CHAPTER IV

THE EVERGLADES: ECOSYSTEM, PROBLEMS AND MANAGEMENT
4.1 INTRODUCTION

Wetlands are a major feature of the landscape in almost all parts of the United States. Although many cultures have lived among and even depended on wetlands for centuries, the modern history of wetlands is fraught with misunderstanding and fear. Wetlands disappeared at an alarming rate in the United States until recently. Although the value of wetlands for fish and wildlife protection has been known for several decades, some of the other benefits have been identified more recently. Wetlands in the United States are sometimes described as "the kidneys of the landscape" because of the functions that they perform in hydrologic and chemical cycles and because they function as the downstream receivers of wastes from both natural and human sources. Wetlands have also been called "biological supermarkets" for the extensive food chain and rich biodiversity they support. They play major roles in the landscape by providing unique habitats for a wide variety of flora and fauna.

These values of wetlands are now being recognized in the United States and translated into wetland protection laws, regulations, and management plans. Wetlands have been drained, ditched, and filled throughout history but never as quickly or as effectively as was undertaken in the United States beginning in the mid-1800s. Since then more than half of the nation's original wetlands have been drained. More recently wetlands have become the Cause celebre for conservation-minded people and organizations in the United States and throughout the world in part because they had been disappearing at alarming rates and in part because their loss represents an easily recognizable loss of nature to economic "progress". Many scientists, engineers, lawyers, and regulators in the United States are now finding it both useful and necessary to become specialists in wetland ecology and wetland management in order to understand, preserve, and even reconstruct these fragile ecosystems.
This chapter deals with an important wetland resource of United states the Everglades; its ecosystem and its management. But before the Everglades, it is imperative to highlight the wetland resources of the United States of America.

4.2 WETLAND RESOURCES OF THE UNITED STATES OF AMERICA

The wetland resource of the United states is extremely varied (Table 14). The greatest abundance of wetlands occurs in the southeastern states, the lower Mississippi valley, and Alaska. Wetlands in these areas support coastal and

<table>
<thead>
<tr>
<th>Common Term</th>
<th>Distribution and Hydrology</th>
<th>Biota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh water marsh</td>
<td>Widespread; seasonal to permanent flooding</td>
<td>Grasses, sedges, frogs</td>
</tr>
<tr>
<td>Tidal salt and brackish marsh</td>
<td>Intertidal zone; semidiurnal to fortnightly flooding</td>
<td>Salt tolerant grasses and rushes, crabs, snails, killifish, clams</td>
</tr>
<tr>
<td>Prairie Pothole</td>
<td>Northern plains states; temporary to permanent flooding; fluctuating water levels</td>
<td>Grasses, sedges Herb’s</td>
</tr>
<tr>
<td>Fen</td>
<td>Associated with mineral rich water; permanently saturated by flowing water</td>
<td>Sedges, grasses, shrubs, trees</td>
</tr>
<tr>
<td>Bog</td>
<td>Abundant in recently glaciated regions; precipitation principal source of water</td>
<td>Sphagnum moss, shrubs, trees</td>
</tr>
<tr>
<td>Swamp</td>
<td>Prolonged saturation and flooding</td>
<td>Cypress, gum, red maple</td>
</tr>
<tr>
<td>Bottom land</td>
<td>Seasonal flooding; annual dry periods</td>
<td>Oaks, sweetgum, other hardwoods.</td>
</tr>
<tr>
<td>Mangrove</td>
<td>Subtropical tropical regions; intermittent flooding by seawater through tidal action</td>
<td>Red, black, white mangrove</td>
</tr>
</tbody>
</table>

Source: Cowardin, et. al., 1979.
freshwater fisheries as well as vital overwintering grounds- and in the case of Alaska breeding grounds-for waterfowl. Vast swamps known as bottomland hardwood forests occur in the lower Mississippi River valley and in the floodplains of other Southeastern rivers. One particularly large freshwater marsh is the everglades of southern Florida. This wetland system covers the southern 20 percent of the Florida peninsula. (Map 4)

These wetlands in the Southeast where more than 35 inches of rainfall occurs each year can be contrasted to the expansive tundra wetlands on the North slope of Alaska. The north slope receives approximately 10 inches of precipitation per year, but the permanently frozen soil keeps the tundra surface continuously wet. These wetlands are important as calving grounds for Caribou herds as well as waterfowl breeding Alaska also has vast acreage of fresh and salt water marshes and forested wetlands, including bogs.

There is relatively lesser extent of wetlands in other parts of United States. However, the rare riparian wetlands along arid Western streams provide some of the only habitat and corridors for many wild life species. Moreover, they are some of the only areas that support trees and other vegetation in this arid climate.

The prairies Potholes of the north Central and plains states are important not only to support the migration of millions of birds each spring and fall, but also as breeding areas for much of the north America waterfowl population. These important breeding areas extend from the central provinces of Canada into the states of North Dakota, South Dakota and Minnesota.

Wetlands along the Atlantic seaboard are similarly important to the Atlantic Flyway as well as to the support of major coastal and off shore fisheries. The continuing large landings of finfish and shellfish from the Chesapeake Bay are dependent on the wetlands in the Bay and tributary streams. The mid Atlantic
LOCATION OF MAJOR WETLANDS IN UNITED STATES

Map 4
and New England states have numerous types of wetlands including saltwater and freshwater marshes, riverine swamp, and lake fringing marshes. A type of wetland that is well represented in the New England states is the northern bog. At higher elevations in the mountains, the extent of wetlands generally becomes more restricted to the immediate vicinity of streams.

Thus in general, wetlands of the United States fall into four main types based on origin and location.

1. Salt marshes on the outer coastal plain of the Atlantic which merge into the mangroves of the Gulf Coast. The Everglades of Florida are a special subset of this group.

