# NATURAL SYSTEMS

## > INTRODUCTION

Natural resources in Southwest Florida have had a major influence on the area's economic development and growth. The most important of these resources are the Region's location and climate, land and water resources, vegetation and wildlife, and inland and tidal wetlands. These resources have attracted the large number of retirees and tourists to the region, thereby fueling the area's service, trade, and construction industries.

#### > THE CLIMATE

#### Temperature

Due to the Region's southerly location, a near-subtropical climate with an associated high annual rainfall is typical. Average monthly temperatures range from 64.3 degrees Fahrenheit in January to 82.6 degrees Fahrenheit in August.

Freezes are not common in the Region, but may occur once or twice a year. "Jacket weather" occurs periodically during the fall and winter months.

Weather and climate are very important factors in the economy of Southwest Florida. The combination of warm weather, decreased humidity, and low rainfall during the winter months encourages tourism and an influx of seasonal residents. A high yearly rainfall and moderate winter temperatures enable agriculture to thrive year-round. Periods of freezing weather, when they occur, have adverse effects upon the local economy. Unusually severe winter freezes and resulting agricultural losses in other parts of the state have caused a migration of agricultural interests into the Region from counties to the north.

#### **Precipitation Patterns**

Patterns of precipitation in Southwest Florida exhibit strong seasonal variations. The Region enjoys a rainy season from May through October and a dry season from November through April. Increased atmospheric moisture and incoming solar radiation levels in May generally trigger the rainy season, while a reversal of these conditions occurs in September to signal the start of the dry season. There are also longer-term variations as shown on Figure 13.



FIGURE 13 ANNUAL RAINFALL FROM 1960 TO 1992

The winter is commonly referred to as the dry season. Typically, it is less humid, cooler, and drier. Storms, which do occur, are generally associated with the movement of frontal systems. Isolated hurricanes and tropical storms can cause abnormal annual rainfall levels, but they have little effect upon long-range precipitation patterns.

With the advent of spring, cold fronts stall to the north of Southwest Florida, causing drier weather and forcing water tables to their lowest levels of the year. At this time of year, frequent wild fires occur, sparked by the dry conditions. To cope with the lowering of regional water tables, water managers may restrict the consumption of water by the public. This is particularly true of nonessential activities such as lawn watering and car washing.

The following table was acquired from the National Weather Service for the Fort Myers area to provide an example of the Region's weather extremes. Information for other areas of the Region are also at their Internet site for the Tampa Station at:

http://www.marine.usf.edu/nws/docs/climate/ClimateCoop.html

The low topographical relief of the Region causes problems when heavy rainfall does occur. A major concern of the Region is when such rains precede the onset of tropical storms and hurricanes. The high water levels due to the combination of smaller storms and a tropical storm can be disastrous.

FORT MY	TABLE 85 ERS TEMPERATURE E	XTREMES
Event	Temperature	Date
3 Warmest Highs	103	6/7/81
_	103	6/16/81
	101	6/15/81
3 Coldest Lows	26	12/13/62
	27	12/24/89
	28	12/25/89
3 Coldest Highs	44	12/24/89
C C	45	1/27/40
	46	12/20/96
3 Warmest Lows	83	7/7/97
	83	7/3/97
	83	7/16/81
Coldest Month	55.5F	Jan-58
Coldest Year	72.3F	1958
Warmest Month	85.9F	Jun-81
Warmest Year	76.7F	1997
Earliest Freeze		12/12/57
Latest Freeze		2/26/67
FORT MY	ERS PRECIPITATION H	EXTREMES
Event	Precipitation Amount	Date
3 Wettest Days	7.78"	9/21/62
y ~	7.75"	5/18/89
	6.82"	8/30/32
Wettest Month	20 25"	Jun-36
Wettest Year	80.17"	1947
Driest Month	Trace	Apr-70
Driest Vear	32.83"	1964

## **Tropical Storms and Hurricanes**

Southwest Florida has been identified by the National Weather Service as one of the most hurricane-vulnerable areas of the United States. The potential for large-scale loss of life and property during a hurricane is great. The analysis of hurricane probability is based upon historical occurrences in Southwest Florida, as evidenced in data available from the National Climatic Center, Asheville, North Carolina; the National Hurricane Center, Coral Gables, Florida; and the Fort Myers and Tampa Area Offices of National Weather Service.

From 1873 to 1998, Southwest Florida experienced forty-nine tropical cyclones of hurricane intensity. Eight of these typical cyclones prior to 1885 were not differentiated as tropical storms or hurricanes. Therefore, some of these early storms could have been below hurricane intensity. A hurricane is defined as a tropical storm with sustained winds equaling or exceeding seventy-four

miles per hour. (This is approximately 64.3 knots.) Seventeen hurricanes passed within fifty miles of Fort Myers, averaging one every seven years (Map 5). For the fifty-to-one-hundred-mile radius from Fort Myers, an additional thirty-two hurricanes passed by and through the Region at a rate of one every two and one-half years (Map 6). Based on this information, using a one-hundred-mile radius as a minimum distance for issuing hurricane warnings, Southwest Florida can expect to receive such warnings once every two and one-half years. Of course, deviations can occur. During the 1985 hurricane season, for example, two warnings were issued in Southwest Florida.

The official Atlantic hurricane season is June 1 through November 30. The period of greatest hurricane frequency in Southwest Florida is the three-month period from August to October, when 90 percent of all hurricanes passing within 100 nautical miles of Fort Myers (the center point of reference) have historically occurred. September is the worst single-month for hurricanes in the Region.

Hurricanes that cause the greatest amount of damage have wind velocities averaging greater than one hundred and eleven miles per hour (96.5 knots). Such storms passed within one hundred miles of Fort Myers on the average of once every five and one-half years from 1973 to 1993. The last hurricane to make landfall in Southwest Florida was Hurricane Donna. This storm had winds averaging nearly 135 miles per hour. Donna passed directly over Fort Myers Beach and Fort Myers on September 10, 1960. Hurricane Andrew was the last hurricane to cross the Region from the east, passing south of Naples in 1992.

Coastal flooding from tropical storms and hurricanes is a common occurrence. Such storms occur almost annually, with flooding in low-lying areas, along barrier islands, and around river and bay systems (Map 7).

# **MAP 5- HURRICANES AT 50 MILES**



# MAP 6 - HURRICANES AT 100 MILES







# **MAP 7 - STORM SURGE MAP**

# Air Quality

A few common air pollutants are found all over Florida. Pollution can cause serious health problems, destroy the environment, and damage property. The U.S. Environmental Protection Agency (EPA) has identified six pollutants as criteria air pollutants. They are carbon monoxide, lead, nitrogen, ozone, particulate matter, and sulfur dioxide. Moreover, EPA has regulated them by first developing health-based criteria (science-based guidelines) as the basis for setting permissible levels. One set of limits (primary standard) protects health. Another set of limits (secondary standard) is intended to prevent environmental and property damage.

A geographic area that does better than the primary standard is called an attainment area; areas that do not meet the primary standard are called non-attainment. Fortunately, all of Southwest Florida is under attainment status. The Federal and State Ambient Air Quality Standards are provided in Table 86 below.

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SIA.	LE AND FI	EDERAL AMBIENT AIR	<b>X QUALITY STANDAR</b>	05
Pollutant	Averagi	Florida Standard	Primary NAAQS	Secondary
	ng Time			NAAQS
Carbon	8-hour <sup>a</sup>	9 ppm	9 ppm	-
Monoxide	1-hour <sup>a</sup>	35 ppm	35 ppm	-
Lead	Quarterly	1.5 ug/m <sup>3</sup>	1.5 ug/m <sup>3</sup>	1.5 ug/m <sup>3</sup>
Nitrogen	Annual <sup>b</sup>	100 ug/m <sup>3</sup> (53 ppb)	100 um/m <sup>3</sup> (53 ppb)	100ug/m <sup>3</sup> (53 ppb)
Dioxide				
Ozone	1-hour <sup>c</sup>	0.12 ppm	0.12 ppm	0.12 ppm
	8-hour <sup>d</sup>	0.08 ppm	0.08 ppm	0.08 ppm
Particulate Matter	Annual <sup>b</sup>	$50 \text{ ug/m}^3$	$50 \text{ ug/m}^3$	-
$(PM_{10})$	24-hour <sup>c</sup>	$150 \text{ ug/m}^3$	$150 \text{ ug/m}^3$	-
Particulate Matter	Annual <sup>b</sup>	$15.0 \text{ ug/m}^3$	$15.0 \text{ ug/m}^3$	-
(PM <sub>2.5</sub> )	24-hour <sup>c</sup>	$65 \text{ ug/m}^3$	$65 \text{ ug/m}^3$	-
Sulfur	Annual <sup>b</sup>	$60 \text{ ug/m}^3$ (20 ppb)	$60 \text{ ug/m}^3$ (20 ppb)	-
Dioxide	24-hour <sup>a</sup>	$260 \text{ug/m}^3$ (100 ppb)	$260 \text{ug/m}^3$ (100 ppb)	-
	3-hour	$1300 \text{ ug/m}^3(500 \text{ ppb})$	-	$1300 \text{ug/m}^3$
				(500ppb)

a - Not to be exceeded more than once per year.

b - Arithmetic mean.

c - Not to be exceeded on more than an average of one day per year over a three-year period.

d - Not to be exceeded by the three-year average of the 4<sup>th</sup> highest daily maximum.

e – Not to exceeded by a three-year average of the 98th percentile of the 24-hour averages.

Source: Florida Department of Environmental Protection, South District Office, December 2001.

# Monitoring Network

The Florida Department of Environmental Protection notes that there are over two hundred (200) ambient air monitors located strategically throughout the state. Two types of monitoring networks are used to collect the ambient air data in the state. The first network is the "State/Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS) Network. The SLAMS/NAMS network is designed to meet a minimum of four basic objectives:

- 1. To determine the highest concentrations expected to occur in the area covered by the network.
- 2. To determine representative concentrations in areas of high population density.
- 3. To determine the impact on ambient pollution levels of significant sources or source categories.
- 4. To determine general background concentration levels.

Data from the SLAMS/NAMS network provide an overall view of the state's air quality and are used in the development of statewide control strategies.

Individual stations within the network are designated as either "SLAMS" or "NAMS" sites. The NAMS sites are a subset of the stations selected from the NAMS/SLAMS network with emphasis given to urban and multi-source areas. Areas monitored are selected on both urban population and pollutant concentration levels. The primary objective is to monitor in areas where the pollutant concentration levels and population exposures are expected to be the highest.

## Particulate Matter Pollution

According to information provided by the Florida Department of Environmental Protection (FDEP), there are nine monitoring devices in Lee, Collier, and Hendry Counties. Lead pollution is not monitored in any of the counties of Southwest Florida. The Florida Department of Environmental Protection has targeted the installation and location of PM <sub>2.5</sub> monitors in Collier, Lee, and Sarasota Counties. These monitors will capture particulate matter less than 2.5 microns. The Federal Environmental Protection Agency updated the PM<sub>10</sub> standard in 1997 and promulgated a new standard for fine particles designated as PM <sub>2.5</sub>. Health studies indicate that particles measuring less than 2.5 micrometers in diameter are most damaging to human health because they penetrate and remain in the deepest passages of the lungs.

The FDEP currently maintains monitoring devices in Lee County. Lee County is monitored for particulate matter 10 microns or less in diameter, and particulate matter 2.5 microns or less in diameter. Two particulate matter ( $PM_{10}$ ) monitors are maintained by the Florida Sugar Cane League in Hendry County. endry County's monitoring stations are for particulate matter 10 microns or less in diameter. Three monitors in the Naples area are operated and maintained by Collier County.

