise Run reflooding and other flow-through measures in Pool A be incorporated in the Final Feasibility Report as project design features to maximize ecosystem restoration, as described in our 1991 FWCA Report for the Kissimmee River.

The draft FWCA report was circulated for review and comment by the participating agencies. The Florida Game and Fresh Water Fish Commission generally concurred with our draft and provided additional recommendations. The enclosed Final FWCA Report represents the Secretary of Interior's report to Congress as required by Section 2(b) of the FWCA. This report should accompany the Final Feasibility Report and Environmental Impact Statement when it is submitted to Congress.

Thank you for the opportunity to participate in this important ecosystem restoration effort. The Service views the implementation of this project as a step towards fulfilling the restoration goals of the South Florida Ecosystem Task Force.

Sincerely yours,

Robert T. Pace
Acting Field Supervisor

cc:
FG&FWFC, Tallahassee, FL
FG&FWFC, Vero Beach, FL
FG&FWFC, Kissimmee, FL
DEP, Tallahassee, FL
SFWMD, West Palm Beach, FL
FWS, Jacksonville, FL
FWS, Atlanta, GA

United States Department of the Interior
FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

February 1, 1994

Mr. A.J. Salem
Chief, Planning Division
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

On January 24, 1994, Mr. Robert Pace of my staff attended an "In-Process Review Conference" for the Kissimmee Headwater Lakes Revitalization 1135 project. He presented the results of the Service's community-level evaluation of the latest two alternatives in the iterative testing of proposed lake regulation schedules. We have been quite pleased to date with the approach of the HEP team members (led by Lou Toth of the SFWMD) in guiding design of this environmental project. We stated on January 24th that in our opinion the agencies had enough data to select a preferred alternative, based on the general behavior of the water routing models. We believe it is now time to move ahead with the species models on the preferred alternative so the Corps will be able to meet its planning deadlines.

On the basis of Mr. Pace's presentation, Richard Bonner proposed that the agencies concur on selection of the 400C150RR as the preferred alternative. There were no objections to this motion, but the agencies agreed to meet in Vero Beach in February to ensure that all parties agreed on the justification for this selection.

Enclosed are draft copies of what will be sections of our Fish and Wildlife Coordination Act report. The first section describes the approach taken to evaluate the water regulation schedules. The second section will be inserted in the "Future with Project" section of our FWCA report, summarizing the results of the general evaluation methodology. An as yet unnumbered table also summarizes these results.

Please forward copies of these materials to Gerald Atmar and Mike Smith, who are expected to meet with us in February on this matter. Your continued cooperation on this important restoration project is greatly appreciated. If you have any questions, please call Mr. Pace at (407) 562-3909.

Sincerely,

David L. Ferrell

David L. Ferrell
Field Supervisor

cc: (w/encl)
Ed Moyers, FGFWGC, Kissimmee
Larry Parent, FGFWFC, Tallahassee
Lou Toth, SFWMD, West Palm Beach
Patricia Sculley, SFWMD, West Palm Beach
Bill Helferich, SFWMD, West Palm Beach

ACKNOWLEDGEMENTS

The authors of this report are Robert T. Pace and Joseph D. Carroll, Senior Field Biologists.

We greatly appreciate the instruction and guidance of Arnold Banner, who introduced Mr. Pace to the concepts and practice of GIS analysis. He also provided assistance directly related to completion of this project.

We appreciate the encouragement of David Ferrell, our Field Supervisor, who has strongly supported development of GIS capabilities in the Ecological Services program of the Fish and Wildlife Service.

Fred Schaeffer, of our Vero Beach Field Office, provided invaluable support in keeping our computer hardware running and technical advice.

The members of an interagency review panel provided guidance and information throughout the analysis: Ed Moyer and Larry Perrin, Florida Game and Fresh Water Fish Commission; Gerald Atmar and Mike Smith, Corps of Engineers; Lou Toth and Patricia Sculley, South Florida Water Management District.

Paul Holt (Corps of Engineers) and Carl Horton (formerly with the South Florida Water Management District) assisted in development of the topographic/bathymetric data. The GIS data provided by personnel at the Florida Game and Fresh Water Fish Commission, Tallahassee, were used extensively in this analysis.

Finally, we must acknowledge the patience and assistance of the species experts we consulted in developing the species models. Those from the Florida Game and Fresh Water Fish Commission include: Ed Moyer, Jim Rodgers, Steve Nesbitt, Paul Gray, and Diane Eggeman. Brian Toland, now an employee of the U.S. Fish and Wildlife Service, also worked for the Game Commission when this evaluation started. Rob Bennetts of the University of Florida's Cooperative Fish and Wildlife Research Unit, James Layne of the Archbold Biological Station, and Herb Kale of the Florida Audubon Society also provided information and advice.

EXECUTIVE SUMMARY

The Kissimmee Lakes Revitalization Project provides the water storage and discharge characteristics to restore the Kissimmee River, while also providing a wider range of water fluctuation in the Kissimmee Chain of Lakes. We strongly recommend that the Corps implement design features as described below to maximize the environmental benefits achievable from this proposal.

The presently recommended revised lake schedule will provide seasonal flooding of greater duration for elevations between about 51 feet and 52.5 feet. Restoration of short hydroperiod wetlands is expected between elevations of 52 feet and 52.5 feet. We have predicted restoration of about 5939 acres of additional marsh relative to the present for the basic project without breaching of levees. If all three levees adjacent to the shorelines of Lakes Kissimmee, Hatchineha, and Cypress are breached (as recommended by the Service), about 7236 acres of marsh would be restored. The selected water regulation schedule would also provide routine low water levels (<47 ft.) of greater duration, which means greater overall fluctuation of water levels. The resulting increased hydrologic dynamics in the lakes is considered beneficial across the entire ecosystem.

Among the 10 evaluation species, 6 species are predicted to benefit significantly from the proposed new schedule. Compared to the future without the project, the predicted increase in availability of suitable habitat ranges from about 10% to 35%, depending on the species and the range of alternative futures considered. The 6 species include the Florida duck, ring-necked duck, snail kite, great egret, snowy egret, and wood stork. For the remaining species; Audubon's crested caracara, bald eagle, sandhill crane, and largemouth bass; we do not predict any major change in habitat availability. If any change occurs, the models point to a possible slight increase for these species.

As indicated in Section XII of this report, the Service has concurred with the Corps' determination that the proposal is not likely to adversely affect any Federally-listed threatened or endangered species. We predict the project is likely to benefit the endangered snail kite and wood stork.

The following summarizes our recommendations:

I. DESIGN AND OPERATION OF THE PRESENTLY PROPOSED PROJECT

- Periodic extreme drawdowns should be superimposed on the normal regulation schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

- Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for these losses.

- The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

II. ADDITIONAL PROJECT FEATURES RECOMMENDED TO MAXIMIZE ENVIRONMENTAL BENEFITS

- Lands up to 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. This will result in the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risks during storm events.

- The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that separate regulation at levels higher than Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

III. PROJECT MONITORING AND CONTINUED EVALUATION

- The Interagency Review Team that convened to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

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I. IDENTIFICATION OF PURPOSE, SCOPE AND AUTHORITY

Funding for the proposed Federal action is authorized by Section 1135 of the Water Resources Development Act of 1986. The primary purpose of the proposal is environmental quality, including restoration of fish and wildlife resources of the Kissimmee River Basin, including the Kissimmee Chain of Lakes (upper basin) and the Kissimmee River (lower basin). In response to a request from the South Florida Water Management District (SFWMD), the Congress directed the Corps of Engineers (Corps) to consider a restoration plan for the Kissimmee River, leading to selection of the Level II Backfilling Plan. The authorization calls on the Corps to provide a feasibility report and to implement the backfilling of Canal 38 of the Central and Southern Florida Flood Control Project. The selected plan calls for partial backfilling of the canal, and leaves the northern end (Pool A and part of Pool B) as well as the southern end of Pool E unfilled for flood control purposes.

The Section 1135 Kissimmee Headwater Lakes Revitalization Project is necessary to provide the volume and timing of water discharges to enable restoration of the Kissimmee River. Lakes Kissimmee, Cypress and Hatchineha are the larger lakes that would fall under a revised schedule; water levels in smaller Tiger Lake and Lake Rosalie would also be directly affected. The FGFWFC is currently constructing a project to allow regulation of Lake Jackson apart from the other lakes. Therefore, Lake Jackson was removed from the study area; it would only be affected indirectly by this project in that water levels on Lake Kissimmee could, during higher stages, affect the tailwater conditions at the new Lake Jackson structure.

II. ACKNOWLEDGEMENT OF COORDINATION AND CONCURRENCE OF FLORIDA GAME AND FRESH WATER FISH COMMISSION

Appendix A is a letter, dated June 6, 1994, from the Florida Game and Freshwater Fish Commission (FGFWFC), which concurs in the findings contained in this report. The Service agrees with the FGFWFC's additional recommendations, and we have added to the recommendations in Section XIV. Other letters from the Florida Department of Environmental Protection commenting on the Draft FWCA Report are included as Appendices B and C.

III. DISCUSSION OF RELEVANT PRIOR STUDIES AND REPORTS

The Kissimmee River was dredged as a Federal project in the 1960's resulting in a wide canal from the Kissimmee Chain of Lakes to Lake Okeechobee. In the late 1970's the State of Florida petitioned the Corps to restudy the channelized Kissimmee River, identified as Canal 38 (C-38). After resolutions were passed by Congress in 1978, the

Corps responded with reconnaissance and feasibility reports and an environmental impact statement. These documents established that the original Federal project had severely depleted fish and wildlife resources. These reports reviewed several alternative restoration plans. The report released in September 1985 concluded that there was "no Federal interest" in restoring the Kissimmee River, even though the report indicated that implementing many of the alternatives studied would result in significant benefits to fish and wildlife resources. The conclusion that no Federal action was justified was based on interpretation of the 1983 Principles and Guidelines of the Water Resources Council.

In December 1991 the Corps of Engineers submitted a Final Integrated Feasibility Report and Environmental Impact Statement on Environmental Restoration of the Kissimmee River. This report recommended backfilling of Canal 38 in Pools B, C, D, and E to restore the ecological integrity and fish and wildlife values of the Kissimmee River ecosystem.

A. Prior Fish and Wildlife Service Reports

Because the Kissimmee Chain of Lakes and the Kissimmee River are closely related biologically and administratively, the following listing of Service involvement considers both areas.

1. FWCA Report, December 17, 1958

A major report, entitled "A Detailed report of the Fish and Wildlife Resources in Relation to the Corps of Engineers Plan of Development, Kissimmee River Basin, Florida", was released by the Fish and wildlife Service in 1958. The report comprehensively described the fish and wildlife resources of the entire Kissimmee River basin, both the Chain of Lakes and the Kissimmee River. Particular emphasis was placed on the importance of the recreational use of the river, primarily for largemouth bass fishing, and the significance of the river basin for wintering waterfowl. These findings were based on more than a year of field surveys conducted throughout the basin. The report quantified existing public use of the river for fishing and hunting, and predicted that there would be a reduction in sport fishing and a loss of 40 percent of the waterfowl habitat.

As mitigation, the Service recommended seasonally varying the water levels in the headwater lakes, and substituting a leveed floodway for most of the canal. These recommended modifications were not implemented, and the river was subsequently channelized.

2. Kissimmee River Restudy Planning Aid Report, August 1979

In August 1979, the Service prepared a Planning Aid Report comparing the pre-project conditions with 1979 conditions in the lower basin. That report noted the loss of over 75 percent of the original wetlands and over 50 percent of the original river channel. The report concluded that mitigation efforts in the form of "fish breeding" canals did not offer significant compensation for fish and wildlife resource losses caused by channelization. The Service concluded that overall habitat values declined 90 percent, and offered various restoration and management alternatives for investigation by the Corps.

3. Habitat Evaluation Procedure Report, August 1984

This report described fish and wildlife habitat values evaluated by an interagency Habitat Evaluation Procedures (HEP) team in 1979 and 1980. The report discussed the methods, assumptions, models, and results of the HEP analysis. Baseline conditions were established from surveying the existing system, and results were presented for pre-project conditions and the restoration alternatives.

4. Fish and Wildlife Coordination Act Report on Restudy, March 1986

This report recommended that the Federal government take action to mitigate damages to fish and wildlife resources resulting from the construction of the Kissimmee River Flood Control Project. The Service preferred the alternative of backfilling the C-38 Canal to achieve as complete a restoration of the river's original functions and attributes as is consistent with reasonable flood protection and navigation. The partial backfill alternative, a flow-through marsh proposal in Pools A and B, and the Paradise Run proposals were all supported by the Service.

5. Fish and Wildlife Coordination Act Report, October 24, 1991

The Fish and Wildlife Service endorsed the restoration of the Kissimmee River and provided substantial evidence for improved habitat conditions for fish and wildlife, if restoration was achieved through backfilling C-38.

6. Planning Aid Report, Kissimmee Headwater Lakes Revitalization, February 25, 1994

By letter dated November 16, 1992, the Service provided a Plan of Study (Scope of Work) and cost estimate to evaluate the Kissimmee Headwater Lakes Revitalization Project and provide a Final Fish and Wildlife Coordination Act Report. On February 25, 1993, we provided a Planning Aid Letter for this project; this report provides our official response under the Coordination Act.

IV. LOCATION AND DESCRIPTION OF STUDY AREA

The Kissimmee Chain of Lakes is located in central Florida, south of Orlando, and it forms the upper end of a hydrologic system sometimes referred to as the Kissimmee/Okeechobee/Everglades system (Figure 1). The study area was selected to include the lakes that are regulated together under normal conditions--Lakes Cypress, Hatchineha, Kissimmee, Rosalie, and Tiger. Lake Jackson is currently held at the level of Lake Kissimmee, but the FGFWFC intends to regulate this lake separately from Lake Kissimmee. The water level in all of these above-named lakes remains below the 54-foot contour, except in extreme floods. Lakes Marian, Weohyakapka, Tohopekaliga and East Lake Tohopekaliga are also part of the Kissimmee Chain of Lakes, but because these are regulated at higher water levels, they will not be directly affected by the proposed water regulation schedules.

The Kissimmee Chain of Lakes is located in the Osceola Plain, a geologic feature east of the Lake Wales Ridge. A smaller ridge to the east separates the 1,633 square mile upper basin from the northward flowing St. Johns River basin. The present headwater lakes were probably once the deeper portions of a vast marsh complex. The original flow of water has been highly modified by manmade flood control canals. Lake Marion Creek and Reedy Creek are the remaining natural inflows to Lake Hatchineha. Rosalie Creek and Tiger Creek are also relatively short natural water bodies between Lake Rosalie and Tiger Lake and between Tiger Lake and Lake Kissimmee, respectively. The remainder of the waterways between the lakes in the study area and those connecting outside the study area have been channelized. These include Canoe Creek (C-34), South Port Canal (C-35), Hatchineha Canal (C-36), Short Canal (not part of C&SF system), and two channelized sections of the Kissimmee River: C-37, between Lake Hatchineha and Lake Kissimmee, and C-38, the long, wide canal between Lake Kissimmee and Lake Okeechobee. Several water control structures surround the lakes, but the main structure of significance in this report is S-65, which releases water from Lake Kissimmee, through C-38, to Lake Okeechobee, about 56 miles downstream.

Figure 2 illustrates the boundaries of the study area. State Road 60 forms the southern and southeastern edge, while the Florida Turnpike forms the northeastern boundary. The total area is approximately 213,625 acres (86,453 hectares). Although the effects of the project will be limited to the periphery of the lakes, the Service believes it is important to assess the environmental impacts within the surrounding landscape. For example, the lake shorelines are excellent foraging habitat for wading birds, but the extensive acreage of wetlands outside of the lake shorelines must also be considered to assess the effects of the project on the species within the surrounding landscape.

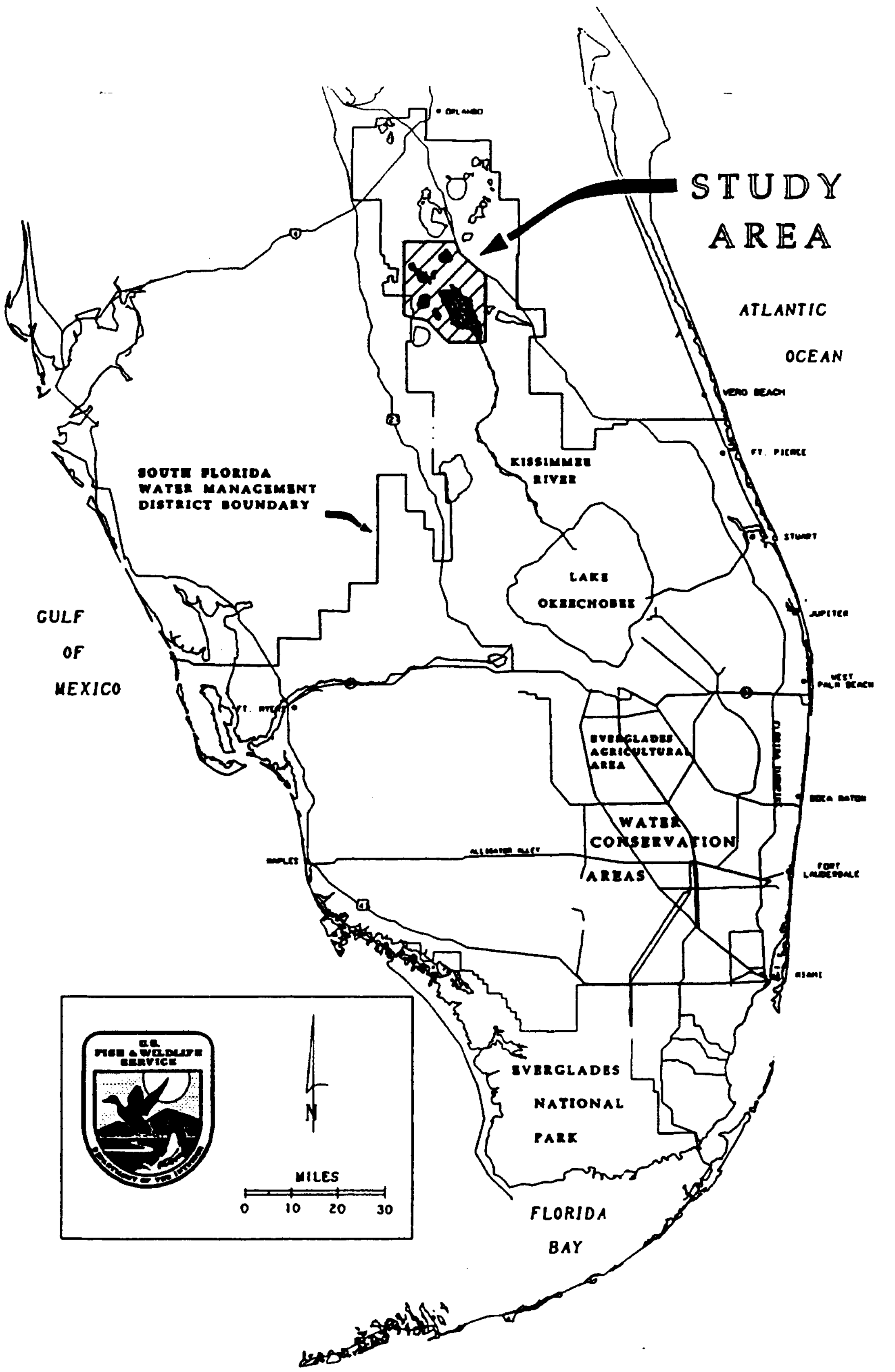

FIGURE 1 - LOCATION OF THE STUDY AREA WITHIN THE KISSIMMEE/OKEECHOBEE/EVERGLADES WATERSHED

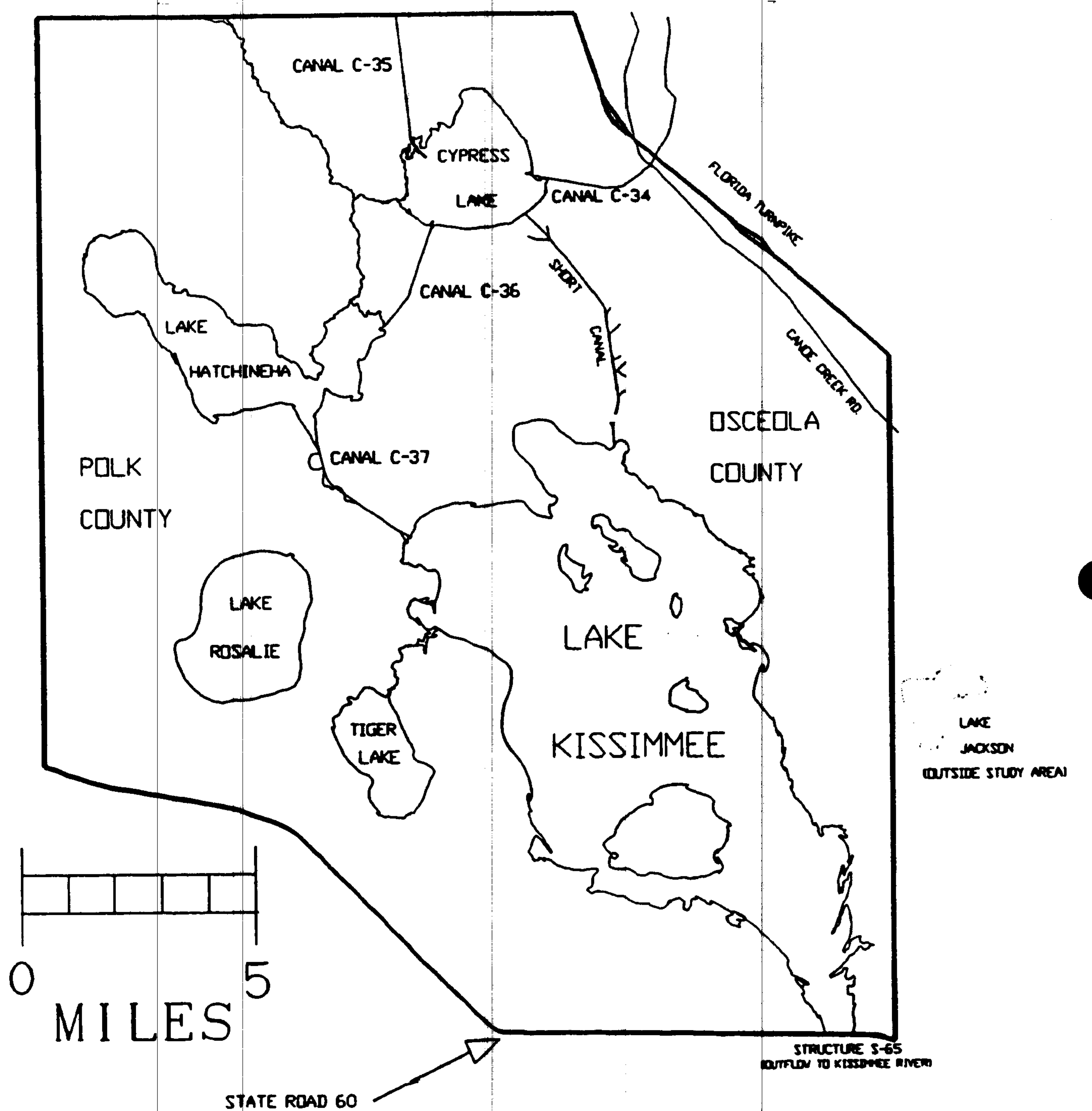

FIGURE 2 - LIMITS OF ENVIRONMENTAL STUDY AREA. KISSIMMEE HEADVATER LAKES

V. SUMMARY OF PLAN SELECTION PROCESS AND IDENTIFICATION OF EVALUATED ALTERNATIVES

The proposed project is largely alteration of the existing water regulation criteria, which is non-structural; however, to achieve the intended water storage in the lakes and discharge characteristics in the Kissimmee River without increasing flood risk, the Corps has determined that structural modifications will be required for canals and water control structures.