2. The alluvial riverine bottomlands of the flood plain of the lower Mississippi and its tributaries south of the Ohio, and its delta in Louisiana.

3. The glacially derived lands mainly of heavy clay soils, low relief and immature impeded drainage that stretch across the Midwest from Ohio to Iowa and Southern Minnesota, and extend northward with scattered but extensive areas of peat into the three lake states.

4. Miscellaneous wetlands associated with waterlogged soils and irrigation, mainly in the west.

Wetlands of the United States are in many cases similar to those in other parts of the world and in other cases quite different. The prairie potholes, bogs, and Tundra wetlands that occur in the northern states are well represented in Canada and other northern latitudes. Similarly, the extensive bottomland hardwood swamps and freshwater marshes of the United States mid-latitudes are represented in mid-latitudes of other countries. The subtropical savanna type Everglades of Florida are unique in the United States, but occur commonly on
other continents such as Africa and South America. Coastal mangrove swamps are limited in distribution to the Florida Atlantic coast and the Gulf of Mexico. Similar mangrove swamps are widely distributed in the lower Latitudes around the world.

4.3 EXTENT OF WETLANDS IN THE UNITED STATES

Historical estimates of wetland area in 48 coterminous states are given in Table 15 as compiled by Mitsch and Gosselink 1995.

The wetland estimates vary for several reasons. First, the purposes of the inventories varied from study to study. Early wetland census, e.g., Wright (1907) and Gray et al. (1924), were based on lands suitable for drainage for agriculture. Later inventories of wetlands (Shaw and Fredine, 1956) were concerned with waterfowl protection. Only within the last decade have wetland inventories considered all of the values of these ecosystems. Second, the definition and classification of wetlands varied with each study, ranging from simple terms to complex hierarchical classifications. Third, the methods available for estimating wetlands changed over the years or varied in accuracy. Remote sensing from aircraft and satellites is one example of a technique for wetland studies that was not generally available or used before the 1970's. Finally, early estimates were often based on fragmentary records.

The first studies of wetland abundance, by the US Department of Agriculture, took place in the early twentieth century. A 1906 inventory was the result of a request from congress to determine "the amount and location of swamp and overflow lands in the United states that can be reclaimed for agriculture"\(^1\), that study, which did not include intertidal coastal wetlands,

### Table 15

**Estimates of wetland Area in the United States at Different Times**

<table>
<thead>
<tr>
<th>Date</th>
<th>Wetland Area million hectares</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presettlement</td>
<td>87</td>
<td>Roe and Ayres (1954)</td>
</tr>
<tr>
<td>Presettlement</td>
<td>51</td>
<td>Soil Conservation Service (cited in Shaw and Fredine 1956)</td>
</tr>
<tr>
<td>Presettlement</td>
<td>60-75</td>
<td>Office of Technology Assessment (1984)</td>
</tr>
<tr>
<td>Presettlement</td>
<td>86.2</td>
<td>USDA estimate, in Dahl (1990)</td>
</tr>
<tr>
<td>Presettlement</td>
<td>89.5</td>
<td>Dahl (1990)</td>
</tr>
<tr>
<td>1906</td>
<td>32</td>
<td>Wright (1907)</td>
</tr>
<tr>
<td>1922</td>
<td>37 (total) 3 (tidal) 34 (inland)</td>
<td>Gray et al. (1924)</td>
</tr>
<tr>
<td>1940</td>
<td>39.4</td>
<td>Whooten and Purcell (1949)</td>
</tr>
<tr>
<td>1954</td>
<td>30.1 (total) 3.8 (wastal) 26.3 (inland)</td>
<td>Shaw and Fredine (1956)</td>
</tr>
<tr>
<td>1954</td>
<td>43.8 (total) 2.3 (estuarine) 41.5 (inland)</td>
<td>Frayer et al (1983)</td>
</tr>
<tr>
<td>1974</td>
<td>40.1 (total) 2.1 (estuarine) 38.0 (inland)</td>
<td>Ibid; Tiner (1989)</td>
</tr>
<tr>
<td>Mid-1970’s</td>
<td>42.8 (total) 2.2 (estuarine) 38.6 (inland)</td>
<td>Dahl and Johnson (1991)</td>
</tr>
<tr>
<td>Mid-1980’s</td>
<td>41.8 (total) 2.2 (estuarine) 39.6 (inland)</td>
<td>Dahl and Johnson (1991)</td>
</tr>
</tbody>
</table>

**Source:** Mitsch and Gosselink 1995.

estimated 32 million hectares (79 million acres) of wetland in the United States. Of that area 21.3 million hectares (52.7 million acres) or two thirds of the total were found to be "not fit for cultivation, even in favorable years, unless cleared or
protected” (Gray et al., 1924), found 37 million hectares (91.5 million acres) of wetlands, including 3 million hectares (7.4 million acres) of tidal marshes and the remainder composed of inland wetlands.

One of the first wetland surveys in the United States that was undertaken based on their habitat values rather than on value for agriculture was carried out in 1954 and published by the US Fish and wildlife service two years later as circular 39 (Shaw and Fredine, 1956). That survey, which relied on a classification scheme of 20 wetland types, estimated that the nation had 30.1 million hectares (74 million acres) of wetlands that were important to waterfowl. The major short coming of the circular 39 survey was that it considered only wetlands that were important for waterfowl and thus failed to consider a large portion of wetlands in the United States.

A later assessment of wetland abundance in the United States, called National wetland Trends study (NWTS), was conducted by the US Fish and wildlife service (Frayer et al. 1983) the results indicated that, in the mid-1950‘s, there were 43.8 million hectares (108 million acres) of wetlands in the United States, about 45 percent more than the estimate by the Circular 39 study. The NWTS study also estimated that by the mid-1970’s wetlands in the United states had decreased to 40 million hectares (99 million acres). More recent Fish and Wildlife service analyses of mid-1970’s and mid-1980’s data (Dahl and Johnson, 1991), show higher estimates for the 1970’s and a continuing slow decline to about 42 million hectares (103 million acres) in the mid-1980’s.