In Sarasota County, ambient air quality monitoring devices are operated and maintained by the Sarasota County Natural Resources Department. Sarasota County has the largest number of monitoring stations. Pollutants that are monitored include sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, and particulates.

## Historical Data Analysis

In November of 1992, the Southwest Florida Regional Planning Council examined the air quality of the Region in a publication titled "Southwest Florida Air Quality 1985-1991." The purpose of the study was to determine whether any areas of the Region were significantly impacted by poor ambient air quality. Findings were based on existing field data using air quality monitoring site information and stationary point source emission data supplied by the Florida Department of Environmental Protection, Division of Air Resource Management. The approach was to examine the trend of ozone

and particulate pollution over time.

In summary, the 1992 study of the particulate matter pollution trend showed that there are variations within the Region. For example, three particulate monitoring sites in Sarasota recorded a downward trend while one site illustrated an upward trend. Perhaps of greater significance, all sites within Charlotte, Lee, and Collier Counties recorded an upward trend. Sites in Hendry County, however, recorded just the opposite. Of the twelve sites monitored, fifty percent registered an upward trend, while the remaining fifty-percent registered a downward trend. This might suggest that the particulate pollution of the area remained at a consistent level.

## Particulate Pollution Trend Analysis

While parts of Florida are experiencing nuisance amounts of particulates in the form of dust or soot, particulate levels have always registered under the standards in Southwest Florida. Recent obtained data for Southwest Florida notes that the region is in attainment of the State and Federal Ambient Air Quality Standards for particulate matter. The data below reflects the 1<sup>st</sup> to 4<sup>th</sup> highest values for monitoring sites in Lee, Collier, and Hendry Counties as noted in Table 87. Table 88 reflects the most recent particulate matter values for Sarasota County.

The highest particulate matter  $(PM_{10})$  annual average (arithmetic means) was 25 ug/m<sup>3</sup>, well below the 50 ug/m<sup>3</sup> maximum. Of the four (4) monitoring sites in Lee, Hendry and Collier Counties, both sites in Hendry County recorded 23 ug/m<sup>3</sup> in 1997. The Sarasota Reverse Osmosis Plant site registered the highest value of 25 ug/m<sup>3</sup> for the five-year period. In 1998, Sarasota County recorded 24 ug/m<sup>3</sup>, the second highest average particulate concentration during the years between 1997-2001. Although, Collier County particulate matter has remained consistent since 1997, Lee County's particulate pollution has steadily increased over the years from 17 uq/m<sup>3</sup> in 1997, to 23 ug/m<sup>3</sup> in 2001.

		TABLE 8	7							
	PARTICULA	ATES MON	ITOR VAL	UES						
	Year <u>Highest Maximum Value (µ/m<sup>3</sup>)</u> Annual (µ/m									
Location PM <sub>10</sub>		1 st	$2^{nd}$	3 <sup>rd</sup>	$4^{\text{th}}$					
Fort Myers – Princeton	2001	47	43	41	41	23				
	2000	44	43	30	29	19				
	1999	33	32	32	30	19				
	1998	40	36	36	30	18				
	1997	38	33	33	-	17				
Naples – Collier County	2000	42	29	24	24	18				
Government Complex	1999	36	30	28	27	17				
	1998	67	43	34	33	18				
	1997	46	37	31	-	17				
Clewiston – FSCL, Lopez St.	1997	43	38	36	-	23				
Clewiston – Delta Ranch		60	39	36	-	23				
	Year	1	<u>Highest Max</u>	<u>timum Valu</u>	es	Annual (µ/m <sup>3)</sup>				
Location PM <sub>2.5</sub>		$1^{st}$	$2^{nd}$	$3^{rd}$	$4^{\text{th}}$					
Fort Myers – Princeton Street	2001	21.4	19.8	18.5	16	9.63				
	2000	32.4	24.9	24.6	23.5	10.33				
, The second sec	√olume <b>Ø199</b> 0f 1	he Spategic	Regio <u>na</u> l Po	licy Plan	18.7	9.99				
	Southwest Flor	rida Regiona	l Planning C	ouncil						

Source: Florida Department of Environmental Protection, South District Office, 12/2001.



# FIGURE 14 PARTICULATES

Source: Derived from Table 87.

At present, there are fewer PM  $_{2.5}$  monitoring stations in Southwest Florida than PM $_{10}$  stations. The highest annual PM  $_{2.5}$  average of 11 ug/m<sup>3</sup> was recorded in 2000 at the Bee Ridge site of Sarasota County. The Princeton Street site within the City of Fort Myers recorded the next highest average of 10.33 ug/m<sup>3</sup> during the five-year period.



#### FIGURE 15 PARTICULATES

Source: Derived from Table 87.

	PARTICIIL	TABLE 8 ATES MON	8 ITOR VAL	UES		
	Year	Hig	hest Maxim	um Value (µ	ı∕m <sup>3</sup> )	Annual (µ/m <sup>3)</sup>
Location PM <sub>10</sub>		$1^{st}$	$2^{nd}$	$3^{rd}$	$4^{th}$	
Bee Ridge Park	2001	58	52	39	30	20
115-0013	2000	42	31	31	30	18
	1999	39	35	33	33	19
	1998	39	34	31	28	19
	1997	52	37	30	29	19
City of Sarasota R.O.Plant	2001	58	41	39	39	23
115-1003	2000	44	40	40	40	25
	1999	44	42	41	39	23
	1998	48	43	42	41	24
	1997	47	45	40	37	23
Venice 115-2001	2001	61	45	41	30	19
	2000	35	35	35	34	20
	1999	38	34	33	31	19
	1998	41	39	38	36	20
	1997	50	35	29	27	19
	Year		Highest Max	<u>ximum Valu</u>	es	Annual (µ/m <sup>3)</sup>
Location PM <sub>2.5</sub>		$1^{st}$	$2^{nd}$	$3^{rd}$	$4^{th}$	
Bee Ridge Park	2001	42.4	29.2	27.9	22.8	10
	2000	37.6	36.1	30.2	24.6	11
	1999	34.1	25.2	23.2	22.4	10

Source: Sarasota County Natural Resources Department, Environmental Services, January 15, 2002.

#### **Ozone Pollution**

Ozone is formed from chemical reactions involving sunlight and nitrogen oxides, hydrocarbons and oxygen. The reactions begin in the morning when sunrays react with these various chemicals. The heaviest concentration of ozone is said to be in the evening when the air is generally stagnant. Both volatile organic compounds and nitrogen oxides are emitted by transportation and industrial sources as diverse as autos, chemical manufacturing, dry cleaners, paint shops, and other sources using solvents. Ozone in the upper atmosphere is beneficial to life because it shields the earth from harmful ultraviolet radiation.

#### Ozone Program Developments

The Federal Environmental Protection Agency revised the National Ambient Air Quality Standard for ozone in 1997 from 0.12 ppm of ozone measured over one hour to a standard of 0.08 ppm measured over eight hours. Health studies, which indicate longer exposure at lower concentrations can cause adverse effects on humans, serve as the basis of the new standard. Also, repeated exposure to ozone can make people more susceptible to respiratory inflection and lung problems, and can aggravate pre-existing respiratory diseases.

## Ozone Trend Analysis

Ozone monitoring for the southern part of the region, consists of two (2) monitors, strategically located in Lee County, and two (2) new sites in Collier County, which are to be established. The data in Tables 89 & 90 provide the highest averages for the 1 and 8 hours ozone monitoring sites between the years of 1993-2001. As shown in Table 89, there have been slight decreases in pollution at the Lee County monitored sites in recent years. An examination of all of 3-year periods beginning in 1993 show attainment of the standards, excluding the 1998-2000 period which registered 80 ug/m<sup>3</sup> for ozone. The Florida Department of Environmental Protection has noted that the fires in Mexico contributed to the high values in 1998. Moreover, the data shows that during the last eight years, ozone concentration in the southern part of the region was less than the 0.12 parts per million (ppm) for the 1-hour ambient air quality standard.

In recent years, the data revealed an upward trend in ozone pollution at the South Lido Park site in Sarasota County. The complexity of the ozone problem, including its dependence on meteorological conditions, photochemical formation, and land use, makes it a difficult problem to solve. Pollution from the Tampa Bay area is thought to be a contributing factor of the high concentrations in Sarasota County. Clearly, in the near future, the Florida Department of Environmental Protection will be faced with ways of reducing ozone exposure to the residents of Sarasota County to safeguard public health and welfare.

						TAE	BLE 8	9	~~~~						
				<u>OZON</u>	E VA	ULES	FOR	LEE (	COUN	ſΥ					
			1	1		8 Hour	·Aver	age		1				1	
	Order	1995		1996		1997		1998		1999		2000		2001	
		Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date
Location		ppb		ppb		ppb		ppb		ppb		ppb		ppb	
Cape Coral	1st	75	4/14	65	6/6	71	4/17	95	5/14	88	4/20	85	10/17	56	1/6
071-2002	2nd	72	5/6	65	7/11	70	3/23	95	5/20	87	4/13	77	4/20	56	2/7
	3rd	69	5/22	65	7/12	67	4/24	95	5/20	81	9/4	75	10/18	53	2/6
	4th	66	3/21	62	6/5	67	8/29	92	5/13	77	3/20	73	3/6	52	2/18
	5th	63	3/29	61	6/3	66	4/8	80	4/25	77	4/21	73	4/30	51	1/25
Fort Myers	1st	58	12/3	81	3/14	81	10/3	95	5/14	86	3/12	94	10/17	75	8/25
Beach	2nd	58	12/5	74	4/17	73	3/23	91	5/13	84	9/4	83	10/18	73	5/24
071-3002	3rd	54	12/2	72	4/11	73	4/24	91	5/20	83	4/20	78	10/19	71	3/23
	4th	52	12/7	70	7/11	72	4/17	82	4/25	81	4/13	77	4/20	68	3/27
	5th	50	12/6	70	7/12	71	4/8	82	5/21	76	4/21	75	3/6	68	8/26

	TABLE 89 (CONT.) OZONE VAULES FOR LEE COUNTY														
						1 Hour	Aver	age							
	Order	1995		1996		1997		1998		1999		2000		2001	
		Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date
Location		ppb		ppb		ppb		ppb		ppb		ppb		ppb	
Cape Coral	1st	92	5/6	74	8/1	81	4/8	117	5/20	96	4/13	90	10/17	80	4/18
071-2002	2nd	86	4/14	72	7/1	76	3/23	109	5/14	96	4/20	86	7/27	78	3/23
	3rd	78	5/22	69	6/4	75	4/24	100	5/21	87	4/19	84	8/28	75	3/24
	4th	73	3/21	68	3/14	75	8/29	96	5/13	86	3/20	81	4/20	75	4/17
Fort Myers	1st	66	12/3	89	3/14	98	10/3	103	5/20	96	3/12	98	10/17	85	5/24
Beach	2nd	65	11/17	80	4/17	83	10/2	102	5/13	93	9/4	91	10/18	79	3/23
071-3002	3rd	63	12/5	77	4/11	82	4/8	102	5/14	91	4/13	88	10/20	79	8/25
	4th	62	12/2	73	5/31	80	8/14	89	5/21	89	4/20	86	4/30	74	2/23

Source: Florida Department of Environmental Protection, South District Office, 12/2001.

FIGURE 16 OZONE POPULATION



Source: Derived from Table 89.