Regarding the non-structural aspects, Section VII.B.1. of this report describes the iterative testing process used to select the water regulation schedule. We provide the results of our analysis of the last two modelled alternatives in Section XI.A. of this report; the agencies have concurred on selection of a regulation schedule designated 400C150RR.

Early in plan formulation the Corps considered enlarging the Short Canal between Cypress Lake and Lake Kissimmee (Figure 2) to provide more rapid response to flood conditions. However, based on response from the Service and the Corps' own internal review, this proposal was rejected. The short canal is presently quite small and is surrounded by extensive wetlands. Large volumes of dredge spoil would have to be disposed in adjacent wetlands if traditional canal design were contemplated. Both agencies concurred that excavation of a flood control channel in this area would have unacceptable environmental impact.

Since rejection of the Short Canal design theory, the Corps has investigated widening of Canals C-35, C-36, and C-37 and increasing the capacity of water control structure S-65 to provide additional flood control response capacity. The Service's then recommended widening the canals on one side only, because widening on the existing center line would increase possible impacts on natural areas and increase turbidity effects within the canal and in wetlands outside of the existing spoil banks. Because the canal banks and spoil mounds are vegetated and stabilized, we recommended that one side of the canal remain undisturbed by widening to one side of the center line. After reviewing right-of-way information, the Corps and the SFWMD determined that if they widened to one side, road access requirements led them to select widening of the canals to the east.

The environmental studies in this report identify and evaluate the following five alternative future scenarios:

- Alternative Future 1 -- Adoption of the proposed water control schedule without breaching shoreline levees;

- Alternative Future 2 -- Proposed schedule with breaching of levee south of Lake Hatchineha;

- Alternative Future 3 -- Proposed schedule with breaching of levee north of Cypress Lake;
- Alternative Future 4 -- Proposed schedule with breaching of levee east of Lake Kissimmee;
- Alternative Future 5 -- Proposed schedule with breaching of all three levees (full restoration of all potential areas).

Each recommended breaching of a levee is considered to be an increment on the basic plan; however the Service strongly recommends that the project sponsors take full advantage of all restoration potential in the upper basin. All of these alternative futures were compared to the future without the project, which as stated in Section VIII.B. of this report, is assumed to be substantially the same as the present condition.

VI. EXPLANATION OF FISH AND WILDLIFE CONCERNS AND PLANNING OBJECTIVES

A. Fish and Wildlife Concerns

Fish and wildlife resources of concern and of major Federal interest include migratory birds (especially waterfowl and wading birds), and Federally-listed threatened and endangered species (bald eagle, wood stork, snail kite, Audubon's crested caracara) These wildlife species are, to varying degrees, dependent on wetland habitats in the study area. The Service also advocates public uses of fish and wildlife, including the observation of wildlife, hunting and sport fishing.

The primary planning objective of the Service is recovery and mitigation of habitat supporting these species. Distribution, timing, and volume of water flow to approximate, or at least approach, historic patterns are the principal concerns at the present phase of planning ecosystem restoration. Water quality issues also need to be addressed in the long term to ensure adequate habitat quality in both the upper and lower basins.

Hydrologic conditions were altered by construction of the Kissimmee River Flood Control Project. Water is released from the lakes in sudden pulses when the existing regulation schedule is exceeded. The approved maximum water level is seldom reached because the schedule allows it only late in the year, after the peak of the normal rainy season. Flood control measures instituted since about 1965 have restricted water levels to an extremely narrow range. This lake level stabilization has reduced the size of the littoral zone marshes, reducing the total area for recruitment of forage to the in-lake fishery. Foraging areas for waterfowl and wading birds have also been reduced.

The static condition of the lakes appears to be adversely affecting vegetation in the littoral zone. Short hydroperiod marshes have been displaced by pasture grasses and invaded by shrubs. After decades of restrictive water regulation, even woody vegetation appears affected; although we have no statistics on wetland change during this period, observations indicate a net loss of cypress trees in the upper littoral zone. This is particularly true of Lake Cypress. Lake Cypress was historically upstream of Lakes Hatchineha and Kissimmee, but all three lakes are now held at a flat pool. This exaggerates the effects on the littoral fringe of Lake Cypress. The Service is providing a recommendation that an additional study be conducted to determine the feasibility of constructing a water control structure with a navigational lock at the northern end of C-36, just downstream of Cypress Lake.

Although year-to-year low water levels contribute to the dynamics of the lakes, extreme drawdowns are considered essential on a periodic basis to achieve their beneficial effects on vegetation and organic berms. Deposition of a band of organic material around the lakes' shorelines is exacerbated by narrow restriction of lake levels. At least three factors are involved in this phenomenon. First, if annual low water levels recede to about the same level in most years, deposition of silt is concentrated at that elevation. Secondly, if water levels are not allowed to descend drastically during droughts, as they did under unregulated conditions, vegetation becomes overly dense, impeding the movement of animals, particularly fish that serve as food for other species. Finally, the buildup of dense vegetation has a synergistic effect by accelerating the rate of additional organic material in the same bands of vegetation.

Both the static condition of the lakes and nutrient inputs have contributed to proliferation of nuisance vegetation. Water primrose and cattails are among the emergent nuisance plants that propagate to an unnatural degree in static conditions. Submersed and emersed floating aquatic plants, such as the exotic *Hydrilla* and the native American lotus (*Nelumbo lutea*) also proliferate beyond historic abundance. Lake level stasis is thought to promote formation of floating batteries. Patches of aquatic plants, primarily fragrant water lily and spatterdock, with associated peat and starchy roots, lift up from the bottom and float to another location where they lodge. In addition, *Scirpus cubensis* forms thick mats of vegetation which support colonization by many species of undesirable plants. Battery formation can in turn cause formation of patches of higher islands in the marshes of the littoral zone.

Extreme drawdowns of several months duration allow drying of the built-up sediment load, and even without mechanical removal of the sediment berms, levelling of these berms by extended drying is beneficial to the exchange of water and animals across these berms after re-flooding. Extreme drawdowns help thin out the overly dense bands of vegetation that can develop in static systems. If mechanical removal of vegetation is not practical in a lake as large as Lake Kissimmee, a controlled burn can be an effective management tool in the shoreline exposed by an extreme drawdown. Natural oxidation and consolidation of sediments is beneficial even without mechanical removal of muck.

The FGFWFC has instituted programs to draw down the lakes on a periodic basis. They attempt to hold water down for at least 90 days, starting in mid-February; results will vary according to rainfall patterns during this period, which normally has low rainfall. Increased rainfall is normally anticipated in June, which is generally the latest lakes can be held down (Ed Moyer, FGFWFC, pers. comm.). For Lake Kissimmee, water levels should remain below 46 feet for a minimum of 90 consecutive days for effective treatment.

Extreme drawdowns were completed for Lake Tohopekaliga in 1971, 1974, and 1987; the last included muck removal. East Lake Tohopekaliga was drawn down in 1990, also with muck removal. (Both of these lakes are in the Kissimmee Chain of Lakes, but north of the limits of the study area for the project considered here.) A drawdown of Lake Kissimmee was completed in 1977; this did not include mechanical removal of muck, but was beneficial through the natural processes described above. A drawdown is planned for Lake Kissimmee in the next two to three years, if funds and permits can be secured.

Wegener and Williams (1974) describe the beneficial response of fish populations to the 1971 extreme drawdown of Lake Tohopekaliga. Standing crop of fish in the littoral zone increased from a high of 191 pounds per acre before the drawdown to 455 pounds per acre within two years after reflooding.

Compounding the adverse effects of overly restrictive water management, several levees have been constructed around the lakes, further restricting interchange of water and accelerating conversion of former wetlands to uplands. Figure 3 shows the locations of the three principal levees, north of Lake Cypress, south of Lake Hatchineha, and along the east shore of Lake Kissimmee.

Public access is always a concern for fishermen, froggers and hunters. The higher powering of airboats and other boats has made more and more land (including privately held land) accessible. Conflicts can arise between certain factions among recreational users and landowners. Development of recreational plans by the Corps should consider the balance between the limits on public access sought by landowners along the shoreline and the legitimate needs for public access to the natural resources.

B. Planning Goal

Optimize environmental improvements to the upper Kissimmee basin while reestablishing discharges to the lower basin that are necessary to restore the ecological integrity of the Kissimmee River

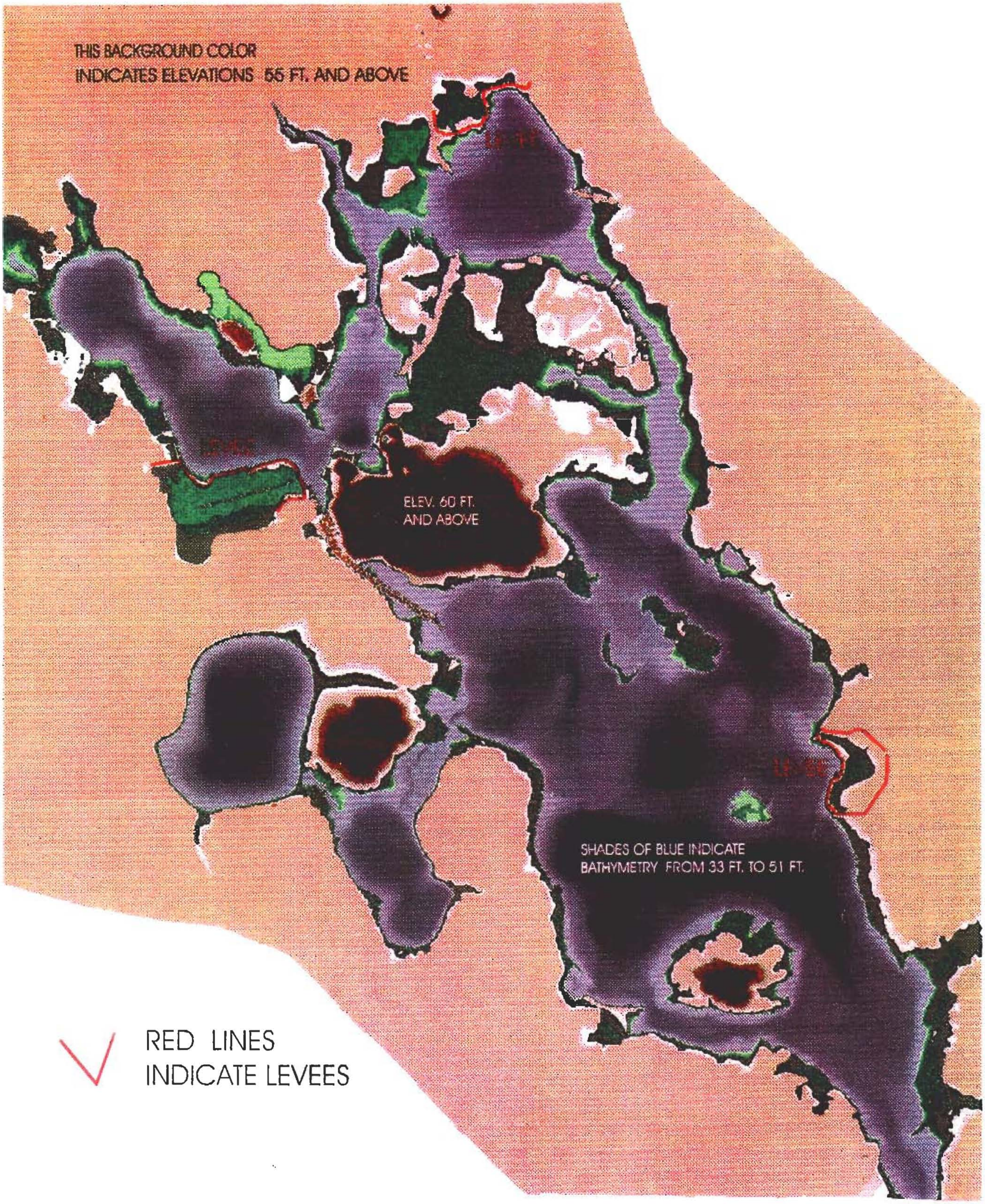

FIGURE 3 - TOPOGRAPHY/BATHYMETRY AROUND KISSIMMEE CHAIN OF LAKES
AND LOCATION OF SIGNIFICANT LEVEES.

(POTENTIAL AREAS FOR WETLAND ENHANCEMENT ARE ISOLATED BY THESE LEVEES)

C. Planning Objectives

1. Provide necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits ascribed to Kissimmee River restoration.

2. Increase the quantity and quality of the wetland habitat in the upper basin lake littoral zones to benefit fish and wildlife.

3. Provide increased potential for recovery of endangered and threatened species, while not jeopardizing any listed species.

VII. DESCRIPTION OF EVALUATION METHODS

A. Data Used in the Evaluation

1. Vegetative Cover

Characterization of habitat suitability in this evaluation relies principally on a classified Landsat Thematic Mapper (TM) image. The study area was cut out from data provided by the FGFWFC. The FGFWFC classified vegetative cover in Florida into 22 categories (including barren areas and open water). Kautz et al. (1993) provide a description of the process of classification, definition of the habitat characteristics of each land cover type, and analysis of the results. Figure 4 shows the original Landsat image used as a basis for our analysis. Sixteen of the 22 land cover types used for Florida are present in the study area. The 5 most abundant cover types in the study area are the following:

TABLE 1 -- PREDOMINANT LANDCOVER CLASSES IN STUDY AREA

LANDCOVER CLASS	ACREAGE	PERCENT OF STUDY AREA
Grassland	48,900	22.9%
Open Water	39,373	18.5%
Dry Prairie	30,161	14.1%
Marsh / Wet Prairie	28,673	13.4%
Shrub / Brushland	13,860	6.5%

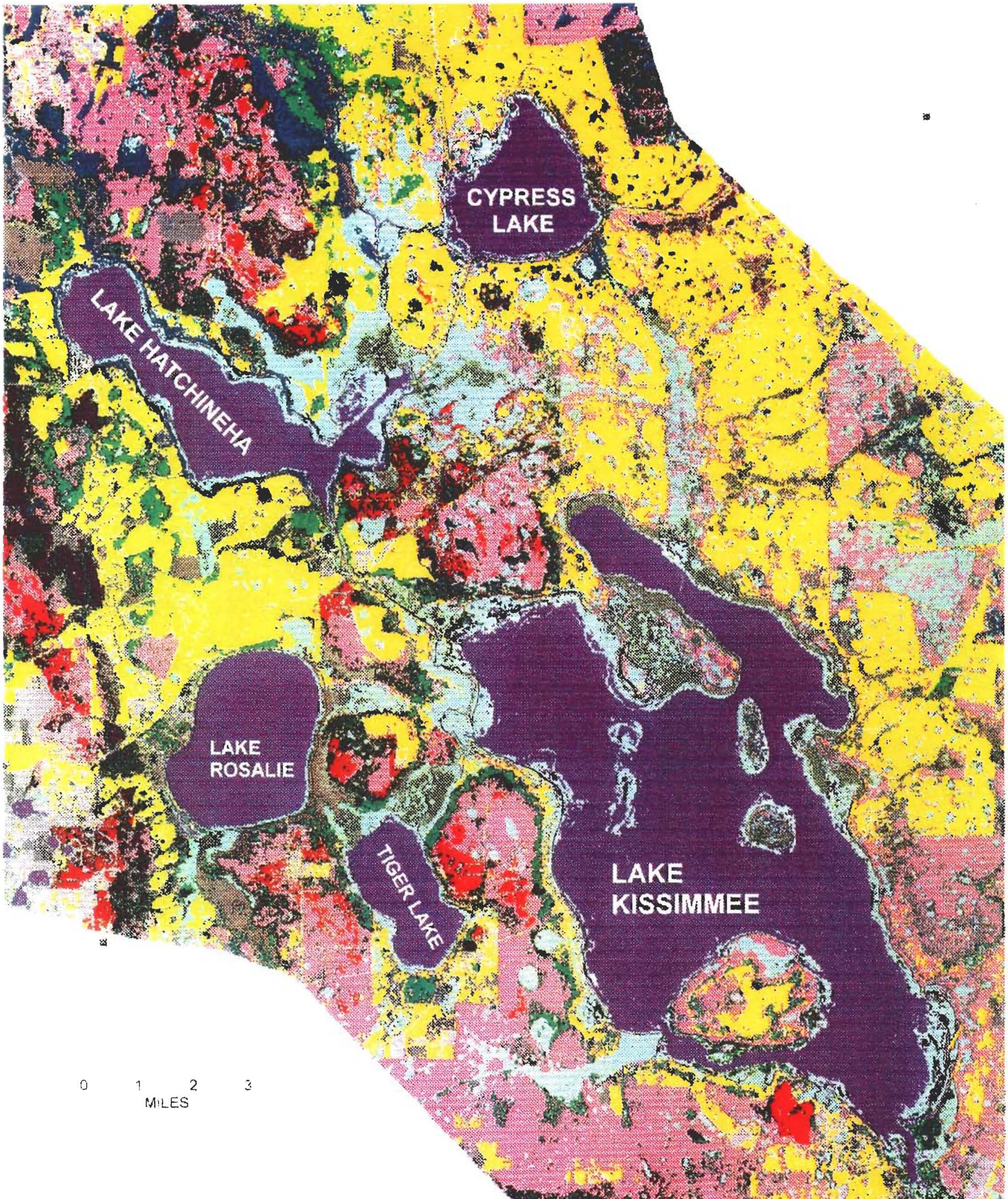

FIGURE 4 - COVER TYPES IN STUDY AREA, KISSIMMEE HEADWATER LAKES
(From FGFWFC classification of 1986 LANDSAT image)

LEGEND FOR VEGETATION CLASSES IN FIGURE 4
FLORIDA GAME & FRESHWATER FISH COMMISSION CLASSIFICATION

- DRY PRAIRIE
- PINELANDS
- SAND PINE SCRUB
- XERIC OAK SCRUB
- MIXED HARDWOOD/PINE FORESTS
- HARDWOOD HAMMOCKS AND FORESTS
- FRESHWATER MARSH & WET PRAIRIE
- CYPRESS SWAMP
- HARDWOOD SWAMP
- BAY SWAMP
- SHRUB SWAMP
- OPEN WATER
- GRASSLAND
- SHRUB AND BRUSHLAND
- BARREN

Additional classes were derived from the 16 classes in the study area, based on National Wetlands Inventory data and projections of future with project conditions, as described below. Although the land cover data distinguishes several categories of woody wetland vegetation, it provides a single category for herbaceous marsh/wet prairie. Duration of flooding and water depth are the main variables used in our analysis of the lake regulation schedules, and the landcover data provide no indication of water regime for the wetlands or open water areas. Therefore, additional data sets, as described below, were used in conjunction with the vegetative cover to assess project effects.

2. Water Routing Model

The Hydrology Section of the Corps' Jacksonville District ran several iterative tests of water regulation schedules. The South Florida Water Management District was the principal designer and initial evaluator of the schedules. The Corps provided historic water level records (1929-42 and 1945-1958), observed conditions (1970-1988), and model outputs from the UKISS water routing model for a series of alternatives.

These data were exported as ASCII files and imported by the Service into a spreadsheet program. The use of these data in the evaluation of general ecological parameters and in species models is summarized in following sections of this report. The two principal variables were water levels in Lake Kissimmee and percent floodplain inundation in the Kissimmee River, which was estimated from discharges from Lake Kissimmee. A major assumption in our analysis is that all the lakes in the study area are treated as a single pool, i.e. water levels are assumed to be at the given level measures or modeled in Lake Kissimmee. In reality, water levels in the peripheral lakes, particularly Cypress, Rosalie, Tiger, and Jackson may be at times perched above the water levels in Lake Kissimmee. However, in the long term, environmental conditions in all the lakes are correlated with regulation of Lake Kissimmee (except for the probable future management of Lake Jackson as a separate entity).

A variety of statistics were extracted from the water records. The general evaluation of alternatives, as described in greater detail in a subsequent section of this report, used daily records, extracted on a seasonal basis, over an 18-year period of record. Where water regulation parameters were used as input in species models, a weekly average over the 18-year period of record was used in most cases, and specific water level variables were extracted from those data. Water elevation in turn had to be referenced to topography to provide a measure of water depth and/or hydroperiod at a given geographic point.

3. Topography and Bathymetry

A reliable topographic data set was not available prior to initiating this analysis. In the Scope of Work for this project, we anticipated that detailed topography (at least to 1-ft

contours, and preferably to 0.5-ft. contours) would be determined by photogrammetry for the entire study area. Certain portions of the study area had already been surveyed in detail, but contracts were not issued to provide detailed surveys of the remainder of the study area. Consequently, significant uncertainty in topography remains, particularly in the area between the three large lakes (Kissimmee, Tohopekaliga, and Cypress) and in the area west and northwest of Cypress Lake.

Despite these data gaps, all available bathymetric and topographic data were assembled from a variety of sources into a single line coverage. The major sources were: bathymetric contours from a 1954 Corps survey, detailed photogrammetric surveys of selected areas, scattered transects by the SFWMD, cross-sections at the major canals from the Corps, and the 55-foot and 60-foot contours from USGS quad sheets. A topographic surface was interpolated from the assembled line coverage using the TIN module in the ARC/INFO program. The resulting 30-meter grid of interpolated values was split into 0.5-ft intervals centered on the contour line. The image was then clipped at the 55-foot contour. Figure 3 shows the resulting map; the map contains some central areas with elevations of 60 feet or above, which are included only for graphic integrity, so as not to show up as "holes". The locations of principal levees in the study area were added. For purposes of the analysis, any elevations above 54 feet are irrelevant, because the effects of the project would not reach above that elevation.

Among the areas lacking topographic accuracy are several significant tracts of low elevation (roughly 52 to 54 feet) located behind levees. The main concern of the Corps and SFWMD has been to minimize the acreage of land acquisition lying below 54 feet. The topographic surveys were generally carried up to the nearest 54-foot elevation around the shore of the lake. Where the surveys encountered a levee at or above 54 feet, the low-lying areas behind the levee were either ignored or not surveyed in adequate detail. However, the Service has attempted to include these areas for possible restoration or enhancement of wetlands if the levees are breached.

4. National Wetlands Inventory

Water regime descriptors from the National Wetlands Inventory were used to supplement the generalized marsh/wet prairie category available from the FGFWFC's Landsat image. Polygons described as temporarily flooded, seasonally flooded, or semi-permanently flooded palustrine emergent wetlands were selected from the 9 quad sheets within the study area. A grid value was assigned as an attribute to each polygon in accordance with the above water regime designations, and the polygons were converted to a 30-meter grid. Any contiguous cells of generalized marsh in the Landsat image were considered to have the same water regime, and any generalized marsh category that did not correspond with a NWI water regime remained as generalized marsh. These marsh categories were used only for wetlands outside the hydrologic influence of the lake shores, i.e. above the 54-foot contour.

B. General Evaluation of Water Regulation Schedules

1. Background of Iterative Testing

Between August 1993 and November 1993, an iterative testing process was conducted using schedules recommended by the South Florida Water Management District (SFWMD). Hydrologists in the Corps' Jacksonville District ran the UKISS hydrologic routing model and provided the results to the SFWMD, the Service, and the FGFWFC for review of the output. Although the SFWMD was the principal designer and reviewer of the schedules, they conferred with all four agencies in a series of meetings to review the model outputs and to fine-tune the schedules. In this iterative process, a total of at least 21 regulation schedules were reviewed. The last two alternatives, T1000HISRR and 400C150RR, were evaluated by the Fish and Wildlife Service, using a series of criteria judged to measure ecologically significant factors. We describe below the theory and assumptions underlying the general ecological evaluation of these schedules and their comparison with the historic (pre-project) condition and the recently regulated conditions (1970-1988).