4.4 THE EVERGLADES

The Everglades of Southern Florida comprise a unique wetland ecosystem
in the United states of America. The country’s largest wetland-Everglades lies at
the intersection of the tropical and temperate, making it the only true subtropical
wilderness in the United states. Over the last half-century, they have been
subjected to a multiplicity of environment impacts that have greatly modified
their ecology. Although no species is thought to have been lost in the Everglades,
this southern Florida wetlands have more than 30 species that are endangered and
threatened. Here, “floristic and faunistic elements of the caribbean mingle with
those of North America resulting in a blend of species which makes it one of the
most distinctive wetland complexes in the world”3.

4.4.1 THE ECOLOGICAL SETTING

The Everglades originally covered more than 10,000 km square extending
southward from the Okeechobee as a curved strip 65 km wide and 167 km long,
bounded on the north by the southern edge of lake Okeechobee, the east by the
Atlantic ocean, the South by the Latitude of Miami and the west by the
Everglades–Big Cypress drainage divide “the Everglades is a part of a larger
ecological context called the South Florida Ecosystem which includes the
Kissimmee River Valley, Lake Okeechobee, the Big Cypress swamp, Florida
Bay, the Atlantic Coastal Ridge, Biscayne Bay, the Florida keys, and the Florida
Reef Tract. These units are connected by Wetlands that form the Kissimmee-Lake
Okeechobee-Everglades drainage basin”4.(Map 5).

The Everglades have two common names - ‘Pa hay Okee’ given by the
Miccosukee Indians meaning grassy water; and ‘River of Grass’ given by
conservationist and author Marjorie Stoneman Douglas.

p. 67.

THE EVERGLADES
(Major Watersheds, Drainage Patterns, and Coastal Zones)

Map 5
4.4.2 FLORA

The Everglades National Park, comprising 5,668 km square covers most of the Southern part of the Glades. It is a vast graminoid-dominated wetland. The upper reaches are covered by sawgrass (*cladium jamaicensis*) marshes which are replaced to the South by wet prairie and finally by a fringing belt of mangrove (*Rhizophora mangle*), along the Gulf coast. Within the Glades are scattered islands of bay and willow and hardwood hammocks dominated by subtropical trees. The 2.8 cm/km southward slope favors the slow movement of water Through this “sea of grass” during the rainy season. Historically, the flow included the overflow from lake Okeechabbee, but since 1,600 km square directly south of the lake were drained and converted to agricultural use, this no longer occurs.

Everglades National park can be broken down into two basic division: the southern deep water swamps and the inland freshwater marshes.

In the Southern most portion of the Everglades National Park where mangroves are best developed, non woody vegetation is confined to the seaward and land ward intertidal fringes. In the landward fringe, where the frequency of salt water tides are much lower, narrow strips to extensive areas of black needlerush and higher marsh plant communities often develop. In brackish, wet areas, extensive stands of leather fern also occur in southwest Florida.

Coastal salt marshes typically give way to vast mangrove wetlands. The Everglades have best development of mangroves in Florida and one of the largest mangrove swamps in the world. There are three species of mangroves that are common in Everglades National Park: the red mangrove, the black mangroves, and the white mangrove. The black mangroves has short vertical roots that protrude out from the ground from 2 cm to 20 cm radically from the base of the trees. Black mangroves can reach a height of 20 cm.
Red mangroves are characterized by their complex network of “prop roots” that arise from the water and converge at an elevated trunk. Typically shorter, they have been known to reach up to 25 m in height. These trees have viviparous seedlings that germinate while they are still in the parent tree.

White mangroves are classified as either a free or a shrub and reach 15 m in height. Salinity control is achieved through two salt glands on each leaf. The white mangroves also has the erect breather roots, but these are fewer, wider, and more often branched than in that species.

Coastal wetland of mangroves and tidal salt marshes gives way to inland fresh-water marsh in the Everglades. The Everglades are predominately sawgrass and flag marshes. Deeply flooded areas provide for water lily marshes, where shallower areas support beak-rush and spikerush marshes. Sawgrass marshes are the characteristic association of the Everglades. Sparse sawgrass marshes occurs throughout the southern portion, especially along the periphery, while dense sawgrass covers much of the core. It accounts for 70 percent of the remaining Everglades landscape and is quiet impression.

The plant may exceed 3 m in height and form an impenetrable mars. A common pattern identified in the Everglades is called strand and slough physiography altercating sawgrass and flag or water lily marshes.

4.4.3 WILD LIFE HABITAT

Hidden in the savannas, hammocks, and forests of the Everglade is a high degree of biodiversity. Over 350 bird species, many of limited distribution in the United states, have been recorded. White ibis and wood stork are an endangered species of wading birds. Other wading birds include great white heron, great blue heron, great egret, snowy egret, tri-coloured heron, little blue heron, cattle egret, reddish egret black crowned night heron, yellow crowned night heron, least
bittern glossy ibis and the colorful roseate spoonbill.

Of the 350 birds that have been sighted in the Everglades, about 200 are migratory. Cardinals, bluejays, meadowlarks, bob whites, and red-bellied woodpecker are common on dry grounds in the Everglades and reside all through the year.

There are 60 known species of reptiles and amphibians, including three listed federally as threatened or endangered. They are America alligators (Alligator mississippiensis), the America crocodile (crocodylus acutus), and the green sea turtle (chelonia mydas).

There are 25 native mammals of Cohick the West Indian manatee (Trichechus manatus) and the Florida Panther (Felis concolor coryi) are two noteworthy endangered species.