						TAB	LE 9	0							
			OZ	ONE V	AUL	ES FOI	R SAF	RASOT	A CO	UNTY					
						8 Hour	Avera	age						-	
	Order	1995		1996		1997		1998		1999		2000		2001	
		Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date
Location		ppb		ppb		ppb		ppb		ppb		ppb	-	ppb	
South Lido Park	1st	87	8/16	85	6/6	92	7/13	108	5/14	96	10/13	96	10/19	105	5/24
115-1005	2nd	82	6/14	75	4/11	90	9/20	100	5/13	94	4/21	91	5/30	92	8/27
	3rd	78	5/6	75	9/23	80	5/14	97	5/15	91	8/13	89	10/29	90	8/28
	$4^{\text{th}}$	77	3/29	74	6/3	79	4/8	88	11/1	85	4/13	86	10/16	86	8/26
	$5^{\text{th}}$	75	5/22	74	6/5	79	9/9	83	4/25	82	4/20	84	10/17	82	8/8
Paw Park	1st											85	10/17	88	5/24
115-1006	2nd											84	10/19	81	8/26
Site established	3rd											82	8/30	80	8/28
Nov-99	4th											81	4/30	78	3/24
	5th											81	10/18	78	8/25
	· · · ·					1 Hour	Avera	age							
	Order	1995		1996		1997		1998		1999		2000		2001	
		Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date
Location		ppb		ppb		ppb		ppb	-	ppb		ppb		ppb	
South Lido Park	1st	101	5/16	97	7/11	107	9/20	131	5/13	111	8/13	122	10/29	121	5/24
115-1006	2nd	99	8/16	94	6/6	93	9/9	122	5/14	111	9/3	107	5/30	114	8/26
	3rd	89	8/17	87	9/23	92	5/28	106	5/15	102	4/21	104	8/30	101	8/22
	4th	88	6/14	86	4/17	88	5/6	97	5/16	100	4/13	104	10/19	98	8/28
Paw Park	1st											109	10/29	102	8/22
115-1006	2nd											100	8/30	101	5/24
Site established	3rd											98	10/17	100	8/26
Nov-99	4th											93	5/30	97	8/25

Source: Sarasota County Natural Resources Department, January 15, 2001.

## FIGURE 16 OZONE POPULATION



# Pollen Pollution

Air pollution is generally seen as a product made by man. Pollen however, is a natural air contaminant, which occurs during periods when plants are pollinating. Pollination is the transfer of pollen from one plant to another and is an essential step in the reproduction of most seed plants. Wind-pollinated seed plants, such as many trees, grasses, and flowering weeds, are the principle sources of pollen. Airborne pollen is a major allergen responsible for seasonal allergic rhinitis. Upon contact with the nasal membrane, pollens release proteins that may cause an allergic response in sensitive persons.

## Summary and Conclusion

Current air quality is good, or "attainment". The current sources of air pollution are "areawide" resulting from autos in urban areas, land clearing, and partly from various licensed emitters. Auto emissions <u>per car</u> are down, but the increasing volume of cars has turned around the reduction leading to areawide increases. Fortunately for those of us residing in Southwest Florida, large industrial polluters are limited. Although the area has a small number of industrial smokestacks spewing out poisonous gasses, there is considerable pollution from automobiles and licensed emitters throughout the region.

The rapid rate of growth in Southwest Florida will put even more pressure on the environment. It is important to recognize that a regional approach to air quality is critical if the existing air quality is to be maintained and improved. Modeling or site monitoring may not present a clear picture of what is occurring in a given area. Occasionally, underlying factors may be the dominant criteria, which

influence the outcome of a sampled population. Such factors are location, spatial distribution, and the sheer number of monitors, which can have a profound impact on the outcome of the data. Similarly, computer modeling has its limitations as well. Problems leading to data constraints may involve physical characteristics, meteorological conditions, technological disasters, topography, and development activities.

Future air quality improvements will not come unless emissions from growth are fully offset. Controlling growth alone will not solve the Region's air quality problem. Effective environment management, incorporating new technologies, and effective land use planning are some answers to the air quality dilemma facing the citizens of Southwest Florida. Clearly, the high ozone levels in Sarasota County will require immediate attention to avoid future air quality problems.

## > GEOLOGY

## Formation of the Land

The land mass that is now Southwest Florida remained shallowly submerged beneath the ocean until the Miocene and Pleistocene Epochs. Most of Collier and eastern Lee Counties emerged during the Miocene Epoch, about fifteen million years ago. Not until the Pleistocene Epoch, slightly more than one million years ago, did the coastal areas from southern Sarasota County to southern Collier County emerge and begin evolving into the coastline known today. Most of Glades and Hendry Counties also emerged during this epoch.

The process of emergence and submergence of the Florida peninsula is believed to have been cyclic, occurring throughout known geologic time. The emergence, characteristic of the Miocene and Pleistocene Epochs, was caused principally by declining sea level. Evidence exists, however, that global sea level has been rising.

Southwest Florida can be divided into ten major physiographic provinces, as described in the Southwest Florida Ecological Characterization Atlas, 1984 (Map 8):

<u>Gulf Coastal Lowlands</u>: Found in northwest Lee County and most of Sarasota and Charlotte Counties, the Gulf Coastal Lowlands are separated from the DeSoto Plain by marine terraces that developed on the south side of the Peace River Valley. The transition from upland to shoreline occurs as a broad, gently southwestward sloping plain composed of depositional sediments of marine origin. These sediments are aligned generally parallel to the coastline, an arrangement that indicates their formation by marine forces.

<u>DeSoto Plain</u>: The DeSoto Plain is broad and flat. It is found in northeast Charlotte and northwest Glades Counties. At the southern portion of the plain, it ends in a scarp which declines thirty feet in elevation over five or six miles. The DeSoto Plain, as postulated, is an emergent, ancient submarine shoal formed during a time of high sea level. The submarine origin of the plain is suggested by the absence of linear features such as ancient shorelines or beach ridges.

<u>Okeechobee Plain</u>: The southern extent of the Okeechobee Plain falls within Glades County. The Plain is dominated by Lake Okeechobee and the Kissimmee River. It is broad, flat, and descends to meet the Caloosahatchee Valley to the south.

<u>Caloosahatchee Valley</u>: The Caloosahatchee Valley rises less than fifteen feet in elevation. It extends from Lake Okeechobee in Glades County to the Lee County shoreline. It is underlain by clay, shell, and limestone deposits. The northern extent is marked by the descending scarp of the DeSoto Plain.

<u>Immokalee Rise</u>: The Immokalee Rise occupies most of Hendry County, northern Collier County, and part of eastern Lee County. It is generally twenty-five feet in elevation, but in some areas it peaks at thirty-five and forty-two feet. Sandy surface deposits are underlain by shell and limestone. The Rise can be delineated by a number of small solution lakes at its borders. It formed as a submarine shoal approximately 100,000 years ago.

<u>Everglades</u>: The eastern portion of Hendry County can be characterized as part of the Everglades. The average elevation within this area is 10 feet. The natural watery grass and hammock vegetation has been replaced by agriculture.

<u>Big Cypress Spur</u>: The Big Cypress Spur is located mainly in northeastern Collier County and includes the Big Cypress Swamp. The area not included in the Big Cypress Swamp is covered by peat and marl, while the Swamp is distinguished by an irregular surface, an abundance of quartz sand, and karst surfaces.



SWFRPC - JAN 1990

SOURCE: SOUTHWEST FLORIDA ECOLOGICAL CHARACTERIZATION ATLAS, 1984.

<u>Southwestern Slope</u>: Most of Collier County is included in the Southwestern Slope area. The Slope most likely originated as a marine terrace during periods of higher sea level. It varies in elevation from a high of twenty-five feet to sea level. The surface consists of shells, marls, and organic material underlain by limestone.

<u>Gulf Barrier Chain</u>: The Gulf Barrier Chain is a string of barrier islands from Longboat Key to Cape Romano. It is believed that these islands formed as dune ridges and spits from sand supplied by coastal headlands, rivers, and formerly emergent areas of the continental shelf. When the rise in sea level began to slow, 4,000 to 5,000 years ago, this sand was acted upon by winds, currents, and waves to form islands parallel to the shoreline. Sanibel Island, however, is believed to have formed from deltaic deposits composed chiefly of mollusk shells.

<u>Reticulate Coastal Swamps</u>: Found along the coast of Collier County, the Reticulate Coastal Swamps are characterized by a profusion of mangrove islands separated by narrow creeks. Encompassing approximately 200 miles of coastline, the Ten Thousand Islands of Collier County are part of the largest mangrove system in the world (the Ten Thousand Islands/Everglades Park Complex). The Coastal Swamps are composed of saltwater vegetation (primarily mangroves) at the ocean fringe, which gradually becomes brackish, then fresh, as the swamps extend landward.

## **Aquifer Systems**

Aquifers are geologic formations of primary interest to man because of their ability to store freshwater. An aquifer is a water-bearing layer of rock that will yield water in a usable quantity to a well or spring. (The water-bearing properties of the various geologic formations in the Region are discussed in Appendix.) Generally one or more of an aquifer's strata are impermeable to water penetration. At some point in the aquifer, however, there is usually an area for water recharge where penetration by water is possible. All water stored in aquifers originates as rainfall.

The two principle aquifer systems in Southwest Florida are the Floridan and surficial aquifers. The importance of these to the Region and their formations are discussed in greater detail below.

## TOPOGRAPHY

Topography is the result of natural forces acting upon regional geologic formations from ancient time until the present. It is an important aspect of the Region's character. It determines drainage patterns, flood limits, soil type, settlement history and potential, and vegetation and wildlife range. Topography in the Region (Map 9) is quite flat, ranging from sea level to a maximum elevation of ninety feet.

## > SOILS

Soils in Southwest Florida consist of sand, silt, and clay derived from geologic substrata, water, and organic matter. Of the fourteen types of soil associations within the Region, four account for over half of the Region's soil: the Adamsville-Pompano, Immokalee-Myakka-Pompano, Felda-Wabasso-Penida and Pompano-Charlotte Associations. All are deep, nearly level, and poorly drained, with a water table less than ten inches from the surface during at least part of the year.

Other associations present in significant amounts include the Ochopee-Broward and Broward-Pompano Associations (Map 10).

While most soils in the Region have some suitability for agricultural uses, they act as natural constraints to urban development. Extensive soil preparation is required prior to development in most areas of the Region. For example, in areas with a high water table, many feet of soil must be added vertically to development sites to facilitate drainage and provide flood protection.

## > FRESHWATER RESOURCES

The major surface water systems in southwest Florida include the Kissimmee-Lake Okeechobee-Everglades System, the Peace River-Myakka River-Charlotte Harbor Basin, the Coastal Sarasota Basin, the Big Cypress Basin, and the watersheds of the Caloosahatchee River. (Map 11 and Map 12 shows the major surface waters of the Region) The natural surface hydrology of south Florida resulted from the interaction of the region's subtropical climate with its topography and geology. The natural hydrologic system was self-sustaining and dynamic with conditions ranging from dry periods to prolonged flooding during wet periods. During wet periods, water tended to accumulate on the predominantly flat, low-lying lands, flowing overland and via shallow streams into freshwater lakes and the Gulf. Ponding persisted for several months, allowing infiltration of surface water into the underlying aquifers. During dry periods, surface water levels receded, but water stored in the soil and aquifers provided the base flow for the rivers and wetlands. Occasionally, prolonged droughts caused more complete drying of the land. As a result, wild fires were not uncommon during droughts.



# ELEVATIONS SOUTHWEST FLORIDA REGION



Mostly Histosols. Dominated by level, very poorly drained organic soils underlain by mari and/or limestance. Primarily used for sugar cone, vegetables, pastures, and sod Very poor for homesiles and urbon development.

