SECTION 5

PROBLEMS AND OPPORTUNITIES

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Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the planning setting, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. Planning objectives are statements of what a plan is attempting to achieve; they communicate to others the intended purpose of the planning process. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section describes the problems and opportunities in the study area and the planning goals and objectives developed for the study.

5.1 PUBLIC CONCERNS

At the heart of the identification of problems and opportunities process is an understanding of the public's concerns. As part of the reconnaissance phase of the study, an extensive public program was designed to determine the public's concerns through responses to three questions:

Question #1 - What are the **important resources** in the south Florida ecosystem?
Question #2 - What do you think are the **problems and opportunities** in the ecosystem?
Question #3 - How will you recognize **successful restoration** of the ecosystem?

Ten public workshops to address these questions were conducted across the study area in December 1993; about 2,200 people attended these workshops. Additional responses to the three questions were received through the mail primarily during January and February 1994.

All of these responses were read to identify the public's ideas about important resources, problems, opportunities and success. These ideas were grouped in ten general categories that covered the full range of concerns expressed by the public. While it is not possible to provide a count of the number of times any given concern was stated, the review provided a very good sense of the public's perception of the magnitude of each concern. Based on this review, the magnitude of public concerns can be grouped as follows:

Most people identified concerns about:
ecosystem health
uncontrolled growth

Many people identified concerns about:
water quality
water supply
balance
"they're the problem"

Some people identified concerns about:
flood control
recreation
economy
social considerations

A technical analysis of conditions in south Florida was conducted concurrent with the identification of public concerns. The technical analysis was designed to investigate and verify the dimensions of the concerns identified by the public, as well as to reveal other problems and opportunities that had not been identified by the public. The analyses covered:

- Ecosystem health
- Water quality
- Water supply
- Flood control
- Recreation
- Economic and social considerations

The public also expressed concerns about growth, “they’re the problem”, and balance that did not result in technical analysis.

Management of local and regional growth issues, including changes in population and development, is the responsibility of state, county, city, and other local interests. Although, in this study, alternative plans were not formulated to address public concerns about growth, the possible effects of alternative restoration plans on population, development, and other growth issues were evaluated and presented in the assessment of the effects of alternative plans.

The study team recognized many people's views about other interests being the cause of one or more problems, especially the view that government is "the problem" in south Florida. This study has been designed to elicit and use ideas and information from as many individuals and interest groups as desired to participate. It is through this extensive program of public involvement that the study hopes to build better understanding among all the concerned interests, and demonstrate the Corps' commitment to responsive public service.

One of the major steps in the planning process is the evaluation of the effects of alternative plans. Evaluation will reveal the plans' important effects, including effects that reflect progress toward meeting the objectives and constraints, as well as effects that are of interest for other reasons. Evaluation will cover the full range of effects on the human environment, including ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social and health effects, whether direct, indirect, or cumulative (Council on Environmental Quality, 1978). This information about the plans effects will provide interested members of the public and responsible decision makers with a basis for judging trade-offs within and among alternative plans; that is, for determining what they individually believe is a “balance” in view of likely beneficial and adverse effects. In short, this study will provide information that people can use to make decisions about “balance”.

As a result of this effort, the reconnaissance study produced an initial set of planning objectives and constraints. As a part of this feasibility study, the reconnaissance study problem identification was refined further.

5.2 ECOLOGICAL PROBLEMS AND OPPORTUNITIES

Natural resource specialists agree that the remaining ecosystems in south Florida no longer maintain the functions and richness that defined the pre-drainage system, and that these measures of ecological health will continue to decline without preventative actions. Not only is it certain that these natural systems will not recover their defining attributes under current conditions, it is unlikely that even the current, unacceptable ecological conditions can be sustained into the future. For example, wading birds, key indicators of broad, regional patterns of aquatic production, continue to show declines in the total number of birds initiating breeding in south Florida colonies. Other examples are the declines in population levels of commercially and recreationally important fish species in the St. Lucie and Caloosahatchee Estuaries, and Biscayne and Florida Bays. High water levels in recent years in Lake Okeechobee have resulted in widespread losses of the emergent and submerged plant communities that provide habitat for economically important fish. If this trend continues, there may be substantial declines in the lake’s fisheries. Regulatory releases to the Caloosahatchee and St. Lucie Estuaries can have damaging effects on the plants and animals inhabiting these areas. Prolonged high volume releases from Lake Okeechobee are believed responsible for the defoliation of seagrasses, fish kills, and deformed fishes within the St. Lucie Estuary during 1998, for example.

Many of the defining characteristics of the pre-drainage ecosystem (spatial extent, habitat heterogeneity, and dynamic storage) have either been lost or substantially altered as a result of land use and water management practices during the past 100 years in south Florida. Loss in spatial extent of natural areas has been most severe in the past 50 years with the construction of the C&SF Project, including the construction of Herbert Hoover Dike around Lake Okeechobee. Nearly half of the original Everglades ecosystem has been converted to agricultural and urban uses. The ecological effects of this loss in spatial extent include:

- a substantial reduction in habitat options for fish and wildlife,
- reduction in the system-wide levels of primary and secondary production, changes in the proportions of community types within the remaining system, and
- increasing concentrations of pollutants in remaining natural system surface waters, sediments, and wetlands and degradation of water quality.

The hydrology of the remaining Everglades has become altered by the operation of the C&SF Project, which has generally:

- reduced average annual flows and surface water stages,
- lowered regional ground water,
- either increased or decreased annual hydroperiods, depending on location,
- geographically relocated long and short hydroperiod wetlands,
- reduced the extent of long hydroperiod refugia,
- altered the frequency, duration and magnitude of interannual wet and dry cycles, and
- altered salinity levels in estuaries.

Overall, the construction and operation of the C&SF Project and its subsequent modification of the natural system have:

- contributed to the substantial reduction in spatial extent and system resiliency,
- provided a network of canals and levees which have accelerated the spread of polluted water, sediments, and exotic species,
- greatly reduced the water storage capacity within the remaining natural system, and
- created an unnatural mosaic of impounded, fragmented, and both over-inundated and over-drained marshes throughout the natural system.

Some level of ecological improvement is expected to occur as a result of the implementation of a number of projects such as: changes in the Lake Okeechobee regulation schedule, the addition of the stormwater treatment areas as part of the

Everglades Construction Project, rainfall-based schedules for Water Conservation Areas 2 and 3, implementation of Minimum Flows and Levels for the Everglades and Lake Okeechobee, and the completion of the C-111 and Modified Water Deliveries projects. The effects of these projects on the regional system were modeled and analyzed. The magnitude of the cumulative, regional benefits from these improvements, relative to the level of ecological improvements required to recover a functional, Everglades-type system, is uncertain. The best professional opinion is that these projects will contribute less than 25 percent of the overall, improvement in hydrological patterns required for the recovery of a regionally integrated ecosystem, or to achieve the ecological targets that were contained in the performance measures used to define the restoration objectives. In general, these projects are expected to produce a higher level of improvement in the quality of water in the remnant natural system. Further discussion of water quality follows this section.

Translating these levels of improvement in hydrological patterns and water quality conditions into predictions of regional ecological health is risky business. A large question in this evaluation is concerned with ecological thresholds, and whether modest improvements in hydrological patterns are sufficient to shift production and animal behavior patterns towards more Everglades-like patterns. The prevailing technical opinion is that these modest hydrological improvements are not expected to produce major, and in some cases, measurable, improvements in regional ecological conditions or in habitats critical to several species of endangered species. As mentioned above, relatively greater levels of improvement are expected for water quality conditions. Reduced inputs of excessive nutrients should slow the spread of cattails and other plants with high nutrient tolerances, and should produce a slow recovery of natural vegetation patterns in some nutrient-stressed parts of the system.

5.3 WATER QUALITY PROBLEMS AND OPPORTUNITIES

5.3.1 Regional Overview

Many of the regulatory and environmental restoration programs, which are assumed to be in place in 2050 (see Section 4.8) are projected to result in a net improvement in water quality in south Florida. In addition to those assumptions, water quality improvement actions undertaken to comply with the requirements of the Federal Clean Water Act (P.L. 92-500) as implemented by the U. S. Environmental Protection Agency, the Florida Department of Environmental Protection, the South Florida Water Management District, the Seminole and Miccosukee Tribes, and local governments are expected to result in improvements in regional water quality necessary to comply with state, tribal, and local water quality standards. Examples of these programs include: Municipal Separate Storm

Sewer Systems (MS4) and other National Pollutant Discharge Elimination System (NPDES) point and non-point source pollution reduction permitting requirements, Total Maximum Daily Loads established under Section 303(d) of the Clean Water Act., and Pollutant Load Reduction Goals (PLRGs) established pursuant to the State of Florida's Surface Water Improvement and Management (SWIM) Act for designated priority waterbodies.

From a regional perspective, the most comprehensive of these programs is the TMDL program implemented by the Florida Department of Environmental Protection and the Seminole and Miccosukee Tribes. Under Section 303(d) of the Clean Water Act, states and tribes are required to identify water bodies within their jurisdictions not meeting water quality standards and rank those water bodies in terms of the severity of the pollution and designated and actual uses of the water bodies. The 303(d)-listed water bodies are to be reported to the U.S. Environmental Protection Agency in accordance with Section 305(b) of the Clean Water Act. TMDLs are to be developed for 303(d)-listed water bodies consistent with the priority ranking and are to be established "at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." However, the TMDL program, for the most part, has not been implemented in the study area.

In its 1998 report to the U.S. Environmental Protection Agency, the Florida Department of Environmental Protection identified approximately 160 impaired water bodies in the study area in accordance with the requirements of Section 303(d) of the Federal Clean Water Act. The Florida Department of Environmental Protection has developed a strategy for assessing watersheds (basins) and developing TMDLs and remediation plans for pollutants causing impairment of 303(d)-listed water bodies (FDEP, 1996a and FDEP, 1996b). (It should be noted that excessive nutrient loads were typically identified as the most common pollutant causing impairment.) The Florida Department of Environmental Protection's statewide strategy for implementing TMDLs involves five-year cycles for basin assessment, monitoring, data analysis and TMDL development, development of basin management plans, and implementation of basin management plans. However, it should be noted that this strategy has not yet been approved by the U.S. Environmental Protection Agency, and would take up to 15 years to complete (statewide) once approved. It should be further noted that the Florida Department of Environmental Protection's strategy for TMDLs does not give regional priority to south Florida; rather, the strategy was developed from a statewide perspective. Nevertheless, several key water bodies in south Florida will receive priority for TMDL development, including Lake Okeechobee and the Indian River Lagoon.