Other wildlife species found in the Everglades includes raccoons, opossums, rodents, snakes, turtles and frogs.

4.5 PROBLEMS OF THE EVERGLADES ENVIRONS

The Everglades have suffered a succession of disruptions, including hunting, logging, fire, abrupt and fundamental changes in the water regime and the encroachment of farms. The effects are diffused, erratic and difficult to codify. They become clear when the species are threatened, habitats lost, water flow disrupted, whole populations eliminated.

4.5.1 HYDROLOGIC CHANGES

Extensive man-made alterations to the natural flow pattern for the purpose of flood control, reclamation, and water storage have greatly altered the hydrological regime north of Everglades National Park. The once unregulated, slow-moving "sheet flow" of water is now a complex system of levees, canals,
water impoundment’s, and water control structures which induce the quantity, quality, and timing of water entering the Park. Flooding has long been a problem in the Everglades. An extensive canal and drainage scheme was begun in the 1920’s. In the 1960’s a more sophisticated water-management system was constructed by the US Army Corps of Engineers. It included 1,500 miles of levees and canals and three conservation Areas which could impound and release water when and where it was deemed necessary, which interrupted the natural flow originating from lake Okeechobee. Water management for flood control, agricultural use, wildlife, recreation and maintenance of Everglades National Park was now under human control - the South Florida water management District. In the years that followed, both excessively dry and wet seasons occurred “A severe natural drought in 1971, accentuated by an inadequate natural flow into Everglades National Park, resulted in several wildlife losses." During a very wet season in the 1980’s the Everglades were so severely flooded that the deer heard was threatened with drowning. Drainage has also takes its toll. In fact government engineers first began to consider the possibility of “draining” the Everglades to create room for development in the 19th century. Farmers, meanwhile, wanted a dependable supply of water to irrigate crops. And there was also a need for protection from annual floods. Such competing aims resulted in the creation of a complex system of man-made waterways, flood control levees, irrigation canals, and environmental areas that exist side-by-side.

“Since 1880, 50 percent of the historic Everglades wetlands have been drained, and an expanding south Florida human population of nearly 6 million competes for this ecosystem’s water and land." Today, the Everglades includes only one fifth of the original Everglades that once encompassed over 2 million

---


wood stork population and is an endangered species today. The steady decline in number is also due to the irregular water flow into the Park. Over the decades water mangroves have on occasion, dumped too much water into Everglades National Park flooding out small pools rich in fish, and making it harder for the wood shark to find food to feed its young.

In contrast to the wood stork, the endangered snail kite is favoured by continuously flooded conditions. In some areas, as a result of human induced water-level changes, the population has increased. As a specialized feeder on the apple snail however, its future is insecure. Shooting and encroachment by exotic plants pose additional threats to its survival.

4.5.3 DECLINE OF THE PARK FISHERY

The water area currently included in Everglades National Park historically supported numerous fisheries both commercial and recreational. The species comprising the bulk of the commercial harvest were striped white mulles - (*Mugil cephalus*), Spiny lolister (*Panulirus argus*), spotted seatrout (*Cynosion nebulosus*), crab (*Menippe mercenaris*), and, more recently Florida pompano (*Trachinotus Carolinus*). The principal fishes for the recreational fishery were gray snapper (*Lutjanus*), red drum (*Sciaenops ocellata*), spotted seatrout (*Centropomus undecimalis*), tarpon (*Megalops atlantica*) and bonefish (*Albula Vulpes*). These resources have declined, and according to most experts it is correlated with changes in upland watershed management. Research is underway to understand how adjacent ecosystems, especially the wetlands are coupled with estuarine waters. Odum (1970) documented the importance of mangroves in contributing to fisheries productively, but this community suffered widespread destruction is many areas. Filling and other alterations resulting in the loss or modification of other wetland types have also been contributory. Fish populations are critical to wading birds and other wildlife.
acres (7,800 km square). One fourth of the historic Everglades is now in extensive agricultural production within the 2,600 km square Everglades Agricultural Area, where sugar cane and vegetables are grown on drained Everglades soils.

### 4.5.2 DECLINE IN THE PARK'S BIRD POPULATION

The dwindling populations of colonial, fresh-water wading birds within the park serves as a dramatic illustration of the decline of a significant natural resource. In the 1870s it was estimated that 2.5 million colonial wading birds nested in the Southern Florida. These populations were primarily comprised of snowy egrets (Egretta thula), Great egrets (Casmerodius albus), Great blue herons (Ardea herodias), wood storks (Mycteria americana), white ibis (Eudocimus albus), Louisiana herons (Egretta tricolor), and little blue herons (Egretta Caerulea). In the 1930s approximately 250,000 wading birds nested in the Florida Everglades. In the spring of 1990, scientists estimated as few as 2,200 wading birds nested in Everglades National Park. There has been a decline of ninety percent of the wading bird population.

Two main reasons have accounted for this dramatic decrease in the members of the wading bird community—commercial plume hunting and the draining of the wetlands.

Extensive commercial hunting, especially in the 1880s and 1890s, caused a severe decline in the overall wading bird population as feathers from these species were widely sought by millinery manufacturers. Plume-hunting has been illegal for many years, but by the year 1900, only a few thousand herons and egrets remained.

The Everglades wetland has been reduced to a small fraction of its original size. The draining and the habitat destruction of the wetland has lead to loss of
The fish populations of the Everglades are also keyed to seasonal water changes. "Over a 27-month period during which the water level was stable rather than fluctuating, there was a striking shift from small-sized omnivorous fish to larger-sized carnivorous fish which are poorly adapted to oscillating water conditions." Although there was a decrease in fish density, it was noted that biomass, average size, species richness, and diversity increased. Such changes may also affect certain predator-prey relationship.