# SOILS OF THE REGION SOUTHWEST FLORIDA REGION



# SURFACE WATERS SOUTHWEST FLORIDA REGION



# MAJOR BAYS AND RIVER SYSTEMS SOUTHWEST FLORIDA REGION

Long periods of flooding and the extremes of droughts and hurricanes made much of south Florida inhospitable to development. Early development was generally confined to isolated uplands and the coastal ridge, often the only dry land available. There was, however, a strong desire to settle the lowlands, which were very fertile and potentially of great agricultural value. In order to accommodate development, the natural hydrologic system was modified to meet the population's desire for drainage for agricultural and urban activities. Extensive damage wrought by floods and droughts led to the construction of the Central & Southern Flood Control Project, a regional network of canals, levees, storage areas, and water control structures designed to provide reliable water supply and flood protection for existing and future development and other major drainage systems. The region's surface hydrology is now largely governed by man-made systems superimposed on the natural hydrology. In an attempt to restore impacted natural systems, the U.S. Army Corps of Engineers has recently completed a Restudy of the Central & Southern Flood Control Project. The Restudy proposes a series of methods to accomplish restoration including storage of excess runoff in reservoirs and aquifer storage and recovery wells. These methods will be furthered studied during the Reconnaissance and Feasibility Study phase of this overall project.

The Florida Department of Environmental Protection has a permanent fixed surface water quality station network. The results of this monitoring are entered into EPA's STORET computer database. The "1996 Florida Water Quality Assessment, 305 (b) Technical Appendix" (Florida Department of Environmental Protection), provides an excellent summary of water quality conditions within the Region and State. Additionally, the District Water Management Plans and the Charlotte Harbor National Estuary Program's "Synthesis of Existing Information Volume 1: A Characterization of Water Quality, Hydrologic Alterations, and Fish and Wildlife Habitat in the Greater Charlotte Harbor Watershed" contain information on the region's water resources. Finally, the Central and Southern Florida Project Comprehensive Review Study prepared by the U.S. Army Corps of Engineers, (Restudy) contains extensive information on the Kissimmee- Lake Okeechobee Everglades system.

The following basin descriptions are excerpts from those documents:

## Sarasota Bay Basin

The Sarasota Bay Basin, which drains 268 square miles, extends from Tampa Bay to Charlotte Sarasota, Little Sarasota, and Lemon bays, all Outstanding Florida Waters, have a Harbor. combined estuarine area of about 24 square miles. Sarasota Bay, an Estuary of National Significance, is really more like a sound, protected by a strip of barrier islands and receiving little fresh water. Several small streams, most less than five miles long, enter the estuary. Nearly all these and the basin's relatively clear waters support healthy, but degrading, seagrass beds. The basin has two major urban centers, Sarasota and Bradenton; most of the rest is developed into subdivisions and small municipalities. Some agricultural drainage occurs, mostly from citrus groves in the eastern basin and rangeland at the headwaters of Phillippi Creek and Cow Pen Slough. The city of Sarasota wastewater plant, which discharges into Whitaker Bayou, is the basin's major point source of pollution, creating nutrient, dissolved oxygen, and coliform bacteria problems. The plant, which has had a long history of enforcement actions, has now up-graded to advanced treatment. Currently, a combined system of seepage irrigation and direct discharges to Whitaker Bayou are used to dispose of wastewater. The plant is allowed a maximum of 59 days a year of direct discharge (primarily into Phillippi Creek). The Corps of Engineers and Sarasota County's Stormwater Utility are considering a flood-control

project for the bayou's tributaries that would channel the creek. FDEP has suggested that these agencies explore other alternatives. Agricultural and urban stormwater runoff are also a problem, however, according to SWFWMD staff, urban stormwater is thought to be the dominant factor in non-point source runoff, as agricultural runoff accounts for only 6% to 9% of Stormwater runoff in the basin. Septic tanks affect many streams running through developed areas. Tributaries and direct runoff supply the bay with large amounts of nutrients.

Past studies have indicated that seagrass beds are declining in Upper Sarasota Bay, especially on the eastern side, presumably because high algal concentrations are reducing the water's transparency. However, according to more recent studies prepared by the Sarasota Bay NEP, seagrass habitat has increased by 18% within the Bay since 1988.

Runoff from the Bradenton area provides further nutrients. According to material provided by the Sarasota Bay NEP, nutrient (nitrogen) pollution has been reduced in the Bay by 47% since 1990 and nitrogen pollution from wastewater treatment plants has been reduced by 80%. Sarasota, Little Sarasota, and Lemon bays are all threatened by increased boat traffic, seawalling, and the replacement of mangroves by lawns and drainage canals. The dredging of Stump Pass in Lemon Bay has provoked controversy, and FDEP has rejected requests from Sarasota County for a permit to dredge and reopen Midnight Pass. In association with the National Estuarine Program, several local agencies are monitoring the bay's water quality. Additionally, the Sarasota Bay NEP has established a Comprehensive Conservation and Management Plan for the Bay.

## Myakka River Basin

The Myakka Basin lies in a transitional area between temperate and subtropical habitats. The upper basin, sitting in a flat, marshy area with a small, fringing cypress floodplain, is very sparsely populated and developed, and used mostly for pasture and some citrus groves. The headwaters of the Myakka arise from marshes in Hardee County in southwestern Florida. SWFWMD staff has stated that a very small portion of the Myakka River headwater tributaries that exist in Hardee County have been altered and contribute only a small amount, if any, to the rivers flow. The majority of the headwater marshes and tributaries contributing to the Myakka River occur in Manatee County.

The blackwater river then enters two successive impoundments, Upper and Lower Lake Myakka (the latter is only partially impounded). This part of the basin, also sparsely populated, is mostly included in the 45-square-mile Myakka River State Park. Below the park, the river winds crookedly through undeveloped marsh and swamp prairies until it widens into the Myakka Estuary. This area receives water from two main tributaries, Deer Prairie Creek and Big Slough Canal. The North Port and Port Charlotte developments lie just east of the estuary. The river traverses about 54 miles, draining roughly 540 square miles before discharging to Charlotte Harbor.

Because the basin is relatively undeveloped and contains so many varied habitats (such as marshes, swamps, prairies, flatwoods, hammocks, and estuary), many endangered species have been found, and it is a popular recreational area. Much of the river is a State Wild and Scenic River and an Outstanding Florida Water. Additionally the estuary is a SWIM priority water body and is recognized as an estuary of national significance within the Charlotte Harbor NEP program.

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The basin generally has very good water quality and supports productive freshwater and estuarine habitats. The river is very sluggish, often with no net flow during the dry season. Dissolved oxygen levels are typically low. Tidal influence on flows and salinity can extend as far as 20 miles upstream. Part of the upper basin drains phosphate-rich areas, which, combined with agricultural and rangeland runoff, elevate the river's nutrient levels. Upper Lake Myakka is eutrophic, with dense mats of hydrilla and water hyacinth and low concentrations of dissolved oxygen. The lake provides habitat and feeding areas for abundant wildlife.

In the lower basin, Deer Prairie Creek and Myakkahatchee Creek (Big Slough Canal) both drain rangeland. The latter's upper stretches have been channeled to enhance drainage. In the lower stretches, it traverses some urban areas, receiving drainage from residential canals. Myakkahatchee Creek shows elevated coliform and nutrient levels, probably because of runoff from pastures and urban development. Myakkahatchee Creek is also a potable water supply and that, as such, it is a Class I water body. Relatively little development is present along the estuary, which maintains much of its pristine, mangrove-vegetated shoreline. The estuary is threatened by encroaching development to the east.

## **Peace River Basin**

The Peace River, a blackwater stream, originates in the Green Swamp and some of central Polk County's numerous, partially connected lakes. It coalesces into a defined stream near Bartow and flows generally southwest for about 105 miles, entering Charlotte Harbor. The basin's drainage encompasses approximately 2,400 square miles. Numerous lakes and large areas of swamps in the headwaters of the Peace River act as important recharge areas for the Floridan Aquifer. Cypress and hardwood floodplains line the river corridor itself, which contains little development. The river provides a popular canoe route from Ft. Meade to Arcadia. Its main tributaries include Peace, Saddle, Charlie, Horse, and Shell Creeks. Major urban areas in the upper basin and out side of the Southwest Florida Region include Lakeland, Winter Haven, and Bartow. At the river's mouth lie Port Charlotte and Punta Gorda.

Agriculture dominates land uses in the upper basin. The large expanses of barren land (about 25 percent of the basin) reflect extensive phosphate mining in the upper basin and the headwaters of many of the Peace River's tributaries. In the lower basin, land is used mainly for agriculture and rangeland. Citrus groves prevail in the middle stretches. Pollution sources in the basin include domestic wastewater, industrial discharges from phosphate mining, chemical- and citrus-processing plants, and surface runoff from urban, agricultural, rangeland, and barren (mined) areas. Charlotte Harbor and its watershed, including the Peace River, are SWIM priority water bodies and are contained in the Charlotte Harbor National Estuary Program.

Four major pollution sources affect different areas along the river and its tributaries. In the northern basin both domestic and industrial point sources and urban stormwater severely degrade water quality. Part of the upper basin has also been affected by phosphate mining. Most of the major tributaries throughout the basin contribute varying degrees of agricultural and rangeland runoff. The worst water-quality problems originate in the upper basin. Lake Parker, Banana Lake, and Lake Hancock and their tributaries (Saddle Creek, Banana-Hancock Canal, and Lake Lena Run) have some of the poorest water quality in the state, with elevated nutrients, periodically low levels of dissolved oxygen, low acidity, high bacterial counts, and severely depressed biological communities.

The Peace River in the vicinity of Bartow, Fort Meade, and Zolfo Springs is degraded by several phosphate mining and fertilizer industries. Strip mining of phosphate rock occurs (or has occurred) within the drainage of the river and most of its tributaries in this stretch. Although waters flowing through phosphate strata have higher background concentrations of phosphorus, these mining operations contribute far greater nutrient loading than natural background loads. Furthermore, mining disrupts the flow regime of the small creeks and severely limits habitat for biota. In addition to the mining operations, this area has many citrus groves so pesticides may cause further threats to aquatic life.

The nonpoint sources shift from mining operations to agricultural and rangeland runoff further south in the basin. Because of this less intensive land use and the confluence of Horse Creek (a relatively undisturbed tributary system) the Lower Peace River exhibits relatively good water quality, as compared to the upper reaches of the river. The only exception as it enters Charlotte Harbor is high phosphorous content.

Within the Southwest Florida portions of this basin, increased development threatens the Prairie and Shell Creek drainage basins. Near its confluence with the Peace River, Shell Creek has been impounded for drinking water for the City of Punta Gorda. The City of Punta Gorda is permitted to withdraw an annual average of 5.38 million gallons per day from the reservoir. Development in Port Charlotte and Punta Gorda affects the estuarine portion of the river. Construction and urban runoff add sediments and nutrients. The Punta Gorda wastewater plant has converted from surfacewater discharge to spray irrigation. Because the sprayfields are underdrained and flow to Myrtle Slough, the plant must convert to advanced treatment.

A five-year study by FGFWFC found that the upper and lower ends of the Peace River have fishery problems, but the middle is fairly clean, with plentiful fish. In the upper river the composition of fish populations, largely gar and tilapia, reflects the environmental impacts of drainage from Lake Hancock and the Peace Creek Drainage Canal. By the time the river reaches Wauchula, better water from tributaries changes fish populations. In the middle section of the river, largemouth bass, bluegill, and sunfish can be found in addition to tilapia and gar. Diversity decreases again near the river mouth at Punta Gorda on the Gulf of Mexico.

The Peace River Water Supply Facility is located in Desoto County and provides public water supply to areas of Charlotte, Sarasota and Desoto Counties. The facility is owned and operated by the Peace River/Manasota Regional Water Supply Authority (PR/MRWSA). The raw water source is the Peace River. The treatment facility is currently designed to treat 12 million gallons per day (MGD) and is currently undergoing construction to add an additional 12 MGD giving the facility a total treatment capacity of up to 24 MGD.