Development and implementation of TMDLs is an essential step for achieving overall ecosystem restoration in south Florida. Water quality restoration targets are necessary for detailed design of Restudy recommended plan components to achieve water quality restoration performance objectives. Further, implementation of basin management plans developed under the TMDL program is necessary to achieve ecological restoration in watersheds "downstream" of recommended plan components.

The triennial review of state and tribal water quality standards performed under Section 303(c) of the Clean Water Act is another essential step for achieving ecosystem restoration in south Florida. States and tribes are required to periodically review their water quality standards to ensure that standards are adequate to protect designated uses of waters. Within the study area, there are no specific numeric water quality criteria for many pollutants (e.g., nutrients and several pesticides) detected in ongoing water quality monitoring activities. The extent of the contribution of such pollutants to overall "impairment" levels in 303(d)-listed water bodies is also unknown. As part of the triennial review process, Florida Department of Environmental Protection and the Seminole and Miccosukee Tribes may propose modifications to existing water quality criteria and propose additional water quality criteria (as appropriate) to protect water resources. Modified and additional water quality criteria should be integrated with future detailed planning and design activities to assure that recommended plan components are operated consistent with water quality restoration targets.

The South Florida Water Management District is also developing pollution load reduction goals (PLRGs) for SWIM-listed water bodies. In south Florida, SWIM-listed water bodies include Lake Okeechobee, the Indian River Lagoon, and Biscayne Bay. PLRGs are similar to TMDLs in that numeric water quality targets are promulgated and remediation programs are developed. TMDLs and PLRGs are essential water quality restoration targets to be integrated into future detailed planning and design activities for recommended plan components during the implementation period.

Several larger municipalities within the study area are required to apply to the U.S. Environmental Protection Agency for "Municipal Separate Storm Sewer System" (MS4) permits to address non-point source pollution sources within their jurisdictional boundaries. MS4 permit requirements apply to master drainage systems of local governments with populations greater than 100,000. The U.S. Environmental Protection Agency has generally implemented the MS4 permitting program on a countywide basis, incorporating cities, Ch. 298 drainage districts, and the Florida Department of Transportation (FDOT) where appropriate. Cities with populations greater than 100,000 are permitted separately. The following municipal governments in the study area are currently subject to MS4 permitting: Reedy Creek Improvement District, Broward County (25 co-permittees), City of Ft.

Lauderdale, City of Hollywood, Palm Beach County (39 co-permittees), City of Hialeah, Dade County (20 co-permittees), City of Miami, and Lee County (12 co-permittees). Local government regulatory programs to control smaller point and non-point sources of pollution will compliment state and tribal water quality regulatory and remediation programs.

The following Sections 5.3.2 through 5.3.11 summarize projected water quality problems and opportunities in study area sub-regions. Accurately projecting future water quality conditions in the Restudy area is difficult, due to the vast scope of the study area, uncertainty in future growth and land use changes, and in part to the lack of comprehensive water quality data indicative of statistically reliable trends (FDEP, 1996a). The following sub-sections predict water quality changes expected to occur within each of the C&SF Project sub-regions based on current water quality data and descriptions of existing conditions, available trend data, future population growth projections and the assumed implementation of certain specific regulatory and environmental restoration and water supply projects. Actual improvements in water quality conditions, where projected to occur, depend in large degree upon the successful implementation of the programs and projects included in the future without plan assumptions. For mercury (***Section 5.3.12***), conditions are projected for the regional system as a whole.

5.3.2 Kissimmee River Region

By 2050, water quality conditions in the Kissimmee River watershed south of urbanized Orange County are expected to be improved overall compared to existing conditions due to ongoing and planned ecological restoration programs in the drainage basin. In its 1998 303(d) list, the Florida Department of Environmental Protection identified approximately 25 waterbodies or segments of waterbodies within the Kissimmee River watershed where water quality was not adequate to sustain designated uses. Several of the 303(d) listed waterbodies are actually reaches of the Kissimmee River. Most of the watershed is classified as Class III ("fishable–swimmable") waters; several waterbodies within the watershed are designated Outstanding Florida Waters by the State of Florida. Pollutants and/or water quality criteria identified contributing to impairment of designated use include: low levels of dissolved oxygen, excessive nutrients, coliform bactieria, high biochemical oxygen demand, several trace metals including mercury (based on fish-consumption advisories), turbidity, and un-ionized ammonia.

Kissimmee River restoration projects are expected to reduce net pollution loading to the Kissimmee River and in downstream Lake Okeechobee through the restoration of remnant wetlands presently used as agricultural lands currently contributing pollutants to wetlands. Restored wetlands will also have a pollutant assimilation function, resulting in improved water quality in downstream water bodies (tributaries and oxbows). Additional ongoing land acquisition activities by the South Florida Water Management District will supplement ongoing environmental restoration projects (SFWMD, 1997a).

The extent of urbanization in the vicinity of the cities of Orlando and Kissimmee, north of the Kissimmee River Chain of Lakes is expected to increase. While new developments must comply with water quality treatment requirements for stormwater runoff, the net load of pollutants, particularly those typically associated with urban stormwater runoff contributed to the watershed north of the Kissimmee Chain of Lakes is expected to increase. Most of this increased pollution load would be expected to be retained in the Kissimmee Chain of Lakes and not enter the Kissimmee River – Lake Okeechobee system. Urbanization and attendant pollution loads in the region are not expected to increase significantly south of Lake Kissimmee.

5.3.3 Lake Okeechobee

Lake Okeechobee is a Class I waterbody (potable water supply) according to Florida Administrative Code rule. Class I waterbodies generally have the most stringent surface water quality and pollution control criteria in Florida. However, water quality data for Lake Okeechobee indicate that the lake is in a eutrophic condition, primarily due to excessive nutrient loads from agricultural sources both north and south of the lake.

The main tributary to Lake Okeechobee is the Kissimmee River. As stated above, several waterbodies within the Kissimmee River watershed, including segments of the river itself, are impaired to various levels. Degradation of water quality in the Kissimmee River watershed contributes to downstream degradation in Lake Okeechobee. Lower reaches of the Kissimmee River contribute high levels of nutrient loading to Lake Okeechobee.

Another important tributary to the lake is the Taylor Creek/Nubbin Slough basin. The Taylor Creek/Nubbin Slough basin contributes high levels of nutrient loading, low levels of dissolved oxygen, and elevated coliform bacteria and turbidity levels to the lake. The Taylor Creek/Nubbin Slough basin contributes only 4 percent of the total volume of inflows to Lake Okeechobee, but accounts for approximately 29 percent of the total phosphorus inflow loads.

Eight segments of Lake Okeechobee are also included on the Section 303(d) list. Water quality parameters/criteria causing impairment at eight different monitoring locations in Lake Okeechobee include: excessive nutrients, low levels of dissolved oxygen, and high concentrations of unionized ammonia, iron, chlorides, and coliform bacteria. The Fisheating Creek and C-41 basins on the northwest side of the lake also contributes pollutants causing impairment in Lake Okeechobee.

Water quality in Lake Okeechobee is expected to slowly improve between 1999 and 2050. Field and laboratory studies of phosphorus stored in lake sediments indicate that sediment bound phosphorus is a dominant pollutant affecting lake water quality (Reddy et al., 1995). Currently, the average cumulative phosphorus load to the lake exceeds the Surface Water Improvement and Management Plan target by approximately 100 tons per year (SFWMD, 1997f). Phosphorus loads to the lake eventually become sequestered in lake sediments. The phosphorus in these sediments, which has accumulated over time from excessive external loads, is frequently resuspended (primarily by wind-aided mixing: Havens, 1997) and will tend to maintain a high phosphorus concentration in the water column, even if all sources of phosphorus in the contributing watershed are controlled consistent with regulatory and watershed management programs. Although short-term water quality conditions in Lake Okeechobee are not expected to improve, in place pollutant reduction programs in the lower Kissimmee River and Taylor Creek/Nubbin Slough basins are expected to result in long-term reduction in Lake Okeechobee water column nutrient concentrations

Urban development in the Lake Okeechobee watershed and non-point source pollution loading associated with urban stormwater runoff is not expected to increase significantly by 2050.

5.3.4 Upper East Coast and Indian River Lagoon

The Upper East Coast region includes Martin and St. Lucie Counties and a small portion of Okeechobee County. The principal water body is the Indian River Lagoon, which includes the St. Lucie River. The Upper East Coast is hydrologically connected to the Everglades and Florida Bay ecosystems through the C-44 (St. Lucie) Canal. The Indian River Lagoon is a SWIM priority water body. Most of the Upper East Coast watershed consists of Class III waters; however, there are small areas of Class II waters (shellfish propagation or harvesting) within the watershed. Class II waters are generally afforded greater protection than Class III waters. Currently, nine locations in the St. Lucie (C-44) Canal, the North and South Forks of the St. Lucie River, and several sub-basins draining to the Indian River Lagoon are listed by the Florida Department of Environmental Protection on the 1998 303(d) list of impaired waterbodies. Pollutants/constituents causing impairment include: low levels of dissolved oxygen, excessive nutrients, high levels of total suspended solids (TSS), high biochemical oxygen demand, coliform bacteria, and mercury (based on fish consumption advisories). There are an additional eight monitoring locations in the southern Indian River Lagoon area also included on the 1998 303(d) list. In addition to the above-listed constituents, copper and turbidity were identified to be causing use impairment at some of the monitoring sites.