The primary criterion used by the team members in reviewing the hydrologic outputs was the percent of time that the Kissimmee River floodplain would be expected to exceed a given percentage inundation and the discharge characteristics at structure S-65. This analysis looked at both the percentage of time over the full period of record, and the percentage of time by month, that at least 1%, 15%, 40%, 75%, 95%, or 100% of the floodplain would be inundated. Estimates of the percent floodplain inundation were based on the relationship (in the river's pre-channelization condition) between stages at the Fort Kissimmee station and the extent of floodplain inundation. Stages at Fort Kissimmee were in turn derived from discharges at S-65 modeled for each of the alternative schedules. Evaluation of the effects on the Kissimmee River and comparison of stage exceedence curves for Lake Kissimmee were the basis of the iterative evaluation and re-design of lake regulation criteria.

Because higher water levels in the Kissimmee River floodplain ultimately depend on drainage from the Chain of Lakes, trade-offs must be reconciled. Early in the testing process, it was determined that attempting to provide historic discharges to the Kissimmee River throughout the year would lower the high end of the stage exceedence curves for Lake Kissimmee, relative to the presently regulated condition. As this was considered unacceptable for the Chain of Lakes, the evaluation team continued to seek distribution of discharges for the Kissimmee River in keeping with the typical wet season/dry season pattern characteristic of central and southern Florida, while not lowering the frequency of higher stages in the lakes. To avoid reduction of the higher water levels in the Chain of Lakes, the regulation schedule alternatives were eventually modified by inserting both a 150 cfs zone and a transitional zone with discharges between 400 cfs and 150 cfs.

2. Assumptions and Description of Community-level Evaluation

Because habitat changes can favor one species and be adverse to another species, species-by-species modeling, as presented in another section of this report, often may identify trade-offs in the effects of a proposal on species of particular concern. This may help wildlife managers set priorities for actions beneficial to a given species or perhaps set limiting factors on the scope of project alternatives if a given alternative is unacceptably detrimental to an important species. However, greater emphasis is now being placed on development of community-level evaluations, especially for measures of ecosystem restoration.

We have used several parameters available from the hydrologic data to assess the overall dynamics and productivity of the last two modelled alternatives, the observed 1970-1987 regulated condition (one using the full record, and another version with the 1977 extreme drawdown excised) and historic conditions prior to regulation. All of the water routing models used inputs from the 18-year period between 1970 through 1987. In evaluating the historic pre-project condition, an 18-year period was selected to keep the evaluation equitable. According to the USGS, regulation of the lakes began in July 1964. The pre-project water records supplied by the Corps were 1929-1958. Because historic records were incomplete in 1943 and 1944, the most recent available full-year periods summing to 18 years were 1939 through 1942 (4 years) and 1945 through 1958 (14 years).

A description of the general evaluation technique and its assumptions follows. The evaluation is divided into two parts -- the first part assesses performance of the observed and proposed hydrologic regimes in the Chain of Lakes, and the second assesses them from the perspective of achieving restoration of the Kissimmee River floodplain.

The present regulation schedule of the lakes has been criticized by wildlife managers as being too restrictive of water levels in a narrow range, without the degree of fluctuation in high and low water levels before regulation. Maintaining water levels within narrow limits has several detrimental effects. Figure 5 shows a graph prepared in 1957 that predicted compression of the elevations at which certain wetland plant species would grow in response to the anticipated more restrictive water regulation following construction of the project. Indeed, water levels are considerably more static today than in the pre-project condition, but we are unaware of any follow-up studies to confirm that such changes have occurred or are in the process of occurring. The most obvious effect is that hydrologic conditions suitable for growth of productive wetland vegetation are concentrated to a narrow band. Areas that used to sustain herbaceous wetlands at higher elevations are now less frequently flooded and/or have been displaced by upland

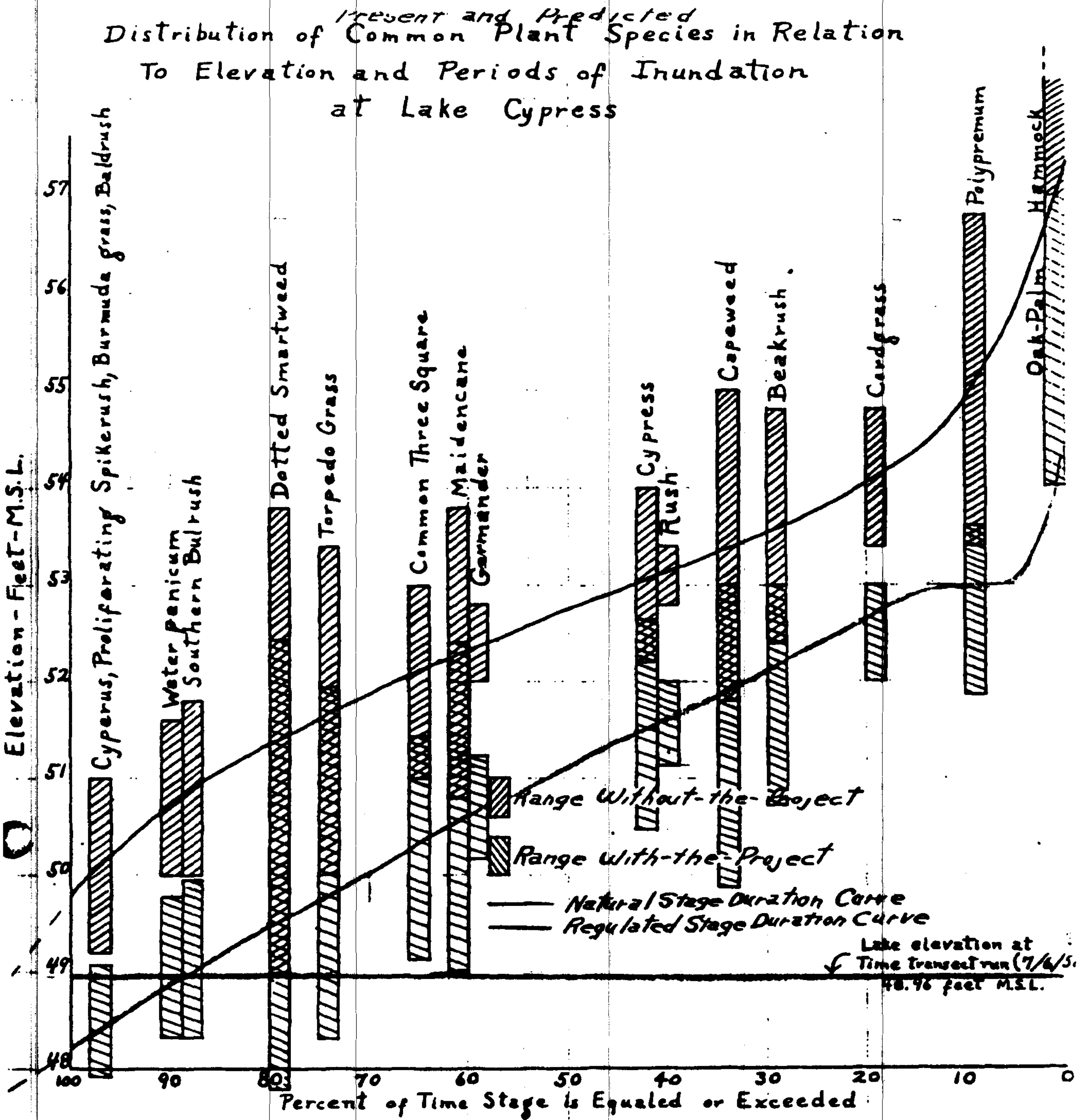

FIGURE 5 - PREDICTION OF CHANGES IN VEGETATION DUE TO REGULATION OF LAKES.
(FROM USFWS' 1957 COORDINATION ACT REPORT)

vegetation. Longer-lived wetland plants such as cypress trees (particularly at Cypress Lake) are now less frequently flooded, and part of the cypress fringe has been lost (Ed Moyer, pers. comm.) Greater fluctuation in water levels expands the distance across which a given species can encounter conditions matching its preferred hydroperiod. Generalist species, including non-native aquatic plants, are expected to dominate in closely regulated conditions, reducing the diversity of the wetland. Therefore, both total area and diversity of wetland vegetation are reduced by the more restrictive water regulation schedules.

Based on the ecological criteria described above, the evaluation assumes that measures of high water periods, routine low water periods, and overall variability in water levels are all indicators of general productivity and health of the lakes.

Screening of the water model outputs for the earlier schedule alternatives was based on inspection of the stage-exceedence graphs. Those alternatives exhibiting higher stages at the upper end of the curve (above the 1970-1988 observed values) were preferred for further consideration. Although this was considered adequate for initial screening of the alternatives, the Service decided to conduct a more detailed analysis of several more refined alternatives in the latter stages of selection. The stage-exceedence curve will only indicate the percent time over the period of record that a certain water level is exceeded; it does not indicate the duration of each occurrence. That is, several one-day or two-day periods of water over 52.5 feet will contribute to the percentage of time exceeding that value in a stage exceedence curve, but these short periods of flooding will have little biological significance. We decided that the average durations of flooding and drying events is more significant, because they will correlate with the suitability of flooded areas as wildlife habitat and with the beneficial effects of routine low water levels.

Three quantitative criteria were examined through use of a spreadsheet program, using the output of the hydrologic models provided by the Corps. The first criterion is the average duration, in days, of water levels greater than 52.5 feet, the presently regulated maximum of the lakes. The second criterion is the average duration of water levels lower than 49 feet, the presently regulated minimum (what we are calling a routine drawdown). The third criterion is the coefficient of variation of the daily records over 18 years, which provides a measure of overall variability of water levels from the mean. All of the above measures were used in the ranking formula as an index of success in achieving restoration in the Chain of Lakes.

Four additional criteria were used to measure performance of the alternatives in achieving restoration of the Kissimmee River. Although the criteria used for the upper basin did not consider seasonality, we considered seasonality important in evaluation of the lower basin. Data for the wet season (June 1 - Oct. 31) and for the dry season (January 1 - May 31) were extracted to separate sections of the spreadsheet throughout the 18-year period of record. Again, the duration of events was considered biologically more significant than simply the percentage of time over the period of record. (For example, a percentage of time with a certain level of floodplain inundation could consist of many short periods of inundation, but a longer average time period above a certain level of inundation would provide more opportunity for animals to use these areas as habitat.) The spreadsheet accounted for the end of each seasonal period to avoid the possible error of a period that met the criterion erroneously being extended to the next seasonal period. For example, floodplain inundation exceeding 90% until October 31 of one year and picking up again in June 1 of the next year should not be considered a single event of long duration, but rather two separate events meeting the criterion.

We considered it important that the project provide high levels of floodplain inundation during the wet season months (June through October), providing a more natural (i.e. rain-driven) pattern of floodplain inundation. The fourth criterion (first lower basin criterion) measured the average duration, in days, during the June through October wet season when floodplain inundation covered 90% or more of the floodplain. The fifth criterion also started with daily records in the wet season, and measures the duration of periods of very low flow (< 200 cfs). Examination of the model outputs led us to select 200 cfs as indicative of low flow that might lead to adverse conditions in the Kissimmee River; first, 200 cfs is below the level at which water is contained fully within the river banks (0% floodplain inundation) and secondly, periods of less than 200 cfs were found to be relatively infrequent. The wet season months are also the period of high water temperatures, when fish kills due to oxygen depletion are more likely to occur. Oxygen depletion generally occurs during extended periods of no flow or very low flow. High values for this criterion are undesirable and should correlate with a greater risk for harmful situations involving oxygen depletion. The sixth criterion determined the average duration of greater than 25% floodplain inundation in the January - May period. We considered it important that some lower level of floodplain inundation occur in the dryer months, but we felt it would be unrealistic to set a high level of inundation as a goal for this period. The seventh criterion measured the duration of periods with less than 200 cfs flow at S-65 between January 1 and May 31 for the period of record. Although we considered reduction of periods of low flow to be a valid overall goal, we do not consider avoidance of low flow as important in the dry season because water temperatures are lower at that period, and oxygen depletion is less likely.

3. <u>Calculation of Overall Score for Alternatives</u>

A formula was devised to provide an overall ranking of the final two alternatives and to compare these alternatives with the period of record. The preceding section describes the 8 criteria used to calculate the overall ranking. The overall ranking (R) equals the weighting factor (W) for each criterion times the individual ranking value (r) for each criterion, summed across the 7 criteria:

$$R = W_{C1} \times r_{C1} + W_{C2} \times r_{C2} + \ldots W_{C7} \times r_{C7}$$

The individual ranking value (r) for each criterion is a value from 0 to 1, based on the range of values observed for the alternatives and the observed values in the reference periods of record. For criteria 1, 2, 3, 4, and 6, high values are more desirable, and r is calculated as follows:

$$r = \frac{X}{X_{max}}$$

where X_{max} is the highest value for each criterion among the alternatives or the periods of record.

For criteria 5 and 7, lower values are more desirable, and r is calculated as follows:

$$r = 1 - \frac{X}{X_{max}}$$

Evaluation team members assigned weighting factors, based on the following premises that account for institutional priorities::

- The preliminary review of water regulation schedules had already been based on evaluation of the timing and volume of discharges to the Kissimmee River. Although we considered it appropriate to include lower basin criteria in the final selection of a preferred schedule, we decided it was important to give greater weight to the factors originally intended for the Kissimmee Headwater Lakes Revitalization Project -- higher water levels and greater water level fluctuation.

- For the lower basin criteria, we considered that delivery of water to the Kissimmee River during the wet season months was more important than providing floodplain inundation and avoidance of low flow in the dry season.

Therefore, among the 7 criteria, the average number of days with water levels above 52.5 feet (criterion 1) and the overall variability in water levels (criterion 3) were considered most important to the evaluation for the Chain of Lakes, and were assigned a weighting factor of 2. The effects on the lower basin during the dry season (criteria 6 and 7) were considered relatively less important, and were assigned a weighting of 0.5. The other 3 criteria (numbers 2, 4, and 5) were considered to be intermediate in importance, and were assigned a weighting factor of 1.

On February 18, 1994, the four review agencies met in Vero Beach to approve documentation for the evaluation methodology described above. Agency comments were incorporated in the evaluation methodology prior to issuance of the Draft Fish and Wildlife Coordination Act Report.

C. Methods to Estimate Extent and Location of Wetlands to be Restored

1. Introduction

A major benefit of the Kissimmee Headwater Lakes Revitalization Project is the opportunity to restore wetlands that have been degraded or eliminated by too restricted water fluctuations and/or construction of levees holding back water from low-lying areas. An important assumption in our analysis is that the waterward edge of the marsh around the lake shores will not change as a direct result of the proposed change in the water regulation schedule. The rationale for this assumption is that the wetland plants (mainly cattails and bulrushes) at the waterward edge of the marsh are highly tolerant of extended periods of deep flooding. We consider that the outer edge of the marsh would recede in response to higher water levels only if the existing vegetation were drowned out by prolonged periods of extremely high water. However, the higher water levels for the proposed alternative are approximately one half foot higher than at present and are not held high for extended periods of time. In addition to the somewhat higher levels, the proposed schedule would also provide lower average water levels, resulting in greater overall fluctuation. We consider that consistently higher water levels would cause a recession in the waterward edge of the marsh, but since that is not the case, we predict no change for the waterward edge, while the upland edge of the marsh will be extended by the seasonally higher levels, resulting in a net increase in marsh acreage. The following sections describe how we determined the average elevation of the existing marsh/upland edge and how we predicted the extent of additional acreage of wetlands to be restored by the higher water levels.

2. Topographic Range of Wetlands (With and Without the Project)

Two analytical approaches were used to compare the existing extent of wetlands with projected future conditions. The main objective was to determine the elevation at which marshes or wet prairie transition to grasslands or dry prairie. The first analysis (using GIS) centered on delineation of the wetland/upland transition as sensed by the Landsat image used to define vegetative cover in the study area. The second analysis was performed in a spreadsheet program and was based on the regulatory definition for wetland hydrology.

The GIS-based analysis started with the coverages containing the contour lines for the bathymetry and topography of the study area. As previously stated, some areas were surveyed in detail and others were not, requiring extensive interpolation, particularly in low-lying areas distant from lake shorelines. Therefore, we searched for areas where most or all of the 1-foot bathymetric and 0.5-foot topographic contours were present, where these lines ran generally parallel, and where the slope was gradual to better determine at what elevation the wetland/upland transition took place. In this way we intended to select areas with as accurate data as possible and with regularly sloping shorelines (i.e. without islands, peninsulas, embayments or natural berms). We also sought to distribute these areas throughout the study area. However, more complete and accurate contours were available for Lake Kissimmee than for Lake Hatchineha and Cypress Lake, and we avoided selecting areas in Tiger Lake or Lake Rosalie, because these lakes have relatively steep shorelines. Nine areas were selected, drawn in over the contour line coverage, and transferred over the Landsat image. In the Landsat image, we digitized the transition between the marsh/wet prairie vegetation type and the adjacent uplands (usually grassland or dry prairie) in the nine selected sections of shoreline. The resulting lines were rasterized and superimposed on the raster version of the topography/bathymetry. The topographic data used here had been interpolated to 0.1 feet by the SFWMD. We were confident in using this level of interpolation along selected shorelines, but not over the entire study area. (Interpolation to 0.5-foot contours were used for all other GIS analyses, including prediction of future wetland extents and habitat suitability in the species models.) By overlaying the two files, we could determine the elevation of each grid cell along the wetland/upland transition. These data were exported to a spreadsheet and to a statistical program. A total of 395 grid cells were analyzed in the 9 areas distributed geographically as follows: 2 areas in the southern half of Lake Kissimmee; 3 in the northern half of Lake Kissimmee; 2 adjacent to the Short Canal, between Lake Kissimmee and Cypress Lake; 1 at the northern end of Lake Hatchineha; and 1 along the northeastern shore of Cypress Lake. The mean elevation of the upland/wetland transition line on the 1986 Landsat image was 51.96 feet ($\pm$ 0.1, 95% confidence limit).

The current Federal manual for delineation of jurisdictional wetlands uses three diagnostic parameters: vegetation, soils, and hydrology. Our analysis assumes that if suitable hydrology is restored over suitable soils, characteristic wetland vegetation will follow. Consideration of soils enters our analysis later in this section, when we estimate the likely quality of the additional wetlands to be produced by the new water regime. Our spreadsheet-based wetlands analysis, however, considers only the hydrologic criterion, comparing water level readings for the full 18-year period of record for both the selected alternative, 400C150RR, and the observed period of record (1970-1988). By examination of the stage exceedence curve for the preferred alternative, relative to the observed, evaluation team members noted that the two lines crossed at about a 51-foot elevation, and that by "eyeball" it appears that the preferred alternative runs somewhere between a quarter and a half foot higher than the observed (Figure 6). In the section of this report dealing with the community-level comparison of the schedules, we presented the biological reasoning behind the use of duration of flooding and drying events, rather than the stage exceedence curves, as ecological indicators. The Federal wetlands manual stresses that the duration of continuous periods of inundation and/or saturation is more important in defining wetlands than the total number of days per year with inundation or saturation.

The minimum hydrologic regime for defining wetlands is generally accepted as continuous saturation for at least 5% of the growing season. Assuming that the growing season is year-round in the study area (the most rigorous standard), this equates to 18 days of continuous saturation. In our analysis, we have required 18 consecutive days of water levels at the surface (i.e. saturation) to define suitable hydrology for production of wetlands. We set up a spreadsheet, similar to those used in the general evaluation of the water schedules, that measured the average duration of flooding or drying events. However, rather than measure an average duration above or below a particular elevation, we determined at what elevation (in the 0.01-foot increments provided by the UKISS routing model) the observed and preferred alternative water models produced (on average over the 18-year period of record) saturation of more than 18 continuous days duration. The observed 1970-1988 period had an average duration of 18.2 days saturation at an elevation of 52.19 feet; while the 400C150RR alternative provided an average duration of 19.25 days saturation at 52.87 feet. The 52.19 feet for the observed period is slightly above the elevation where the transition between wetlands and uplands was sensed in the Landsat image, but given the level of precision in the topographic data, they agree quite well, at roughly 52 feet elevation. The difference (52.87 - 52.19 = .68 feet) between the two elevations for the observed and proposed alternative at which wetlands are expected to be produced also generally corresponds with the approximate half-foot difference between the upper ends of the stage exceedence curves for the observed and preferred alternative.

3. Prediction of Future Wetland Conditions

Based on the above figures, we generalized to project the future extent of wetlands under the proposed water regime. Because large portions of the study area lacked detailed topographic contours, extensive interpolation was required, and we were not willing to accept interpolation beyond half-foot intervals. Interpolation to finer increments would be too inaccurate for most of the study area. Therefore, 0.5-foot increments were used for both the projection of future wetland conditions and the species models. We generalized the findings of the previous analysis and assumed that the present upper end of the wetlands is approximately 52 feet and that the future upper end of wetlands would be 52.5 feet. Because the stage exceedence curves cross at about 51 feet elevation, and

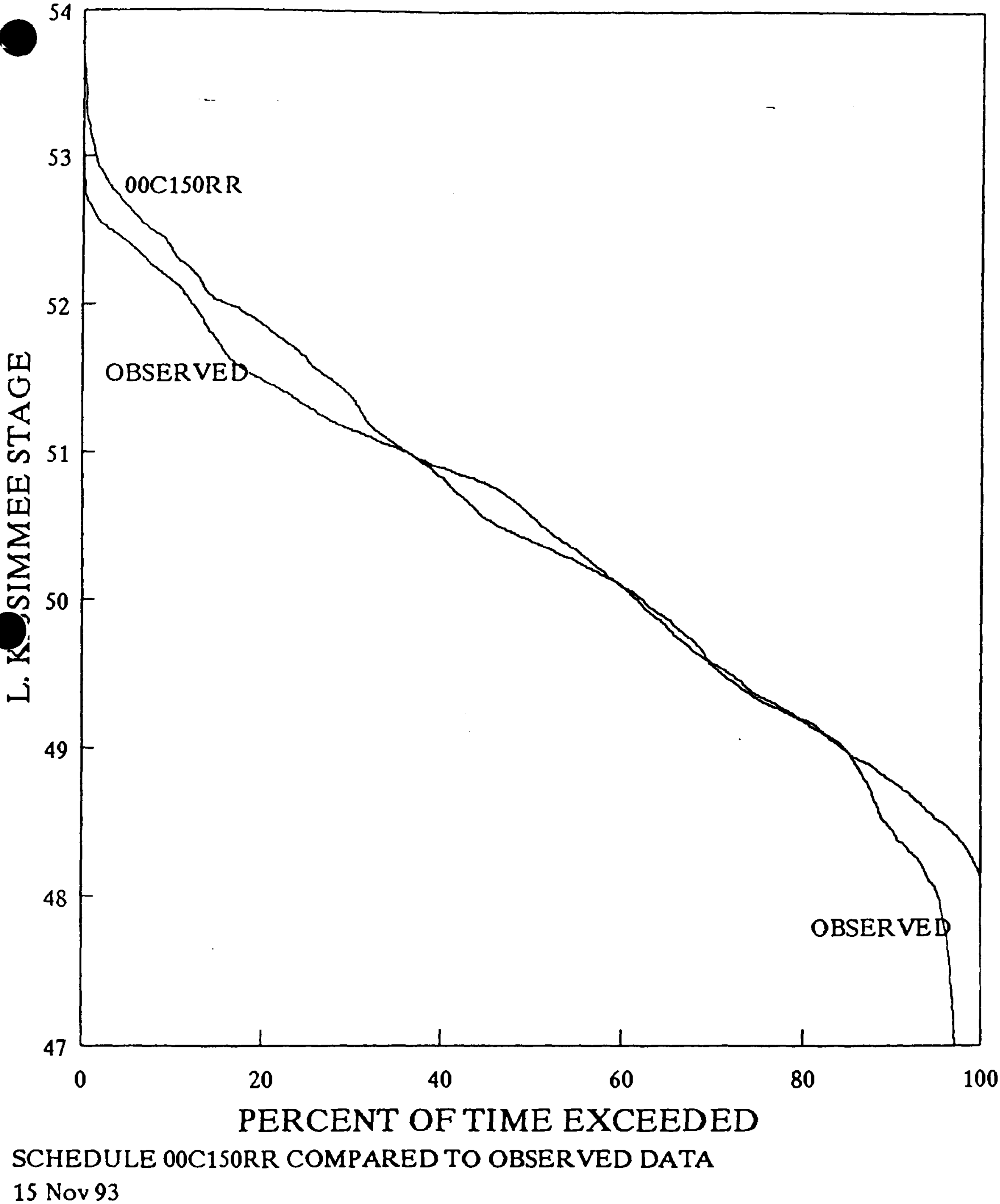

FIGURE 6 - STAGE EXCEEDENCE CURVES FOR OBSERVED PERIOD (1970-1987) AND PROPOSED 400C150 SCHEDULE. NOTE THAT THE PROPOSED SCHEDULE IS ROUGHLY 0.5 FEET HIGHER THAN THE OBSERVED AT WATER LEVELS EXCEEDING 51 FEET.

because the geographic coordinates for the topographic data could be somewhat imprecise, we selected an elevation zone between 51 and 52.5 feet as the zone across which the higher water stages would restore wetlands (hereinafter called the "transitional zone").