An 85-acre off-stream reservoir 625 MG capacity and aquifer storage and recovery (ASR) system supplement water supplies during periods of low river flows. The off-stream reservoir is filled with untreated river water during periods of high river flow. The ASR system stores treated water when excess treatment capacity and raw water supply is available and provides for recovery of the treated water when either the river cannot supply adequate raw water or the demand exceeds the treatment facility capacity. The ASR system currently consists of 9 wells. Twelve 12 additional ASR wells are currently under construction for future use.

There are currently three large phosphate mines proposed within the Peace River basin, including Horse Creek and other tributary watersheds, and Myakka River basin, including Myakkahatchee Creek. These proposals include the following:

- IMC Phosphates Ona Mine, approximately 20,595 acres straddling Horse and Brushy creeks in the Peace River basin, in Hardee County.
- Farmland-Hydro Mine, approximately 15,100 acres straddling Brushy and other creeks in the Peace River basin and adjacent to the Peace River corridor, in Hardee County.
- IMC Phosphates Pine Level Mine, approximately 23,000 acres straddling Horse Creek in the Peace River basin in DeSoto County and straddling Myakkahatchee Creek in the Myakka River Basin in Manatee County.

The IMC-Agrico Ona and the Farmland-Hydro mines are currently undergoing the Ecosystem Management Team Permitting review process. IMC Phosphates has held off on pursuing the Pine Level mine permit until the Ona mine permit application review is resolved.

## **Charlotte Harbor Basin**

The Charlotte Harbor Estuary is one of Florida's largest bays, covering 119 square miles of Charlotte Harbor as well as Pine Island Sound (71 square miles), San Carlos Bay (23 square miles), and Matlacha Pass (23 square miles). The northern part of Charlotte Harbor receives fresh water from the Peace and Myakka rivers. The eastern side of the bay also receives drainage from several small coastal creeks and canals. San Carlos Bay is an extension of the Caloosahatchee River Estuary. Northern Charlotte Harbor is heavily influenced by flows from the black-water, phosphorus-laden Peace River. The northern portion of Charlotte Harbor is also a SWIM-priority water body under the direction of the Southwest Florida Water Management District (SWFWMD). The southern portion of the Harbor Complex contained within the South Florida Water Management District's jurisdiction is not considered as a priority SWIM body by the District.

Pine Island Sound and Matlacha Pass have less fresh water flows. Mangroves line the shorelines, creating hundreds of small islands and supporting seagrass growth. The Caloosahatchee River influences San Carlos Bay's water. The basin is a productive nursery area for marine life. Urban development is heavily concentrated in the northern basin at Port Charlotte and near the mouth of the Peace River at Punta Gorda. Local urbanization is present in the south at the mouth of the Caloosahatchee. More and more of the drainage area is being developed, however, mainly as massive communities. Most of the rest of the shoreline comprises mangrove swamps. The barrier islands are moderately developed, primarily for tourism, and the area's economy is based on tourism, retirement communities, and fisheries.

Water quality in the basin is generally good. Most pollution comes from development, including bacteria from accelerated urban runoff through canals and sediments from construction and reverse osmosis discharges. Nutrient levels, particularly phosphorus, are elevated, and Secchi readings are somewhat low in areas. High phosphorus levels primarily originate from the Peace River Basin. Nutrient pollution in San Carlos Bay may result from urban runoff around Ft. Myers and agricultural runoff from the Caloosahatchee River drainage. Urbanization at the mouth of the Peace

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River probably affects Upper Charlotte Harbor to some degree. Fisheries have declined, and shellfishing is periodically closed because of bacterial contamination. An extensive canal system in the largely undeveloped northern portion of Cape Coral affects the timing and possible quality of freshwater flows into the north end of Matlacha Pass.

The most serious historic water-quality problems were found in the Sanibel River on Sanibel Island, at the southern end of the Charlotte Harbor Basin. For years, the river historically received domestic wastewater and stormwater runoff from the island's more developed areas. Although leachate from local wastewater plants has been controlled, runoff remains a problem. The area has not been sampled recently.

Excessive surface water withdrawals from rivers and creeks for purposes of water supply may also degrade estuaries that receive freshwater inflows. Changes in historic/natural duration, seasonality and volume of water may affect important sport and commercial saltwater fisheries and other estuarine species. Surface water withdrawals from the Peace River and Myakahatchee Creek are proposed for expansion.

The Charlotte Harbor National Estuary Program study area covers the entire Charlotte Harbor Ecosystem Complex, including Lemon Bay and Estero Bay and their watersheds. Detailed information also exists as part of the Charlotte Harbor National Estuary Program. A "Synthesis of Exiting Information" has been prepared that contains comprehensive information covering the NEP Study Area including Peace River, Myakka River, Coastal Venice, Lemon Bay, Cape Haze, Gasparilla Sound, Charlotte Harbor Proper, Pine Island Sound, Matlacha Pass, San Carlos Bay, Tidal Caloosahatchee River and Estero Bay. Further information about the program and a copy of their Comprehensive Conservation and Management Plan can be found at their Internet location: http://www.charlotteharbornep.com

## Kissimmee River Basin

One of the most prominent hydrologic features of south Florida is the Kissimmee-Lake Okeechobee-Everglades system. Shingle, Boggy, and Reedy creeks comprise the main headwaters of the Kissimmee River in the southern outskirts of the highly urbanized Orlando area. Shingle Creek flows sluggishly through urban and swampy land, eventually emptying into Lake Tohopekaliga (Toho). Reedy Creek flows from Disney World through swamps into a slough between Cypress Lake and Lake Hatchineha, and then southward into Lake Kissimmee. This flat upper basin also contains hundreds of small lakes. After leaving Lake Kissimmee, the river once meandered through a large, sparsely populated floodplain to Lake Okeechobee. Connections between the lakes have been modified by channels, primarily for navigation in the 1800s and later for flood control. In the late 1960s the Corps converted the river into a canal, C-38, to provide flood control, allow navigation, and reclaim agricultural land. The 103-mile long, shallow, meandering river was replaced with a 56mile long, 30-foot deep channel. This resulted in the drainage of 43,000 acres of floodplain wetlands Unfortunately, aesthetics, biological diversity, and downstream water quality declined. The river which eventually discharges into Lake Okeechobee is a major source of surface water flow into the lake.

The South Florida Water Management District (SFWMD) is currently engaged in an effort to reintroduce flows to remnant river oxbows and restore 26,500 acres of wetlands in the river floodplain.

Construction of this project is expected to be completed in 2009.

The two most notable water quality problem areas in the Kissimmee River basin are Lake Tohopekaliga (Toho) and the lower Kissimmee River. Lake Toho has eutrophication problems due to excessive nutrient loads, while the lower Kissimmee River's problems are due to channelization. Water quality in the channel varies from north to south. From Lake Kissimmee to near Lake Okeechobee, water quality is fairly good. The channel flows mostly through unimproved rangeland. However, as the river nears Lake Okeechobee, cattle become more concentrated and dairies more numerous. Nutrient and BOD-rich runoff from all along the channel flows quickly through the river to Lake Okeechobee and exacerbates eutrophication problems there.

Perhaps more significant than the water quality problems in the river is the habitat modification and consequent loss of biological diversity and functional wetlands. Recently, efforts have been made to restore parts of the river to its natural, meandering course by strategically placing weirs in the channel. In those sections the river has returned to its original floodplain, effectively re-creating the buffering wetlands. Land purchases, design plans, and monitoring are being continued toward the restoration goal of 32,000 acres.

## Fisheating Creek Basin

Fisheating Creek Basin forms part of Lake Okeechobee's northwest drainage basin. The creek itself, which is mostly lined by cypress swamps, is a meandering blackwater stream that flows through rangeland in Highlands and Glades counties. It eventually empties into Gator Slough, which then flows into Lake Okeechobee. The river is an excellent place to observe wildlife. In drier years, many of Lake Okeechobee's wading birds seek refuge in its swamp and sloughs. The basin, which drains 918 square miles, is primarily improved rangeland with some agriculture. Other waterways include several major canals connected to a network of smaller canals designed to drain land for more intensive grazing and agriculture. The basin is very sparsely populated, with no major urban areas; it also contains the Brighton Indian Reservation.

Fisheating Creek and Gator Slough generally have good water quality; several remote segments are popular for recreational canoeing and swimming. Rangeland and agricultural runoff, however, have impaired the canals' water quality. Altered flows and habitats as well as nutrient enrichment have produced low biological diversity and declining fisheries. The canals also have problems with odors and weed growth. Slowly flowing streams such as the upper part of Fisheating Creek and the canals usually have low dissolved oxygen levels. The basin is one of the many sources of nutrient pollution for Lake Okeechobee. Lykes Brothers restored 22 miles of wetlands where it had illegally dug ditches and canals. Subsequent monitoring reports indicate a very high success rate for the restoration.

#### Lake Okeechobee Basin

Lake Okeechobee, which covers 700 square miles depending on the lake's level, is Florida's largest lake and the second largest in the United States. It is a priority Surface Water Improvement and Management water body. The Kissimmee River is the largest basin draining into the lake, followed by Fisheating Creek, the Indian Prairie Canal, and Taylor Creek/Nubbin Slough. Land use in the surrounding basins is predominantly improved pasture, rangeland, sugar cane and wetlands

(Fisheating Creek). The lake's natural drainage, which spills into extensive wetlands south of the lake, has been diked and dredged into six major canals: the westward-flowing Caloosahatchee and the eastward-flowing St. Lucie, West Palm Beach, Hillsboro, North New River, and Miami canals. These and numerous other drainage canals have allowed about 1,200 square miles of land, the Everglades Agricultural Area, to be claimed for agriculture. The EAA is planted mostly in sugar cane but also has significant crop and sod farming.

The Lake may be considered an historically eutrophic water body that is becoming hypereutrophic, due primarily to nutrient inputs from the Kissimmee River and the Taylor Creek/Nubbin Slough Basins. Water quality conditions in the upper Kissimmee River appear to be improving, primarily due to re-routing of wastewater flows from the river to reuse and ground-water discharge sites. However, large quantities of nutrients are still discharged from Lake Toho to Lake Kissimmee and other downstream areas. Water quality improves from Lake Kissimmee to near Lake Okeechobee, where the channel flows mostly through unimproved rangeland; however, pollutant loadings significantly increase as cattle and dairies grow more numerous near the lake.

The lake's total phosphorus levels have doubled in the last 20 years, due in large part to agricultural runoff. This same runoff also has contributed to frequent and widespread algal blooms and at least one major fish kill. Even with the extensive pollutant abatement programs implemented in Lake Okeechobee watersheds during the past 15 years (i.e., reduction of Everglades Agricultural Area backpumping, dairy buyouts, the Florida Department of Environmental Protection Dairy Rule, the South Florida Water Management District Works of the District Regulatory Program), recent lake water nutrient concentrations and loads show no substantive signs of improvement. Further, because the lake's phosphorus is internally recycled, and a vast reservoir of the nutrient is stored in lake waters may not reach acceptable levels for many decades.

The situation in south Florida today, as summarized in the the Central and Southern Florida Project Comprehensive Review Study, can be attributed largely to a diminished capacity to retain the huge volume of water that once pooled and sheet flowed across the pre-drainage landscape but that now is either discharged in massive volumes through canal systems to tide or is stored at unnaturally high levels in remnant diked wetlands of the Everglades. In hindsight, many of these problems are now recognized to be unanticipated effects of the existing Central and Southern Florida (C&SF) Project. They are exacerbated by the inescapable reality that people continue to move to south Florida at one of the highest rates in the nation. The result is a currently non-sustainable system of urban, agricultural and natural environments in south Florida that exceeds the capacity, or is hampered by, the existing system of water management.