Overall, water quality conditions in the Upper East Coast and the Indian River Lagoon are expected to be somewhat improved by 2050, compared to existing conditions. Lake Okeechobee freshwater discharges via the St. Lucie Canal (C-44) alter ambient salinity levels and deliver nutrients and other pollutants contained in Lake Okeechobee water and runoff from localized sources (agricultural and urban) to the estuary. The C-23/C-24/C-25 Canal system in St. Lucie County facilitates drainage to sustain agricultural (primarily citrus groves) and urban development in the vicinity of those canals. Implementation of a different regulation schedule for Lake Okeechobee is also expected to improve water quality conditions in the Indian River Lagoon Estuary by reducing the frequency and volume of fresh water delivered to the estuary. It is also expected that agricultural non-point source pollution loads delivered to the estuary via secondary and tertiary canals connected to C&SF Project canals will be reduced compared to existing conditions through the implementation of agricultural Best Management Practices and the conversion of some agricultural lands to other uses (e.g., conservation, urban/suburban development).

The extent of urbanization in the watershed is expected to increase by 2050. New growth and development in the watershed will be regulated to comply with water quality regulations governing point and non-point source discharges; however, the net pollution load contributed to the St. Lucie River and the Indian River Lagoon system from these sources is expected to increase compared to existing conditions. Ongoing and planned pollutant load reduction activities in the Upper East Coast region should help offset additional pollutant loads expected to occur from future urbanization.

5.3.5 Everglades Agricultural Area

According to the Florida Department of Environmental Protection's 1998 303(d) list of use-impaired water bodies, there are approximately 10 canal segments within the Everglades Agricultural Area not meeting designated uses for Class III waters. For the most part, these include canal segments affected by operation of the primary pump stations and canals discharging water from the Everglades Agricultural Area to downstream areas (e.g., S-7, and S-8 pump stations; North New River, Hillsboro, and West Palm Beach Canals). In addition to excessive nutrient loads, low dissolved oxygen levels and high levels of mercury (based on fish consumption advisories), coliform bacteria, total suspended solids, turbidity, and unionized ammonia contributed to use impairment in Class III waters within the Everglades Agricultural Area. It should be noted that within the Everglades Agricultural Area, there are many agricultural canals or ditches in agricultural water management systems controlled by water control structures permitted by the South Florida Water Management District. Such water bodies are classified as Class IV waters (agricultural water supply) pursuant to Rule 62-302.600(3)(a), Florida Administrative Code. Generally, the water quality criteria for Class IV waters are less stringent than those for Class III waters. None of the 303(d)-listed segments within the Everglades Agricultural Area are in Class IV waters.

Water quality conditions within the Everglades Agricultural Area are expected to improve in 2050 compared to existing conditions. It is important to note that the existing conditions for the Everglades Agricultural Area demonstrate significant water quality improvements compared with recent past conditions. Recent water quality improvements in the area have occurred as a result of the implementation of the Everglades Agricultural Area regulatory program (Florida Administrative Code Rule 40E-63) beginning in 1993. The regulatory program requires Best Management Practices and monitoring to achieve a 25 percent reduction in phosphorus loading from the Everglades Agricultural Area to the Everglades Protection Area. Recent monitoring results indicate that phosphorus loads in area runoff have declined approximately 51 percent (three year average, SFWMD, 1997b). The current average concentration of total phosphorus contained in Everglades Agricultural Area runoff is approximately 100 parts per billion (Havens, 1997). Best Management Practices are also expected to have resulted in a net reduction of other pollutants contained in agricultural runoff, although the extent of load reduction for other pollutants has not been fully quantified since the implementation of the program; nor is it a specific objective of that program.

5.3.6 Natural Areas

Approximately 18 waterbody segments within Loxahatchee National Wildlife Refuge (Water Conservation Area 1), and Water Conservation Areas 2 and 3 were listed as use-impaired on the Florida Department of Environmental Protection's 1998 303(d) list. Pollutants/water quality parameters contributing to use-impaired conditions include: excessive nutrient loads, low dissolved oxygen levels, high levels of mercury (based on fish consumption advisories), un-ionized ammonia, coliform bacteria, total suspended solids and certain trace metals. There are also four waterbody segments in Everglades National Park on the 303(d) list. Those water body segments include: ENP Shark Slough, ENP L67 Culvert @ US 41, Taylor Slough, and the Tamiami Canal. Problem constituents in Everglades National Park waters include low levels of dissolved oxygen, and high levels of nutrients, mercury (based on fish consumption advisories), iron, other trace metals. Many of the water body segments in the Water Conservation Areas and Everglades National Park may eventually be removed from subsequent 303(d) lists because the Everglades Forever Act includes schedules and strategies for achieving compliance with water quality standards, consistent with the requirements of the Clean Water Act.

Water quality conditions in the Rotenberger and Holey Land Wildlife Management Areas, Loxahatchee National Wildlife Refuge, the Water Conservation Areas and in downstream Everglades National Park are expected to be significantly improved in 2050 compared to current (without the Everglades Construction Project) conditions.

In the southern Everglades, implementation of the C-111 and Modified Water Deliveries Projects may also involve developing water quality treatment features necessary to assure that regulatory requirements are met. Minimally, implementation of the C-111 Project involves acquisition of the Frog Pond agricultural area adjacent to the C-111/L-31W levee/borrow canal system, which will result in a net reduction of pollution loading (nutrients, pesticides) into Everglades National Park via the existing canal system from non-point source agricultural runoff.

5.3.7 Lower East Coast and Biscayne Bay

For Restudy planning purposes, the Lower East Coast consists of Palm Beach, Broward, and Miami-Dade Counties, including Biscayne Bay and Lake Worth Lagoon. According to the Florida Department of Environmental Protection's 1998 303(d) list, approximately 42 waterbody segments (both fresh and marine waterbodies) within the Lower East Coast are use-impaired. Pollutants/water quality constituents causing impairment include low levels of dissolved oxygen, high levels of mercury (based on fish consumption advisories) and other trace metals, and high levels of coliform bacteria, total suspended solids, bio-chemical oxygen demand, and un-ionized ammonia.

Four of the main C&SF Project canals delivering flows from Lake Okeechobee and the Water Conservation Areas (the West Palm Beach, Hillsboro, New River, and Miami Canals) traverse the Lower East Coast. In addition to conveying Lake Okeechobee and Water Conservation Area flows, the C&SF Project canals and a network of connecting secondary and tertiary canals provide drainage in the Lower East Coast, which conveys stormwater runoff and attendant pollution loads to estuarine waters. Management of stormwater runoff and flooding via the existing canal system has been implicated as the chief cause of water quality degradation in the region, particularly in the northern portion of Biscayne Bay.

Improving water quality in the Lower East Coast to meet water quality standards in all impaired water bodies will likely be difficult, considering the extent of urban development, minimal or non-existent water quality treatment for non-point source runoff, and other direct (point source) and indirect discharges adversely affecting water quality in the Lower East Coast. Water quality conditions are expected to worsen in the Lower East Coast (central and southern Palm Beach, Broward, and Miami-Dade Counties) by 2050 compared to current conditions. Florida Department of Environmental Protection's 1996 Section 305(b) report to the U.S. Environmental Protection Agency describing water quality conditions in the region indicates that most of the region exhibits "fair" or "good" water quality. The report goes on to state that "most pollution (in the region) comes from stormwater", although bacteriological contamination from wastewater discharges and septic tanks is also a significant problem, particularly in the Miami River, downstream in Biscayne Bay, and urban areas west of the intracoastal waterway in Broward

County and north of the New River. Water quality conditions in receiving water bodies in 2050 are expected to be further degraded, due to the developed condition of the watershed and the continued accumulation of pollutants in sediments in receiving water bodies.

Nearly all of this heavily urbanized watershed drains to estuarine waters. Net pollution loads, especially from non-point sources, to receiving waters in the Lower East Coast are expected to increase as a result of projected population increases. The expected increase in net pollution loads may not be directly proportional to population growth. New growth and urban/suburban development in the Lower East Coast must comply with water quality treatment requirements for non-point source runoff, whereas much of the existing development in the Lower East Coast does not include facilities for treatment of non-point pollution sources. Nevertheless, the projected addition of approximately 2.7 million people to the region is expected to cause water quality conditions to be further degraded, especially in those basins which are already stressed by existing pollution loads.

In Palm Beach County, the Lake Worth Lagoon Estuary is the receiving water body for most of that urban watershed. There are approximately eight use-impaired waterbodies in Palm Beach County on the Florida Department of Environmental Protection's 1998 303(d) list. Listed waterbody segments include coastal canals and freshwater areas further inland. Water quality conditions are expected to improve (in terms of estuarine salinity targets) as a result the C-51 (Stormwater Treatment Area 1 East) Project, which will divert fresh water discharges to Lake Worth Lagoon to a treatment area prior to discharge to Water Conservation Area 1. However, net non-point source pollution loads to Lake Worth Lagoon may increase commensurate with increases in population and development.

Although there are no extensive estuarine water bodies in Broward County, remaining mangroves in southern Broward County canals and along the Intracoastal Waterway provide similar habitat. There are approximately 21 303(d)-listed use-impaired water body segments in Broward County. These waterbody segements are primarily coastal canals providing drainage. Due to the extent of existing urban development in the watersheds of those canals, it is not likely that there will be a significant increase in future non-point source pollution loads into these water bodies. However, it is also unlikely that basin-wide stormwater best management practices (e.g., retention/detention facilities, filtration, etc.) can be implemented effectively in heavily urbanized watersheds, due to the lack of available land for such facilities. Future basin planning efforts during TMDL development and implementation may result in more effective controls of other direct (point source) and indirect discharges of pollutants (e.g. car washes and other industrial facilities). At best, the long-term prognosis for improving all use-impaired water bodies in coastal areas of Broward County is uncertain.