4.5.4 EXOTIC SPECIES

In the South Florida wetlands, exotic plants pose a very serious threat to the indigenous vegetation. Three aggressive exotics-Australian pine (*casuarina spp.*), Cajeput or punk tree (*Melaleuca quinquenervia*), and Brazilian pepper (*Schinus terebinthifolius*) – are capable of colonizing disturbed sites faster than native species and once established can shade out the natives. Eradication is very different.

*Melaleuca* is a common invader of the prairie marshes. "It is moving rapidly both eastward and westward into the wetlands from the coastal ridges. Simple trees become established and soon reproduce to become dense monocultures that shade out the typical wet-prairie flora." Disturbed cypress forests, even strands, have been taken over by this aggressive Australian introduction which since its seed dispersal is favored by fire. By the year 2,000 it is estimated that *Melaleuca* will cover vast acreages of the Everglades south of lake Okeechobee and north of Everglades National Park.

Brazilian pepper, a large shrub or small tree introduced from Brazil, is an aggression shade-tolerant invader of abandoned land. It fruits in winter and the

---

fruit is carried by birds into cypress swamps, even to the least-flooded sections of
the mangrove region.

Exotic fishes pose another potential threat. Although the Everglades
continue to support a vigorous native fish population despite the exotics, it may
be only a matter of time until the extensive flooding permits a dramatic increase
of those already present or until a particularly successful exotic arrives.

4.5.5 THREATS TO ENDANGERED SPECIES

The Everglades wetland harbor a large number of endangered, threatened
and rare species. Alligator, which has been protected, it still threatened,
especially in the shark river slough, where nest flooding is the most critical factor
to reproductive success nesting is keyed to water-level fluctuations during the
rainy season. Among endangered reptiles are the crocodile and the green sea
turtle. The crocodile, now fewer than 500 in number, is associated with both
fresh-and saltwater habitats. The young crocodile needs some exposure to saline
water to survive and is therefore affected by water level manipulation. Current
studies indicate the population to be relatively stable although the range has
decreased somewhat due habitat loss.

Further problems include: the endangered green sea turtle, which is highly
dependent upon the aquatic beds to turtle grass in the shallow coastal waters; the
west Indian manatee, easily injured by boat propellers and harassed by
swimmers; and the endangered Florida panther, which is dependent on sizable
tracts of undisturbed wetlands.

Lumbering and plant collectors are encroaching on certain endangered,
threatened, and rare plants, especially epiphytic orchids and the bromeliads found
in swamp forests and hammocks. The epiphytic leaflers orchid, the range of
which extends into Venezuela, through Trinidad and the Antilles, occurs in the
Faka hatchee strand. In the absence of leaves it carries on photosynthesis in the roots. The threatened powdery catopsis, a tank bromeliad, is a recently discovered, insectivorous epiphyte found in tropical hammocks and occasionally in mangrove swamps. The air plant also threatened, was unknown in Florida until 1956. In the 1960's the plants were sold as novelties along the Tamiami Trail.

Several epiphytic terns are also endangered. The tropical birds nest spleen-wort, with vase-shaped rosettes of leaves which resembles a bird's nest, is widespread in the West-Indies and Central and South America. Although it is rare in South Florida, it has great horticultural appeal and is a target for both amateur and commercial collectors.

The rare and endangered plants at the northern limit of their range are in an ecologically precarious environment. The added human impact could easily lead to extinction.

4.5.6 CONTAMINATION OF THE EVERGLADES ECOSYSTEM

The super cave industry, which holds much of the land south of Lake Okeechobee, has for years polluted the Everglades with fertilizer and pesticides laden runoff. The pollution has not only contributed to the decline of the Everglades but has also harmed off shore waters such as Florida Bay, and consequently, Florida fishing and tourism industries.

Since the initial detection of elevated levels of total mercury in freshwater fish in 1989, it has become increasingly apparent-that the Everglades has an extensive contamination of its ecosystem Transformation of in–organic mercury into methylmercury, which is the most toxic form of mercury, and its subsequent bioaccumulation in predatory game fish, is a cause for concern for human health. Elevated level of methylmercury have been found in various Everglades biota, including fish, the endangered Florida Panther, raccoons, wading birds and
alligators. A Florida panther found dead in Everglades National Park in 1989 had an extremely high liver methylmercury concentration of over 110 ppm.

4.5.7 PROBLEM OF EUTROPHICATION

Eutrophication of the Everglades created an imbalance in natural populations of aquatic flora and fauna, with a resulting loss in biological integrity. Some eutrophic impacts, such as periphyton community change, are thought to be short-term and reversible if nutrient additions can be significantly decreased. Other impacts are considered long-term (decades or centuries), such as loading peat soil with excess phosphorus that triggers the loss of native plant communities and foraging habitat. Recent studies have shown that total phosphorus concentrations entering Everglades National Park are lower than concentrations recorded in 1986. A combination of agricultural best management practices and construction of approximately 43,000 acres (174 km square) of wetlands known as storm water treatment areas is being implemented in the Everglades Agricultural Area in an attempt to control phosphorus wading to the Everglades. The goal of phase I of the Phosphorus control program is to decrease total phosphorus concentration in the water discharged to the Everglades to at least 50 g/l.

4.6 MANAGEMENT AND PROTECTION OF THE EVERGLADES

Wetland management of the Everglades has meant both wetland alteration and protection. In earlier times wetland drainage was considered the only policy for managing wetlands. However with the recognition of wetland values wetland protection has been emphasized by many federal and state policies.
4.6.1 ESTABLISHMENT AND PURPOSE OF THE PARK

Everglades National Park was authorized by Congress in 1934 and established in 1947. The purpose of the park was clearly articulated in the enabling legislation, which stated, “the said area shall be permanently reserved as a wilderness, and no development of the project on plan for the entertainment of visitors shall be undertaken which will interfere with the preservation of the unique flora and fauna and the essential primary natural conditions now prevailing in the area.” Subsequent designations, both national and international have reiterated the 1934 Establishing Act.