## Caloosahatchee River Basin

The Caloosahatchee River, a blackwater river that drains low, flat mucklands, runs from Lake Okeechobee to the lower Charlotte Harbor Basin at San Carlos Bay. Basically a waterway channeled for flood control, the river flows about 45 miles from the Moore Haven Locks on western Lake Okeechobee to the Franklin Locks near the town of Olga. Ortona Locks lies in between, near Ortona. The three locks prevent saltwater intrusion. The Caloosahatchee is the only flood-control outlet leading west from Lake Okeechobee, part of the Okeechobee Waterway, and the only navigable passage between the Gulf of Mexico and the Atlantic Ocean. From Olga to the Gulf,

roughly 30 miles, the river broadens into a tidally influenced estuarine system. Rangeland and agriculture dominate land use in the basin, particularly the upper portion. Tributaries are generally drainage canals.

The lower river, below Ortona Locks, still has portions of the old meanders and natural tributaries, some of which receive water from saline artesian wells. Citrus and fern farms predominate here, and some large residential developments have been built. Much of the area is made up of wetlands. Although the upper basin contains no large urban centers, Fort Myers, North Fort Myers, and Cape Coral - which number among the state's fastest growing cities - lie along both banks of the estuarine portion of the Caloosahatchee.

The river has a long history of human use and flows by some of southern Florida's oldest settlements. The Indians used the river as a trade route before the Seminole Wars in the early 1800s. It later became more important as a steamboat waterway, especially after dredging and channeling in the early to mid-1900s.

The upper portions near Lake Okeechobee frequently violate dissolved oxygen standards and also have high conductivity and nutrient levels from low flows and agricultural drainage (mostly sugar cane). Nine-Mile Canal, which drains agricultural fields, has very poor water quality, and pollutiontolerant species dominated biological samples. Although no algal blooms were seen during a sample period, they have been reported. Water quality improves downriver near Alva. Here land use is less intensive (mostly orchards), and the river has more natural tributaries and old channels. Several tributaries have good water quality and diverse biological communities. The river's biological communities are somewhat poorer than those in its tributaries, probably because reduced flow in the channel has decreased available habitat. The city of Fort Myers uses the Caloosahatchee above Franklin Locks for potable water.

Below the locks, the river widens, becoming estuarine, with Fort Myers on one bank and Cape Coral on the other. The latter, a massive residential area, developed largely before dredging and filling were strictly regulated. A huge network of canals provides the fill and drainage for roads and homes. Once sparsely populated, the community is growing rapidly. As more houses are built, polluted stormwater runoff will degrade the canals' water quality, and already limited underground drinking water supplies will dwindle. In 1992 Cape Coral officially connected its first home to a dual-water system that allows treated effluent and canal water to be used for irrigation, an approach that will also help preserve drinking-water supplies over the long term. The two Fort Myers wastewater plants that discharge to the river must meet advanced treatment standards, and eventually Fort Myers may implement its own dual-water system.

While wastewater discharges remain a problem, at present high-nutrient waters from the river and tributaries and storm-water runoff from cities more seriously affect the estuary. Nutrient and chlorophyll levels are high, and small algal blooms occur regularly. The Orange River, a tributary entering the Caloosahatchee below the locks, is a favored wintering place for manatees because a nearby power plant discharges warm water. A fish kill and clam die-off occurred in 1990 because of high-temperature water discharges and low dissolved oxygen levels.

# **Big Cypress - West Coast Basin**

The basin, which comprises 2,657 square miles of land south and east of the city of Fort Myers, has very little topographic relief; wetlands dominate the southeastern basin, and mixed dry land and wetlands dominate the northwestern basin. A network of ditches drains much of the "dry" area, which is periodically wet. Sawgrass interspersed with patches of cypress or hardwoods dominates the wetlands. Inches of difference in elevation account for vast differences in vegetation. Along the southern coast lies a thick mangrove swamp extending inland five or more miles. This area below Naples, known as the Land of Ten Thousand Islands, is a rich estuary where freshwater sloughs and rivers mix with the Gulf of Mexico's bays and tidal creeks. Most of the basin east of the Barron River Canal is part of the Big Cypress Swamp or Everglades National Park - which, along with Ten Thousand Islands Aquatic Preserve, contains most of the state's coastal wetlands.

In the northwestern basin, considerable farming (including cattle ranching and vegetable growing) goes on in the quadrangle formed by the cities of Naples, Sunniland, Immokalee, and Ft. Myers. The citrus and ranching industries are exerting pressure to extend this area southward. Some ranching already exists in privately owned areas in the southwestern basin, especially near major drainage canals.

A 175-square-mile east of Naples was extensively ditched and drained in the 1960s for a residential development called Golden Gate Estates. A network of 183 miles of canals and 813 miles of roads was built. Within the southern portion of the project few lots were ever inhabited, the canals and roads remain, and the site has never recovered. FDEP is now acquiring part of southern Golden Gate Estates and restoration efforts are planned.

Farther west along the coast, urbanization is rapid, and cities and communities are springing up from Fort Myers to Naples. In fact, the coast around Naples is one of the country's fastest growing areas. Development has brought new canals and roads; the canals join natural drainage channels that lead west to southwest to the Gulf of Mexico. Marco Island, a winter resort south of Naples, is almost completely developed. Water flows very sluggishly in this part of the basin because of the small difference between land and sea elevations. Water in man-made canals and natural streams is typically low in dissolved oxygen, often below state criteria. Although low levels are considered natural in many southern Florida waters, care must be taken to prevent dissolved oxygen from dropping further through nonpoint or point source discharges.

Because the basin is so large and remote, STORET water-quality data are very limited. Water quality is also hard to assess because of the naturally low levels of dissolved oxygen and the fact that most "streams" are actually man-made canals. Given these background conditions, however, some impacts can be seen on the canals. The 1994 Nonpoint Source Assessment noted that most canals run through agricultural lands. The western half of the Tamiami Canal is threatened or moderately impaired from nutrients, algal and weed growth, and pesticides. Canals draining urban areas are also affected by urban runoff and septic tank leachate. Naples Bay and parts of Estero Bay are threatened or moderately impaired. Lake Trafford, near Immokalee, which is severely impaired from agriculture, urbanization, and septic tank runoff, experiences algal blooms, weed growth, and occasional fish kills. In addition, health advisories recommending no consumption and limited consumption of largemouth bass because of high mercury content have been issued for portions of Everglades National Park.

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The basin's most disturbing, ecologically destructive problem is severely altered freshwater flows from drainage canals with inadequate or nonexistent control structures. In addition, proposals have been made to expand existing canals and create new ones to alleviate flooding in developed and developing areas. The canals cause excess fresh water to drain into the estuaries in the wet season and increase saltwater intrusion in the dry season. The unnatural shifts in salinity may also be damaging the estuary's seagrasses and lowering productivity and fish yields. The bays at the mouth of the main canals are the most seriously threatened. Finally, the drought of the last few years has severely stressed the region's plants and animals. The potential for widespread, disastrous fires is great. Water-use restrictions have been implemented in much of the basin.

## > GROUND WATER RESOURCES

#### Principal Aquifer Systems

Virtually all areas within the Region are underlain by aquifers capable of yielding some quantity of water. Three principal aquifer systems exist in southwest Florida: the Surficial, Intermediate, and Floridan Aquifer Systems. Generally, the Surficial and Intermediate Aquifer Systems are utilized for ground water supply in areas where the quality of water from the underlying Floridan Aquifer System is poor.

The Surficial Aquifer System contains the undifferentiated water table aquifers and the confined Lower Tamiami Aquifer. The Intermediate Aquifer System contains two major confined aquifers, the sandstone and mid-Hawthorn aquifers located along the southwestern Florida coast from Charlotte to Monroe counties. The Floridan Aquifer System underlies all of south Florida; however, the quality of water is good only in the Kissimmee Basin area north of Lake Okeechobee. Within this region, the Floridan Aquifer System behaves predominantly in a confined manner, and is overlain by laterally discontinuous undifferentiated surficial deposits, which produce small quantities of water.

## Surficial Aquifer

In general, the Surficial Aquifer System is composed of interbedded unconsolidated sand and shell units along with carbonate rocks, which together represents the water producing zones. Shallow water table aquifers are the principal water source for domestic self supply within the Region. Water table aquifers are also a source of water for agricultural irrigation in these areas. There is limited use of water table aquifers in Hendry County by agriculture.

In the Region, the water table aquifer is moderately to highly productive, with transmissivities ranging between 10,000 to 1,000,000 gallons per day/foot. As with all shallow aquifers, the proximity of the water table aquifers to the surface increase their susceptibility to contamination from a variety of man-made sources. Lack of confinement, high recharge, relatively high permeability, and a high water table, all increase contamination potential. In addition, because of increasing demands on these aquifers, they are in constant threat of saltwater intrusion along the coasts.

#### Lower Tamiami Aquifer

The Lower Tamiami Aquifer is the most prolific aquifer in Collier and Hendry Counties, serving as the primary source of municipal, industrial, and agricultural water supply. As with all shallow aquifers, the proximity of the Lower Tamiami Aquifer to the surface increases its susceptibility to contamination from a variety of man-made sources. In addition, because of large demands placed on this system, it has been endangered by saltwater intrusion along the coast and is frequently included in water shortage restrictions.

#### Intermediate Aquifer System

The Intermediate Aquifer System consists of the sandstone aquifer and the mid-Hawthorn artesian aquifer. It is composed predominantly of interbedded clays/silts, sand, sandstones, dolostones and limestones. The sandstone aquifer is relatively thin and discontinuous when compared to the mid-Hawthorn aquifer. It produces more water, however, particularly for agriculture in Hendry, eastern Lee and northern Collier Counties.

#### Floridan Aquifer System

Except for Sarasota and Charlotte Counties this aquifer system not only serves as a major drinking water source, but also as a major source of water for irrigation and livestock. In Sarasota and Charlotte counties, water in the aquifer is mineralized and surface water sources provide most of the public drinking water supply. This predominantly artesian system contains several distinct producing zones.

The Floridan aquifer serves as a major source for irrigation water within the Region and is utilized, on a small scale, as a complementary source of drinking water for blending with the Surficial Aquifer System supply. Within this region, however, Floridan water typically must undergo desalination prior to use. Transmissivities are typically high, ranging from 100,000 to 500,000 gallons per day/ft.

#### **Regional Water Use**

Estimated water demand for Southwest Florida is shown on Table 88. These figures were taken from the "Districtwide Water Supply Assessment," prepared by the South Florida Water Management District and from the "Southwest Florida Water Management District Water Supply Assessment." The primary water users in Southwest Florida are agriculture (spray irrigation), municipal water supply systems, and industry.

					TA	BLE 88							
				ESTIM	IATED V	WATER	DEMAN	ND					
					(aver	age mgd)							
			Commerc	ial/Industrial	Recreati	onal Self							
	Potable	Water	Self	Supply	Sup	ply	Thermo	electric	Agricu	ıltural	ltural Total		
County	1995	2020	1995	2020	1995	2020	1995	2020	1995	2020	1995	2020	
Charlotte	16	28.2	1.54	1.79	2.1	0.5	0.0	0.0	24.9	30.6	44.5	65.1	
Collier	43.9	87.9	6.0	11.4	45.6	91.6	0.0	0.0	142.4	179.7	237.9	370.6	
Glades	0.9	1.8	0.0	0.0	0.07	0.07	0.0	0.0	109.6	162.0	110.6	163.9	
Hendry	5.9	8.8	0.0	0.0	0.7	0.7	0.0	0.0	534.9	564.8	541.5	574.3	
Lee	45.9	75.3	5.4	8.6	32.9	59.7	0.8	0.8	60.4	80.3	145.4	224.7	
Sarasota	46.7	74.7	0.9	1	8.8	13.5	0.0	0.0	14.2	19	70.6	108.2	

Source: "Regional Water Supply Plan", Southwest Florida Water Management District, pg. 65, 66 "Lower West Coast Water Supply Plan", South Florida Water Management District, Appendix F.