In Miami-Dade County, approximately 13 waterbody segments were identified as use-impaired on the Florida Department of Environmental Protection's 1998 303(d) list. Most are coastal canals providing drainage of runoff to Biscayne Bay. Biscayne Bay is the largest estuarine water body in the Lower East Coast, and is the receiving water body for most of the developed area of Miami-Dade County. Most of Biscayne National Park is located within the central and southern portion of the Biscayne Bay Estuary. As with some of the Broward County canals, controlling non-point sources of runoff in heavily urbanized areas in Miami will be difficult, due to the lack of available land for basin-wide best management practices. Some incremental improvement of non-point source pollution loads may be realized through the basin management plans to be developed by the Florida Department of Environmental Protection. Point sources and other direct discharges of pollutants to Biscayne Bay and tributary canals should be significantly improved if basin management plans are fully implemented. However, overall, it is not expected that water quality in coastal canals draining to Biscayne Bay will be improved to the point that all surface water quality standards will be achieved. Furthermore, any water quality benefits achieved as a result of the Biscayne Bay Surface Water Improvement and Management Plan may be offset by increases in non-point source pollution loads associated with projected population increases.

5.3.8 Florida Bay

Barnes Sound is the only segment of Florida Bay included on the Florida Department of Environmental Protection's 1998 303(d) list. Excessive nutrients, chlorides, and low dissolved oxygen were identified as constituents of concern in ambient water quality monitoring. Other areas of the bay also experience periodic water quality problems. Salinity is the primary water quality parameter of concern in the bay. Bay waters are periodically hypersaline or too low in salinity, depending upon the frequency of hurricanes and other significant storm events and flood release discharges from Central and Southern Florida Project features. Advective conditions in the bay have also contributed to extensive algal blooms. Water temperature levels are also periodically elevated above prescribed temperature limitations. Seatrout collected from Florida Bay also exhibit elevated mercury levels.

Water quality conditions in northeastern Florida Bay should improve in 2050 compared to existing (1995) conditions. Full implementation of the Biscayne Bay SWIM Plan elements should benefit water quality conditions in Florida Bay also. When fully completed, it is anticipated that the C-111 Project would improve water quality conditions in the vicinity of Taylor Slough through the implementation of structural and operational changes necessary to achieve preferred hydrologic conditions. It is expected that the net load of agricultural non-point source pollution entering the C-111 Canal and south into Florida Bay will be reduced in 2050 compared to existing conditions. The Modified Water Deliveries to Everglades

National Park Project is also expected to result in water quality improvements in Florida Bay through the delivery of increased volumes of fresh water to the bay via Northeast Shark River Slough.

5.3.9 Florida Keys

The Florida Keys as a whole were identified as having use-impaired water quality on the Florida Department of Environmental Protection's 1998 303(d) list; however, water quality problems are generally restricted to canals, marina basins, and nearshore waters as opposed to adjacent open waters. The principal pollutants of concern are excessive nutrient loading and fecal coliform bacteria from inadequate wastewater treatment and disposal facilities, although low dissolved oxygen levels are also common in Keys canals.

Due to recently imposed growth management regulations and limitations on expanded urban development, the population of the Keys is not expected to greatly increase by 2050. In addition, the Florida Keys National Marine Sanctuary Plan (National Oceanic and Atmospheric Administration, 1996) contains a Water Quality Protection Program developed by the U.S. Environmental Protection Agency (USEPA, 1996) in cooperation with the Administration and the Florida Department of Environmental Protection. The Water Quality Protection Program Document, approved in 1996, contains a set of initial recommendations for corrective actions, monitoring, research, and education/outreach. These recommendations have been included in a Water Quality Action Plan focusing on wastewater, stormwater, marinas and live-aboard vessels, landfills, hazardous materials, mosquito spraying, canals and research and monitoring. If the recommended wstewater and stormwater corrective actions are implemented, water quality conditions in the Florida Keys region are expected to be improved in 2050 compared to existing conditions.

The U.S. Environmental Protection Agency, other federal, state and local agencies and citizen stakeholders have identified wastewater infrastructure as the single most important investment to improve nearshore and canal water quality. The cost of wastewater improvements necessary to improve nearshore and canal water quality in the Florida Keys has been estimated at between $184 to $418 million, depending on the percentage reduction in wastewater nutrient loadings to be achieved and which treatment system or systems are ultimately selected. Improvements of stormwater management in the area of the Florida Keys is also needed. The cost of stormwater management and treatment necessary to reduce pollutant loadings in the Florida Keys is estimated at between $370 to $680 million, depending on the percentage reduction in stormwater pollutant loadings targeted to be achieved and which areas are selected to be retrofitted. Water quality improvements in Florida Keys canals and nearshore areas are expected to result from improved wastewater collection, treatment, and disposal implemented through the Monroe County Wastewater Master Plan and through implementation of the Monroe County Stormwater Master Plan, both of which are major components of the Water Quality Protection Program.

5.3.10 Big Cypress Basin

The Big Cypress Basin (the watershed of Big Cypress National Preserve) includes agricultural areas west of the Everglades Agricultural Area, the Seminole Tribe's Big Cypress Reservation, most of the Miccosukee Tribe of Indians' reservation lands, and developed areas of the west coast including Naples and Marco Island. Five waterbody segments within the Big Cypress Basin were included on the Florida Department of Environmental Protection's 1998 303(d) list. Pollutants/constituents of concern include excessive nutrients, coliform bacteria, biochemical oxygen demand, mercury (based on fish consumption advisories), and low levels of dissolved oxygen. It should be noted that none of the 303(d) list sites are within the Big Cypress National Preserve. However, the L-28 Interceptor Canal, on the east side of the Big Cypress Basin was listed as use-impaired due to elevated nutrient levels and low levels of dissolved oxygen. It should be further noted that due to the scarcity of ambient monitoring sites in coastal waters of the basin, actual water quality problems are likely to be more severe in coastal waters than as described in the Florida Department of Environmental Protection's 1996 305(b) Report due to development pressure and point and non-point source pollution loading in developing areas.

Water quality in interior areas of the Big Cypress Basin (the watershed of Big Cypress National Preserve) is not expected to be significantly changed in 2050 compared to existing conditions. However, the rapidly expanding extent of agricultural (citrus) development in the north-central area of the region (Immokalee, southwestern Hendry County) could create an increase in non-point source pollution associated with agricultural activities in Mullet Slough and East Hinson Marsh. Water quality in coastal areas is expected to decline consistent with projected population growth.

Excessive drainage and the introduction of water of poor quality into Big Cypress National Preserve via the existing canal system constitutes the most significant existing and future water quality problem for Big Cypress National Preserve. It should be noted that the canals contributing pollutants into Big Cypress National Preserve are not part of the C&SF Project. Existing pollution loads entering the Big Cypress National Preserve from northwestern areas of the watershed (Big Cypress Seminole Indian Reservation, C-139 Basin and C-139 Annex agricultural areas) are expected to be reduced in 2050 through the implementation of planned and ongoing water quality improvement projects.

5.3.11 Caloosahatchee River Region

The Florida Department of Environmental Protection listed approximately 14 water body segments in the Caloosahatchee River basin and in downstream coastal waters on its 1998 303(d) list. Water quality parameters of concern include excessive nutrients, coliform bacteria, biochemical oxygen demand, and depressed levels of dissolved oxygen. As with the Big Cypress Basin, the number of monitoring locations in coastal waters of the region used to prepare the 305(b) Report is probably inadequate to accurately characterize the extent of water quality degradation in coastal areas. Extensive urban development (Ft. Myers and vicinity, Cape Coral) at the mouth of the Caloosahatchee River contributes significant point and non-point source pollution loads into coastal canals and downstream into the Caloosahatchee estuarine system.

In 2050, water quality conditions in the upper (eastern) and central portions of the watershed are expected to be unchanged compared to existing conditions. Water quality in downstream coastal areas is expected to decline as a result of increased population growth and urban and agricultural development. Water quality impacts from increased agricultural development are expected to be most readily observed in downstream areas of the watershed. The projected increase in population growth in urban areas of the Caloosahatchee River region's watershed is expected to exacerbate existing water quality problems in coastal waters, particularly those associated with wastewater discharges. Offsetting the coastal development and inland agricultural development water quality impacts is the implementation of a different regulatory schedule for Lake Okeechobee, which is expected to improve water quality conditions in the Caloosahatchee River and estuary by reducing the frequency and volume of large quantities of nutrient/sediment laden Lake Okeechobee flood regulation waters.

5.3.12 Mercury

There is much uncertainty about the sources of mercury in south Florida and the Everglades marsh mercury cycling processes that control mercury bioaccumulation. Controlling mercury contamination of the Everglades ecosystem depends on actions that are beyond the scope of the Restudy. The major external source of mercury for the Everglades ecosystem is atmospheric deposition. Some estimate that a high percentage of the mercury deposited into the Everglades could be contributed from local atmospheric emission sources in the urban area (Dvonch, 1998). Others estimate that most of the mercury deposited on the Everglades originates from outside Florida. Research indicates that mercury deposition rates in portions of North America have greatly increased since the turn of the century (Swain, et al, 1992). Some of this historically accumulated mercury is being recycled by the ecosystem; however, this historical mercury could also be buried beneath the recycling zone by accumulating peat if new sources are shut off.

The effect of this burial process hypothesis has been estimated with a mercury cycling model (Ambrose et. al., in press). The model predicts that as little as a 50 percent reduction in atmospheric mercury deposition over the next 50 years (2050) will decrease methylmercury concentrations in Everglades water and fish. Recent and potential future regulatory emission controls may be needed to reduce the atmospheric loading to the system from local sources; however, the significant global atmospheric mercury component is much more difficult to control and will require international agreements.

If control of atmospheric mercury deposition can be affected by decreasing local emission sources in concert with the implementation of the 44,000 acres of Stormwater Treatment Areas constructed as part of the Everglades Construction Project, additional benefits may accrue. However, the complex interactive modeling predictions have not yet been done. The long-term efficiency of the Stormwater Treatment Areas in removing phosphorus and other water quality constituents is presently uncertain, as is the effect of these water quality changes on mercury cycling downstream. Among the key factors that are thought to influence mercury cycling within the Everglades are complex inter-relationships involving phosphorus, sulfur, oxygen, carbon, periphyton, peat accretion and sediment redox conditions. There is no scientific consensus as to which of these factors will dominate, and whether the driving factors will be the same throughout all portions of the 4,000 square mile Everglades ecosystem. Given the 80 percent reduction in total phosphorus obtained in the Everglades Nutrient Removal Project during the early years of operation, it is possible that a decrease in the methylation of mercury could occur downstream due to the declining nutrient concentrations to the marsh and the reduced stimulation of both producers and decomposers. However, it is unclear what effect changes in sulfur forms will have on mercury methylation, and which influence will dominate.

