SECTION 2

PRE-DRAINAGE CONDITION

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This section provides an overall characterization of the conditions that existed in the south Florida ecosystem prior to drainage and development activities. A significant portion of the information in this section (portions of subsection 2.1 and most of subsections 2.2, 2.3, and 2.4) is taken directly from the Science Sub-Group Report (1993) which was undertaken to provide information to the Corps of Engineers to assist in the reconnaissance study. It is important to understand how the pre-drainage south Florida ecosystem functioned in order to understand how natural system functioning has been impacted. This section also provides an overview of historic water quality conditions in the study area.

2.1 INTRODUCTION

The pre-drainage wetlands of southern Florida covered an area estimated at approximately 8.9 million acres. This region was a complex system of hydrologically interrelated landscapes, including extensive areas of ridge and slough landscape and sawgrass plains, as well as, cypress swamps, mangrove swamps, and coastal lagoons and bays. Prior to drainage, the characteristics of this network of wetland landscapes could be described by a set of physical and ecological features that were present across regional scales, and which gave definition to these ecosystems. It was the defining physical characteristics of this region that provided the spatial and temporal framework necessary for the existence of the components and relationships that defined the ecological characteristics of these southern Florida wetlands.

As a result of land use and water management practices during the past 100 years, the regional wetlands of southern Florida either have been lost or have been substantially altered. It is the premise of the Restudy that an understanding of these defining characteristics, and the factors which caused their loss or alteration, provide focus for setting restoration goals and priorities for the southern Florida wetlands. While it is true that the pre-drainage wetlands can not be fully restored, a successful restoration program will be one that recovers to the extent possible these defining characteristics of the former system. Achievement of this goal should result in the recovery of ecologically viable systems that functionally resemble the pre-drainage Everglades and its interrelated wetland systems.

The fundamental tenet of south Florida ecosystem restoration is that hydrologic restoration is a necessary starting point for ecological restoration. Water built the south Florida ecosystem. Water management changes have adversely affected this ecosystem. Restoration begins with the reinstatement of the natural distribution of water in space and time. The spatial extent of the hydrologically restored area is critical to ecological restoration. Water quality improvement must be an integral part of all hydrologic restoration. The focus is on the wetlands because the greater part of the pre-drainage south Florida ecosystem was wet.

2.2 DESCRIPTION OF THE NATURAL SYSTEM

The study area encompasses approximately 18,000 square miles comprising at least 11 major physiographic provinces, including the Everglades, the Big Cypress, Lake Okeechobee, Florida Bay, Biscayne Bay, the Florida Reef Tract, nearshore coastal waters, the Atlantic Coastal Ridge, the Florida Keys, the Immokalee Rise, and the Kissimmee River Valley. The watersheds of the Kissimmee River, Lake Okeechobee, and the Everglades dominate the system. The system functions as an interconnected mosaic of wetlands, uplands, coastal areas, and marine areas. Wetlands dominated the pre-drainage landscape. Prior to drainage, wetlands covered most of central and southern Florida. The Everglades region was characterized by an extremely low gradient (1 - 2 inches/mile), yet heterogeneous landscape mosaic sculpted by 5,000 years of evolution of hydrologic and biologic forces on a Pleistocene limestone platform. The 1850 era military map (Ives, 1856), which defines the "pre-drainage" system discussed in the Science Sub-Group Report (1993), gives some indication of the pre-drainage hydrologic structure and elevation in the study area.

2.3 FUNDAMENTAL CHARACTERISTICS OF THE PRE-DRAINAGE SYSTEM

The pre-drainage wetland landscapes consisted of swamp forest; sawgrass plains; mosaics of sawgrass, tree islands, and sloughs dominated by *Nymphaea*; marl-forming prairies and cypress strands. The upland landscapes consisted of pine flatwoods, pine rocklands, tropical hardwood hammocks, and xeric hammocks dominated by oaks. The natural seascapes of south Florida consisted of shallow seagrass beds, riverine and fringe mangrove forests, intertidal flats, coral reefs, hard bottom communities, mud banks, and shallow, open inshore waters. These were all interconnected on a topographic gradient that ranged from about 20 feet NGVD at Lake Okeechobee to below sea level at Florida Bay.