In 1976, Everglades was designated as a Biosphere Reserve, in 1978, 5, 260 square km of the Park was placed in the National Wilderness Preservation system and in 1979, the Park was designated as a world Heritage site.

Everglades is one of the only three sites on earth declared on International Bioshpere Reserve, a world Heritage site, and a wetland of International importance. The other two are in Tunisia and Bulgaria.

4.6.2 AN EARLY HISTORY OF MANAGEMENT OF THE EVERGLADES

An early history of wetland management, was driven by the misconception that wetlands were wastelands that should be avoided or, if possible, drained and filled. This opinion of wetlands and shallow water environment led to its destruction and reduced the Everglades ecosystem to 50 percent of its original size. There have always been incentives to drain, fill or otherwise impact wetlands. In the early days of European colonization of the United States, the Everglades was characterized simply as one of many hurdles to overcome in order to develop the area. In the mid 1800’s the Congress passed three Federal Swamp lands Acts which encouraged draining and development of the Everglades by giving title to swamp lands to states in exchange for their
'reclamation'. In addition, many early settlements were established around this wetland because of the need to access water-borne commerce.

Agriculture has been responsible for a majority of the impacts to the Everglades. It has not just been the desire of farmers to expand operations that has resulted in the losses, but also that of Federal subsidies which have played an important role. For many years, Federal policies on agricultural subsidies encouraged farmers to put more acreage into production in order to produce more. Farm subsidies were not the only incentive created to encourage conversion of the Everglades wetland. The income tax laws were written in such a way that they made it profitable for a farmer to convert lands to production and receive accelerated depreciation.

'Management' of the Everglades also involved alteration to the natural water flow pattern for the purposes of flood control, land reclamation, and water storage.

The completion of a shallow canal, connecting lake Okeechobee with the Caloosahatchee River in 1883, marked the beginning of significant human impact upon the overall drainage way (Map 6). As the human population increased in southern Florida in the Late 1800's and early 1900 there was extensive wetland drainage to provide land for both urban and agricultural development. In the 1930's the once uninterrupted surface connection between lake Okeechobee and Florida Bay was completely severed. In several locations, fresh water from the Everglades marsh system was being diverted to the canals to be drained into the Atlantic Ocean. In the 1940's it became apparent that there was a need for some form of overall flood control, drainage and water management in the State. In response, congress passed the Flood control Act in 1948 which established the central and South Florida flood control District as the state agency responsible for water management. While the initial concept was to provide flood control and
MAJOR DRAINAGE CANALS IN SOUTH FLORIDA

Map 6
drainage, it soon became obvious that there were also growing, often conflicting, demands for water which made water conservation during the dry season or during years of drought an additional responsibility of the agency. District personnel began the construction of a series of large marsh impoundment's, called “water conservation area” that were intended to store excess water from the rainy season for use in the dry period. From this, point, all efforts in water management were being directed toward agricultural, urban, land industrial use little, if any, consideration was given to the biological needs.

In December 1962, various control structures to the north of the park were closed, and essentially all surface water flow from the north, through shark river slough into the park, was stopped. The structures remained closed throughout 1963, and only a minimal opening for one mouth in 1964 was permitted. This total cut off surface flow, plus unusually late rainy seasons in the 1963 and 1964, caused severe drought conditions in a major portion of the park, which threatened to cause significant, long-term ecological damage to the area. In an attempt to remedy this emergency situations, the National Park service petitioned for surface water delivery guarantees, and a six-year period of negotiations between the Department of the Interiors, Department of the Army, and the Central and South Florida Flood control District followed. Finally, in 1970, Congress passed the Monetary Authorization Act which authorised construction of additional water convergence facilities and established the current guaranteed minimum deliveries to the Park.

Thus the earliest management of the Everglades was on account of the government perspective on wet lands as “wastelands”, and their inherent value which determined the policy with regards to land usage. Thus the first management schemes began in 1881 with the construction of canals for drainage of the Everglades, the attitude being “drain” and “reclaim”. Total extent of canals went from the original 18 km canal built in 1881 to 115 km of levees and 800 km
of canals the examples of legislated land usage and incentives for wetland conversion were primarily for agricultural purposes.

4.6.3 IMPACT OF THE EARLY TWENTIETH CENTURY MANAGEMENT OF THE EVERGLADES.

The settlement of south Florida and the construction of civil works to protect settled areas from flooding have altered the complex ecosystem of the Everglades. From the beginning of the 20th century through the 1950’s, developers and other entrepreneurs drained water from as much as Florida land as they could sell for farm and house. And ever since the early 1960’s when the corps of engineers completed the central and southern Florida flood control Project the areas fresh water has been shunted through”, 1400 miles of canal and levees, 150 gates and spillways, and 16 of the world’s largest pumping stations. The ever-shifting patterns of the original flow have been reduced to a uniform and monotonous “schedule of water deliveries” designed to produce the predictability necessary for large-scale agriculture and for suburbs that don’t periodically revert to swamps.

But altering the hydrology has profoundly affected the Everglades ecosystem for example by forcing colonies of birds to abandon their traditional nesting sites. It has been recorded that in the last 50 years the number of wading birds nesting in the Everglades national park has dropped by 90 percent and there are fears that the once common wood stork could vanish from the national Park. The number of endangered Florida panther has come down drastically. The main cause of death among theathers is no longer on the roads, instead it is adult males killing young rivals in battles over ever-dwindling territory. The alligators of the Everglades are another endangered species. At the same time native species are being ousted by exotic invaders such as Brazilian pepper and Australian pine trees and south American walking catfish and ascarqish. The
Melaleuca tree, for example, has taken over large areas of the Everglades. This species was originally introduced because of its ability to transpire water and help drain the wetland areas.