5.4 ECONOMIC AND SOCIAL WELL-BEING PROBLEMS AND OPPORTUNITIES

The C&SF Project, by providing flood protection and water supply, has enabled the population of south Florida to grow from approximately 900,000 persons in 1950 to over 5.5 million in 1995. By 2050, population is projected to grow to 11.6 million. Increases in population growth intensify the competition for and stress upon regional water resources.

With the current C&SF Project, the availability of water from regional surface and ground water sources remains relatively constant. The growing demand for inexpensive, high quality water for agriculture, industry, and an increasing population could exceed the limits of readily available sources. When factoring in the needs of the natural system, upon which a good part of the region's economy depends, conflicts among water users may become even more severe. In addition, the human community is fundamentally dependent on the project for public health, safety, and welfare.

In the south Florida region in general and the Lower East Coast in particular, per capita income levels are higher than in the rest of the state. There is a strong per capita income difference between the urbanized Lower East Coast and the agricultural areas surrounding Lake Okeechobee. Employment and income opportunities in the important industries of agriculture and tourism are heavily reliant on the benefits provided by the C&SF Project.

Agriculture and tourism were identified as "critical industries" by the Governor's Commission for a Sustainable South Florida. Agriculture depends upon the system for vital water supply and flood protection. The tourism industry is dependent upon the project in a myriad of ways. For example, a healthy ecosystem and its attendant tourism are the mainstays of the Monroe County economy, as reflected by the relative domination of economic activity there in the services, retail trade, and fisheries industries. The ability to sustain the region's economy and quality of life depend, to a great extent, on the success of the efforts to protect and better manage the region's water resources.

Predictions of water shortages in the future indicate serious – and probably unacceptable – levels of water supply cutbacks. Modeling shows that for the Lake Okeechobee Service Area, 24 percent of water supply demands could not be met over a 30-year period. This translates into 16 years (out of 30) in which the area was in water supply cutbacks. In the Lower East Coast, water supply cutbacks were predicted to occur in a range from 15 years in northern Palm Beach County and Miami-Dade County to 29 years in Broward County. The monetary losses incurred by these shortages are quantified in ***Appendix E*** of this report.

5.5 PLANNING GOALS AND OBJECTIVES

The purpose of the Restudy is to review how well the C&SF Project is functioning and determine what modifications may be needed. The precursor to the feasibility phase of the study - the reconnaissance study – was completed in 1994 and identified a set of regional-scale planning objectives. The Governor's Commission for a Sustainable South Florida also developed a set of regional-scale objectives for the Restudy as part of their effort to develop the *Conceptual Plan for the Restudy*. A synthesis of these has resulted in an inclusive set of objectives to achieve two general goals for the south Florida ecosystem: enhance ecologic values, and enhance economic values and social well being. These goals, and the study objectives associated with them, are shown in ***Table 5-1***.

TABLE 5-1
GOALS AND OBJECTIVES FOR THE C&SF RESTUDY

Goal: Enhance Ecologic Values
• Increase the total spatial extent of natural areas • Improve habitat and functional quality • Improve native plant and animal species abundance and diversity
Goal: Enhance Economic Values And Social Well Being
• Increase availability of fresh water (agricultural/municipal & industrial) • Reduce flood damages (agricultural/urban) • Provide recreational and navigation opportunities • Protect cultural and archeological resources and values

5.5.1 Enhance Ecologic Values

Healthy natural systems are integral to the sustainability of south Florida. These systems provide numerous functions such as:

- habitat for numerous plant and animal species,
- recreation and educational opportunities (photography, fishing, hunting, bird watching, etc.),
- water quality filtration including removal of nutrients and silt,
- ground water recharge,
- soil formation,
- hydrologic linkages,
- ground water quality protection,
- interception of airborne pollutants,
- shoreline stabilization, and
- protection against erosion.

Each natural area is uniquely important. Wetlands and lakes, in particular, retard floodwater and provide surface water storage. Mangroves and estuaries provide important feeding areas for manatees and breeding habitat for numerous finfish and shellfish, including several of commercial interest. Upland natural systems function as noise buffers, urban green space, habitat for plants and animals (such as tree snails, deer, hundreds of species of birds, and the endangered panther and indigo snake), and travel corridors for these same animals. Thus, plant and animal habitat, although perhaps the most obvious benefit or function, is just one of many functions that natural systems provide. Collectively, these systems benefit the natural ecology and support agricultural, urban, and other human interests as well. The ecological health and hydrologic characteristics of Lake Okeechobee and south Florida's freshwater wetlands directly affect the quality of the receiving water bodies, including the St. Lucie and Caloosahatchee Estuaries, and Biscayne and Florida Bays.

Two documents are particularly important in framing the Restudy's goal for enhancing *ecological* values. These documents, which were prepared by many of the leading experts on Everglades ecology, are *The Science Sub-Group Report, Federal Objectives for the South Florida Restoration* (Science Sub-Group, 1993), and *Everglades, the Ecosystem and Its Restoration* (Davis and Ogden, 1994). Another earlier publication, *Ecosystems of Florida* (Myers and Ewel, 1990) also contributed substantial input into the Restudy.

5.5.1.1 Spatial Extent

Scientists have identified the large spatial extent of the south Florida wetlands as one of the defining physical characteristics of the pre-drainage ecosystem. The size of the south Florida wetlands, in combination with the complex mosaic of habitats, enabled multiple populations of plants and animals to persist over time. The size of the pre-drainage area made it possible for the natural ecosystem to: 1) support genetically viable numbers and sub-populations of species with large feeding ranges and/or narrow habitat requirements, 2) provide the aquatic production to support large numbers of higher vertebrate animals in a naturally nutrient-poor environment, and 3) sustain habitat diversity despite natural disturbances. The ability of animal populations to recover from disturbances decreases as the available habitat area decreases since habitat diversity, the amount of seasonal refugia, and the number of dispersal options also decrease.

Roughly 50 percent of the pre-drainage wetland area and 90 percent of pinelands have been lost to development. Lake Okeechobee was much larger then it is at present with an extensive littoral/marsh system extending to the north, west, and south. The resulting loss of these natural areas has caused wading bird, snail kite, and panther populations, for example, to be stressed. Assuring adequate spatial extent for natural systems, necessary to support the mosaic of habitats characteristic of the pre-drainage ecosystem, will provide for genetically viable numbers and populations of native species and habitat diversity.

5.5.1.2 Habitat and Functional Quality

Adverse changes in natural habitats, including sawgrass, mangroves, seagrass beds, and other native wetland habitats, as well as in many native fish and wildlife species, such as wading birds, alligators, shrimp, and lobsters, that depend on healthy habitats for survival have occurred in the south Florida ecosystems. The specific functions that wetlands or uplands perform are closely associated with their condition or quality. A reduction in the quality of these areas results in the loss of many or all of the functions that these areas historically performed. Improving the functional quality of the remaining natural areas is important to system-wide restoration given the loss of spatial extent and, thus, function of the historic wetlands and uplands.

South Florida natural habitats have been physically and hydrologically altered and manipulated. Consequently, these Florida ecosystems are now substantially less productive and diverse than the historic system. For example, although many of the historic short hydroperiod wetlands no longer exist, wetlands that were historically much wetter now have short hydroperiods. Another example is the alteration of wetlands in the Water Conservation Areas. These areas are managed as separate entities and are hydrologically different from historic conditions resulting in changed hydropatterns and quality of the wetlands and tree islands. Aquatic productivity has been reduced or highly altered throughout the marshes of the central Everglades and the estuaries. Reductions in aquatic productivity have affected the abundance of birds as well as fish. Changes in habitat, construction of deep canals, and abnormally extreme water levels impact the foraging ability of birds. Additionally, changes within interior and coastal wetlands have adversely influenced downstream commercial fish and other species in coastal ecosystems such as Florida Bay.

Invasive plant and animal species have also impacted the quality of the south Florida landscape. Invasive species include both native (i.e. cattails) and non-native species (e.g. Melaleuca, Brazilian pepper, and Australian pine). The increasing dominance of any community by a single species ultimately reduces the habitat variability necessary to sustain a healthy community of both plants and animals. Water management has encouraged the spread of these invasive species by creating conditions under which they can out-compete the native habitat that existed under pre-drainage conditions. For example, high phosphorus loads and increased hydroperiods have contributed to cattails out-competing sawgrass; altered hydrologic regimes have increased the spread of Melaleuca and Brazilian pepper; and the construction of levees has contributed to the spread of Australian pine and Brazilian pepper. Eliminating the invasive and exotic species and the conditions that favor these species will contribute to restoration of native plants and animal species and a more natural ecosystem hydrology and function.

5.5.1.3 Species Abundance and Diversity

The changes that have taken place in the natural system have led to decreases in native animal and plant populations. One of the most obvious indicators that the south Florida ecosystems have experienced ecologically significant reductions in productivity is the decline in wading bird populations. Several species are now so reduced in numbers that their long-term existence is jeopardized unless measures are taken to ensure their sustainability. Other species have a naturally restricted range; these species are also vulnerable to extinction if their specialized habitats are altered. In addition to considering these species, it is important to recognize that maintaining balanced communities of the more abundant species is also essential to a sustainable ecosystem. It is also important to recognize that a balanced community is dynamic; population levels fluctuate widely from year to year as natural conditions fluctuate. Unnaturally small, isolated populations can be quickly extinguished by natural conditions.