A major use of water is to satisfy domestic demands. Although it accounts for less than one-tenth of the water used for agriculture, domestic water use is generally associated with the water supply problem. Part of this problem results from the high degree of water quality required for domestic use.

## > VEGETATION

The Southwest Florida Region possesses many diverse habitats, which are ecologically linked via water and energy flow systems, wildlife behavior patterns, and vegetation transitions. These distinct communities are discussed below under four major headings: Inland Terrestrial Habitats, Freshwater Habitats, Coastal or Saltwater Habitats, and Domestic Habitats. The community descriptions, ecological considerations, and threats to preservation are extensively borrowed from "Fish and Wildlife Resources of the Charlotte Harbor Area," FG&FWFC, which accurately describes the native habitats of the entire Region.

# > INLAND TERRESTRIAL HABITATS

## Pine-Oak Woodlands

These areas range from xeric, scrubby forests to wet, low lying pine flatwoods. There is much overlapping among the foresters upland habitats found in south Florida, and lumbering or grazing operations may have significantly altered the character of such communities. Sand pine scrub and scrubby flatwoods are the major associations discussed in this category.

## Xeric Oak and Sand Pine Scrub

Xeric oak and sand pine scrub are a dry, fire-dependant subclimax community occurring on deep, acidic, excessively well-drained soils. Sand pine scrub is restricted to Florida and the southeastern coast of Alabama. The largest tracts of this habitat in Florida are the "Big Scrub" of the Ocala National Forest and at the southern end of the Lake Wales Ridge. Within the region, this association occurs primarily on relic sand dunes or bars created in the geologic past when sea level was significantly higher. Sand pine dominated scrubs are restricted to minute areas of the region.

The scrub community may have an overstory of sand pine, but usually is dominated by sand live oak, myrtle oak, Chapman's oak, staggerbush, silk bay, rosemary, saw palmetto, scrub palmetto, and gopher apple. Herbaceous ground cover is sparse, with large areas of white to gray sand and frequent patches of lichens or true mosses, particularly reindeer moss.

Animals residing in scrub must be able to withstand heat and water stress through behavioral or physiological adaptation. Several typical scrub species are endemic to Florida, including the Florida scrub lizard, blue-tailed mole skink, sand skink, short-tailed snake, Florida scrub jay, and Florida mouse. Most of these species prefer the open, early stages of scrub succession as opposed to more mesic, denser stands.

This community exhibits a fire-based ecology, which determines the area's vegetative composition and density. Retention of lower limbs by sand pines and development of a dense understory usually provide ample fuel for a hot, fast burning fire every twenty to forty years. These fires scarify the cones, clear most accumulated litter, and are generally conducive to even-aged forest development. If fire is excluded, succession is toward a xeric, oak-dominated hardwood forest, and ultimately, to a xeric hammock association.

The deep, well-drained sands of these ridges typically provide valuable aquifer recharge areas. Scrubs are of considerable scientific interest because of their endemic fauna, unique ecology, and exemplification of ecosystem response to heat stress. Sand pine scrub is vulnerable to erosion and root damage caused by foot or vehicular traffic, and to trampling by grazing animals. An adequate fire regime is also essential to scrub regeneration. The most pressing threats to this community, however, are urban development and conversion to citrus groves or improved pasture.

## Scrubby Flatwoods

This association is similar to sand pine scrub in its xeric character, evergreen shrubby understory, fire-dependent ecology, endemic fauna, and its occurrence on well-drained, deep sandy soils. It may, however, have slash or longleaf pine as the dominant overstory species, and herbaceous ground cover is more frequent than in true scrub. Like sand pine scrub, this association occurs as relatively small patches interspersed in areas of less well-drained vegetation, and it is susceptible to similar types of disturbance or development.

Exclusion of fire or selective harvesting may result in an association of xeric oaks and typical scrub understory without a pine overstory. This cover type has been termed "oak scrub," and generally possesses the environmental characteristics of sand pine scrub and scrubby flatwoods.

# Hammocks

The term "hammock" in Florida is generally applied to any hardwood or broadleaved evergreen forest community, which is not regularly inundated. Soils are generally more fertile than in pineland or oak-pine dominated uplands, but may range from well-drained sands to wet, highly organic soils. Hammocks often occur as inclusions in other major habitat types, thereby providing many wildlife benefits through greater habitat diversity, protective cover, and food resources. Hammock vegetation may vary considerably with soil fertility, moisture content, and geography. The basic associations found within the study area include the live oak cabbage palm complex, mesic

hammocks, and hydric hammocks. There is considerable intergradation within the live oak - cabbage palm complex. They are, therefore, considered variants of a single hammock association.

Hammocks are vulnerable to the same development pressures threatening other upland communities throughout Florida. Residential, industrial, and agricultural interests often eliminate hammocks entirely, infringe upon their ecological integrity through development of adjacent uplands, or cause dramatic changes in the water table. Although their relatively rich soils permit more rapid recovery than most other upland habitats found in Florida, the mature forest canopy may take many years to recover from selective clearing or other disturbances.

## Cabbage Palm - Live Oak Hammock Complex

Hammocks dominated by live oak are relatively xeric, primarily occurring on well-drained sandy soils within pine flatwoods or pasturelands. Bluejack oak, laurel oak, and cabbage palm are common, and occasionally co-dominant, canopy species. Herbaceous ground cover is sparse in these open woodlands, but Chapman's oak, beautybush, and winged sumac are common shrubs. There is usually a well-developed litter layer of dry leaves in such hammocks. Typical wildlife species include the southern flying squirrel, cotton mouse, eastern mole, bluejay, screech owl, black racer, green anole, southern toad, and squirrel treefrog.

Cabbage palm hammocks occur on moister, highly organic soils. Cabbage palm may be the only tree species, or others, particularly live oak, may be common. Shrubs and vines often form a dense understory in this community, which provides suitable habitat for the squirrel treefrog, rat snake, Carolina wren, fish crow, cotton mouse, and raccoon.

## Mesic Hammock

This association occurs on rich, organic soils of intermediate moisture content. Typical trees include laurel oak, pignut hickory, water oak, red bay, southern magnolia, and American holly. Characteristic shrubs include saw palmetto, beautybush, sparkleberry, greenbriar, Virginia creeper, and muscadine grape. Common vertebrates encountered include the southern toad, green anole, pileated woodpecker, great crested flycatcher, red-eyed vireo, gray squirrel, and cotton mouse.

This community occurs on wet, poorly-drained soils along rivers and streams. Typical trees include swamp bay, water oak, sweetgum, laurel oak, and Florida elm. Lianas, wax myrtle, and saw palmetto are common, and various ferns and lizard's tail provide a relatively sparse ground cover. Characteristic vertebrates found include the green treefrog, southern leopard frog, red-bellied woodpecker, and cotton mouse.

## **Pine Flatwoods**

This association occurs on generally level ground with relatively poorly-drained soils. These areas possess sandy soils with a moderate amount of organic matter in the top three inches, and an acidic, organic hardpan from one to several feet below the surface. Flatwoods are the most abundant natural cover type in the study area, having once occupied over half of the state. They occur over extensive areas, and often contain smaller inclusions of other habitats including ponds, marshes, prairies, bayheads, or cypress domes and strands.

The two major types of flatwoods in the Region are dominated by slash pine and longleaf pine, respectively. The former is much more extensive and occupies wetter sites, while the latter occupies better-drained areas, and is limited in the Region. Beneath the fairly open overstory, the vegetation varies tremendously from a low-growing ground cover of wiregrass, running oak, broomsedge, elephant's foot, and rabbit tobacco to a community also possessing a dense understory of gallberry, fetterbush, saw palmetto, wax myrtle, and sprouts of live oak, water oak, and laurel oak.

Large areas of the Southwest Florida region are vegetated by wet or hydric slash pine flatwoods, which are dominated by a slash pine overstory with an understory of several wetland plant types, including many wet prairie species. This type of habitat is usually considered to be jurisdictional wetlands. Pine densities are typically sparse, lower trunks are buttressed, and trees have a high frequency of double crowning with a sparse canopy. This habitat has a high level of biodiversity due to its changing seasonal function as habitat for wetland and upland species.

Pine flatwoods support an impressive variety of wildlife species. Typical species include white tailed deer, bobcat, raccoon, opossum, nine-banded armadillo, gray fox, gray squirrel, Sherman's fox squirrel, cotton rat, least shrew, great horned owl, redtailed hawk, pine warbler, rufous-sided towhee, brown-headed nuthatch, pine woods treefrog, oak toad, eastern diamondback rattlesnake, black racer, pine woods snake, and box turtle. Mature pine flatwoods along rivers or estuaries provide nesting habitat for the bald eagle. Open pine flatwoods provide habitat for the endangered red-cockaded woodpecker.

Fire and water regimes are primary determinants of flatwoods ecology. Slash pine flatwoods have greater species diversity and are subject to relatively little moisture stress, except in hydric systems. Fire occurs often enough to clear accumulated ground litter and reduce competition from hardwoods, but not frequently enough to eliminate fire-sensitive young slash pines and prevent stand regeneration. If fire is suppressed, succession is toward a mesic hardwood in drier slash pine stands, or to a bay forest community in wetter sites.

Pine flatwoods are diverse, fairly resilient systems, which can tolerate use by man. They are, however, sensitive to fire exclusion and water table fluctuations, which can dramatically alter their vegetative composition and ecology. Tremendous acreages of flatwoods have been converted to cropland or improved pasture, grazed as native range, or supplanted by urban and suburban development. Intensive timber management reduces the natural diversity of flatwoods and can render it relatively useless for most wildlife species. Similarly, overgrazing or trampling by livestock can destroy the value of pine flatwoods both as native range and as wildlife habitat. Development of flatwoods substantially reduces the diversity of wildlife characterizing South Florida's ecosystems, including reptiles/amphibians, songbirds, raptors, game animals and listed species often reduces the value of adjacent wetlands or other habitats through reductions in vegetative diversity, increased erosion, and sedimentation or subsequent pollution of surface waters.

# **Dry Prairies**

These treeless plains, generally resembling pine flatwoods communities without the open overstory, are usually dominated by wiregrass, broomsedge, and carpet grasses. Saw palmetto is the most abundant shrub, but fetterbush, staggerbush, sand live oak, and blueberry are also common. Hammocks, bayheads, and cypress domes are often scattered throughout this association.

The Florida burrowing owl, Audubon's caracara, and the Florida sandhill crane prefer to inhabit dry prairies. In addition, the box turtle, black racer, turkey vulture, black vulture, common nighthawk, eastern meadowlark, least shrew, hispid cotton rat, eastern harvest mouse, and eastern spotted skunk are often encountered. The forested wetlands and other habitats often dispersed through dry prairies contribute significantly to the habitat diversity afforded by this association, and are partially responsible for the abundant wildlife populations.

Large areas of this vegetation have been converted to improved pasture or residential developments. Overgrazing generally leads to trampling of the forested inclusions, reduction of habitat diversity, and deterioration of the range as pasturage. Fire is important to prairie ecology, but either too frequent fires or their exclusion can seriously alter the vegetative composition of this association.

## > FRESHWATER HABITATS

#### Freshwater Wooded Wetlands

This general category includes several major habitat types, the common denominators being seasonal or permanent inundation and predominance of woody vegetation. Their species composition, ecology, and wildlife benefits vary tremendously with soil conditions, hydrology, topography, and watershed characteristics. Hardwood swamps and cypress swamps are the major communities possessing standing water for a substantial portion of the year. Bay forests represent a different type of wetland forest, ecologically, and are often included as a separate major community type.