Moreover, by quickly sending water to the sea during the wet months, the schedule has reduced the amount that lingers in the Everglades into the dry season. This has often resulted in unnaturally parched winters and fewer wet areas to serve as refuges for the fish that are "released" by the wet season rains to supply food throughout the ecosystem. Less water also means a smaller head exerting pressure against seawater, which in turn has resulted in a diminished Biscayne aquifer and the closing of some wells due to salinity. Finally, because most of the water drained off land after heavy rains is rushed east and west to sea, less of it reached Florida Bay. This, scientists increasingly believe may be contributing to a massive die off of sea grass, which provides food and shelter for a number of unique species.

Faced with an ecosystem constantly out of equilibrium, and lacking any real master plan, managers have tended to react simplistically to crisis after crisis. In 1962, for example, when several years of drought followed completion of the Corps' flood control project, the combination so reduced water, flows that manager at Everglades national park dynamited holes in the limestone to create pools for alligators, which were disappearing from ecosystem. When the park superintendent begged for more water, congress mandated monthly "minimum deliveries". But this simplistic "just add water" approach drowned out alligator nests with sweges of ill-timed water, which was contaminated with phosphorus after being quickly drained from sugar fields after a prolonged rain. Even a revised delivery schedule that coordinated water pulses more closely with periods of rain produced only minimal ecological gains; the new arrangement did not sufficiently take into account the smaller size-and hence lower storage capacity-of the modern ecosystem.
4.6.4 THE EVERGLADES RESTORATION PLAN

The word "recovery" reflects a new, more aggressive attitude towards the preservation for biologically rich landscape. Early twentieth century, land in the United states was simply set aside, or "conserved" when that proved insufficient to protect it from politically powerful mines, ranchers, and lumber companies, it was "managed" to balance wildness with the resource needs of a rapidly expanding human population. Now, as the world's biodiversity continues to decline, scientists are embracing the more ambitious goal of not just stopping but reversing the degradation of ecosystems, of returning them to a state that averts the extinction of their native flora and fauna.

Although ecosystem recovery in a landscape as large and barogue as the Everglades is unprecedented, saving the Everglades had long been a popular cause.

The combined effect of the flood control engineering the conflicting needs and desires for distributing water, and the fertilizer-rich runoff from the farms threatens the entire ecosystem of the Everglades. How to balance these competing needs for water, and at the same time protect the ecosystem, habitats, and water of the Everglades, has resulted in a decade long legal struggle. The participants include the state of Florida, the U.S Federal Government, the U.S Army corps of Engineers, and the south Florida water management District (SFWMD). The litigation engendered a major environmental legislation. A 7–year research study, led by the Army corps, to develop a "blueprint" for all future water use, environmental protection, and flood control. And a massive environment engineering project, called the, Everglades construction Project. Run by the SFWMD, of Everglades construction protect will result in the largest man made wetland system ever constructed. The purpose of these wetlands is to improve the quality of the water flowing into the Everglades, one of the fundamental
necessities in saving the fragile environment.

The scientists emphasized three important traits. The first — and least restorable in today's urbanized South Florida — was its vast area, which provided a place for animals, like the Florida panther, that require a large home range. Although scientists are unsure about how much space the ecosystem needs to function well, it must be large enough to accommodate the second essential characteristic: a continuously changing hydrology. This landscape of fluctuating water depths supplied abundant food somewhere in the system for wildlife during every season, and produced the third characteristic, namely a pattern of highly varied, patchy habitats. Together, these habitats furnished an ecological niche even for animals with unusually specialized needs, such as two endangered birds, the snail kite and the Cape Sable sparrow.

The difficulty lies in determining how to engineer those characteristics back into the system. Past experience, which consists of decades of efforts aimed at saving bits and pieces of the ecosystem without addressing the needs of the whole, is mostly a lesson in what not to do. Many environmentalists, despite their advocacy of systemwide restoration, were at first skeptical that it could ever be accomplished. Their concern arose because the restoration blueprint is being assembled, ironically, by the U.S. Army Corps of Engineers, which, at the behest of the local governments, completed in the 1960s the flood-control works causing the current decline. But with ecological guidance from such agencies as the SFWMD, the National Park Service, the U.S. Fish and Wildlife Service, the National Biological Service, and the National Marine Fisheries Service, today's "greener" Corps is in south Florida attempting to reform itself from the country's premier dam builder and filler of wetlands to its most eager student of environmental reconstruction.

Because water is the foundation of the Everglades, many of the recent
ecological ills stem from disruptions in its timing, flow, quality, and abundance. Accordingly, the most powerful tool in planning the restoration is a computer program that mimics the Everglades’ original hydrological patterns. Known as the Natural System Model (NSM), it was developed in 1989 specifically for the restoration project. The NSM is based on an earlier model that guides the decisions of south Florida water managers about which pumps to activate and which gates to open or close in order to direct water where they want it. Because its simulations for a given day can be compared with what actually happens, the NSM’s designers can easily verify its effectiveness: if the model is right, farms and cities prosper, and if it’s wrong, crops are ruined and homes flooded.

When public pressure in the late 1980s pushed thinking toward wholesale restoration, SFWMD, modified the water management model to simulate how water would flow through today’s remaining wild landscape if all the pumps, gates, and other water control devices had never been built. But because no one was around to record water data in presettlement days, the NSM’s algorithms cannot be calibrated and verified against reality. This means the model must be used more as a sketch pad than as a blueprint for restoration: it can perhaps recreate the original system precisely enough to reveal its defining characteristics but not so precisely that scientists are tempted to restore the Everglades acre by acre.