Increasing spatial extent and improving habitat quality can provide a basis for improving species abundance and diversity. However, compartmentalization caused by construction of physical barriers such as dikes, canals, levees, and roads, or even hydrologic barriers (such as the Water Conservation Areas) has fragmented the system by creating a series of poorly connected natural areas. These barriers have restricted the movement of many fish and consequently reduced their range. Fragmented communities are more likely to lose species because the number of individuals in each fragment may be too small to persist. The smaller the fragment, the higher is the likelihood of losing species or favoring an imbalance in the species that do inhabit the areas. Moreover, fragmentation itself alters the landscape by breaking connections between the various habitat types that were distributed historically across the landscape. Therefore, improving the connectivity of habitats will improve the range of many animals and their prey-base and provide for a more natural balance of species within the system. The physical barriers that created the fragmented environment themselves affect species abundance. The introduction of deep canals which act to drain surrounding areas, affect the ability of wading birds to forage over large areas.

5.5.2 Enhance Economic Values and Social Well Being

The C&SF Project provides economic benefits through regional water supply, flood damage reduction, navigation, and recreation. While most people recognize the need for a healthy ecosystem to support the region's economy and jobs, many people are concerned that restoration projects will displace farms and other businesses, limit development, reduce available water supply, and reduce job opportunities. By contrast, continued degradation of the south Florida ecosystem will adversely affect the tourism and recreational industry that are important to the regional economy.

5.5.2.1 Water Supply

Drainage, water supply, and flood protection afforded by the C&SF Project have provided for the growth of south Florida's population, which by 1990 was 5.2 million. Local governments in south Florida are predicting that total population will reach 8 million by 2010 and will range from 12-15 million people by 2050. Approximately 88 percent of the region's current population are concentrated in the coastal urban counties of Miami-Dade, Broward, Palm Beach, Lee, and Collier; this distribution pattern is projected to continue. Urban water supply demands could increase from approximately one billion gallons of water per day today to two billion gallons of water per day by 2050. Lake Okeechobee is an important source of water to both natural and developed areas, particularly during low rainfall years. The growing demand for dependable water for agriculture, industry, and a burgeoning population at a reasonable cost could rapidly exceed the limits of readily accessible sources. If the needs of the region's natural systems are factored in, conflicts for water among users will become even more severe.

In the study area, surficial aquifers supply the majority of water for urban use. These aquifers are vulnerable to salt water intrusion. In the Lower East Coast area, salinity intrusion has resulted from two major events. The first is the lowering of the ground water table in the area due to drainage and reduced recharge as well as the increased withdrawal of water by pumping. The second reason is the construction of numerous drainage and navigation canals from inland areas to the coastal waters.

In order to prevent saltwater from entering the local surficial aquifer and contaminating nearby well fields, the water table in coastal areas should be maintained at the level needed to stabilize the fresh water - saltwater interface. Existing criteria to protect against saltwater intrusion requires maintenance of a one-foot mound of fresh water between the withdrawal point and the saline interface. This is accomplished by maintaining canal levels high enough so that the hydraulic interconnection of the canals and the aquifer maintains a fresh water gradient that is adequate to prevent intrusion of saltwater into the fresh surficial aquifer.

5.5.2.2 Flood Protection

The C&SF Project was conceived and authorized to provide regional flood protection for south Florida. The system of canals, levees, water control structures and pump stations conveys and confines flood waters to regional storage facilities such as Lake Okeechobee and the Water Conservation Areas, or to tidal receiving waters. Further, additional protection is afforded by the local systems operated by special taxing districts, private property owners, and local governments.

Throughout the C&SF Project area, there are varying levels of flood protection. This is primarily due to variations in the original design goals and changes in land use that have occurred. Many areas that were expected to remain in agriculture have been developed, thereby changing the level of flood protection offered by the project. However, the existing investment in flood protection infrastructure was never intended to totally eliminate flooding in developed areas and flooding does occur periodically. In addition, natural areas have also suffered damage as a result of operating the flood control system to benefit the developed areas. For example, damaging releases to estuaries, unnaturally high water levels in the Water Conservation Areas, and backpumping to the Water Conservation Areas have occurred as a consequence of flood control.

Flood protection needs have increased since the original flood control project was constructed. As agricultural and urban development continues, the volume, duration, and frequency of floodwaters may increase; the actual level of flood protection may have declined in some areas. There is an opportunity to further reduce the extent of damages from flooding through operational and structural changes to the C&SF Project and local drainage systems.

5.5.2.3 Recreation and Navigation

Public use has been an important consideration of the C&SF Project since it was first developed. The C&SF Project provides opportunities for a wide range of outdoor activities, including: fresh water and estuarine fishing, boating, hunting, camping, picnicking, nature watching, and photography. It also provides the public with access to areas where they can simply "get away from it all." The opportunity to pursue these activities is very important to the economy of south Florida and to the people who make use of these opportunities, including residents, visitors, eco-tourists, and the Native American Tribes. Restoration and protection of the remaining Everglades system, the Keys, south Florida estuaries (including Florida Bay), and reef tracts are essential to the economic base provided by these recreational and traditional uses.

5.5.2.4 Social and Cultural

Societal sustainability requires the preservation of the rich cultural diversity of the region, such as the Native American communities and the multi-generational culture of the agricultural communities. The rapidly growing population of south Florida is decreasingly dependent directly on the environment for its sustenance, with the exception of water needs. Yet that population is increasingly dependent indirectly on a restored and sustainable environment, such as for support for the economic base of tourism as well as the heightened awareness of the environmental ethic to preserve and sustain this unique natural environment for the future generations to experience and value.

5.6 ECOSYSTEM RESTORATION

Following the development of the planning objectives, there were a number of principles and issues which were developed to guide the overall ecosystem restoration effort. This section defines and discusses these principles and issues.

5.6.1 Why Restore the South Florida Ecosystems?

South Florida ecosystems are highly valued at local, national, and international levels. Locally, people value these areas as places to go to interact with nature, to escape from the pressures of "city life," or as a means of making a living. In response to national recognition and concern for its future, a portion of the historic Everglades was designated as the Everglades National Park in 1947. Internationally, the Park is recognized as an International Biosphere Preserve and a World Heritage Site. Additional recognition of the region's wetlands occurred with the establishment of the Big Cypress National Preserve in 1974, and the Biscayne National Park in 1980.

Lake Okeechobee is one of the largest natural lakes in the United States. Lake Okeechobee is commonly referred to as the “liquid heart” of Florida. It is a vital component of the interconnected Kissimmee River, Lake Okeechobee, Everglades, St. Lucie and Caloosahatchee Estuaries, and Florida and Biscayne Bays ecosystems. This lake is important not only to its resident fish and wildlife species but also to wide-ranging animals, particularly wading and migratory birds. Thus the health of Lake Okeechobee affects not only its own resources but resources throughout south Florida, including the estuaries and bays.

At the ecosystem level, the south Florida lakes and wetlands are not only beautiful to see but help reduce the damage of floods, droughts, and contaminants. Inland freshwater lakes and marshes reduce the danger of floods by collecting runoff, storing it, and releasing it over longer periods of time. The effects of droughts are often offset by the vast quantities of water which are stored as groundwater or in shallow marshes during normal wet seasons. Wetlands clean water by removing organic and inorganic nutrients and toxic materials from water that flows across them. Freshwater wetlands are closely associated with groundwater recharge, and the hydraulic pressure of wetlands along the coast keeps saltwater at bay.

A number of plant and animal species which live in south Florida are in danger of becoming extinct. If these species are removed from the gene pool, the functions and other benefits they provide (known or unknown at this time) will be lost. Without top predators, for example, populations of prey species such as raccoons, rabbits, and rats could explode. The crucial roles of many species in the natural community are only now being determined -- sometimes only as the consequences of their absence are felt. Loss of a species represents an irreplaceable loss of genetic material. The benefits such lost species would have provided will never be known.

Estuaries and bays are also important ecosystems in south Florida. Commercially harvested fish and shellfish depend on estuaries for nursery areas. Estuaries and bays are habitat to numerous fish and wildlife species. The estuaries and bays depend on the health of the freshwater wetlands upstream which are their source of water. These areas are dependent on appropriate volumes of water, which affects salinity; timing of flows, which effect breeding animals; and quality of flows, which effects species composition and abundance. Consequently, estuaries and bays have been impacted by detrimental conditions within the south Florida freshwater ecosystems. Likewise, the health of the south Florida economy is closely linked to the health of all of these interconnected/interdependent ecosystems.

5.6.2 Certainties and Uncertainties

The restored wetlands of south Florida will be smaller in area than the historical ecosystems, and will have different landscape components and proportions. Within this framework of change in spatial scales, it is impossible to predict with certainty how animal populations will respond to restored or improved hydrological conditions. More needs to be known about animals in the south Florida wetlands than the basic biological characteristics of the species, and relationships with abiotic features of the environment, in order to predict responses (DeAngelis and White, 1994). Changes in the spatial scale and landscape patterns of the system create *"... a multitude of complicating factors that are difficult to anticipate, including the importance of population histories, biological feedback on abiotic driving forces, species interactions, and species invasions"* (DeAngelis and White 1994).

The result of these changing conditions is that fundamental relationships between species of animals and the environment may change. For example, Ogden (1994) has shown that the hydrological conditions that stimulate the creation of large nesting colonies of wading birds have changed several times during the past 60 years. At different periods during the evolution of water management practices in the Everglades, nesting wading birds have responded in different ways to any given hydrological pattern, due to shifting patterns of production, distribution and survival of the bird's prey related to management practices. For American alligators, Craighead (1968) suggested that the population centers in the southern Everglades have changed from the marl prairies and interior, mainland estuaries to the central Shark River Slough, as a result of changes in regional hydrological patterns. Although a restoration objective might be to "shift" the centers of high alligator density from the central and northern Shark River Slough to the marl prairies east of Shark River Slough, it remains to be known where, in a restored system, these centers will be.

Our ability to predict animal responses is further complicated by the fact that we *"...rarely have full understanding of the nature of driving forces in an ecosystem..." (White 1994). "Although our collective knowledge of the Everglades ecosystem may be much stronger...",* today than 10 years ago, *"...this baseline of information still contains many gaps"* (Davis and Ogden, 1994). The South Florida Ecosystem Restoration Working Group's Science Subgroup (1993), Davis and Ogden (1994) and Hoffman (1994) agree that a regional hydrological restoration program is an essential prerequisite for ecological restoration, but precise answers to questions of how various natural components will respond, in such a physically altered system, do not exist with certainty.