Overlaying the present vegetative cover on the half-foot topography, we based our projection of future habitat conditions on several assumptions:

1. All marsh within the transitional zone will remain marsh. (See explanation in subsection a., entitled "Introduction", above.) As would be expected, existing marsh was the dominant vegetative cover in the transitional zone, accounting for 36.9% of the total area in the transitional zone.

2. Open water in this zone most likely indicates deeper water and these areas are expected to remain as open water. However, deep water would not generally be expected to occur along the upper edge of the marsh unless it were excavated and impounded. Indeed, less than 1% of the total transitional zone is open water in the present condition.

3. All shrub or forested wetland classes (cypress swamp, hardwood swamp, bay swamp, shrub swamp) in the transitional zone would not be altered by the change in hydrology. Although the increase in water fluctuation would most likely be beneficial to the productivity of these habitats, we do not anticipate a change in gross habitat structure. These 4 classes combined accounted for 16% of the transitional zone in the present.

4. Xeric communities (oak scrub, sand pine scrub) and hardwood upland covers (hardwood hammocks, mixed hardwood/pine forests) generally should not occur in the transitional zone. Any occurrence of these covers in that zone may be the result of remote sensing errors and/or inaccuracy in the topographic data. These classes remained unchanged in the future scenarios. No sand pine appeared in the zone, and oak scrub was sensed in only 0.37% of the zone.

5. Grasslands and shrub/brushland vegetation types are likely to have invaded areas that were wetlands when water levels were higher prior to operation of the original flood control works in 1958. Field observations confirm that wax myrtle and *Sesbania* are invading former marshes, and wet pasture (which most likely was classified as grasslands, rather than wet prairie) is very common around the lakes in low-lying areas that historically supported marshes. Soils in these areas are most likely amenable to formation of wetlands. We therefore predicted these cover types would be likely to produce wetlands of higher habitat value. Grassland was the second most abundant cover type in the

transitional zone, comprising 22.4% of the total area. Shrub/brush was also quite abundant in the zone, making up 8.3% of the area.

6. Areas sensed as dry prairie, pineland, or barren may be converted to wetlands under the new water regime, but these are considered somewhat less susceptible to conversion than grasslands or shrub/brushland. The distinction between wet prairie and dry prairie is gradual, and pine forests can exhibit understory vegetation grading from upland species, through a mixture of facultative wetland species, to a predominance of facultative or obligate wetland species. Soils in both of these transitional habitats are likely to exhibit patchiness on a finer scale than what is normally portrayed as a map unit by the Soil Conservation Service. Lenses of less permeable layers may be found within an area that was sensed as dry prairie, which normally does not have prolonged saturation within 10 inches of the surface. The distribution of these patches within pinelands or dry prairie is not known on a fine scale; soil distribution, like the remote sensing of vegetative cover, is a probabilistic endeavor. In reality, we will probably end up with patches of upland that will be converted to wetland within areas that will remain essentially unchanged from present conditions. Because our species models multiply area times a relative habitat suitability index (HSI), the results will be equivalent if we ignore this indeterminate patchiness and generalize these areas within the transitional zone as "likely moderate quality wetlands". Dry prairie represented 9.9% of the transitional zone, while pineland and barren classifications amounted to 2.3% and 1.4%, respectively.

Using the above relationships, future habitat conditions were predicted for the base project and the three incremental alternatives involving breaching of levees to allow additional restoration of wetlands.

D. The HEP Team, Evaluation Species, and Features Common to all Species Models

Planning and guidance for the evaluation of the proposed project on selected species of fish and wildlife were provided by the same interagency team (Corps, Service, FGFWFC, SFWMD) that evaluated the water routing outputs to select a recommended water control schedule. The first task of the HEP team was to select the evaluation species. The following species were selected:

1. Great egret
2. Snowy egret
3. Wood stork
4. Florida duck
5. Ring-necked duck

6. Snail kite
7. Bald eagle
8. Florida sandhill crane
9. Audubon's crested caracara
10. Largemouth bass

The above species were selected upon consensus of the HEP team, based on the following factors:

- (Federally-listed species (wood stork, snail kite, bald eagle, caracara);

- Wading birds are considered to be sensitive indicators of ecological integrity (great egret, snowy egret, wood stork);

- Species of economic importance to hunting and fishing (Florida duck, ring-necked duck, largemouth bass);

- A State-listed species that is relatively abundant in the study area as compared to other portions of the State (caracara).

Periodic meetings of the HEP team were held to advise the Service regarding development of the evaluation. The HEP team recommended the appropriate species experts to contact in developing the models. These species experts are cited below in the narratives for each species.

The foundation of the modelling was habitat suitability, similar to the Habitat Evaluation Procedures (HEP), in that we used the convention of assigning a habitat suitability index (HSI) of 0 to 1, multiplying by the acreage at that suitability, and summing these habitat unit (HU) values for each species in each of the future scenarios. However Geographic Information System (GIS) technology was used to develop, test, and run the species models. We used both vector-based GIS (PC ARC/INFO, and Generic CAD) and a raster-based (grid cell) program (EPPL7) to prepare data for use in the models. However, the final model runs were all performed in EPPL7, using a 30-meter grid cell size. By using log files (analogous to a macro file), we could string together a series of GIS commands to automate a routine for each model. Using the search and replace capabilities of Wordperfect on DOS text files, we were able to modify each routine to represent either the present (assumed to be the future without project condition) and a series of alternative future scenarios.

The models were all based on two main themes -- landcover (habitat types) and bathymetry/topography. The bathymetry/topography was, in most cases, mapped in 0.5-foot increments. (Interpolation to 0.1-foot increments was used in one portion of the analysis for the snail kite, as described below.) For marsh/wet prairie above the 54-foot elevation (the prairie wetlands) the National Wetlands Inventory water regime designation was used. However, some marshes of unknown hydroperiod remained as generalized marsh in the prairie. For wetlands in the littoral zone, spreadsheets were used to calculate the hydrologic feature of interest for each species in 0.5-foot increments from the water model outputs. This feature was usually the percent time at a certain water depth of significance to the species for that elevation. (Calculating the percent time when water exceed the substrate elevation, regardless of depth provides the hydroperiod.)

Several of the models used a stepwise approach, assigning an initial habitat suitability to a grid cell, then if a condition in another portion of the model was met at the same geographic coordinate, the model could add, subtract or multiply a value according the model instructions. Because EPPL7 deals only with integers between 0 and 255, we needed to export the grid cell counts as ASCII files to a spreadsheet, standardize the HSI to a 0 to 1 range by dividing the grid cell value by the maximum possible value, and multiply by the corresponding acreage for that class of grid cells.

E. General Information and Model Structure for the Evaluation Species

1. Snowy egret and great egret

Experts consulted: Jim Rodgers, FGFWFC; Brian Toland, USFWS; Herb Kale, Florida Audubon Society

The snowy egret *(Egretta thula)* and great egret *(Casmerodius albus)* are among the wading birds that were severely affected by plume hunters in the early 1900's. More recently, water management practices have reduced the number of breeding birds in the southern Everglades relative to historic records (Ogden, 1994). Closer to the study area, channelization of the Kissimmee River has most likely adversely affected wading birds on a regional level; some reduction of wading bird numbers in the adjacent upper basin is a likely consequence, although we are unaware of any studies documenting this. Neither species is listed by the Federal government; the State lists the snowy egret as a Species of Special Concern. Both species feed and nest in the study area, using colonial wading bird rookeries. Both species use visual hunting methods while stalking their prey in shallow waters.

The models for the snowy egret and great egret are similar in structure. The models have a feeding component and nesting component. The feeding component, in turn, is subdivided into selected littoral zone habitats and all other suitable habitats at higher elevations.

First, we calculated in a spreadsheet the percent time each 0.5-foot elevation zone was flooded with up to 18 inches of water or up to 12 inches of water, using weekly average water levels throughout the period of record for the period between February 1 and July 31, which is considered to encompass the full extent of both species' breeding seasons. These values were calculated for the observed period (excluding the 1977 extreme drawdown) and for the selected alternative. (The depth calculation for a given 0.5-foot elevation band was built into the spreadsheet formulas.) The 12-inch water depth is generalized as the maximum feeding depth for the snowy egret, while the longer-legged great egret can presumably feed in water up to 18 inches deep. (Both species are capable of feeding from floating mats of vegetation, but we think the above generalizations are valid overall.)

Both species are capable of exploiting wetlands of suitable depth across a wide range of hydrologic regimes, and they feed readily in both the littoral zone and the smaller prairie wetlands. Elevation bands in the littoral zone exhibiting suitable water depth for 25% or more of the period of record were assigned highest value, and those with 10%-24.9%, 5%-9.9%, and >0%-4.9% were assigned progressively less suitable values. These frequencies were selected for both ends of the hydroperiod continuum, i.e. those wetlands that are generally too deep except for short periods of time and those that are frequently exposed. Deep water areas that always exceeded the suitable feeding depths are assigned no habitat value.

Habitat classes were overlain on hydrologic suitability to refine and "filter" the values in the littoral zone. Forested and shrub wetlands were assigned low values regardless of where they might occur in the elevation bands. Existing marsh and marsh to be restored in future scenarios that is likely to be of high habitat value was given value in accordance with the graduated scale of hydrologic suitability described in the preceding paragraph. Open water or marsh projected to be likely of moderate value in future scenarios was given reduced value by subtracting a constant from the corresponding elevation band.

Forested and shrub wetlands above the littoral zone were assigned the same low value as for those occurring in the littoral zone. Marshes higher than the selected elevation bands were assigned values in accordance with the water regime attributes from the National Wetlands Inventory data. Temporarily flooded marshes are exploited by these wading birds, but due to their infrequent availability, they were assigned relatively low value, slightly higher than for the forested and shrub wetlands. For seasonally flooded and semi-permanently flooded marshes, size classes were significant in assigning habitat values. Feeding areas are most accessible around the perimeter of the marsh in the prairies, and wading birds are most often observed feeding near the perimeter. The center of a marsh may not always be accessible to wading birds during periods of high water. Smaller wetlands have a high edge/area ratio. Semi-permanently flooded wetlands were ranked higher than seasonally flooded wetlands, due to the greater time period they are inundated. Within these water regimes, the marshes less than 2 acres in size were rated higher than marshes between 2 and 10 acres, which were rated higher than marshes covering more than 10 acres. In this ranking scheme, semi-permanently flooded wetlands less than 2 acres in size were assigned highest habitat value in areas above the littoral zone, equivalent to the value given the highest rated elevation band in the littoral zone.

The final step in the model introduces the nesting component. The rationale is based on the energetic demands of providing food to nestlings. Bancroft et al. (1994) state:

> When nesting, wading birds are constrained to feed relatively close to the colony site; therefore, successful colonies must be located in areas that provide adequate food for their 10- to 14-week nesting cycle.

The average foraging distance from the rookery varies among species using the same rookery and for a single species among different rookeries (ibid.). We have selected a 7-kilometer radius as an average for both species. Rookery locations, indicating which species occur at each rookery, were available in our GIS data set (originally obtained from the FGFWFC's Non-Game Program). The great egret uses 6 nesting sites in the study area, while the snowy egret uses only one (a colony south of Lake Rosalie supporting nesting of both species). (See Figure 7.) Although the sites of colonial wading bird colonies can shift in response to changing environmental conditions, they are relatively faithful to historic nesting sites (ibid.) We are assuming that the water regulation changes are not so radical as to cause abandonment of a currently used colony or formation of a new colony. In the long term, shifts in colony sites are likely to occur with or without the proposed water regulation schedules. Unfortunately, data are not available on the average number of breeding birds of each species using a rookery. All suitable foraging sites in the study area are used outside the nesting season, and non-breeding birds continue to use all available foraging sites during the nesting season. Therefore, the model retains value for all foraging sites outside the 7-kilometer radius, and doubles the value of all sites within the radius.

In previous versions of wading bird models, we have used slightly different models for wading birds that incorporated an 800-meter radius around nesting colonies where no development should occur to avoid disturbance of the nesting colony. Fortunately, none of the present nesting colonies are within 800 meters of proposed canal widening or the S-65 water control structure, the only structural aspects of the this project. Therefore, the 800-meter disturbance radius has been dropped from the models for this evaluation.

2. Wood stork

Expert consulted: Jim Rodgers, FGFWFC

The wood stork *(Mycteria americana)*, a large long-legged wading bird, is Federally-listed as an endangered species. The species breeds in Georgia and as far north as coastal South Carolina, but the majority of the United States population resides in peninsular Florida. The colonial nesting sites are located in both estuarine coastal areas and in freshwater sites at inland portions of Florida. Wood storks are considerably more conservative than other wading birds, such as herons and egrets, in the persistence of traditional nesting colonies. Two rookeries have persisted in the study area for many years, one at Reedy Creek and one on the south shore of Lake Rosalie. Another large rookery (230 nests) was discovered by Dr. Rodgers from a 1993 aerial survey north of Lake Hatchineha, near the Dead River.

Wood storks use thermal drafts to reach high altitudes before they depart from the vicinity of the rookery in search of food. Their daily feeding range is large, up to 80 miles from the rookery (Ogden et al. 1978). This means that nesting storks can readily reach any suitable nesting areas within the study area from any of the nesting colonies in the study area or from several outside the study area. For this reason, distance of potential foraging sites from nesting colonies was not included in the wood stork model. This differs from the models used for the egrets. The Fish and Wildlife Service has established guidelines for protection of wood stork colonies from disturbance (Ogden, 1989). As with the egret colonies in the preceding models, structural works associated with this project are not expected to occur within the primary or secondary zones. Therefore, the primary and/or secondary zones, which would most likely be used in a generalized species model, were not included in this application.

Aside from the lack of a multiplier accounting for proximity of foraging sites to nesting colonies, the wood stork model is structured the same as the models described above for the two species of egrets. However, the relative habitat values assigned to the wetland classes and the bathymetric zones were altered to reflect the difference in feeding ecology between the stork and the egrets. Unlike the visual hunting techniques of the egrets, the stork uses a tactile or "grope-feeding" strategy. The stork is more dependent on fish as prey, is less able to exploit recently flooded areas, and prefers wetlands that are drying down after a more prolonged period of inundation, where fish are concentrated. Storks feed in the littoral zone of the lakes primarily when receding water levels isolate pools behind berms along the shoreline. Linear rises, which may represent ancient beaches, are readily visible along the lakes, particularly Lake Kissimmee. However, in order to determine precisely at what water levels such isolated pools are formed or rejoined with the main part of the lake by rising water levels, detailed bathymetry/topography on the order of 0.1-foot contours would be needed (Rodgers, pers. comm.). Such detailed contours are not available for the lakes. In general, the isolated wetlands in the prairie are much more frequently used by storks than the littoral zone.

In view of the above, the preferred bathymetric zones identified for the stork were more narrow than for the egrets and were assigned only a moderate maximum habitat value when compared with the maximum possible value in the prairie. The upper end of the preferred littoral zone occurred where flooding up to 18 inches depth occurred at least 10% of the period of record; any elevations higher than this were considered to be flooded at a frequency that would not allow full exploitation by the prey base, and would be less subject to concentration of prey during receding water levels. Any wetlands situated at elevations above the 10% cut-off zone, up to an elevation of 52.5 feet, were assigned relatively low habitat value. The lower end of the preferred bathymetric zone was also considered more restrictive for the wood stork, and was set at that contour at which the preferred depth occurred at least 3% of the time. Although storks are known to use the littoral zone during extreme drawdown events (Rodgers, pers. comm.), we assumed that such events are infrequent enough so as not to affect the overall habitat suitability for the stork.

As noted above, the preferred wetland types in the prairie were assigned maximum values more than twice the maximum value in the littoral zone to reflect the species' preference to feed in those areas. Because storks prefer a seasonal drying to concentrate prey, seasonally flooded wetlands were rated higher than semi-permanently flooded wetlands, which also distinguishes this model from the models for the herons. While the egret models focused on the higher edge/area ratio of the smaller prairie wetlands, the stork model assumed that prairie wetlands less than 2 acres in size would be less suitable for storks than wetlands 3-10 acres or those over 10 acres. The reasoning is that storks are more able to exploit the lower central areas of the larger wetlands, which have concentrated prey from a larger initial area, and that the prey in these initially larger wetlands is also more likely to be of a size suitable for capture by wood storks.

3. Florida duck

Experts consulted: Paul Gray, FGFWFC; Brian Toland, USFWS

The Florida duck is considered to be a separate subspecies of the mottled duck *(Anas fulvigula)*. It is a year-round permanent resident through most of peninsular Florida and is important as a game species.

The Florida duck breeds primarily between mid-March and mid-May, but will attempt renesting through July. Nesting occurs in a variety of covers, including dense grass or dense shrubs in uplands near the water's edge or even in agricultural fields. (Kale and Maehr, 1990) Tall upland grasses and the borders of agricultural fields are abundant

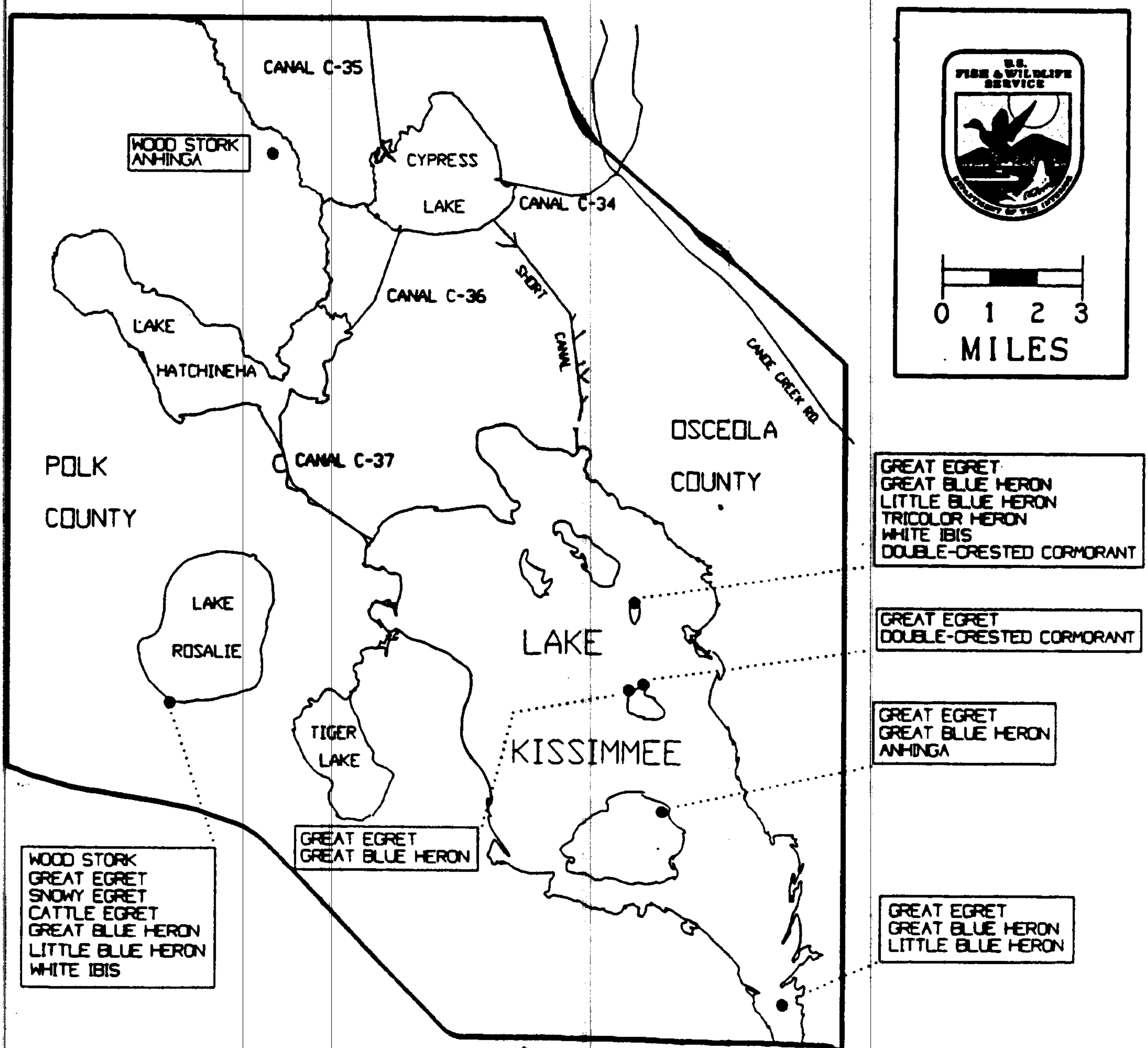

FIGURE 7 - SPECIES OF WADING BIRDS NESTING AT ROOKERIES IN STUDY AREA

around the Kissimmee Chain of Lakes, and because the species can use several different cover types for nesting, we consider nesting habitat not to be a limiting factor. Paul Gray concurs that suitable nesting habitat probably is abundant in the study area,particularly since nesting can occur as much as a mile from water. Also, the cover type data produced by FGFWFC are the principal basis of the models, and these data do not distinguish between tall grasses and grazed or mowed areas.

Based on the likely non-limiting nature of breeding habitat in the study area, we have limited the habitat suitability model to account only for feeding habitat. Florida ducks dabble in shallow waters. Similar to the wading bird models, we used a spreadsheet to determine the percent time the 0.5-foot depth contours were flooded with water up to 18 inches deep. A dabbling duck is considered to have a somewhat narrower preference for wetlands of slightly longer hydroperiod than the snowy egret or great egret, because the latter two species have broader diets and are more able to exploit recently flooded, shorter hydroperiod wetlands. Therefore, we selected those contours with 0-18 inch depths for 25% or more of the period of record as highest initial suitability. Elevations below the previously designated range of elevations and having appropriate water depth for 10-24.9% of the period were assigned moderate initial suitability. Areas within 90 meters of the marsh/open water edge and within the suitable depth zones were given twice the initial value, while the remainder of the suitable depth zones retained their initial values. The resulting values were "filtered" for the appropriate categories in the landcover layer: marsh or open water; any unsuitable landcover types were assigned no value. Finally, for elevations above the littoral zone, any open water, or semi-permanently flooded marsh larger than 2 acres, or undifferentiated marsh was given a relatively low suitability value.