The pre-drainage wetland ecosystems of south Florida had three essential characteristics:

- A hydrologic regime that featured dynamic storage and sheet flow
- Large spatial scale, and
- Heterogeneity in habitat.

2.3.1 Dynamic Storage and Sheet Flow

The structure contributing to dynamic storage included the very shallow elevation gradient, the vast expanses of emergent vegetation, the thick peat substrates, sand hills, and highly permeable limestones. The water masses were constantly progressing downslope but so slowly that, in effect, water was stored in the system during one season to use in the next season. Transportion of water masses within a structural element varied from a number of months to a number of years.

Throughout the system, groundwater seepage, driven by hydraulic gradients, provided the base flow of creeks, rivers, and possibly even surface runoff across the mangrove zone. Base flow is the river or stream flow provided entirely by seepage from groundwater sources. For example, in the Kissimmee River in the upper part of the watershed, prior to drainage and channelization, 80 percent of annual river flow was base flow (Burns, 1975; Burns and Taylor, 1979).

The all-important extended hydroperiods of the natural system depended more on the large dynamic storage capacity and delayed flow-through that were natural hydrologic features of this system than on the immediate effects of rainfall. Because of the dynamic storage and slow rate of water flow throughout the natural system, wet season rainfall kept the wetlands flooded and maintained freshwater flow to the estuaries well into the dry season. The carry-over effect of the enormous dynamic storage capacity of the natural system was so great that a year of high rainfall maintained surface water in wetlands and freshwater flow to estuaries even into one or more subsequent drought years (Walters et al., 1992; Fennema et al., 1994; Browder, 1976). The dynamic storage made wetlands and estuaries less vulnerable to south Florida's spatially and temporally variable rainfall.

2.3.2 Large Spatial Scale

The vastness of the pre-drainage wetland extent made it possible for the natural ecosystem to: (1) support genetically viable numbers and sub-populations of species with large feeding ranges 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 through natural disturbance. Population resiliency is undoubtedly proportional to the area of these wetlands because habitat diversity, the amount of seasonal refugia, and the number of dispersal options are proportional to wetland area.

In the pre-drainage era, the nutrients that were the basis of primary production were derived principally from rainfall. The nutrients in water entering from upstream were scrubbed by the vegetation and soils and not available downstream. Sheet flow enhanced the uptake of nutrients from the water column.

The periphyton community, made up of microscopic algae, not only assimilated available nutrients from the water column but also created an environment that precipitated phosphorus, along with calcium carbonate, into the substrate. The system was extremely oligotrophic, given the nutrient loading, spread over the entire areal extent. During seasonal dry-down, topographic depressions (e.g., alligator holes) became areas of concentrated aquatic biomass, producing localized feeding opportunities for large carnivores, including wading birds. The higher vegetation, as well as the periphyton, had adaptations for surviving under low nutrient conditions.

2.3.3 Heterogeneity in Habitat

Habitat heterogeneity maintained by micro-topographic features, small-scale climatic variation, and natural disturbances such as freezes, fire, and storms, acting on the large spatial scale of the wetlands, was a major contributor to biotic diversity and the persistence of populations. The mosaic of habitat types and water depths provided the spatial framework for the production and survival of animals under a wide seasonal and annual range of hydrologic conditions.

The vegetative landscape resulting from this vast, low relief, low gradient landform was a diverse mosaic of plant communities. These communities varied in extent from patches on the order of tens of meters to areas approaching physiographic provinces. The larger expanses had more long-term resiliency than the patches. Large spaces were necessary to maintain resiliency under conditions that changed on scales from seasons to decades. To some extent, maps from the 1800s, when compared with maps of the 1980s, reveal large scale persistence of landscape patterns, even in the face of major anthropogenic disturbance.