It also should be recognized that the wetland ecosystems of south Florida are undergoing continual change independent of management and restoration programs (Davis and Ogden, 1994). Gleason and Stone (1994) have documented the continuing evolution of environmental conditions in this geologically young system. Alternating bands of peat and marl soils below Everglades marshes reveal an ecosystem that is passing through longer wet and dry cycles than are normally recognized in more contemporaneous discussions of the dynamics of these wetlands. And Wanless et al. (1994) has proposed that an increasing rate of sea level rise in southern Florida can produce profound changes in environmental conditions in the lagoon and estuarine regions, and on the extent of freshwater wetlands, throughout the Everglades and Big Cypress Basins.

Uncertainties in defining optimum hydrological targets for restoration also are created by uncertainties in the accuracy of the Natural System Model output. Because the Natural System Model has played such an important role in defining restoration targets, it is appropriate to summarize what is known regarding the accuracy of this model. Although a technical review of the Natural System Model (Bales et al., 1997) endorsed the value of the model for *"...estimating pre-drainage hydrologic responses in south Florida."*, the review also offered a number of cautionary comments. The review demonstrated that uncertainty in the model is due to a number of factors, including input data (e.g., topography), model assumptions (e.g., rainfall & evapotransporation distributions), parameters (e.g., Manning's *n* and evapotransporation coefficients), and model discretization. The review suggested that the model's *"...total uncertainty cannot be quantified. However...it seems appropriate to interpret the Natural System Model simulated water levels and ponding depths with about a plus or minus 1 foot uncertainty."* The review added that, *because "...the model should not be used to simulate discharges in pre-drainage south Florida... the maintenance of acceptable water levels and hydroperiods, rather than flows, is probably the key to restoration..."* A final conclusion of the review was that, *"The Natural System Model is a regional-scale model (Fennema and others, 1994), and results need to be interpreted at a regional scale rather than cell by cell... restoration success likely will be judged on ecological criteria, rather than on the ability of the water-management system to meet certain hydrologic targets. Much stronger linkages between hydrologic conditions and biological responses are needed."*

5.6.3 Different Views

The vision of the future wetlands in south Florida is influenced by different views of how restoration goals for the system are determined (Hoffman, 1994). The future Kissimmee River, Lake Okeechobee, Everglades, Big Cypress, and Florida Bay ecosystems can be, to some extent, what society wants them to be, based on value systems, and decisions about what conditions and components constitute a restored ecosystem. The different perspectives on a restored ecosystem are represented by one view that says that these wetlands will have been restored once certain population levels have been reached, for wading birds, alligators, endangered species, etc. In contrast, a different view is that restoration will have been achieved when certain defining ecological conditions (functions and relationships) that characterized the pre-drainage ecosystems have been recovered, without setting specific population levels as goals. It may be true that these different restoration targets are nothing more than different ways of characterizing recovered ecosystems, and that achieving one will achieve the other. There is agreement by proponents of both perspectives that a set of performance measures will be required to show whether the restoration programs are carrying these ecosystems in the correct direction. These measures should include the trends in numbers and distribution patterns of characteristic wetland species of wildlife, and the patterns of habitat mosaics, for comparisons with what is known about these species and habitats in both the current and pre-drainage systems. Selection of a set of ecological and hydrological performance measures assumes that a vigorous monitoring program will be maintained, to determine if the restoration program is properly directed, and to serve as a basis for mid-course corrections (adaptive assessment) if problems are detected.

5.6.4 The Recovered Ecosystems

Although there are different views of what these south Florida ecosystems should look like in the future, most of these differences seem to be ones of degree, or different focuses on the elements of the system that need to be measured in order to show that goals have been reached. What is broadly recognized is that there were specific ecological and physical characteristics of these pre-drainage wetlands, which defined “The Everglades”, “The Big Cypress”, and “Florida Bay” as uniquely distinct ecosystems. It must be assumed that these defining characteristics must be recovered before these ecosystems can be recovered and sustained over time, and before the restoration program can be considered to have been successful.

The ecological and physical features that specifically defined these ecosystems have been reviewed and discussed by the Science Sub-Group (1993), Davis and Ogden (1994), Hoffman (1994) and Ogden et al. (1994). These authors identified three ecological and two physical features of the pre-drainage wetlands of south Florida that defined these systems. The process used for selecting these defining ecosystem features was to identify features that best describe the dynamics of animal and plant communities at system-wide scales, and which were present in the pre-drainage systems.

5.6.4.1 Ecologic Features

The ecological features that defined the pre-drainage, south Florida wetland ecosystems are defined below:

(1) Large populations of wetland species of vertebrates were able to maintain long-term stability only by operating over large spatial scales, across community and landscape boundaries, within the system. Populations of several hundred thousand wading birds (herons, egrets, ibis, storks), along with large numbers of snail kites, limpkins, mottled ducks, and other waterbirds, depended on a spatially broad mosaic of feeding and nesting site options, which differed in importance along temporal scales, depending on seasonal and interannual variations in rainfall and surface water patterns.

(2) A second defining ecological feature was that heterogeneous habitat patterns were created and maintained within and across community boundaries due to the dynamic interplay among such factors as micro-topographic features, local climatic variation, fires, freezes, storms, and animal impacts (alligator holes and trails, for example), acting across the large spatial extent of the pre-drainage wetlands. The resulting mosaic of upland and lowland habitat types provided the spatial and temporal network for the production and survival of animals under a wide seasonal and annual range of hydrological conditions. DeAngelis and White (1994) have described how environmental heterogeneity at a variety of scales, in combination with large ecosystem size, functions to enable persistence and resilience of populations of plants and animals.

(3) The third defining ecological characteristic was that the pre-drainage freshwater wetlands evolved as an oligotrophic system, with the very limited input of nutrients coming primarily as phosphorus in rainfall. The low-nutrient environment was essential for the support of green algae/diatom periphyton communities, which were a major food base for the production of aquatic invertebrates and fishes in relatively long hydroperiod, freshwater marshes of the Everglades. The large spatial scale of the historic Everglades and the organizing affects of seasonal and multi-year patterns of flooding and drying, created the pulses of secondary production and the prey densities that were necessary for the support of large populations of the larger species of vertebrates.

5.6.4.2 Physical Features

The physical features that defined the pre-drainage south Florida wetlands are defined below:

(1) Clearly, one defining physical feature was the large spatial scale of the network of pre-drainage wetland ecosystems. The large spatial extent was essential for supporting the regional levels of production necessary for maintaining robust populations of animals with large spatial requirements, and for supporting the range of physical features and the ecological and climatological processes that created and maintained the habitat mosaics of the region.

(2) The second defining physical feature of the pre-drainage wetlands was the region's dynamic patterns of water storage and sheet flow. It was these dynamic hydrological patterns, *"...operating over an extensive region, that made the Everglades a much wetter system than it is today, that organized and concentrated the primary and secondary production of the wetlands, established the salinity gradients in the estuaries, and created the substantial network of dry season refugia that were essential habitats for all freshwater animals"* (Ogden et al., 1994).

5.6.5 Role of Adaptive Assessment

Adaptive assessment is an approach which can be utilized during the implementation and evaluation of large, complex, long-range projects. In a discussion of a national restoration strategy, the National Research Council states that adaptive planning and assessment involve a decision-making process based on trial, monitoring, and feedback. Rather than developing a fixed goal and an inflexible plan to achieve the goal, adaptive assessment recognizes that there always will be gaps in knowledge regarding the relationships within and among natural and social systems, and that these information gaps require that plans be modified as technical knowledge improves and social preferences change. For adaptive assessment to succeed, the new knowledge gained (through monitoring) should be translated into restoration policy and program redesign over time and be shared across restoration programs at all levels of government (National Research Council, 1992). Adaptive assessment is a process which involves the iterative use of models, research, and monitoring in conjunction with on-going planning, in order to revise, improve, and fine tune management procedures (Science Sub-Group, 1993). It involves an iterative process of developing management tactics, and provides a process for breaking impasses where agencies are unwilling to proceed because of an inadequate knowledge base (Hoffman, 1994).

Lack of an adaptive assessment approach during the implementation and evaluation of large and complex projects can result in unintended and unexpected adverse environmental impacts. The initial C&SF Project is an example of what happens when plans are carried out in the absence of clearly defined long-term ecological goals and without provisions for adequate monitoring of project effects. Lack of a strategy resulted in several unanticipated changes being made to the C&SF Project beginning relatively soon after its construction was initiated in 1948. Water Conservation Areas 3A and 3B and a southern extension of Levee 67 were completed in the 1960s. As a result, natural flows to the Everglades National Park were eliminated and water was provided according to a regulation schedule. Sporadic and insufficient flows resulted in ecological decline in the Park. Consequently, in 1971 a minimum monthly schedule of water deliveries was established. Under this water delivery system, unseasonable regulatory releases often occurred during dry season months. During the period of the minimum delivery schedule, the ecological values of the southern Everglades declined at an accelerated pace. The Everglades National Park again requested modifications to the project and the Experimental Program of Water Deliveries to Everglades National Park was initiated in April 1984. Additional projects designed to modify the areas existing hydrologic regime to restore more natural flow and hydropatterns are the Modified Water Deliveries to Everglades National Park, and the Canal 111 (C-111) Project.

A barrier to viewing these projects as part of a larger scale, long-term restoration program has been that much of the information needed to develop the larger plan did not exist. The impact that this barrier has on restoration planning can be substantially reduced through an adaptive assessment process, which recognizes these inadequacies and provides a planning strategy for collecting the necessary information. Shabman (1993) has suggested that adaptive assessment assumes that no knowledge base is adequate for defining and implementing the socially correct and technically feasible long-term plan of action. Instead, decision making should proceed as sequential adjustments in response to new insights about social and economic priorities, and in response to new understandings of the ecological system. Consequently, an adaptive assessment strategy would require that plans be formulated which are designed to create new information. This planning approach maximizes the collection of new information by viewing each iteration as one “experiment” within a series of experiments. Each experiment should be designed from one or more technically-based hypotheses regarding the expected results, which in turn are measured by a monitoring program based on the same set of hypotheses.