4. Ring-necked duck

Experts consulted: Brian Toland, USFWS

The ring-necked duck *(Aythya collaris)* is the most abundant species of wintering waterfowl in both the upper and lower Kissimmee basins and is an important game species. The ring-necked duck arrives in late October and remains in the Kissimmee lakes region through the end of March (B. Toland, pers. comm.); it does not breed in Florida. During fall migration, ring-necked ducks begin arriving in Central Florida in October and remain in the Kissimmee Lake region into March. This species does not breed in Florida.

Ring-necks are classified as diving ducks and typically feed in waters less than 6 feet deep (Bellrose, 1980.) Traditionally in Florida, ring-necks use deep marsh habitats characterized by floating-leaved and aquatic-bed types of wetland vegetation. Seeds of fragrant water lily and watershield are considered preferred foods. In recent years, the distribution of ring-necked ducks appears to be determined primarily by the presence and abundance of "topped-out" hydrilla beds. The location of *Hydrilla* mats around the shorelines of the lakes varies considerably from year to year, and the natural fluctuation is compounded by active aquatic weed control efforts. (D. Eggeman, pers. comm.) Therefore, no particular segment of shoreline can be predicted to be of greater value for feeding of ring-necked ducks, except for the physical characteristics of slope. That is, a greater or lesser area of the appropriate depths for feeding of diving ducks will be found along the lake shore, depending on slope, and the alteration of lake levels may also slightly alter the area of suitable water depths.

The model for this species is greatly simplified because of the nature of migratory species to respond to year to year variations in the location of food resources. First, we extracted weekly average water levels for the observed period and the selected alternative during the October through March period the species is expected to be present. The spreadsheet calculates the percent time for each 0.5-foot bathymetric zone that water depth would be between 3 and 7 feet. High initial suitability was assigned to those bathymetric zones having suitable depth more than 50% of the period of record, while those zones with suitable depth between 25% and 49% of the time were ranked slightly lower in suitability. If grid cells in these bathymetric zones coincide with cells within 60 meters of the open water/marsh edge, they were assigned double their initial value. All open water cells retained these values, while all cells in the original landcover that were sensed as marsh were reduced by a fixed value.

5. <u>Florida snail kite</u>

<u>Experts consulted: Jim Rodgers, FGFWFC; Brian Toland, USFWS; Rob Bennetts, Univ. of Florida</u>

The Florida snail kite, or Everglades kite, (*Rostrhamus sociabilis plumbeus)* is listed as endangered by both the Federal and State governments. Once widespread through peninsular Florida, the species' range in the United States has been reduced to an area from just south of Orlando to the southern Everglades. Around 1964, the Florida snail kite population was estimated to be as low as 25 to 60 individuals. Although population estimates have consistently exceeded 400 birds since the 1980's, the 1964 estimate clearly indicates that the species is highly vulnerable.
Natural cycles in rainfall produce fluctuations in both mortality rates and reproductive success. The "boom or bust" fluctuations in the species' population levels are to some extent part of the natural history of a species with specialized habitat needs. However, human modification and manipulation of the natural hydrologic fluctuations could put the snail kite at risk of extinction if adverse actions were to occur coincidentally at several of the essential habitat sites, particularly during a prolonged period of drought.

The study area is located near the north-central limits of the species' range and is one of several essential areas for the survival and recovery of the species. The study area does not include Lake Tohopekaliga or East Lake Tohopekaliga, the two northernmost principal breeding areas for the kite. However, Lake Kissimmee (and to a lesser extent, the other lakes in the study area) is an essential nesting and feeding area for the species.

The kite feeds exclusively on apple snails *(Pomacea)*. The snails must be located at or near the water's surface, which requires the presence of some emergent vegetation. However, dense vegetation is not suitable as a feeding area, because the snail kite feeds by sight. Therefore, the kite requires a delicate balance between open water areas and emergent vegetation to feed effectively.

Snail kites exhibit a high level of nest failure and abandonment, and research on the species has been unable to determine all the causes of this phenomenon. However, water levels appear to account for at least a portion of the relative success or failure of breeding years. Obviously, extreme drought will result in a poor reproductive year. This is not only due to a reduction in food availability, but also to shifting of nest site selection in response to lower water levels. Even moderate year-to-year differences in water levels in Lake Okeechobee have been shown to affect nesting success (Rodgers, 1992). Several researchers have observed that kites will build more nests on herbaceous vegetation closer to the center of water bodies when water levels are low, and they will build more nests on woody vegetation closer to the periphery of the water body when water levels are higher. Dr. Rodgers has demonstrated a significant correlation between higher water levels, nesting in shrubs, and successful fledging of kites at Lake Okeechobee (ibid.). His observations at Lake Kissimmee suggest that the same correlation applies there. Presently, nearly all kite nests in Lake Kissimmee are in herbaceous vegetation. Nests built on herbaceous vegetation (usually cattails) are subject to being toppled over by wave action, by wind storms, or when water supporting the cattails recedes. When kites nest in woody vegetation, shrub swamps, primarily willow or wax myrtle, are the principal nesting sites; however, nests can occasionally be found in sapling cypress or even cabbage palms. Nests built in woody vegetation are much more secure and exhibit higher success. Although we cannot be certain that higher water levels in Lake Kissimmee during the February-March early nesting period would induce a higher percentage of kites to nest in woody vegetation, the evidence is compelling.

We have taken several approaches to determine the possible effect of this project on the snail kite. First, we needed to be assured that the proposed water regime did not increase the likelihood of abrupt declines in water level during the nesting season. Kites select nesting sites over water, and if the water completely dries out beneath the nest site, increased rates of nest collapse and/or predation generally occur. We used a spreadsheet to calculate when extreme drops in water level would occur in the kite nesting season. First, we extracted February through July weekly average water levels from the 17-year period of record (excluding 1977). Assuming initiation of nest construction over water

1.5 feet deep (a typical average), the water level should not drop more than 1.5 feet in the preceding 6-week period. Such an extreme drop is highly detrimental to kite nesting, and the spreadsheet confirmed that it occurs infrequently. Any abrupt human-induced removal of water of this magnitude could be considered an "incidental take" of snail kites as described in Section 7(b)(4) of the Endangered Species Act. In the observed period (excluding 1977) 94% of the weeks in the February-July period were suitable by this criterion. For the selected 400C150RR schedule, 96% of the weeks were suitable. Therefore, the normal operational schedule (excluding periodic extreme drawdowns for fishery habitat development) for the selected alternative should not pose any additional risk of "take", and possibly reduce its likelihood.

The second assessment we performed involved average water levels near the beginning of the nesting season. According to Dr. Rodgers' research, higher initial water levels in the February-March period in Lake Okeechobee lead to more successful nesting. His observations indicate that higher water levels at that time induce kites to nest at interior portions of the littoral zone, rather away from the disturbance of boat traffic and more likely in woody vegetation rather than herbaceous vegetation. We extracted February-March weekly average water levels and averaged them across the 17 years of record for the observed period and the selected alternative. The observed period (again excluding 1977) had an average water level of 50.57 feet, while the selected alternative had an average water level of 50.36 feet in that period. (Although the selected alternative raises water levels roughly 0.5 feet on an annual basis, that rise apparently does not occur during the February-March period when snail kites normally select net sites.) This 0.2-foot difference is quite small, and was found not to be statistically significant ($P=0.261$); the number of weekly average values compared was 138 weeks. Despite the lack of statistical significance, we proceeded to determine what a 0.2-foot difference would mean in the area of marsh and shrub marsh that would be theoretically available to the kites for nesting. We used the 0.1-foot interpolation of bathymetry produced by the SFWMD and the areas of documented kite nesting in the study area. This limited the area of interest to a narrow band, mostly around Lake Kissimmee, where nearly all of the kite nesting has occurred. The area of marsh below the February-March average water level for the present condition is 2850.8 acres, and for the future condition with the selected schedule, it would be 2809.9 acres. The area of shrub swamp is 1040.1 acres, and for the future with the selected alternative, it would be 1009.2 acres. If we assume that shrub swamp is twice as valuable as marsh for successful kite nesting, and compare the relative availability of nesting habitat, we find that the future with the proposed schedule would provide approximately 98% of the nesting habitat of the present condition. Although this change is, as expected, quite small, we reduced the values produced in the snail kite model by 2% to account for this potential change in nesting suitability. Despite this downward adjustment, the results of the overall habitat suitability model still indicate a significant increase for the proposed schedule (See later section of this report.)

The above analyses indicate that nesting suitability is not likely to change substantially. Therefore, the emphasis of the model used in this analysis was on foraging habitat suitability. We first identified bathymetric zones with suitable hydrology for production of apple snails. Apple snails need long hydroperiod wetlands; drying of occupied habitat will force kills the snails to aestivate, and extended drying may kill them. Therefore, we eliminated shorter hydroperiod wetlands as suitable habitat. Using daily water level readings from the 17-year period of record, we determined at what elevation inundation averaged 80% of the time period. The observed hydrology and the selected alternative were essentially equivalent, both rounding off to an elevation of 49 feet. This was designated in the present and all alternative futures as the upper end of suitability for kite foraging. To determine the lower end, we determined the percentage of time for inundation up to 2 feet deep, selecting those where this condition exceeded 25% of the period of record. We determined that for the observed values, the lower end of this zone occurred at 48 feet, while for the selected alternative, this occurred at 47.5 feet.

Similar to the Florida duck model (both these species prefer shallow waters with a mix of marsh and open water), we selected an area within 90 meters of the border of marsh and open water. Considering that the satellite image classifies an area as either open water or marsh, the kite's preferred 30%-40% open water/emergent vegetation mix is likely to occur in this edge zone. The initial suitability value for the bathymetric conditions described in the previous paragraph was doubled if the marsh/open water edge zone coincided at that grid cell, otherwise the initial value was retained. Next, we determined the interspersion marsh/open water in the original satellite image; those having high values indicated a predominance of marsh in a 5-cell window, and those having low values indicated a predominance of open water. By discarding the upper 25% and lower 25% of resulting values, we selected those areas with an interspersion of marsh and open water. Where these cells coincided with the previous suitability values, the values were doubled, otherwise the values were retained. Finally, where the resulting values coincided with known nesting areas the values were again doubled. As with the egret models, foraging habitat within a short distance of the nest is considered more valuable.

6. Bald eagle

Experts consulted: Steve Nesbitt, FGFWFC; Herb Kale, Florida Audubon Society

The bald eagle *(Haliaeetus leucocephalis)* is listed as endangered in Florida by both the Federal government, and as threatened by the State; the Service is currently considering "down-listing" the eagle from endangered to threatened in Florida and other portions of the species' range. Given that the number of nesting eagles has increased in Florida over the last few years, if the eagle is to be reclassified as threatened, Florida is a likely State for that designation. The banning of DDT in 1972 is thought to be a major factor in the partial recovery of the species, but this positive factor is countered by continued destruction of wetlands and Florida as a whole, and especially the study area, is a stronghold for the species, exhibiting the greatest concentration of breeding pairs in the United States, outside of Alaska. However listing as threatened would still provide protection under the Endangered Species Act, and eagles are also covered under the Bald Eagle Protection Act (16 U.S.C. 668-668d)

As of 1993, Osceola County had 81 active bald eagle nesting territories concentrated in the upper Kissimmee Chain of Lakes, with a cluster of active nests (OS25, OS26, OS27) on Brahma Island in Lake Kissimmee. Polk County had 80 active bald eagle territories in 1993, with most of them close to the Kissimmee Chain of Lakes. Figure 8 shows the location of active eagle nests (as of 1992) in the study area. Future land use patterns around the Kissimmee Chain of Lakes are crucial to the continued recovery of the species on a National scale. The breeding pairs of eagles in the study area may include some year-round resident birds, but the majority are migratory pairs that come to Florida to breed in the winter months.

The species model for the bald eagle selects habitat types within 2 miles of the active (as of 1992) bald eagle nests in the study area. Two miles encompasses the majority of foraging flights from a nest site (Bureau of Land Management, 1973). As with the wading bird rookeries, the eagles show fidelity to certain territories, but over the long term, nesting sites will change. The nests are generally located at some distance from the shorelines of the lakes in prominent pine trees or cypress trees. We do not anticipate that the change in water schedules will have a direct impact on selection of nest trees.

In the vicinity of the Kissimmee Chain of Lakes, fish comprise about 80% of the eagle's diet. Most of these are "rough fish" such as gizzard shad and catfish (Nesbitt, pers.comm.) A variety of other prey items, including small mammals and birds, comprise the remainder of the species' diet. Many of the birds taken by the eagle are "upland" birds, such as crows and cattle egrets. Although aquatic birds, particularly coots and gallinules, are occasionally taken as prey, we estimated that they would contribute no more than 10% of the diet. Therefore, we ranked open water, regardless of depth, as highest habitat value. Semi-permanently inundated marsh over 3 acres in size and undifferentiated marsh were assigned habitat value at one tenth the value of open water, and all other non-forested native cover types were assigned one twentieth the value of open water. Most foraging flights by bald eagles during the nesting season occur within 2 miles of the nest tree (BLM, 1973). We therefore selected the habitat types mentioned above within 2 miles of all active nesting trees in the study area, updated to 1992.

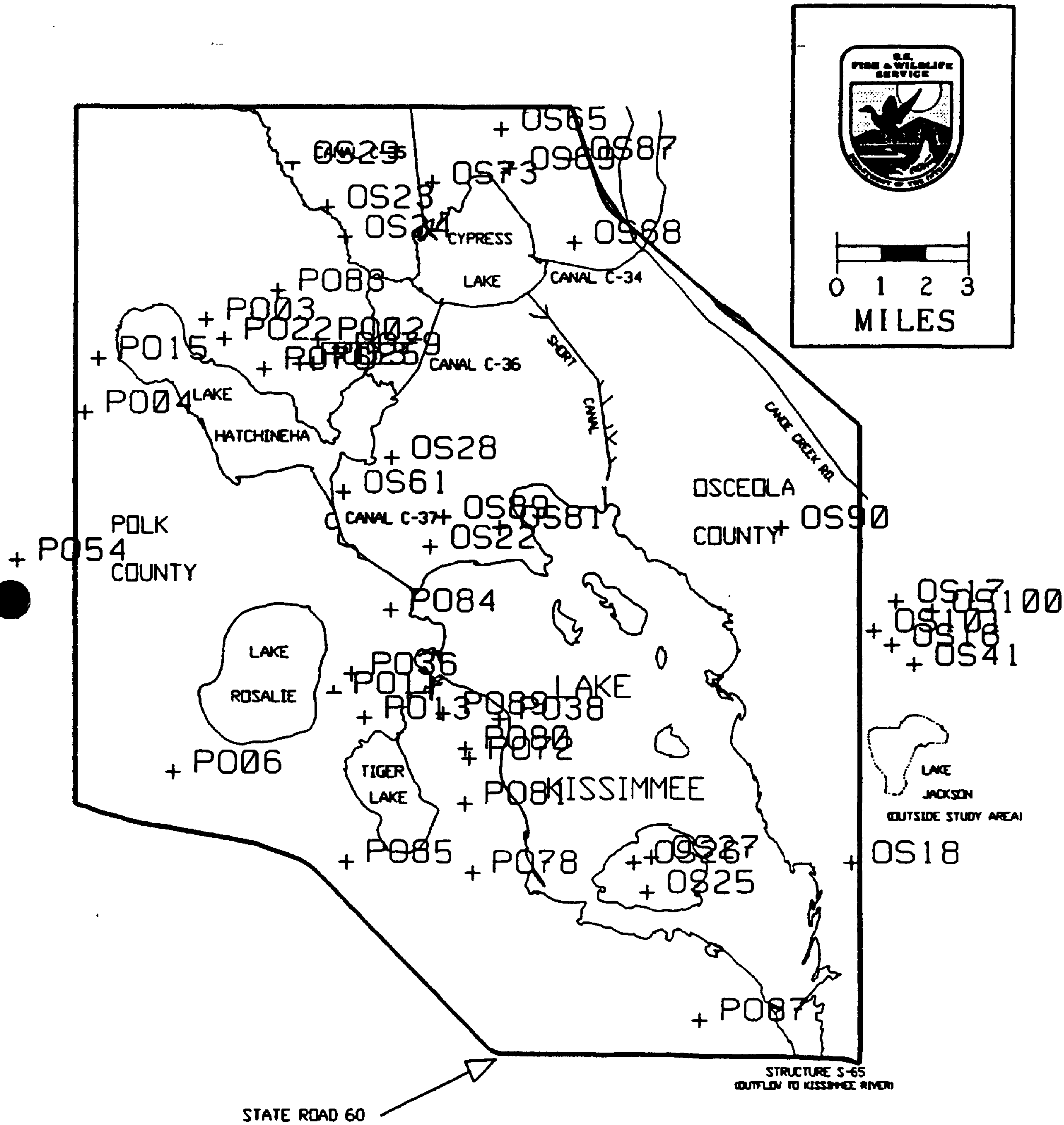

FIGURE 8 - LOCATION OF ACTIVE BALD EAGLE NESTS IN STUDY AREA

7. <u>Sandhill crane</u>

Expert consulted: Steve Nesbitt, FGFWFC

The sandhill crane *(Grus canadensis)* is represented in Florida by two subspecies, the non-migratory Florida sandhill crane *(G. canadensis pratensis)* and the greater sandhill crane *(G. c. tabida)*, which migrates to Florida in late fall through early winter. When both subspecies are present, it is difficult to distinguish between them by casual observation. The Florida subspecies is listed by the State of Florida as threatened; the Service has listed the Mississippi sandhill crane subspecies as endangered, but the Florida subspecies is not Federally-listed.

Sandhill cranes mainly use open grasslands and marshes as feeding areas. The species model assigns highest habitat values to grasslands. Marshes were assigned a range of moderate habitat values, and for those portions of marshes within a 2-cell distance of a border with grasslands, habitat values were increased by adding a constant value.

8. <u>Audubon's crested caracara</u>

Expert consulted: James Layne, Archbold Biological Station

Audubon's crested caracara *(Polyborus plancus audubonii)* is listed by the State and Federal governments as threatened. Layne (1985), based on 1973-1978 surveys, found about 150 active territories (300 adults) and about 100 immature birds, for an estimated total population between 400 and 500 individuals in Florida. Layne (pers. com.) finds that the total population and range of the Florida population has remained stable since the 1980's.

The Florida population is restricted to open grassland and palmetto north and west of Lake Okeechobee. It is geographically isolated from other populations of the subspecies, which are found in northern Baja California, southwestern Arizona, southern Texas south to Panama, and also in Cuba and the Isle of Pines.

The caracara is an opportunistic feeder on both living prey and carrion, combining characteristics of predatory raptors and vultures. The caracara competes with the latter for carrion.

The study area is roughly the northern limit of the Florida population's documented range, as it is rarely observed north of Orlando. Within the study area, the Three Lakes Wildlife Management Area, located near the southeastern corner of Lake Kissimmee, is highly valuable habitat, but all suitable habitat types in the study area are considered in the model.

Native grasslands, the preferred habitat for the caracara, are extremely scarce in Florida. Most of this habitat has been converted to improved pasture, sod farms, citrus groves, or commercial/residential areas. Although caracaras can use improved pasture for feeding, it is suboptimal habitat. Continued operation of large ranches in the Kissimmee prairie, particularly those ranches with large tracts of native rangeland is critical to the continued survival of the caracara. Other land uses, such as housing or groves will not support caracaras in the long term. Fire is used as a management tool on larger tracts of native rangelands. Lack of fire in remnant native prairies on smaller private lands may be adversely affecting caracara habitat. Native grasslands and saw palmetto thickets in dry prairies are fire-maintained communities. Caracaras will use areas with widely separated trees, but if they succeed to denser stands of pine, oak, or cabbage palm, they become less suitable.

The model assigns highest suitability to dry prairie, and slightly less suitability to grasslands. Marshes were assigned values below the grassland, with less permanently flooded areas superior to longer hydroperiod marshes, both in the littoral zone and in the prairie.

Finally, the model uses known caracara territories digitized from maps provided by Dr. Layne. These maps display the estimated extent of caracara territories in the study area for the period 1984-1988. These are the most recent data providing the borders of the territories; surveys in 1989 show only the estimated centers of territories. Because caracaras are known to have restricted ranges, the presence of habitat in recently occupied territories was heavily weighted in the model. Suitable habitat within documented territories was assigned triple the initial value, while the remaining potential habitat in the study area retained its original habitat value.

9. Largemouth bass

Expert consulted: Ed Moyer, FGFWFC

The largemouth bass *(Micropterus salmoides)* is a common species in Florida's natural lakes and in quarry lakes and other borrow areas. Its original distribution was in the southeastern United States, but it has been widely introduced throughout the United States. A Florida subspecies is recognized as *M. salmoides floridanus* (Ramsey, 1975). It is economically very important in Florida's freshwater sport fishery.

The population dynamics of the largemouth bass in the Kissimmee Chain of Lakes most likely depend on a complex combination of physical and biological factors. It is virtually impossible to derive a complete species model for the bass within the timeframe of this study, and water level fluctuations, the main variable in the evaluation of this project, would comprise only one portion of a complete model.

Layher and Maughan (1987) attempted to predict occurrence and standing crop of green sunfish in Kansas streams, based on physical aspects of the habitat and water chemistry, but found their models were not reliable predictors. They were able to better predict occurrence and standing crop of several fish species having more restrictive habitat requirements, and they postulated that the green sunfish models failed because of the difficulty in determining limiting variables for a species with broad tolerance for a variety of habitat conditions. The largemouth bass also has very broad habitat tolerance that makes predictive modeling difficult; complex predator/prey interactions may be more significant, but harder to discern, than physical habitat parameters.

Stuber et al. (1982) published an HSI model for largemouth bass in lakes that included 4 life requisites, described by combinations of 17 variables. The data collection requirements for this model are considerable; and even so, the authors conclude that, "these models will not necessarily represent the population of largemouth bass in the study area." They suggest that the models be used to compare the potential of different water bodies to support largemouth bass. In the present evaluation, the Chain of Lakes is assumed to be a single flat pool, which is close to reality.

Baca et al. (1992) studied 11 Dade County quarry lakes for largemouth bass populations and calculated an array of HSI values. However, they did not provide conclusions as to which of the variables best correlated with the quality of these lakes as bass habitat.

We have decided to use the HSI model by Stuber et al. as a basis for our analysis in terms of the relative contribution of variables to the model as a whole; however specific measures were altered to better fit Florida lakes. Because a wide range of physical attributes (e.g. turbidity, water temperature, dissolved oxygen) are expected to be unaffected by the project, we have used only those variables that would be affected, and have assigned them a relative weight in accordance with their contribution to the outcome of the published model. For example, the percentage of the lake's area less than or equal to 6 meters deep is used as a variable two times out of a total of 14 variables. However, virtually all the area of water in the study area is less than 6 meters deep. Most of the spawning of largemouth bass in these lakes occurs between 3 and 6 feet deep (Moyer, pers. comm.) Therefore, we assigned highest suitability to this depth range, using the present water schedule and the proposed. We selected the 0.5-foot bathymetric zones where water is 3-6 feet deep more than 50% of period of record. Slightly lower suitability was assigned to higher bathymetric contours, up to a maximum where water 0-1 ft deep is present more than 20% of the time. Still lower suitability was assigned to the deeper portions of the lake where water over 6 feet deep is present more than 50% of the time. The model then selected cells of open water within 60 meters of the marsh/open water edge; a constant value was added to the base value for those cells.

Water fluctuation appears in three of 14 variables in the Stuber et al. model. However, it appears that much of the interest in water fluctuation in the model deals with avoiding abrupt declines in more northerly steep-sided reservoirs. This is not a concern in the study area, where vast areas of shallow water are available, and flood control operations normally do not drop lake levels so quickly as to threaten spawning throughout the lake (Moyer, pers. comm.) As stated in our general analysis of the water schedules, greater fluctuation is considered to be an improvement over the current situation. We used the coefficient of variation of the current and proposed schedules, compared to the historic as an indication of lake dynamics.