2.4 RELATIONSHIPS WITH SPATIAL AND TEMPORAL VARIATION

The diverse and large number of aquatic biota that these systems once supported were maintained by the complex annual and long-term hydrologic patterns of the natural system, as expressed in wet-dry cycles, drying and flooding rates, surface water and water depth patterns, annual hydroperiods, flow volumes, and, at the coast, salinity and mixing patterns. For most animals, annual patterns of production, dispersal, and survival were seasonally regulated by the annual periodicity of wet-dry cycles and by the rates of drying and flooding. Primary and secondary production, including that in the key periphyton communities, depended on depth and duration of surface water.

The production of food for consumption by larger predators was largely a function of surface water area and flooding duration during the annual wet period. Food availability was then determined by the amount of forage produced and the rate and degree that it became concentrated into a smaller space during the annual dry season. The distribution and persistence of large animal populations was further influenced by the seasonal patterns of surface water distributions and, in the coastal wetlands and estuaries, salinity patterns, superimposed over major habitat, or plant community, patterns. For example, large, historic wading bird nesting colonies were once clustered in wetlands adjacent to estuaries, presumably because the prey base for these birds was greatest and most reliable at the estuarine/freshwater interface.

Colonial wading birds were extremely abundant in pre-drainage south Florida and were conspicuously present even into the 1960s and, to a lesser extent, the 1970s. Wood storks, White ibis, Great and Snowy egrets, and other species nested in vast numbers in mangrove swamps along the southern rim of the Everglades and at various interior locations, particularly Corkscrew Swamp in southwest Florida and along the Kissimmee River. Other large predators such as alligator, panther, and bear were common. Fish such as snook, tarpon, sea trout, and red drum were abundant in the estuaries. The Florida Reef Tract supported a healthy living coral reef and a rich diversity of associated fish and other organisms, including snappers, groupers, and spiny lobster.

The estuaries of south Florida had salinity concentrations naturally ranging from about 18 parts per thousand to 36 parts per thousand or slightly greater and lower salinity concentrations (0-18 parts per thousand) in the mangrove zone. These estuaries were naturally well mixed, rather than stratified. They had horizontal salinity gradients, with salinity increasing in an offshore direction and a lower salinity range throughout the estuary during the wet season. Parts of the more enclosed estuaries may have infrequently experienced salinity concentrations of between 36 and 40 parts per thousand during the dry season. The estuaries received freshwater across a broad front, flowing across the mangrove zone, as well as from creeks and rivers, which provided some freshwater inflow throughout the year.

Salinity shifted gradually from high flow to low flow conditions because of the enormous dynamic storage capacity of the upstream system. Shallow, oligotrophic waters promoted the growth of seagrass beds, which supported a resident fauna and the juveniles of many species that spawn offshore but depended upon estuarine nursery grounds. The prop roots of mangroves lining the estuaries and tidal creeks also provided habitat for estuarine life. Schooling coastal migratory species such as Spanish mackerel, bluefish, and pompano entered the estuaries during higher salinity times of the year.

2.5 OVERVIEW OF HISTORIC WATER QUALITY CONDITIONS

The following is a summary of the water quality conditions believed to exist within the study area prior to all historic drainage activities. For a more detailed discussion of the pre-drainage water quality see ***Appendix H: Water Quality, Attachment E: Overview of Historic Water Quality Conditions***.

Prior to efforts to drain portions of the Kissimmee River-Lake Okeechobee-Everglades system in the early 1880's, water quality conditions in this 18,000 square mile wilderness watershed were undisturbed and considered pristine. Over the past 120 years, efforts to drain, dike and convert wetlands and watercourses for urban and agricultural uses throughout the watershed, have resulted in substantial degradation to water quality conditions across the fresh water lakes and marshes, estuaries and coastal marine environments of the area.