For the C&SF Restudy, the conceptual ecological models of south Florida wetland landscapes identify the major hypotheses used to set planning priorities and restoration performance measures. The regional ecological monitoring program will evaluate how well the restoration projects correct the stresses shown in the conceptual models, and at the same time, allow for refinement of the hypotheses which were used as a basis for planning the major components of these projects.

5.6.5.1 Monitoring

The restoration of the wetland ecosystems of south Florida requires that a comprehensive monitoring program be in place to provide information that is essential to the planning and evaluation processes. It is assumed in this report that the south Florida ecosystem restoration program will most likely be successful in achieving its goals if implementation of the program is conducted by means of an adaptive assessment strategy. This strategy calls for the incremental implementation of the components of the plan, with each increment treated as one experiment within a stair-step evolution of experiments, each planned and designed to carry the program one step closer to the ultimate goal of systems restoration. An incremental process is required for the south Florida ecosystem restoration program, because of the large and complex nature of the ecosystem and its problems, and because of the uncertainties regarding the ecological responses that will occur as more natural hydrological conditions are established. These uncertainties are inherent where major alterations in the region's spatial scale and landscape components have in some cases substantially changed ecological relationships among species, habitats, and communities throughout the region. A regional monitoring program becomes the framework for designing the sequence of incremental steps, by providing information on how the ecosystem responds at each step as a basis for designing the next steps.

A fundamental requirement of a successful monitoring program is that it be focused on the biological and physical elements in the system which are most likely to reveal how the system responds to project actions. There should be broad agreement on restoration targets, and on the ecological changes that constitute improvements, as a prerequisite for determining which parameters in the system must be monitored. Because of the uncertainties inherent in any effort to restore such a complex and altered ecosystem, specific restoration targets and measures of success can only be provisionally identified. Nevertheless, these targets and measures need to be identified in order to design a monitoring program that is well focused and efficient, to assure that it provides the kind of information that is required for the implementation of an adaptive assessment strategy.

5.6.5.2 Conceptual Ecological Models

Conceptual ecological models have been developed at landscape and physiographic scales for the natural regions of south Florida. These models have performed an essential role in the Restudy, in that they provide a comprehensive framework for organizing existing scientific knowledge about the natural systems in south Florida into formats that are directly applicable to the planning, implementation and evaluation of restoration projects. The conceptual models are simple, non-quantitative tools which illustrate the collective opinion of a group of natural resource specialists for how existing, empirically and intuitively derived understandings of wetlands in south Florida should be organized to show the important ecological relationships in these systems.

The models were developed by teams of resource specialists during a series of workshops between October 1996 and July 1997. Conceptual models have been developed for Lake Okeechobee, the Caloosahatchee and St. Lucie Estuaries, the ridge and slough portions of the central and southern Everglades, the Big Cypress, the southern Everglades marl prairies, the southwestern Gulf Coast Estuaries, Florida Bay, and Biscayne Bay. Each model consists of a schematic representation of the major elements in the system, and a narrative interpretation of the model. An example of a completed conceptual model and narrative statement, for Lake

Okeechobee, is attached to ***Appendix D***. A technical report describing all of the models is in preparation (Ogden and Davis, in prep).

The conceptual models for south Florida show the major cause and effect relationships in stressed natural systems. Each model identifies the principal sources of human influences on the natural systems (societal drivers), the ecological stressors originating from these drivers, and the ecological effects from these stressors. The models also suggest the best set of ecological attributes (endpoints, indicators) and measures, which, collectively, characterize the overall "health" of the system relative to the effects from the stressors.

The broad purposes for creating the conceptual models have been to (1) create a set of measurable indicators of success as a basis for evaluating how well the projects meet the broad, policy-level goals that have been established for the regional restoration programs, and (2) develop a suite of causal hypotheses linking the most important hydrological stressors with the major ecological effects, as a basis for predicting responses to the restoration projects.

For the Restudy, the conceptual models have been used more specifically (1) to help set priorities among the hydrological issues to be resolved by the study, based on links between water management practices and the major ecological problems in the natural systems, (2) as a basis for creating performance measures for evaluating alternative plans for resolving the major ecological problems, and (3) to recommend a priority set of ecological indicators (attributes) to be monitored as a basis for evaluating how well the restoration projects correct the hydrological stressors in the natural systems. The recommended approach for accomplishing (3) will be to design performance measures and the components in a regional monitoring program so that they relate to the hydrological stressors and the ecological attributes shown in each model. The assumption from the conceptual models is that the restoration projects should focus on improving performance among the hydrological stressors, and that the success of the projects in meeting these objectives can best be measured by monitoring the behavior effect on the key ecological attributes in each natural system.

5.7 SOUTH FLORIDA ECOSYSTEM RESTORATION VISION

While a primary goal of the Restudy is the ecological restoration of the Everglades and other natural wetlands in south Florida, the Restudy Team, as well as the broad scientific community, recognizes that complete ecological restoration in this region is not possible. Traditionally, restoration has been defined as the full recovery of a natural system to a condition that existed during some pre-altered period. For the Everglades, this goal would require the creation of a system that mimicked the natural conditions that was here prior to the construction of the first drainage canals and levees, in the 1880s.

For at least two overwhelming reasons this goal is not possible. First, there have been substantial and irreversible reductions in the spatial extent of the wetland systems in south Florida (including an approximately 50 percent reduction in the extent of the true Everglades), and in the total water storage, timing, and flow capacities of these systems. These changes, coupled with the altering affects of sea level rise, infestations of exotic plants and animals, subsidence, and losses of organic soils, are among the factors which preclude any serious consideration of achieving true restoration. The second major hurdle to complete restoration is that few of the quantitative, ecological characteristics of the pre-drainage wetlands of south Florida are known. Simply stated, the pre-drainage Everglades is as much a vision created by opinion as by fact. For these reasons, and because complete restoration is not possible, the natural resource specialists in south Florida lack a strong consensus as to the restoration "endpoint"; i.e., there is a range of legitimate answers to the question, "what constitutes restoration?"

Because the pre-drainage Everglades cannot be recreated in its original form, the restoration goal for the Restudy is to create a "new" Everglades, one which will be different from any system that existed in the past, and one which will be substantially healthier than the current system. For this restoration project to be successful, it must recover important ecological components and patterns which are thought to have characterized the pre-drainage system, and it must be able to sustain these recovered ecological attributes over long time scales. The Restudy Team has attempted to understand the pre-drainage system, using such tools as the Natural System Model, and by creating conceptual ecological models of the major landscape features of Florida. These conceptual models have been developed from a series of hypotheses about the ecological relationships and biological components of the pre-drainage system, which have been derived from studies of the current system. The "new" Everglades must include key features that characterized the earlier natural system, if it is to again become an Everglades-type ecosystem. It also must acquire other natural attributes which are important to people who share an interest in the natural systems in south Florida, and the roles that these systems have in our lives. For example, modifications to the Everglades should recover certain wading bird and alligator patterns of behavior that were characteristic of an earlier, more natural system. It also should recover certain traits that are important to our society, such as clear water and good fishing in Lake Okeechobee, improved salinity ranges in the Caloosahatchee and St. Lucie Estuaries, and an enhanced role for the remaining natural system as a refugia for endangered species in a shrinking natural world.

It is too early in the south Florida ecosystem restoration process to state with certainty exactly what the "endpoint" for the restored Everglades should become. It is likely that the length of time required to implement the restoration projects, and the varying time lags in ecological responses, will mean that the current, managed system will evolve into a "new" Everglades over long time scales. During these transitional years, understandings of ecological patterns and relationships will continue to improve (almost certainly causing a change in the hypotheses currently being used to predict ecological responses to the restoration projects), unexpected responses to the initial restoration projects will occur, and the remaining wetland systems will continue to evolve in response to a wide range of continuing human and natural influences (e.g., sea level rise, hurricanes, long-term rainfall and temperature patterns). Thus, the point at which restoration is achieved, and the precise characteristics of that "restored" system, represent questions that are not completely answerable at present.

At the same time, it is important to not overstate or to be overly concerned about the uncertainties that are a part of the restoration planning process. For example, there is considerable professional agreement that recovery of the regional hydrological patterns depicted by the recent versions of the Natural System Model will result in substantial improvements in the ecological health of the wetland systems. An overall much wetter system, characterized by such features as multi-year hydroperiods in the sloughs, higher, dry season groundwater levels on the marl prairies, and increased flows of freshwater into Florida and Biscayne Bays, will produce dramatic improvements in the ecological health of these systems.

Because of these considerations and uncertainties, the Restudy Team, as well as most resource specialists in south Florida, view ecosystem restoration in south Florida much more as an open-ended process than as a specific set of targets (endpoints). Restoration planning has become a balancing act between the need to agree on desirable directions of change and the general features that should be present in a restored system, and the need to encourage flexibility in thinking about how and when certain objectives are achieved, and what the restored system should look like. For example, is it possible, in order to recover the fundamental ecological patterns that are an essential part of an Everglades-type system, that some features or components may need to be recovered at different scales or locations than were found in the pre-drainage system? This view of the restoration process is in part a response to the point made above, that current opinions still vary among resource specialists on how to set quantitative, ecological targets for a restored system.

More importantly, the realistic perspective at present is that it is premature to force the debate over the question of, "what constitutes restoration?" At this point, it is sufficient that there is broad agreement, demonstrated in the conceptual ecological models, over the identity of the water management and development practices that have caused much of the ecological damage in the south Florida ecosystem. Restoration projects geared to correcting these hydrological stresses should produce strong improvements in the health of these ecosystems. Consensus over the question of what a restored south Florida ecosystem should be, especially over the specific spatial, temporal and numerical targets for restoration, should emerge over time, as system responses from initial restoration projects begin to provide focus for the debate, and new modeling results and empirical data become available.