The anticipated changes in the depth zone and water variability parameters discussed above were multiplied by a factor reflecting the contribution of these variables to the model as a whole. This was done to account for the fact that most of the physical factors in the model would not be altered directly by the schedule change. For the depth zone, this factor was 2/14, or 0.143; for the overall variability in lake levels, this factor was 3/14, or 0.214.

VIII. DESCRIPTION OF FISH AND WILDLIFE RESOURCES

A. Existing

The littoral zones of the lakes are the focus of this study and are among the significant resources in the Kissimmee River Basin. The distribution of plants is intricate and is a result of history of inundation, fire, grazing, nutrient input and soils. Flooding stage and duration is the dominant influence on composition.

The fluctuating waters portion of the littoral zone is important for overwintering waterfowl, which stop at these lakes during southward migrations. Coot, ring-necked duck, baldpate, pintails and blue-winged teal are the principal species. The native Florida or mottled duck also feeds in the shoreline marshes and breeds in the prairie within the study area. The common snipe is also present in these areas in the fall and winter months.

The littoral zone supports a wide variety of wading birds, including common and snowy egrets, great blue heron, tricolor heron, little blue heron, limpkin, and others. White and glossy ibis also feed here. These species are dependent on forage fishes produced in the littoral zone.

The largest consumptive use is the fishery. Based on creel data collected by the FGFWFC, effort expended fishing Lake Kissimmee over a five-year period (1987-1991) averaged 451,582 hours per year (Moyer et al., 1992).

The only creel survey in Lakes Hatchineha and Cypress was conducted in the spring of 1986. The total fisherman effort was 40,832 hours at Hatchineha and 18,007 hours at Cypress Lake (Moyer et al., 1986). As a comparison, fishermen in Lake Kissimmee fished for 213,921 hours during this same spring quarter (February 21, to May 15, 1986). Lakes Rosalie and Tiger are also popular with fishermen, but no creel census has been conducted on these waters.

The principal species sought by anglers on Lake Kissimmee is the largemouth bass. Bass anglers exerted 59% of the total fishing effort over five years (1987-1991). For the same period, black crappie and bream fishermen comprised 24% and 17% of the recreational effort, respectively. Miscellaneous species, such as channel catfish, brown bullhead, spotted sunfish and chain pickerel were also targeted at times. (Moyer et al., 1992).

Similar to Lake Kissimmee, fishermen in Lakes Hatchineha and Cypress spend most of their time fishing for bass, followed by crappie and various bream species (Moyer et al., 1986). However most fishing on Lake Tiger and Lake Rosalie is open water fishing for black crappie and bream.

Kingfisher Maps, Inc. has published a map of recreational areas and marinas with boating facilities (map entitled "Kissimmee Chain South"); they list 17 facilities within the study area. Hunting, fishing, airboating, and wildlife observation provide a significant proportion of the economy in this area.

The alligator is a dominant reptile in the region. The alligator scavenges for carcasses of birds and hunts for fish in the deep water canals and ponds within the marsh zone.

B. Future Without the Project

In the absence of the proposed project, we do not anticipate major changes in the fish and wildlife values for either the Kissimmee River or the Kissimmee Chain of Lakes. We assume the Corps will continue maintenance and operation of the navigational and flood control works. We also expect that the SFWMD and the Department of Environmental Protection (DEP) will continue programs for aquatic weed control.

The Corps and the SFWMD have confirmed with their model runs that the restoration goals for the Kissimmee River would not be adequately achieved under the present regulation schedule for the Chain of Lakes. The Kissimmee River would provide the limited fish and wildlife productivity as it does today without the restoration project. Compared to historic conditions, a great percentage of habitat values would remain lost.

In the upper basin, we believe the future would be similar to the recent past (1970's - 1990's). With or without the change in water schedules, extreme drawdowns will need to be scheduled to counteract the effects of narrow lake regulation and nutrient inflows.

Although urbanization is rapidly spreading southward from the upper end of the Chain of Lakes, near the towns of Kissimmee, St. Cloud, and the Greater Orlando Metropolitan Area, these activities are generally to the north of the study area. The infrastructure in the study area is not capable of supporting intensive residential or industrial development, and most likely will remain as such for several decades. We anticipate the dominant economic activities in the study area -- cattle ranches, sod farms, other agricultural enterprises, and recreation will continue to predominate in the study area.

IX. DESCRIPTION OF SELECTED PLAN

The selected 400C150RR schedule has been selected as the best available balance of benefits to restoration of the Kissimmee River and increased vitality of the aquatic ecosystem in the Chain of Lakes. The selected schedule differs from the present in that it has a maximum water elevation for flood control purposes of 54 feet, rather than 52.5 feet. It also delivers water to the Kissimmee River more on the basis of availability, rather than a fixed target elevation.

Current estimates by the SFWMD indicate that approximately 18,500 acres need to be purchased around the lakes to allow raising of water levels for this project, and about 4,750 acres had been purchased through 1991. The Service is recommending in this report that additional areas be purchased behind three levees surrounding the lakes. For purposes of this study, the Corps has asked that the Service consider that fee title or easements will be obtained on all lands to be reflooded.

The Corps' original estimation called for widening C-35 from a bottom width of 20 feet to 40 feet; C-36 from 60 feet to 80 feet; and C-37 from 90 feet to 160 feet. Since that time, the Corps has recommended doubling the present discharge capacity of water control structure S-65 (the outlet for Lake Kissimmee). As of this date, the Corps has now revised its canal widening plans to the following:

- Maintenance dredging of C-35; no widening
- Widening of C-36 from a present bottom width of 48 feet to a bottom width of 60 feet
- Widening of C-37 from a present bottom width of 70 feet to a bottom width of 90 feet

X. DESCRIPTION OF IMPACTS

The selected 400C150RR water regulation schedule more closely approximates a rain-driven formula, by varying discharges in accordance with water availability in the Chain of Lakes and seasonal rules more in accordance with the normal wet/season dry season rainfall pattern of Central and South Florida. This provides distribution of flows to the Kissimmee River closer to the seasonal patterns in the historic condition, while also providing greater fluctuation in the Kissimmee Chain of Lakes.

The increased storage capacity of the selected alternative relative to the present regulation will expand littoral zones around the lakes. The methodology to determine the anticipated increase in marshes at the upper end of the littoral zone is described in Section VII.C. of this report. Section XI.B. provides the results of our analysis.

The estimated increase in littoral marshes, in turn, causes changes in habitat suitability for the evaluation species. Section VII.D. of this report provides general information and a narrative of the model structure for each species. The results of our analysis are found in Section XI.C. of this report.

The Corps has stated that all spoil material will be disposed within the existing right-of-way. However, some native habitat, particularly wetlands are present within the right-of-way. We expect the Corps to make every effort to accommodate the spoil not only within the right-of-way, but also on existing spoil piles. If some filling of wetlands is determined to be unavoidable in the detailed design phase of this project, the Service recommends that the Corps identify appropriate compensation for any unavoidable losses of wetlands.

Table 2 indicates the potential impact of widening the canals if spoil material cannot be completely disposed on existing spoil mounds. The analysis assumes that fill would be disposed 30 meters (98 feet) beyond the existing toe of fill along the entire east side of C-36, and that fill would extend 60 meters (197 feet) beyond its present extent along the entire east side of C-37. These figures should be considered as the likely maximum possible impact of this construction; we recommend the Corps make every effort to dispose the spoil on existing spoil mounds.

XI. EVALUATION AND COMPARISON OF THE SELECTED PLAN AND EVALUATED ALTERNATIVES

A. Results of Community-level Evaluation

Table 3 summarizes the results of the community-level analysis described in Section VII.B.2. of this report. After the initial screening of alternatives, the study team narrowed the selection to two final alternatives, and this quantitative comparison was used to select between these. The table is divided into two areas; the top area compares the last two alternatives for which routing models were run by the Corps. The bottom area provides a comparative framework, relative to the historic (pre-project, 1939-1942 & 1945-1958) condition and the recent regulated condition (observed, 1970-1988). In a previous section of this report, we stated that comparison of the modelled alternatives with the observed condition may not be appropriate, because none of the models contained an extreme drawdown, which would deviate from the normal operational rules. Therefore, we have provided both the observed period of record and the period of record without the 1977 drawdown as bases of comparison. The agencies have agreed in principal that a periodic drawdown will be superimposed on the normal operational rules for the selected alternative.

The historic condition exhibits the most desirable values for 5 of the 7 criteria. The average number of days duration with greater than 90% floodplain inundation in the wet season is slightly higher for the 400C150RR alternative than for the historic, but this difference is not statistically significant (P=0.95). The 400C150RR alternative also exhibits shorter durations, on average, of low flow conditions in the wet season than the historic. Both of the modelled alternatives appear to improve on the recent (1970-1988) regulated condition of the lakes. The 400C150RR alternative rated slightly more desirable than the T1000HISRR alternative for 5 of the 7 criteria. Despite the selected 400C150RR alternatives' slightly shorter duration of water levels above 52.5 feet, it still produces a higher overall score than the T100HISRR alternative. The duration of water levels over 52.5 feet was assigned the highest weighting; however the 400C150RR alternative exhibited duration of routine drawdowns (water levels < 49 ft.) approaching those of the historic condition and greater overall variability, which resulted in its overall higher ranking.

TABLE 2 – MAXIMUM POTENTIAL EFFECT ON HABITATS FROM WIDENING C-36 (BETWEEN CYPRESS LAKE AND LAKE HATCHINEHA) AND C-37 (BETWEEN LAKE HATCHINEHA AND LAKE KISSIMMEE) – (WORST CASE SCENARIO; ACTUAL IMPACT COULD BE MUCH LESS)

LAND COVER CLASSIFICATION	ACRES AFFECTED BY C-36 WIDENING	ACRES AFFECTED BY C-37 WIDENING
GRASSLAND	8.0	17.5
SHRUB & BRUSH LAND	0.4	7.5
BARREN	0.0	2.2
TOTAL NON-NATIVE	8.4	27.2
MARSH / WET PRAIRIE	13.3	38.8
SHRUB SWAMP	2.0	21.9
CYPRESS SWAMP	0.2	4.9
HARDWOOD SWAMP	0.0	2.0
BAY SWAMP	0.9	0.4
TOTAL WETLANDS	16.4	68.0
MIXED HARDWOOD/PINE	0.0	4.4
HARDWOOD FOREST	0.0	2.0
PINELANDS	0.7	2.4
DRY PRAIRIE	1.6	1.1
OAK SCRUB	0.4	0.7
TOTAL NATIVE UPLANDS	2.7	10.6

Note: For C-36, analysis assumes spoil material would be deposited 30 meters beyond existing toe of spoil mounds along entire canal length.

For C-37, analysis assumes spoil would be deposited 60 meters beyond toe of existing spoil mounds.

TABLE 3 -- RANKING OF THE FINAL TWO WATER SCHEDULE ALTERNATIVES

		CRITERIA						
TOTAL SCORE	ALTERNATIVE	CRIT. 1	CRIT. 2	CRIT. 3	CRIT. 4	CRIT. 5	CRIT. 6	CRIT. 7
4.66	400C150RR	23.3	85.3	2.60	77.3	38.2	102.9	90.4
4.11	T1000HISRR	24.9	63.1	2.57	70.8	52.5	80.7	71.9

COMPARABLE VALUES FOR HISTORIC AND 1970-1988 OBSERVED

		CRITERIA						
TOTAL SCORE	PERIOD OF RECORD	CRIT. 1	CRIT. 2	CRIT. 3	CRIT. 4	CRIT. 5	CRIT. 6	CRIT. 7
7.07	Historic (1939-42; 1945-58)	64.3	87.5	4.35	76.5	50.3	114.9	4.0
2.90	Observed (1970-88)	4.9	38.7	3.08	31.0	56.4	50.3	41.4
2.56	Observed, w/o '77 drawdown	4.9	29.6	2.41	30.9	53.1	49.9	38.0

NOTE: REFER TO TEXT FOR EXPLANATION OF CRITERIA AND THE CALCULATION OF THE TOTAL SCORE

CRITERION 1 = Average duration (days) water levels exceed 52.5 ft. (Positively correlated, with weighting factor = 2)

CRITERION 2 = Average duration (days) water levels below 49 ft. (Positively correlated, with weighting factor = 1)

CRITERION 3 = Coefficient of variation of water levels over 18-year period. (Positively correlated, with weighting factor = 2)

CRITERION 4 = Average duration (days) with greater than 90% floodplain inundation in the wet season (June 1 - Oct. 31). (Positively correlated, with weighting factor = 1)

CRITERION 5 = Average duration (days) with less than 200 cfs flow at S-65, in the wet season. (Inversely correlated, with weighting factor = 1)

CRITERION 6 = Average duration (days) with greater than 25% floodplain inundation, Jan. 1 - May 31. (Positively correlated, with weighting factor = 0.5)

CRITERION 7 = Average duation (days) with less than 200 cfs flow at S-65, Jan. 1 - May 31. (Inversely correlated, with weighting factor = 0.5)

Based on the Service's presentation of these figures to the Corps and SFWMD at an interagency review conference in Jacksonville on January 24, 1994, the agencies concurred that the 400C150RR alternative is preferred and that species models would be run using this alternative.

B. Prediction of Future Wetland Conditions

Table 4 and Figure 9 summarize the results of the analysis to predict the extent and location of additional wetlands to be generated by various alternative futures. In viewing Figure 9, one should be aware that all of the additional wetlands landward of the levees can be realized only if these areas are added to the SFWMD's acquisition plan and the levees are breached.

TABLE 4 – ESTIMATION OF WETLANDS TO BE RESTORED BY RAISING HIGH WATER LEVELS, KISSIMMEE HEADWATER LAKES

DESCRIPTION OF ALTERNATIVE FUTURES	ADDITIONAL WETLANDS TO BE PRODUCED (ACRES)	
	LIKELY HIGHER QUALITY WETLANDS	LIKELY MODERATE QUALITY WETLANDS
Future with project, but without breaching of levees	3827	2112
Additional increment by breaching Hatchineha levee	1001	27
Additional increment by breaching Cypress levee	146	20
Additional increment by breaching Kissimmee levee	45	58
Basic project and all 3 levees breached (sum of above acreages)	5019	2217

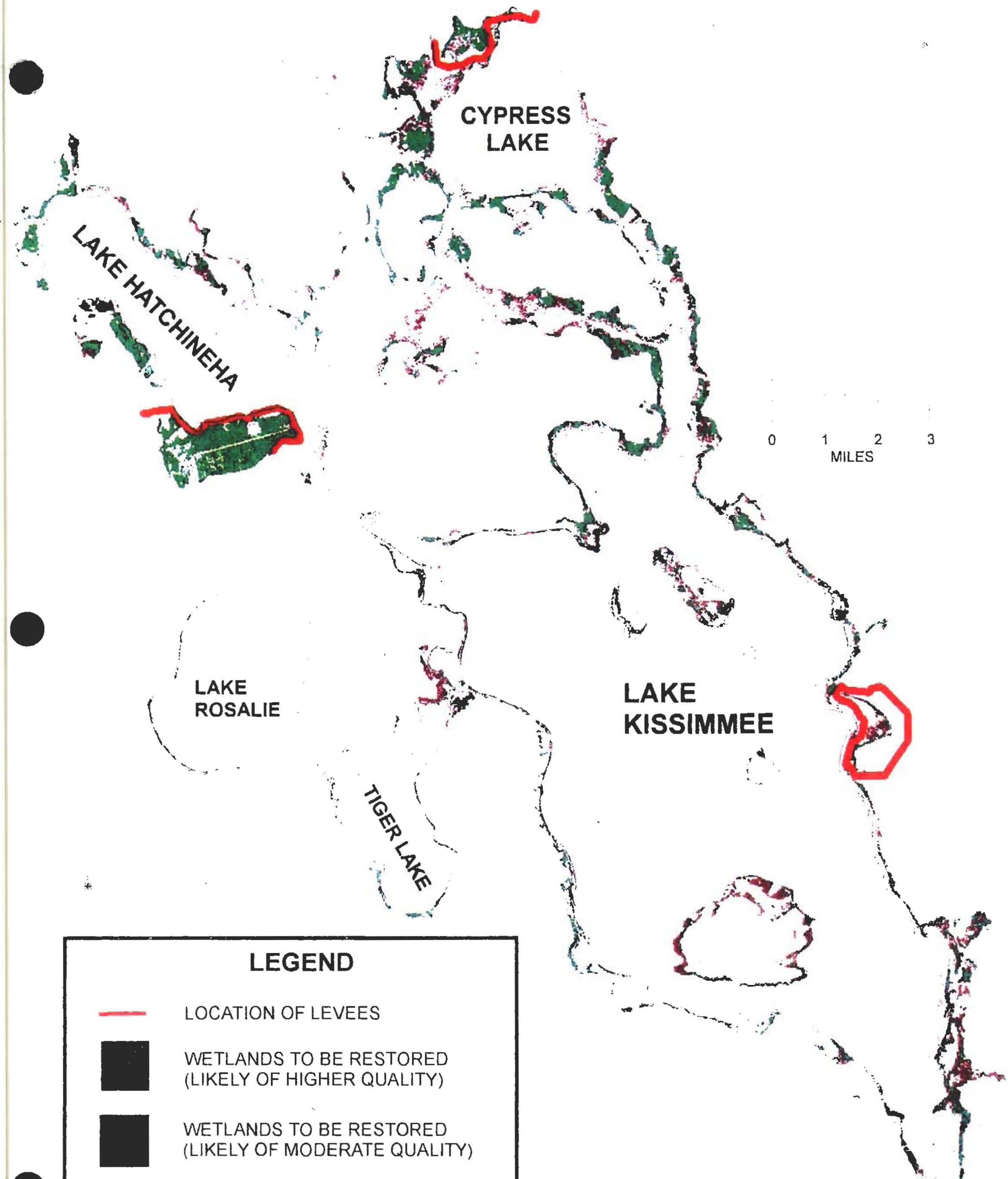

FIGURE 9 - ESTIMATION OF WETLANDS TO BE RESTORED BY HIGHER WATER LEVELS KISSIMMEE HEADWATER LAKES, IF ALL THREE LEVEES ARE BREACHED.

Of the possible total of 2217 acres of moderate quality wetlands that could be produced if all three levees are breached, 1616 acres would be generated in what is now classified as dry prairie, 369 acres in pineland, and 231 acres in barren areas. Of the possible total of 5019 acres of higher quality wetlands to be restored, 3663 acres would be converted from present-day grasslands and 1356 acres from shrub/brushland.

If all three levees are breached, the full potential of 7,236 acres of restored wetlands would be realized.

Breaching the levee south of Lake Hatchineha would produce the greatest benefits of the three additional increments, providing a 17% increase over the basic project in all possibly restorable areas, and more importantly, a 26% increase over the basic project in the acreage of the most readily restorable cover types. Breaching the levee north of Cypress Lake and the levee on the eastern shore of Lake Kissimmee (south of Overstreet Landing) would provide significant additional acres of wetland restoration, but not as great a percentage increase over the basic project as would the Hatchineha levee increment.

C. Results of Species Models

Tables 5 and 6 summarize the results of the species models; the first table expresses the values in terms of habitat units, while the second table expresses the percent change of each future scenario versus the future without the project (assumed to be equivalent to the present).

Six of the 10 species exhibit significant increases in habitat availability; these are the Florida duck, ring-necked duck, great egret, snowy egret, and wood stork. The predicted 2% increase in suitability for the largemouth bass may not be significant, particularly since we assumed that water quality parameters would remain constant with or without the project. Also, a periodic extreme drawdown has such a great beneficial effect for bass (compared to the relatively small differences between the normal operational rules), it would overwhelm any small changes in routine operation. The project is not predicted to have a significant effect on the caracara, bald eagle, and sandhill crane.

Habitat unit values should not be interpreted to reflect abundance of a species, and a given percent increase in habitat units does not imply prediction of a proportional increase in population. Increases in availability of habitat will most likely translate to increases in population, but the degree of effect on relative abundance will vary greatly from species to species. Low habitat unit totals can be the result of a species' narrow selectivity for certain habitat conditions and/or the relative abundance of its preferred habitat type(s) in the study area. For example, the relatively low habitat unit values for

TABLE 5 -- HABITAT UNITS (ACRES X HSI) FOR FUTURE WITHOUT PROJECT AND ALTERNATIVE FUTURES

SPECIES	FUTURE WITHOUT PROJECT	ALT. FUTURE 1 (PROP. SCHEDULE)	ALT. FUTURE 2 (HATCH. LEVEE)	ALT. FUTURE 3 (CYP. LEVEE)	ALT. FUTURE 4 (KISS. LEVEE)	ALT. FUTURE 5 (FULL RESTORATION)
Florida duck	6755	8792	9090	8809	8804	9119
Ring-necked duck	11516	15015	15015	15015	15015	15015
Snail kite	659	839	839	839	839	839
Great egret	17619	20810	21356	20880	20895	21509
Snowy egret	13943	15878	16387	15948	15922	16501
Wood stork	16491	18172	18273	18217	18206	18353
Largemouth bass	38174	38937	38937	38937	38937	38937
Bald eagle	31827	32031	32088	32039	32036	32102
Sandhill crane	63452	63505	63230	63472	63515	63208
Crested caracara	41486	41652	41618	41655	41649	41618
ALL SPECIES	241923	255630	256832	255811	255818	257201

Notes:
Alt. Future 1 = Adoption of proposed water regulation schedule only.
Alt. Future 2 = New water schedule, with breaching of levee south of Lake Hatchineha.
Alt Future 3 = New water schedule, with breaching of levee north of Cypress Lake.
Alt. Future 4. = New water schedule, with breaching of levee east of Lake Kissimmee.
Alt. Future 5. = New water schedule, with breaching of all three levees.

TABLE 6 -- PREDICTED CHANGES IN AVAILABILITY OF SUITABLE HABITAT FOR THE ALTERNATIVE FUTURES

(Expressed as percent increase or decrease, relative to future without project condition, throughout study area.)

SPECIES	ALT. FUTURE 1 (PROP. SCHED.)	ALT. FUTURE 2 (HATCH. LEVEE)	ALT. FUTURE 3 (CYP. LEVEE)	ALT. FUTURE 4 (KISS. LEVEE)	ALT. FUTURE 5 (FULL RESTORATION)
Florida duck	30.2	34.6	30.4	30.3	35.0
Ring-necked duck	30.4	30.4	30.4	30.4	30.4
Snail kite	27.3	27.3	27.3	27.3	27.3
Great egret	18.1	21.2	18.5	18.6	22.1
Snowy egret	13.9	17.5	14.4	14.2	18.3
Wood stork	10.2	10.8	10.5	10.4	11.3
Largemouth bass	2.0	2.0	2.0	2.0	2.0
Bald eagle	0.6	0.8	0.7	0.7	0.9
Sandhill crane	0.1	-0.4	0.0	0.1	-0.4
Crested caracara	0.4	0.3	0.4	0.4	0.3
ALL SPECIES	5.7	6.2	5.7	5.7	6.3

Notes:

Alt. Future 1 = Adoption of proposed water regulation schedule only.

Alt. Future 2 = New water schedule, with breaching of levee south of Lake Hatchineha.

Alt Future 3 = New water schedule, with breaching of levee north of Cypress Lake.

Alt. Future 4. = New water schedule, with breaching of levee east of Lake Kissimmee.