2.5.1 Kissimmee River Basin

The general land elevation in the Upper Kissimmee River Basin headwaters area is about 100 feet NGVD. Historic water flows across this area were likely slow and seasonal with surface sheet flows highest during the annual wet season. Due to the long residence time of surface and ground waters in contact with the moist sandy and organic soils, water quality conditions were likely low in dissolved nutrients, high in color with a strong diel dissolved oxygen pattern. Historically, the Kissimmee River flowed south from Lake Kissimmee to Lake Okeechobee over a 98-mile long, shallow, sluggish meandering path with water depths of one to two feet in many locations. An extensive 50,000-acre wetland floodplain moderated high water and wet season flows and sequestered nutrients and sediments before releasing water flows to Lake Okeechobee.

2.5.2 Lake Okeechobee

Lake Okeechobee, a broad, shallow lake with average depths of nine feet, historically was much less eutrophic then its current water quality condition indicates. In the late 1800’s, Lake Okeechobee had a larger, more extensive wetland littoral zone along the shoreline which extended from the lake's northwestern and southern shorelines. In the late 1960’s and early 1970’s, total phosphorus concentrations as low as 50 parts per billion were measured in the Lake (Joyner, 1974). Currently total phosphorus concentrations in the lake have been measured in the 100 parts per billion range (James et al, 1995). It is likely that historic in-lake turbidity was much lower than current conditions as well.

Before the recent development of south Florida and construction of the C&SF Project, Lake Okeechobee had a larger pelagic zone, a littoral zone that extended nearly 20 kilometers to the west of the present lake shore, and the Lake was contiguous with the Florida Everglades to the south. Output from the District's "Natural Systems Model" indicates that lake levels fluctuated between 17 and 23 feet NGVD, as compared to today's fluctuations between 11 and 17 feet NGVD. In the natural system, these fluctuating water levels may have periodically flooded the exposed areas of an expansive, low gradient marsh. However, under both high and low conditions, there likely was abundant submerged and exposed habitat for fish and other wildlife. Today's Lake is constrained within a dike, and the much smaller littoral zone occurs on a sand-bottomed shelf between the dike and a relatively deep drop-off to open water. As a result, water levels above 15 feet NGVD flood the entire littoral region, leaving no habitat for wildlife that require exposed ground. When water levels are below 11 feet NGVD the entire marsh is dry, and not available as a habitat for fish and other aquatic life. During the years following construction of the Herbert Hoover Dike the Lake has experienced numerous occasions when water levels have been above 15 or below 11 feet NGVD for prolonged periods of time (Havens et al., 1996).

2.5.3 Upper East Coast

Prior to drainage activities, the St. Lucie River Basin and southern Indian River Lagoon area (Upper East Coast area) was a low, flat coastal region. It contained poorly drained sandy soil uplands intermixed with numerous scattered isolated freshwater wetlands grading to a broad, shallow coastal lagoon. Tidal flushing throughout the southern Indian River Lagoon was more limited historically and the lagoon waters would have exhibited a much lower salinity than current conditions. Historic lagoon substrates were dominated by freshwater plants rather then the current seagrasses. Water depths in the southern lagoon averaged only three to four feet and contained a luxuriant growth of rooted aquatic plants. The aquatic plants efficiently trapped dissolved and suspended particles and nutrients, and helped to maintain low turbidity in lagoon waters. The major freshwater inflows to the southern Indian River Lagoon were dominated by wet season flows from the St. Lucie River and the Loxahatchee River systems.

2.5.4 The Central Everglades

In the Central Everglades Basin, the Everglades ecosystem developed under extremely low rates of total phosphorus supply. Historically, nutrient inputs to Everglades marsh waters were derived primarily from atmospheric deposition of rainfall and dry fallout. Total phosphorus concentrations in rainfall to the Everglades marsh, in water column concentrations and throughout the central Everglades region was low, ranging from five to 10 parts per billion (McCormick et al., in preparation). Relative to other key water chemistry features, the interior Everglades marsh, Water Conservation Area 2 and 3, and Everglades National Park, were slightly basic and highly mineralized when compared to the northeastern Everglades region, Loxahatchee National Wildlife Refuge area. This northern region was slightly acidic and contained extremely low concentrations of major ions, a condition which reflects the rainfall-driven hydrology of the area (McCormick et al., in preparation). Concentrations of nitrogen and other macronutrients in interior Everglades surface waters were relatively high when compared to total phosphorus. These concentrations varied in the surface water from location to location within the Everglades. However, they would not generally be considered limiting compared with the extremely low total phosphorus concentrations in the Everglades marsh.