Using the model, researchers have examined long-held assumptions about the Everglades and tested new ones. Scientists long knew, for example, that during wet years water once spilled over the southern rim of Lake Okeechobee to the north and onto the Everglades’ richest soils. Now, though, more than 500,000 acres of this rich black peat support enormous sugar cane and vegetable farms. To protect them from flooding, the Corps of Engineers diked the southern rim of Okeechobee, cutting the remaining natural Everglades off from an important source of its lifeblood.
Scientists were uncertain about the volume, timing, and direction of that water. How much of it spilled into the Everglades from Lake Okeechobee, and how often? How much of it did the northern portions of the landscape absorb and how much passed through to the rest of the Everglades? To what extent did friction from a half-million acres of sawgrass slow the water down? How important was Okeechobee overflow in keeping Florida Bay at just the right salinity to maintain its remarkable fertility? Without accurate answers to questions like these, scientists cannot know how much water to ask for, or where and on what schedule it should be delivered.

The problem was not merely imagining the farms converted back to sawgrass and pond apple. Exposing soil long covered by water greatly speeds up its breakdown into dust by microorganisms in some parts of the Everglades agriculture region as much as four feet of soil has been lost this century. By asking the NSM what would happen if 500,000 acres of northern Everglades farmland regained its lost soil and reverted to sawgrass, scientists have learned that the area served as a massive storage vessel. The rainwater lingered there for months, combing during wet years with an undetermined amount of Okeechobee overflow. Then, like a saturated kitchen sponge, the soil released the water slowly over more months than Ogden and his colleagues had earlier believed.

This delayed flow explains the disappointing results of tying water releases into the Everglades directly to rainfall patterns, which tends to introduce the water too soon to the southern ecosystem, throwing off such critically timed events as alligator and wading-bird nesting cycles. It also means that because more water was around later into the dry season, more was available all year to the Biscayne aquifer and, by extension, to city faucets. Environmentalists have seized upon this link between natural and urban landscapes to argue that the restoration need not be at odds with the requirements of Miami and Palm Beach. Similarly, water slowly released from the northern Everglades in the dry season
allowed more fresh water to reach Florida Bay over a longer period, helping to keep its salinity in check; this in turn makes restoration advantageous to the commercial and sports fishing industries dependent on the Gulf of Mexico.

The NSM has also helped scientists understand gaps in the ecosystem's range of habitats. In the early dry season, for example, wetlands east of today's Everglades were the perfect depth to serve as the main feeding area for hundreds of thousands of wading birds fattening up for breeding. Many biologists now theorize that the loss of 80 percent of these wetlands may have been the trigger for the birds' departure from the southern Everglades.

This kind of detailed information and analysis gives south Florida scientists and resource managers a focus for their management strategy. By quantifying the arrangement of the original system, the NSM allows them to think about where in the current landscape they might recreate its essential components. If restoration means more water slowly released from the north, the overarching question becomes, Where can that water be found today and how can it be delivered?

All but one of the Corps's six alternatives for restoration call for pumping water from Lake Okeechobee and sending it through the northern Everglades agricultural district either in widened canals or in huge widened marshes known as "flowways." The water would then be stored in secondary wetlands farther south and pumped along at a rate in keeping with NSM estimates. But obtaining and building flowways one to three miles wide would mean taking as much as 167,000 acres out of agricultural production. Beyond that, storing water in a system already reduced by half may require buying many more acres of developed land, a solution that can get prohibitively expensive. This kind of impact requires winning over federal, state, and local officials as well as the owners of these lands—who have long had political influence at every level of
government. So far, though, environmentalists have been extraordinarily successful at fueling popular support for Everglades restoration.

The NSM has emboldened scientists to envision a natural Everglades ecosystem coexisting with today's developed south Florida landscape. They can do little to regain the spatial extent of the presettlement Everglades, of course. But they now dare to predict that flowways and canals will prove just as effective in sustaining dynamic hydrology as the untouched plain of sawgrass and pond apple they are designed to replace.

4.7 CONCLUSION

The Everglades lies at the intersection of the tropical and temperate, making it the only true subtropical wilderness in the United States the area is refuge to numerous plants and animals declared endangered or threatened under the federal Endangered species Act. Scientists have become so enraptured by it that the Everglades is one of only three sites on earth declared an international Biosphere reserve, a world Heritage site, and a wetland of international Importance yet for all its richness, today's Everglades is also a drastically diminished place. It has been drained and reshaped for the benefit of farms and cities. The increasing demands of urban areas and agriculture for water and land have reduced this unique ecosystem to 50 percent of its original size.

The rookeries of herons, egrets, and stories in Everglades National Park—colonies that once each contained tens of thousands of birds whose bustling extravagance helped inspire the founding in 1905 of the National Audubon society - have shrunk by 95 percent since 1930's. Once abundant species like the wood stork and Florida panther are now balanced on the edge of extinction. All this has made the Everglades the ideal candidate for the biggest ecosystem recovery project in history, a project aimed at reinstating the hydrological ballet of the original natural system. Its success depends on three formidable technical
achievements: gathering information on the plants and animals living in the Everglades; integrating that information into a rough but useful description of how the entire ecosystem works, and developing a management scheme that, while clearly articulating specific restoration target remains flexible and patient enough to adapt, to new information and inevitable mistakes.

Given its complexity, an ecosystem recovery project this sweeping and this expensive represents a huge environmental gamble. If it fails, the experiment will certainly add to the knowledge of the regions hydrology and ecology, while teaching scientists something about the limits of ecological restoration.

If is succeeds, Everglades recovery will mean creating a new 18,000 square-mile ecosystem that includes farm and city as well as swamp. For scientists and environmentalists now admit that the Everglades can survive only if reconciled with the lives of the 4 million people who live on farms and in cities along its periphery.

The most compelling argument for the public investment in Everglades recovery is its potential as a modal for preserving bio–diversity elsewhere, particularly in the rapidly growing list of places where the natural environment is dwarfed by crowded human settlement.