Alt. Future 5. = New water schedule, with breaching of all three levees.

the snail kite and the Florida duck reflect these species' foraging preferences in a narrow band of marsh/open water fringe around the lakes with suitable hydroperiod and water depth. However, because the effects of the project are restricted to the littoral zone, both species show a relatively high percentage increase in habitat availability in the future with project scenarios. The high habitat unit totals for the caracara are the result of large areas of grasslands and moderate amount of dry prairie in the areas above the littoral zone. However, because only the upper end (short hydroperiod) of the littoral zone was scored as moderate habitat suitability for this species, the project has a relatively minor effect on habitat availability in the entire study area. The caracara is a relatively uncommon bird, so this well illustrates that it is incorrect to interpret the habitat unit values as a measure of abundance.

Figures 10 through 14 illustrate examples of the geographic distribution of habitat suitability and predicted change in habitat suitability. We have selected the great egret and the snail kite for these illustrations because other species that exhibit change in habitat suitability as a result of the project show similar patterns.

Figure 10 shows the habitat suitability for the great egret for the basic restoration plan (adoption of the proposed regulation schedule, but without breaching the three levees around the lakes). Note that although the highest habitat values are in the littoral zone, the great egret can use a wide range of wetland habitats both in the littoral zone and in the prairie wetlands that are elevated above the normal water fluctuation in the lakes. As stated previously in the description of the methodology, this provides an estimation of the relative importance of the water regulation changes in the context of the surrounding landscape.

Figure 11 shows the changes in great egret habitat suitability for the basic restoration project, expressed as percent change relative to the future without the project. Notice that although some areas show moderate declines in suitability, larger areas show either moderate or great increases in habitat suitability. The largest percentage increases generally occur along the eastern shoreline of Lake Kissimmee, around Brahma Island, and near Sturm Island. Moderate increases occur over much larger areas in the area between the three major lakes and around Lake Hatchineha. The net gain in habitat units for the great egret with the basic restoration plan is about 18% over the future without the project.

Figure 12 shows the predicted changes in great egret habitat suitability relative to the future without the project, if all three levees around the lakes are breached. The arrows point to the areas behind the levees where additional habitat will be generated, relative to the basic restoration plan (without breaching the levees).

The output for the snowy egret and wood stork vary in their details, but the same general pattern holds for those species as for the great egret.

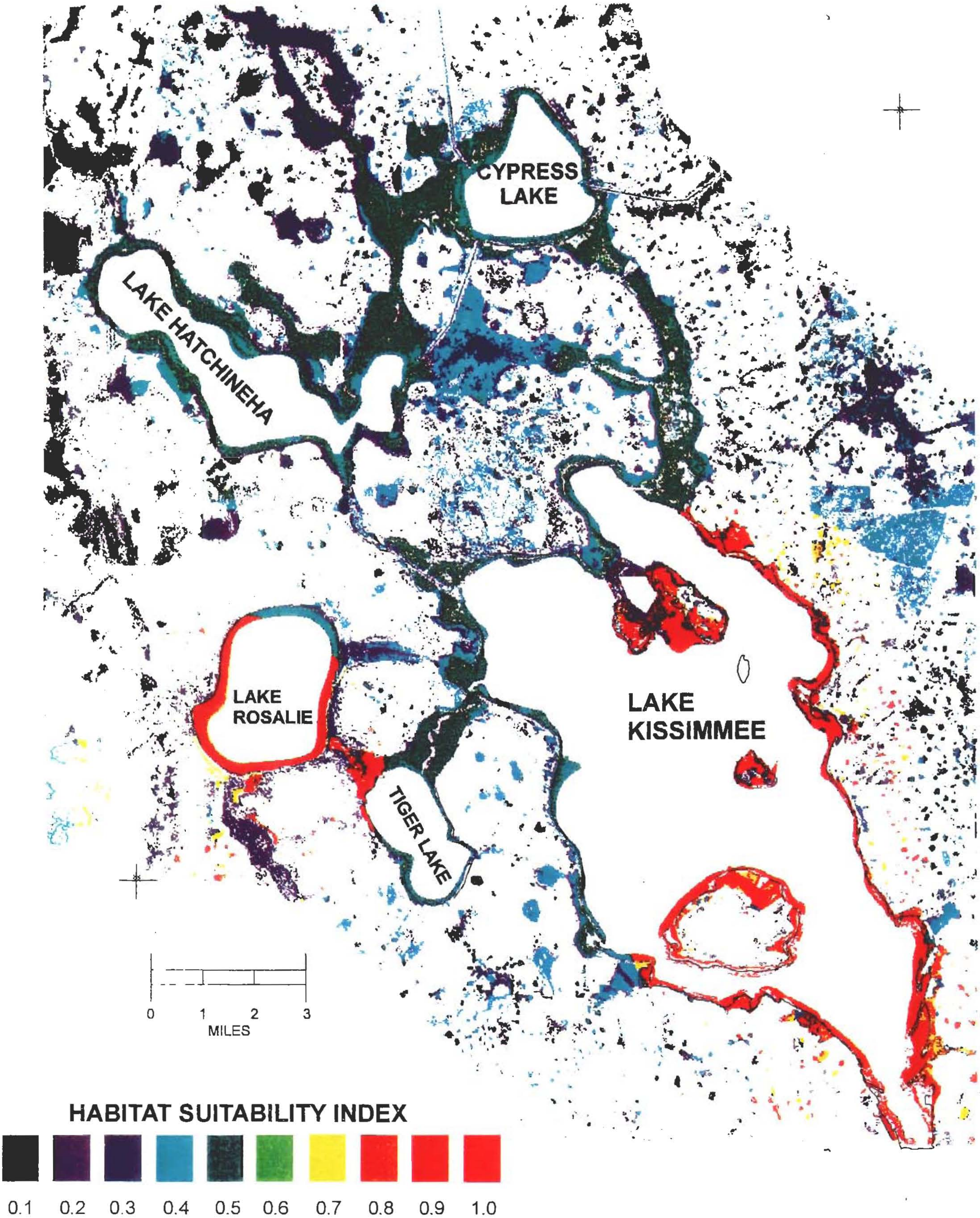

FIGURE 10 - GREAT EGRET HABITAT SUITABILITY, FUTURE WITH BASIC RESTORATION PLAN (No breaching of levees)

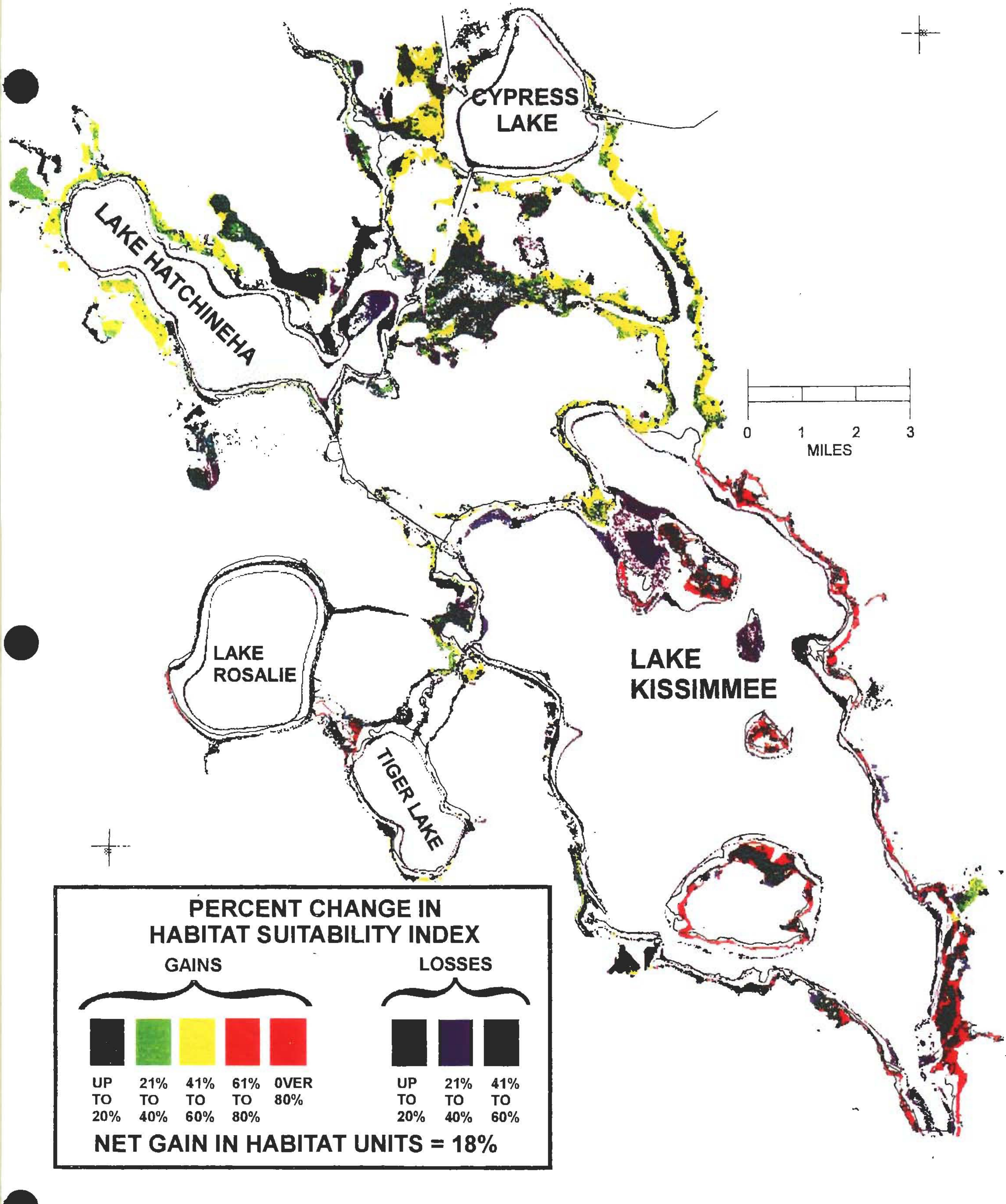

FIGURE 11 - CHANGES IN GREAT EGRET HABITAT SUITABILITY, FUTURE WITH BASIC PROJECT RELATIVE TO FUTURE WITHOUT PROJECT.

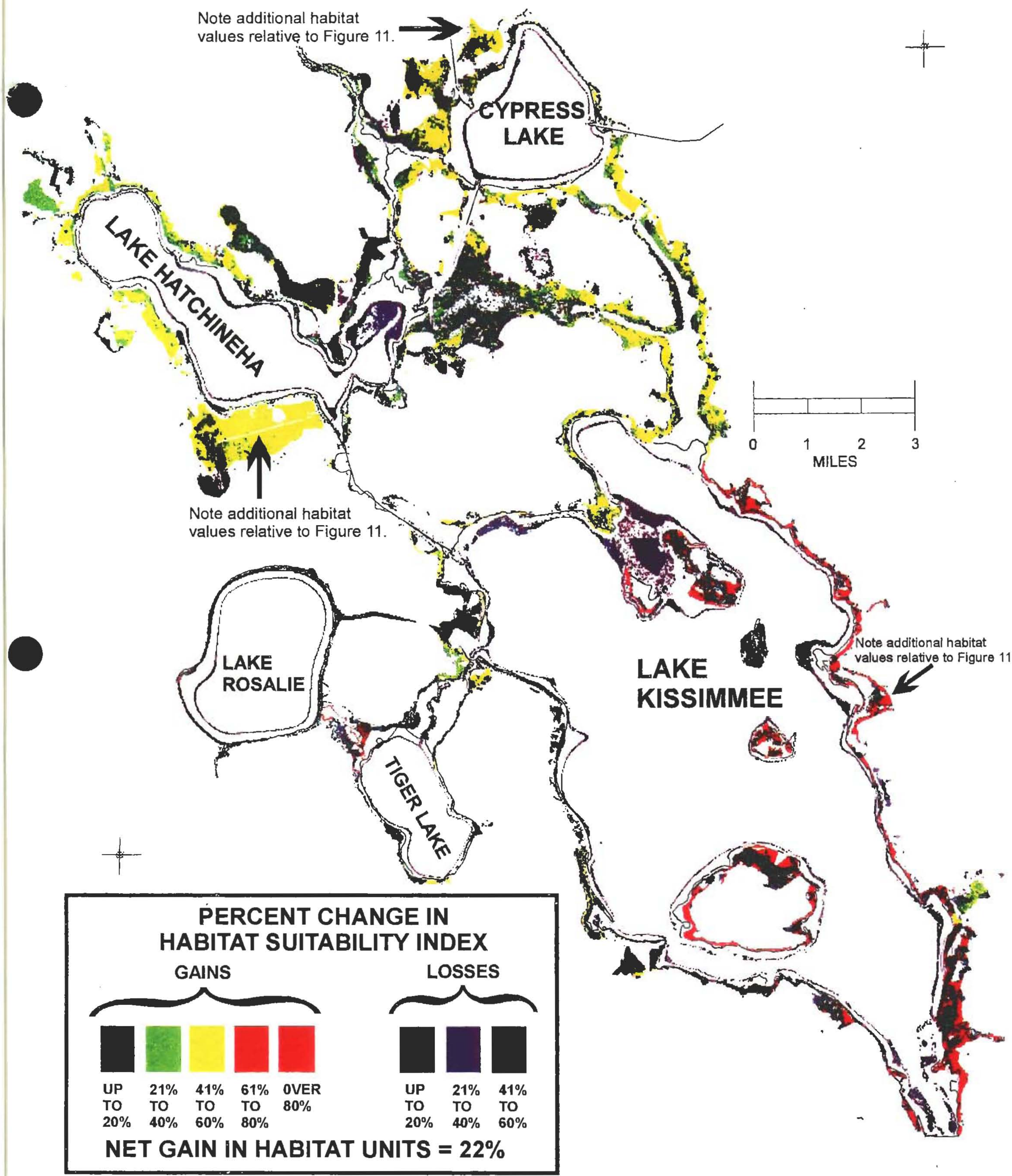

FIGURE 12 - CHANGES IN GREAT EGRET HABITAT SUITABILITY, FUTURE WITH ALL LEVEES BREACHED RELATIVE TO FUTURE WITHOUT PROJECT.

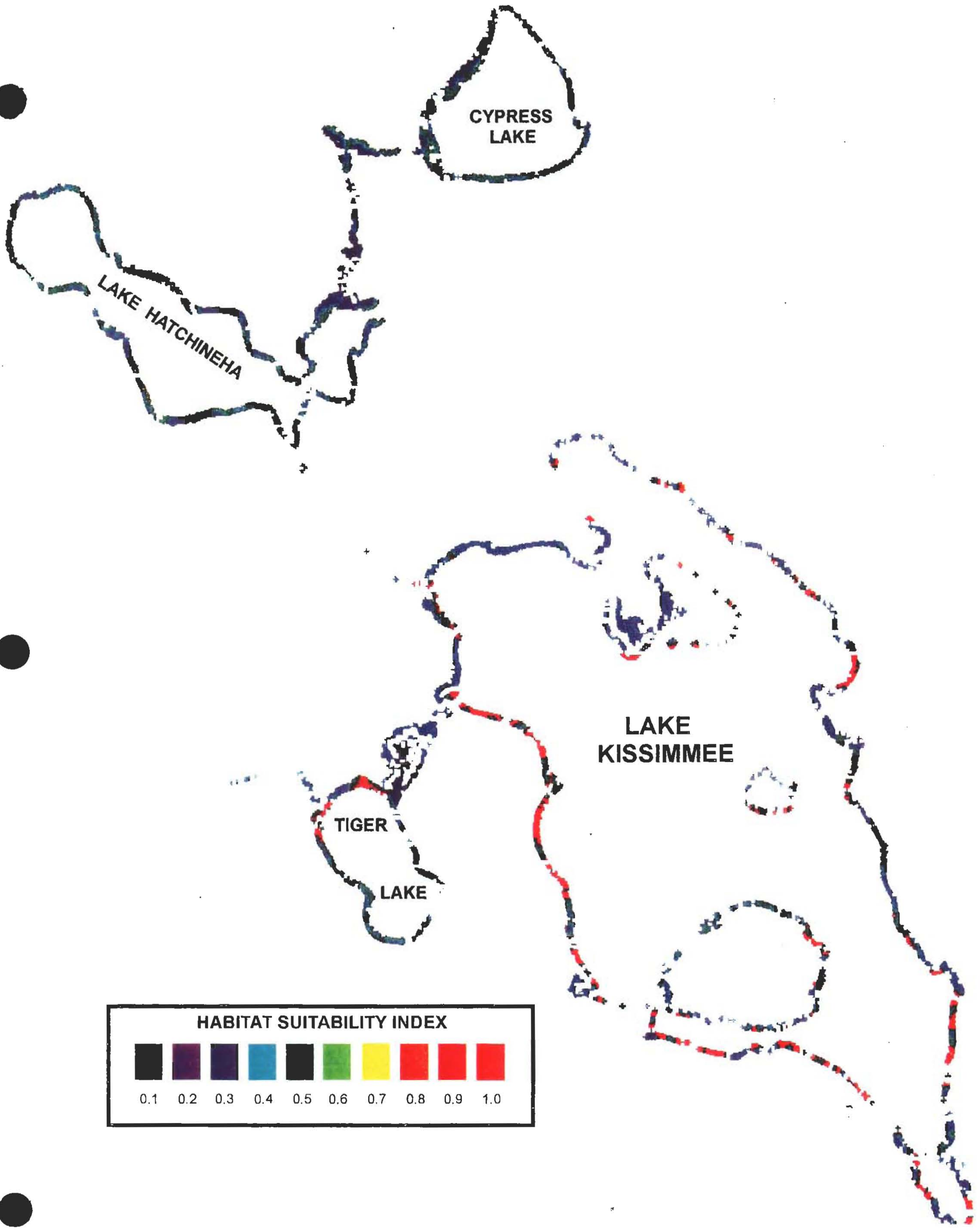

FIGURE 13 - SNAIL KITE HABITAT SUITABILTY, ANY OF THE ALTERNATIVE FUTURES

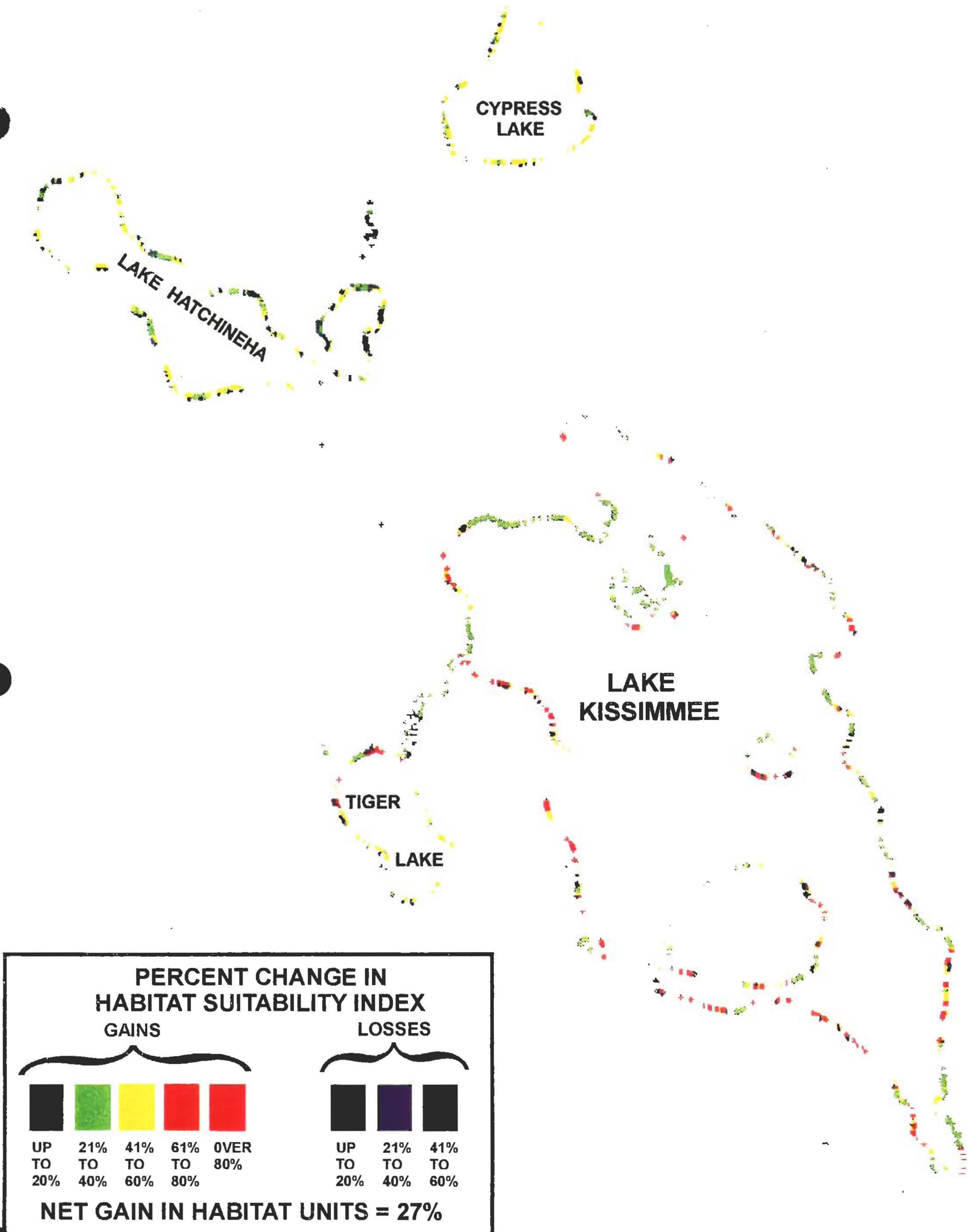

FIGURE 14 - CHANGES IN SNAIL KITE HABITAT SUITABILITY, ANY OF THE ALTERNATIVE FUTURES, RELATIVE TO FUTURE WITHOUT PROJECT.

Figure 13 shows habitat suitability for the snail kite for any of the alternative futures. Notice that the snail kite is not as likely to feed in the prairie wetlands as are the wading birds; the snail kite preferentially selects areas of suitable vegetation and hydrology in narrow portions of the littoral zone. Also notice that the highest habitat values are assigned to portions of the shorelines of Lake Kissimmee and Tiger Lake, where feeding areas are located close to documented nesting areas.

Figure 14 shows the change in habitat suitability for the snail kite for any of the alternative futures, relative to the future without the project. The greatest increase in habitat suitability are predicted to occur along a narrow band around Lake Kissimmee and the northern shore of Tiger Lake. Moderate increases in suitability are predicted for the shorelines of Cypress Lake and Lake Hatchineha. The absolute area of habitat changes for the snail kite is smaller than for the great egret. However, the kite's selectivity of habitat along the shorelines of the lake is precisely in areas to be affected by the project. This translates to a greater percentage change for the species due to the effects of the project, with a predicted net gain in habitat units of about 27%. As stated in Section VII.E.5. of this report, nesting conditions for snail kites are not expect to change significantly; the predicted gains in habitat suitability are strictly the result of improved foraging conditions in response to changes in hydrology.

The relatively high percent increase in habitat units for the Florida duck and the ring-necked duck are also the result of these species using areas to be affected by changes in regulation of the lake. The Florida duck's use of prairie wetlands for feeding was taken into account for the model, but its strongest preference for a mixture of open water and marsh along the shallow edges of the lakes is quite similar to areas preferred for feeding by the snail kite. (Although the species use very different resources and feeding strategies, they can often be seen in the same wetlands.) The ring-necked duck would nearly always be seen in the lakes rather than in the prairie wetlands, but preferring deeper water than the Florida duck. We have predicted a substantial increase of about 35% in habitat units for the Florida duck if all 3 levees are breached, while ring-necked duck habitat is predicted to increase by about 30%, whether or not the levees are breached.