2.5.5 Lower East Coast and Biscayne Bay

Water quality conditions in the Lower East Coast would have varied considerably depending on salinity, substrate and nutrient input conditions; however, it can be inferred that water quality conditions were pristine simply because significant pollutant sources were non-existent. Coastal rivers were likely highly stained and low in nutrients while water quality conditions in the shallow freshwater coastal water bodies were likely nutrient poor with high color and low turbidity. Drainage and dredging activities in this area irrevocably and significantly modified salinity conditions in Lake Worth, a coastal freshwater lake.

Historical accounts of Biscayne Bay indicate that prior to inlet dredging and navigational channel dredging, the northern and central portion of the bay had much lower salinity conditions. Biscayne Bay water quality in the late 1800s can be characterized as low in nutrients, low in turbidity and high in light transmittance promoting luxuriant seagrass meadows on the bay bottom.

2.5.6 Florida Bay and the Florida Keys

Florida Bay is a subtropical estuary, averaging three feet in depth. Historically, these estuarine waters could be characterized as warm and very clear with the presence of lush seagrass beds on the bay bottom. Historically, both Florida Bay and Florida Keys estuarine and marine habitats evolved under very low nutrient conditions and were sensitive to increased levels of nutrients. Water quality in Florida Bay was highly variable with substantial variability in bay turbidity and salinity conditions relating to climatological events such as hurricanes and cold fronts, and large freshwater inflows from the southern Everglades during annual wet seasons. In the deeper marine waters off of the Florida Keys, water clarity was excellent with visibility through the water column routinely exceeding 100 feet.

2.5.7 Big Cypress Basin

The Big Cypress Basin is a large, flat area with maximum elevations of 22 feet above mean sea level in the northern region which gradually grades south to sea level in the coastal mangrove region of the Ten Thousand Islands area, on the Gulf of Mexico (Duever et al., 1979). Historic water quality conditions in this region were tied to the predominant carbonate marl soils of the area. Organic peats were found in the low-lying north-south sloughs and strands and in the coastal mangrove areas; however, they covered a relatively small portion of the entire basin. The single largest physiographic region in the Big Cypress was the slightly elevated interior Pineland region indicative of a juvenile karst terrain (Duever et al., 1979) suggesting substantial interaction of rainfall derived surface waters and the surficial aquifer.

Due to the topography, soils and vegetation of the area, water quality conditions had relatively high levels of dissolved constituents, such as calcium, chloride, sodium, potassium, hardness, specific conductance, and dissolved solids (Duever et al., 1979). Watercolor was highly stained with tannins and turbidity would have been relatively low. Historic nutrient concentrations in Big Cypress Basin were relatively oligotrophic in phosphorus and nitrogen compounds (Odum, 1953; Klein et al., 1970; Carter et al., 1973). However, total phosphorus and nitrogen compound levels in Big Cypress surface waters would have been substantially higher than total phosphorus and total nitrogen concentrations in the central Everglades marshes due to differing soil conditions.

2.5.8 Caloosahatchee River Basin

Prior to early drainage work, the Caloosahatchee River was a shallow, meandering river. Water quality was likely dominated by high color and high organics exhibiting the highly stained tannic nature of many south Florida coastal rivers. Dissolved oxygen levels in the river likely fluctuated widely with a daily pattern. In the lower Caloosahatchee River near its convergence with San Carlos Bay, the Caloosahatchee Estuary likely exhibited luxuriant seagrass beds with high light transmittance to the substrate and low nutrient and suspended solids conditions.