The bottom row of Table 5 sums the habitat units for all 10 evaluation species for each of the alternative futures. The bottom row of Table 6 expresses the percent change anticipate for each alternative future, based on the sum of habitat units for all evaluation species. We have predicted approximately a 5.7% increase in habitat availability for the basic lake re-regulation, and about a 6.3% increase if all 3 levees are breached, taking into account habitat values in the prairie portions of the study area that are not likely to change in response to the project.

Among the evaluation species, the Florida duck, great egret, snowy egret, and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from breaching the levees.

D. Relative Frequency of Extreme Drawdowns

In a spreadsheet, we calculated the number of extreme drawdown events (natural droughts in the pre-project period) in the 18-year period of record. An extreme drawdown was defined as water levels below 46 ft. for at least 90 consecutive days. In the same period we used to compare the evaluated alternatives with historic conditions (1939-1942 and 1945-1958), we discovered only one extreme drawdown of this magnitude. Water levels remained below 46 feet for 187 consecutive days, from mid-April to mid-October 1956. Under regulated conditions (1970-1988) the single extreme drawdown of 1977 also met this criterion, lasting 175 consecutive days, from mid-March to the end of August.

We also examined the 15-year period between 1929 and 1943. Although no droughts in this period met the criterion we set, extended low water periods occurred in 1932 and 1933. Water levels below 46 feet occurred a total of 70 days in the 15-year period, without consideration of consecutiveness. In April-August 1932, water levels stayed below 46.5 feet for more than 90 consecutive days, with 13 consecutive days below 46 feet. The longest consecutive period with water below 46 feet lasted 32 days, from early June to early July 1933.

It appears that extreme drawdowns of the magnitude we have defined did not occur more frequently than roughly every 10-20 years. However, the unregulated system fluctuated much more each year than is feasible under today's system of gates and canals. After long periods without fluctuation, a more pronounced and/or more frequent extreme drawdown is necessary to partially compensate for the lack of year-to-year variability in the location of the low water line.

The frequency and timing of extreme drawdowns need to be negotiated among the concerned agencies. The fisheries program of the FGFWFC currently recommends a frequency of once every 7 to 10 years. Due to the degree of coordination and expense of performing an extreme drawdown, once the process has been started, all attempts should be made to complete the drawdown satisfactorily. Barring any unseasonable heavy rains, the 46-foot/90-day duration guideline should be met to provide the desired benefits for the funds expended.

XII. FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES

A. Determination of Effect and General Findings

By letter, dated December 3, 1993, the Corps' Planning Division provided the Service with a determination of effect in accordance with Section 7(a)(1) of the Endangered Species Act (ESA). They determined that the proposed project is not likely to adversely affect any Federally-listed threatened or endangered species. On March 28, 1994, the Service concurred with this determination.

Section VII.E. of this report provides general biological information and the basis of our models for the bald eagle, snail kite, wood stork, and Audubon's crested caracara, which in addition to being Federally-listed as endangered, are also evaluation species for this report. On the basis of our familiarity with the species' biology in the area and the results of our species models, the Service predicts that the project will likely be beneficial to the snail kite and wood stork, while it is not likely to have a significant effect on the bald eagle or the caracara.

The Corps' evaluation included the Eastern indigo snake (*Drymarchon corais couperi*), which is listed as threatened. The indigo snake is likely to occur in higher elevations unaffected by the changes in water regulation schedules. We concur with the Corps' determination, and provide Conservation Recommendations to assist them to protect any indigo snakes that may be found during earth work in widening the flood control canals.

The Corps also mentioned the whooping crane (*Grus americana*) in its determination. The FGFWFC and the Service are cooperating in an attempt to re-introduce the whooping crane in and adjacent to the study area. Most of the introduced flock presently uses habitat west of the study area, near Lake Marian and Lake Jackson. Although the whooping crane is listed as endangered in the remainder of its range in the United States, this flock is considered an experimental population, and is not currently covered under Section 7 of the Endangered Species Act. However, we encourage the agencies to consider effects on this population in project planning. The whooping crane has a greater affinity for wetlands than the sandhill crane (Nesbitt, pers. comm.), and we expect that establishment of a breeding population in Central Florida will be enhanced by the greater water fluctuation and expanded littoral zone as a result of the Kissimmee Headwater Lakes Revitalization Project.

B. Conservation Recommendations

1. Snail kite

The Service has recommended that each of the principal nesting areas and drought refugia be managed to benefit reproduction of the species during most years, while recognizing that droughts and management of other fish and wildlife species will require periodic deviations from what is considered an ideal management plan for snail kite reproduction. Coordination of management actions throughout the species' range would be required to ensure that the majority of the essential kite habitats were managed for kite nesting in any given year. For example, an extreme drawdown of a waterbody for water supply, construction activity, aquatic weed control or fishery habitat management could be permitted if other essential habitats in the species' range were managed for kites in that same year. Ongoing telemetry studies indicate that kites will migrate long distances within their overall range to find favorable conditions and that they exhibit a high level of resilience to environmental conditions (Bennetts et al., 1994 and Bennetts, pers. comm.). However, if a number of activities adverse to the kite coincide during a prolonged drought, the impact could overwhelm the species' inherent capacity to respond with opportunistic behavior.

The responsible agencies must insure that potentially conflicting goals (such as habitat enhancement for fisheries and water management for snail kite nesting) are reconciled. This may be more a matter of timing and coordination than an inherent conflict. The long-term management of the lakes should include extreme drawdowns which could be beneficial for all species, including the snail kite. However the frequency of these events and the compatibility of lake management with kite nesting in the intervening years can be worked out through cooperation. Bennetts et al. (1994) stated the following with regard to the Everglades, but it could apply throughout the range of the snail kite:

> Undoubtedly, compromise solutions will need to be identified in order to accommodate increasing demands for water, habitat for snail kites, and flow systems that will maintain the unique Everglades environment. Almost any proposed solution to the problems of the Everglades and the kite will meet with opposition from individuals or groups with differing objectives or viewpoints.

2. Eastern indigo snake

The indigo snake (*Drymarchon corais couperi*) is a large black to glossy blue-black snake. Indigo snakes prefer sandy upland habitats, but can be found in many kinds of habitats, including canal banks and spoil mounds. In much of Florida it uses gopher tortoise burrows for shelter. In addition to habitat destruction, illegal collection of indigo snakes for the pet trade is a significant threat.

All construction personnel involved in this project should be informed of the possible presence of the indigo snake in the area, its recognition, and the possible civil and criminal penalties resulting from the unauthorized take (harming, harassing, killing, collection) of a listed species. The Service can furnish, under separate correspondence, an outline for an education/protection program for the indigo snake.

C. Conclusion

The Service concurs with the Corps' determination that the project is not likely to adversely affect the Audubon's crested caracara, bald eagle, wood stork, and Eastern indigo snake.

Although this does not constitute a Biological Opinion described under Section 7 of the Endangered Species Act, it does fulfill the requirements of the Act, and no further action is required. If modifications are made in the project or if additional information involving potential impacts on listed species becomes available, please notify our office (407-562-3909).

XIII. STATE-LISTED SPECIES AND SPECIES OF SPECIAL CONCERN

The sandhill crane is one of our evaluation species, and is listed by the State of Florida as Threatened. The snowy egret, another evaluation species, is listed as a Species of Special Concern. We have predicted a likely benefit for the snowy egret, and no significant effect on the sandhill crane.

Among the more prominent Species of Special Concern that occur in the study area are: gopher tortoise, osprey, burrowing owl, limpkin, little blue heron, and tricolored heron. Based on our modelling of effects on wading birds, the Service anticipates that the last three species are likely to benefit from the proposed project, because they are wetland-also wetland-dependent wading birds.

XIV. CONCLUSIONS AND RECOMMENDATIONS

Restoration of the Kissimmee River and the associated proposal to improve water regulation in the Kissimmee Chain of Lakes are environmental restoration projects on an unprecedented scale; they serve as nationally significant cornerstones in efforts to restore ecosystems.

The Service recommends the following:

1. Lands up to 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. These actions will realize the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risks during storm events. Among the evaluation species, the Florida duck, great egret, snowy egret, and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from this action. Direct hydrological connection of the wetlands with the lakes would increase the flow of nutrients and promote movement of aquatic animals; the wetlands behind the levees are now generally isolated from the lakes. Acquisition of the area behind the levees would also ensure that existing wetlands behind the levees are not pumped dry by more intensive agricultural practices on private lands.

2. Periodic extreme drawdowns should be superimposed on the normal regulation schedule and should be referenced in the operational notes for the schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. Field research has demonstrated substantial increases in the yield of the sport fishery for several years after an extreme drawdown. The periodic reduction in density of vegetation in the littoral zone is also beneficial to the ecosystem as a whole. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

3. Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for losses of wetlands. The Corps should investigate redirecting flow to the remnant river run adjacent to C-37. After widening the canals, the banks should be replanted

with cypress trees, and a littoral shelf should constructed and planted with desirable aquatic plants such as bulrush.

4. The Corps should develop an aquatic plant management plan, including funding projections, to address control of *Hydrilla*, floating plants, and tussocks in the lakes.

5. The Interagency Review Team used to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

6. The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that separate regulation at levels higher than Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

7. The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a restoration project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

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FLORIDA GAME AND FRESH WATER FISH COMMISSION

June 6, 1994

Mr. David L. Ferrell
Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, FL 32961-2676

Re: Kissimmee Headwater Lakes Revitalization Project, Draft Fish and Wildlife Coordination Act Report

Dear Mr. Ferrell:

The Division of Fisheries, Division of Wildlife, and Office of Environmental Services of the Florida Game and Fresh Water Fish Commission have reviewed the referenced document, and offer the following comments.

The Kissimmee Headwater Lakes Revitalization Project is an important component of the Kissimmee River restoration, which we believe is the premier natural resource oriented public works project in the history of Florida. For the restoration to work, river flow from the headwater lakes must be reestablished in a regime similar to the historic condition. This will require new lake regulation schedules, the centerpiece of the revitalization project, and for these to maximize potential natural resource benefits within the Kissimmee basin, the historic condition should also be the goal.

We concur with the six conclusions and recommendations, as stated on pp. 68 and 69 of the Draft Coordination Act Report. However, we believe that the fish and wildlife habitat benefits of this project could be greatly enhanced if the water level schedule for lakes Cypress, Hatchineha, and Kissimmee provided high water levels closer to the historic condition. The modest wetland habitat benefits of the Corps of Engineers' proposed schedule (400C150RR) could be dramatically improved with longer durations of water level between the 52.5- and 54-foot contours. Table 3 of your report illustrates that the proposed schedule closely approximates historic low water stages, but provides only 36% of the historic high water levels. Your specific recommendation for the Interagency Review Team to "revisit" this issue in the future acknowledges the environmental desirability of higher lake stages, but our experience has been that any modification in lake regulation schedules is an arduous, protracted process. The current Kissimmee Headwater Lakes Revitalization Project is our window of opportunity to establish an optimum schedule; should we not "go for it"? If additional flood plain acquisition is required to restore historic water levels, that requirement should be defined now. The Kissimmee River restoration is a visionary project, and we believe the headwater lakes (as well as Lake Okeechobee and the Everglades) require and deserve a similar vision. Thus our principal recommendation to the Corps of Engineers is to modify their proposed schedule to allow longer duration of water levels between the 52.5- and 54-foot contours.

Specific comments pertaining to your recommendations are as follows:

Recommendation 1. Analysis of the benefits derived by breaching the levees on lakes Cypress, Hatchineha, and Kissimmee should include the enhancement and protection of the wetlands presently existing behind these levees, which were excluded from your wetland restoration estimates. An addition to Table 4 could include this acreage, which we calculate to be 721 acres for Lake Cypress, 1,500 acres for Lake Hatchineha, and 429 acres for Lake Kissimmee. Potential project benefits would include: protection of wetlands currently in private ownership which are jeopardized by existing drainage systems; enhancement of wetland function, especially fisheries, via reconnection with the lakes; and additional flood storage acreage.

Recommendation 2. Extreme drawdowns should be referenced in the operational notes for the lake regulation schedules.

Recommendation 3. As part of the Corps of Engineers' plan to widen canals C-35, C-36, and C-37, they should investigate adding flowways through the levees adjacent to these canals. A remnant river run parallels C-37, and should be restored. After dredging, the canal banks should be replanted with cypress trees, and a littoral shelf should be constructed and planted with desirable aquatic plants such as bulrush.

We would also add a recommendation that the Corps of Engineers develop an aquatic plant management plan, including funding projections, to address hydrilla control in flowing lake water, and control of floating plants and tussocks.

We have given additional minor recommendations and corrections for this Draft Coordination Act Report to Robert Pace of your staff via telephone. Attached to this letter are two memoranda from waterfowl biologists in our

Division of Wildlife, offering specific language changes for sections of the report dealing with ring-necked ducks and mottled ducks.

Sincerely,

Bradley J. Hartman

Bradley J. Hartman, Director
Office of Environmental Services

BJH/BSB/tgw
ENV 2-6
kissimmee.bsb
Attachments
cc: Col. Terrence C. Salt, USACOE
Mr. Dennis Holcomb, GFC
Mr. Ed Moyer, GFC
Mr. Dennis Hammond, GFC
Ms. Diane Eggeman, GFC
Mr. Paul Gray, GFC

325

FLORIDA GAME AND FRESH WATER FISH COMMISSION

WATERFOWL MANAGEMENT SECTION
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M E M O R A N D U M May 24, 1994

TO: Duke Hammond
SWIM Coordinator

FROM: Paul N. Gray, Ph.D. Paul
Bio. Sci. III

SUBJECT: Comments on USFWS Kissimmee Headwater Lakes Revitalization Project

---

Thank you for sending parts of the Kissimmee Project report to me. I applaud the USFWS for working on plans of this sort--they will help. Here are suggestions/comments:

-He misspelled my name--Gray.

-The Fish and Wildlife Concerns (p. 8) has a good discussion about the pejorative effects of stabilized water levels in the lakes. The one point I would emphasize more is that high water levels impede decomposition--which helps create the excess muck--and serves to bind up nutrients. In continuously flooded sites, the vegetation gets thick (forms batteries or tussocks) and chokes that area out--but actually has low primary productivity, which makes the system less productive overall. During drawdowns, decomposition frees the nutrients, which allows increased productivity (such as improved fish growth).

-The Florida subspecies of mottled duck (p. 33) is denoted *Anas fulvigula fulvigula*, if he wants to include that.

-I would rewrite the first sentence of the second paragraph of the mottled duck account (p. 33) to say, "Florida's mottled duck nests primarily between mid-March and mid-May, but will attempt renesting through July."

-I would add that mottled ducks can nest as much as a mile from water, which helps reduce the chance that nesting habitat is limiting.

-Change to, "Paul Gray concurs that suitable nesting habitat probably is abundant in the study area." (changes in bold)

Mr. Duke Hammond
May 24, 1994
Page 2

-Paragraph 3 mentions "non-limiting nature of the breeding habitat" and while that might be true, it may not--and we don't know for sure. A fudge word could be added, "**presumed** non-limiting..."

Further, BROOD REARING areas have not been discussed and are a critical part of the breeding habitat. However, I think brood rearing habitat will take care of itself if the "feeding habitat" part of the model is done correctly. I think the author could explicitly state that good brood habitat resembles good feeding areas, but with a mandatory component of nearby cover (which should be no problem on lakes with cattails, bullrush, maidencane, or a similar robust cover). Adult birds do not need cover to have suitable feeding habitat.

-I am not sure I understand how the model will work, so I hope the following comments make sense.

-Mottled ducks "prefer" feeding in water less than 6 inches deep. They can use water as much as 12 inches deep, but water more than 12 inches deep should be considered unsuitable (unless it is a bed of hydrilla or some plant that grows close to the surface). Mottled ducks LOVE recently flooded, short hydroperiod wetlands because these wetlands frequently are dominated by seed-bearing plants (good food), and when newly flooded, the seeds and bugs float, making them easy to feed on. Hence, I think the authors should give very high suitability scores to shallow water areas and temporarily flooded wetland areas. Of course, short hydroperiod wetlands are suitable only when flooded.

-I'm not sure areas within 90 m of marsh/open water edges are better for mottled ducks than other areas; I think it could be deleted.

-The last sentence confuses me a little. Mottled ducks appear to "prefer" small wetlands that are found out on the prairies--and have no clear preference for large lakes. Hence, semipermanent wetlands (and some open water areas) above the littoral zone should be assigned high habitat values. Ducks do "prefer" littoral zones of large lakes when natural marsh cycles make temporally suitable habitat (such as the productive period following a drawdown or fire). However, when there is a drought, the ducks have nowhere else to go--and the lakes can become important (preferred?) habitat, even when the lakes have low quality habitat.

-I think the conclusions/recommendations (p. 68) are good, especially #2.

If you have any questions, please call.

W892/PG/pg
FN: C:\P\DUKE2
WLD 8-7
cc: Lt. Col. Daniel Dunford
Mr. David Brakhage

FLORIDA GAME AND FRESH WATER FISH COMMISSION

Waterfowl Management Section
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May 25, 1994

M E M O R A N D U M

TO: Brian Barnett, Biological Administrator
Office of Environmental Services

FROM: Diane Roth Eggeman, Waterfowl Biologist
Division of Wildlife

SUBJECT: Comment on Draft Report on Kissimmee Lakes Revitalization Project

Duke Hammond provided me with pages from the draft Fish and Wildlife Coordination Act Report for the Kissimmee Headwater Lakes Revitalization Project and asked that I review them and provide comments to you. My comments concern the section on ring-necked ducks on pages 35-36. I am listed as one of the "experts consulted". I did not, to my knowledge, provide any written input for this report, but I vaguely remember discussing this issue over the telephone in the distant past. I am not comfortable with the section as it is written. The first paragraph is a fairly accurate description of the ring-necked duck and its habitat. However, the application of that information to the model appears to be based almost solely on water depth. As I indicated below, the distribution of ring-necked ducks in the upper Kissimmee Lakes and elsewhere in central and southern Florida in recent years has been most strongly influenced by the presence and abundance of "topped-out" hydrilla (hydrilla growing up to the water surface). In the absence of hydrilla, ring-necked duck habitat is characterized by deep-marsh type of vegetation, typically white water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*). Although these communitites and their value to ring-necks are more directly determined by water depth, I would not expect the extent of these communities to be dramatically influenced by the types of water regulation changes being considered. The most important point is this: I would not expect use of the upper Kissimmee lakes by ring-necks to change appreciably as a direct result of changes in the water regulation schedule. I definitely do not want my name associated with the model for ring-necked ducks as it currently described on page 36 because the model is based solely on water depth, which is relatively unimportant given the current availability of hydrilla as habitat in the region. I suggest the following re-write of the first paragraph of this section:

"The ring-necked duck (*Aythya collaris*) is the most abundant species of wintering waterfowl in both the upper and lower Kissimmee basins and is an important game species. During fall migration, ring-necked ducks begin arriving in central Florida in October and remain in the Kissimmee lakes region into March. This species does not breed in Florida. Ring-necks are classified as diving ducks and typically feed in waters less than 6 feet deep (Bellrose 1980). Traditionally in Florida, ring-necks use deep-marsh habitats characterized by floating-leaved and aquatic-bed type of wetland vegetation.

Memorandum
May 25, 1994
Page 2

Seeds of white water lily (Nymphaea odorata) and watershield (Brasenia schreberi) are considered preferred foods. In recent years, the distribution of ring-necked ducks appears to be determined primarily by the presence and abundance of "topped-out" hydrilla beds. This conclusion is based on aerial surveys and other field observations of wintering waterfowl in central and southern Florida. Johnson and Montalbano (1984) studied the selection of plant communities by wintering waterfowl in the littoral zone of Lake Okeechobee. Ring-necked ducks were the most abundant spec s observed. Of all vegetative communities available, hydrilla received the highest preference ranking, and wildcelery (Vallisineria americana) the second highest. This study examined preference based on habitat use and abundance but did not examine food habits. However, hydrilla is a predominant duck food in areas where it occurs (Montalbano et al. 1978, 1979). Johnson and Montalbano's research suggested that water depth was of relatively minor importance in habitat selection. Ring-necked ducks feed on all parts of hydrilla, including vegetation, tubers and turions. Water depth is relatively unimportant to ring-necks using hydrilla beds, because hydrilla leaves, stems, and turions are available at or near the surface even in water deeper than the birds would dive if they were feeding on foods on the bottom. Therefore, given the current availability of hydrilla in the region, changes in the hydrology of the Kissimmee lakes likely will substantially influence habitat for ring-necked ducks only to the extent that the changes directly or indirectly determine the availability of "topped-out" hydrilla."

I would also suggest the author(s) consider deleting the ring-necked duck from the report because the species is not a sensitive barometer of changes in habitat caused by changes in water regulation schedules.

Thank you for this opportunity to comment. If you have questions, please give me a call.

CITATIONS:

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WLD 2-9-V

cc: Mr. Duke Hammond

Florida Department of

Environmental Protection

Marjory Stoneman Douglas Building
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Lawton Chiles
Governor

Virginia B. Wetherell
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May 10, 1994

Robert T. Pace, Senior Biologist
Joseph D. Carroll, Senior Biologist
U.S. Fish & Wildlife Service
P.O. Box 2676
Vero Beach, FL 32961-2676

Dear Gentleman:

I was provided a copy of your draft report entitled "Kissimmee Headwater Lakes Revitalization Project, Fish and Wildlife Coordination Act Report" for review. The following are comments as they relate to aquatic plant management in the upper Kissimmee Chain of Lakes.

The Department of Environmental Protection recognizes the significance of the Kissimmee River restoration project, and supports this effort. However, we have concerns regarding the effect the Revitalization Project may have on aquatic plant management in the upper basin lakes. Hydrilla is extremely difficult to manage in flowing water conditions. Because the Project greatly restricts periods of zero discharge, costs to manage the invasive hydrilla could escalate far above recent annual expenditures which have averaged one million dollars.

Hydrilla is expanding in the upper Kissimmee Chain of Lakes, and has the potential to adversely affect implementation of the Revitalization Project. A concerted interagency effort is now underway to develop a hydrilla management plan for the South Florida Water Management District. District staff has assured us that this management plan will be incorporated into the draft plan, and final plan, of the Revitalization Project. We, therefore, request that the USFWS Coordination Act Report also acknowledge the importance of hydrilla management in the upper basin lakes.

Please contact me at 904-488-5631 if you have any questions or comments pertaining to this issue.

Sincerely,

Judy Ludlow

Judy Ludlow, Biologist
Bureau of Aquatic Plant Management

/jl

Florida Department of
Environmental Protection

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1800 Wekiwa Circle
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June 1, 1994

Mr. Robert Pace
U. S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, FL 32961-2676

Dear Mr. Pace:

After review of the supporting documentation and consultation with Tony Morrell, park manager at Lake Wales Ridge GEOpark, I have the following comments with respect to the Fish and Wildlife Coordination Act Report on the Kissimmee Headwater Lakes Revitalization Project. The proposed project will result in more frequent seasonal flooding and higher water levels within the hydric communities of Lake Kissimmee State Park; this action will contribute to the hydrological restoration of these communities within the park and is consistent with the Department of Environmental Protection's emphasis on ecosystem management. The increased water levels and periodic extreme drydown events associated with the project will assist in the eradication of exotic plants such as *Sesbania vesicaria*, and the control of pest plants, such as *Ludwigia* spp. In addition, numerous vertebrate species will benefit as a result of the restoration of these communities.

If you have any questions regarding my comments, please contact me at 407-884-2102.

Sincerely,

Alice M. Bard

Alice M. Bard, District Biologist
Bureau of Parks, District 3 Administration

AMB/amb
cc: Mark Glisson, Natural and Cultural Resources
Rosi Mulholland, District 3 Administration
Tony Morrell, Lake Wales Ridge GEOpark
Judy Ludlow, Aquatic Plant Management
Patricia Sculley, South Florida Water Management District