#### Hardwood Swamps

This community is characterized by a canopy of large hardwoods including black gum, pop ash, red maple, sweetgum, and water oak. Bald cypress may occur as a minor canopy element, and buttonbush, wax myrtle, Virginia willow, dahoon holly, American hornbeam, and elderberry are common in the scattered understory. During dry periods, exposed mud may occupy most of the forest floor, but lizard's tail, smartweed, water pennywort, and various grasses or sedges usually occur in patches. Degree of canopy closure and seasonal water levels generally determine the understory and ground cover species and density.

These communities provide valuable habitats for fish and wildlife, with backwaters, oxbows, sloughs, and other features contributing significantly to habitat diversity. The wetlands and hammocks or other associated uplands provide nest and den sites, feeding areas, and suitable refuge from predators or flood waters. Animals likely to be encountered in swamps include the bobcat, opossum, raccoon, gray squirrel, river otter, pileated woodpecker, barred owl, red-shouldered hawk, wood duck, cottonmouth moccasin, Florida water snake, banded water snake, American alligator, green tree frog, squirrel tree frog, southern leopard frog, mosquitofish, and Everglades pigmy sunfish.

Periodic water level fluctuations are essential to the maintenance of hardwood swamp communities. Alternating floods and dry periods provide seasonal nutrient pulses to the forest and prevent successful invasion of the swamp by more aquatic or terrestrial vegetative associations. This dynamic hydrologic regime produces a multitude of ecological benefits including natural retention of stormwater, damping of peak flood stage levels, subsequent slow release of floodwaters, and vegetative filtration and assimilation of pollutants and nutrients contained in upland runoff.

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This sensitive, productive ecosystem has traditionally been labeled as worthless by agricultural, industrial, and residential interests, with the resultant destruction of large swamp tracts via filling, drainage, or alteration of natural water regimes. State and federal laws now protect these habitats to a certain degree, but development of previously impacted wetlands, flood control or navigation projects, trampling by livestock, and development of critically important adjacent uplands continue to impact areas of hardwood swamp adversely.

#### Cypress Swamps

Cypress swamps are usually found along rivers or lake margins, interspersed through other communities such as pine flatwoods or dry prairies, and in shallow drainage systems called sloughs or strands. They are normally inundated for much of the year. Bald cypress predominates in lake and stream margin swamps and major sloughs, while pond cypress may dominate smaller domes or cypress heads. Though cypress is often the only canopy species encountered, black gum, red maple, coastal-plain willow, pop ash, and slash pine may occur as well. Understory species composition varies with the degree of canopy closure and the inundation regime, but often includes wax myrtle, buttonbush, poison ivy, and greenbrair. Arrowhead, pickerelweed, sawgrass, bacopa, water pennywort and various ferns are often encountered as ground cover, and in open marshes within cypress swamps.

Cypress swamps provide habitat for many of the same species as hardwood swamps, but often possess more aquatic habitat for fishes, amphibians, and reptiles. They are particularly important as seasonal refuges for deer and other animals occurring in adjacent flatwoods communities, and as feeding areas for wading birds during the dry season when forage animals are concentrated into depressions within the slough or dome.

Both fire and drought are important stress factors in cypress swamps, and fluctuating water levels play much the same role as in hardwood swamps. The ecological benefits, and development pressures threatening cypress swamp are also similar to those of hardwood-dominated wetlands.

## Swamp Thickets

These are dense stands of shrubs or low trees occupying standing water or periodically flooded sites. They occur in or around ponds, lakes, impoundments, and marshes or along rivers and streams. Thickets generally form a transition zone between more aquatic and terrestrial habitats, or represent marshes and wet prairies undergoing secondary succession due to fire exclusion or a lowered water table. Wax myrtle, coastal-plain willow, red maple, buttonbush, and dahoon holly are characteristic shrubby species. Various grasses, sedges, and other forbs comprise the ground cover. Many passerine birds reside in such thickets permanently or seasonally, or utilize this habitat during migration. The marsh rice rat, cotton rat, and marsh rabbit are also common.

#### **Bay Forests**

This association occurs on wet, acidic, highly organic soils, which are seasonally flooded. Though often classified as a swamp habitat, bay forests usually have shallower standing water, shorter inundation periods, and less dramatic water level fluctuations than forested wetlands.

Bay forests usually occur along the margin of flatwoods ponds, or in shallow depressions in pine flatwoods, having succeeded from marshes, low pine flatwoods, and swamps through accumulation of organic matter. They are dominated by loblolly, red, and sweet bay, all broadleaved evergreen species with similar growth form. These species usually form a dense canopy, with little sunlight penetration to promote understory or ground cover growth in the humid, dimly lit forest interior. Most understory vegetation occurs at the forest fringes, consisting of wax myrtle, gallberry, fetterbush, and various lianas.

Although seldom extensive and providing little food for wildlife when compared to other wetland habitats, bay forests may contribute significantly to the habitat diversity of a given tract. The southeastern shrew prefers bay forests as its primary habitat, and the yellow-billed cuckoo, Carolina wren, blue-grey gnatcatcher, short-tailed shrew, and cotton mouse are also common in this community.

## Freshwater Herbaceous Wetlands

These habitats are found in shallow drainage systems, flatwood depressions, and floodplains of lakes, ponds, and streams. The two major community types, wet prairies and freshwater marshes, are differentiated by the somewhat subjective analysis of species composition and water level regime. Wildlife resources are especially diverse and abundant, with many non-resident species making seasonal or occasional use of these productive communities. Marshes and wet prairies provide significant ecological benefits including filtration and assimilation of runoff, sediment stabilization, damping of flood peaks in rivers and lakes, and subsequent slow release of these stored floodwaters during the dry season.

## Wet Prairies

This association occurs on low flatlands subject to periodic flooding, and often grades imperceptibly into a freshwater marsh or dry prairie community. Usually dominated by shorter grasses and herbs such as maidencane, cordgrass, beakrushes, spikerushes, white-topped sedge, yellow-eyed grass, and red root, wet prairies often also support St. John's wort and occasional patches of wax myrtle, coastal-plain willow, or buttonbush.

The Florida sandhill crane, marsh rice rat, hispid cotton rat, marsh rabbit, ribbon snake, and pygmy rattlesnake are characteristic of this association. Other species including the round-tailed muskrat, common snipe, marsh hawk, wood stork, white ibis, and numerous other wading birds often utilize wet prairies when water levels are suitable for their feeding or habitat requirements.

Water level fluctuation and fire are co-dominant factors in wet prairie maintenance and productivity through the resultant expansion and contraction of aquatic habitat for forage animals, and prevention of succession to more advanced vegetative associations.

Wet prairies are susceptible to trampling by livestock, overgrazing, disturbance by all-terrain vehicles, and conversion to agricultural lands or residential developments. The degree of disturbance often depends on specific development plans, because wet prairies can be seriously impacted by increased water depth due to stormwater retention systems, or by desiccation through drainage of adjacent lands and general lowering of the water table.

# <u>Marshes</u>

Freshwater marshes include a number of vegetative associations composed of grasses, rushes, sedges or broadleaved herbs, where the ground surface is inundated for at least a few months of the year. They are found bordering lakes or streams, in shallow natural depressions, and on lowlands with very little topographic relief. Ranging in size from small pockets within flatwoods or other communities to vast, uninterrupted wetlands, marshes often intergrade into wet prairie or possess hammocks, cypress domes or strands, and deeper aquatic habitats. Sawgrass, lizard's tail, pickerelweed, cattail, arrowhead, spikerush, smartweed, bulrush, fire flag, cordgrass, and maidencane are common dominant species of particular marshes or patches within a marsh. The species listed under the wet prairie association are frequent, as are bacopa and water pennywort. Natural depressions, alligator holes, and sloughs often contain vegetation associated with deeper waters, including fragrant water lily, spatterdock, coontail, stonewort, milfoil, bladderwort, and pondweeds.

Marshes are extremely productive areas for wildlife, with all of the species listed in the wet prairie discussion being encountered when water levels are suitable. The American alligator, Everglade kite, redwinged blackbird, sora rail, common snipe, river otter, largemouth bass, bluegill, pig frog, leopard frog, cottonmouth moccasin, Florida water snake, Florida softshell turtle, red-bellied turtle, apple snail, crayfish, and numerous other species are characteristic inhabitants of various types of marshes. Because of the deeper, longer inundation schedule when compared with wet prairies, fire plays less of a role in marsh ecology than do fluctuating water levels. Periodic burning, however, is important in controlling natural succession, and in maintaining vigorous, productive stands of sawgrass and other marsh species. Marshy fringes of lakes and rivers are particularly important for maintaining water quality of the adjacent waterbody, and certain marsh communities offer potential for future use in treatment of domestic wastes.

Marshes are subject to encroachment from both upland and waterward fringes for residential or agricultural use, and channel, boat basin, or beach development. Drainage and over-inundation also pose a serious threat in many areas, as mentioned in the discussion of wet prairies.

## Freshwater Aquatic Habitats

This category includes lakes, ponds, rivers, streams, drainage or navigation canals, and any other permanent, open freshwater habitat. These range from major waterbodies such as Lake Myakka and the Caloosahatchee River to farm ponds, small headwater streams, and residential canals. Salinity, currents, water quality, and cross-section vary considerably with seasonal rainfall, topography, watershed size and development, habitat types surrounding the waterway, and proximity to estuarine or marine waters.

The vegetation within these waterbodies may include various pondweeds, millfoils, fragrant water lily, stonewort, widgeon grass, fanwort, naiad, bladderwort, hydrilla, Brazilian elodea, coontail, water sprite, spatterdock, water lettuce, water hyacinth, and many other species. Stream salinity, seasonality, water quality, depth, and currents all determine which species, if any, occur at a given site.

Fish and wildlife resources of these areas also vary tremendously. Mosquitofish, bluegill, largemouth bass, Florida gar, golden shiner, Florida softshell, Florida snapping turtle, peninsular cooter,

stinkpot, and the American alligator usually occur in suitable waters, and estuarine or coastal species such as tarpon and mullet often enter river and stream systems.

Aquatic habitats are inseparably linked to the maintenance of adjacent habitats through conveyance of runoff, provision of nutrients during seasonal floods, and control of vegetative succession by preventing more xeric communities from invading the floodplain. The habitat diversity of adjacent flatwoods, marshes, prairies, and swamps generally determines the wildlife and water characteristics of the actual waterbody. Many species inhabiting these adjacent lands depend on streams, lakes, and ponds for drinking water, feeding areas, or seasonal habitat requirements. These include the wood duck, anhinga, osprey, bald eagle, belted kingfisher, numerous migratory waterfowl species, whitetailed deer, raccoon, river otter, pig frog, southern leopard frog, and American alligator, as well as numerous invertebrate species with terrestrial adult forms and aquatic juveniles.

Recreational and commercial values of aquatic habitats are related to navigability, hunting and fishing opportunities, and non-consumptive recreational uses such as canoeing, powerboating, birdwatching, and camping. Except for navigability, these values are directly dependent on preservation of native vegetation in and adjacent to the waterbody.

These areas are often adversely affected by channelization, water level stabilization, and other navigation or flood control measures. Pollution via municipal, industrial, or agricultural runoff also poses a serious threat to aquatic habitat productivity. Aquatic weeds such as water hyacinth and hydrilla may adversely affect the accessibility and natural flow of these waterbodies.

## Lakes and Ponds

The lentic waterbodies under this designation include such diverse areas as Lake Myakka, man-made reservoirs and retention ponds, and small farm ponds. Water quality and vegetative characteristics vary tremendously, and generally determine wildlife diversity and abundance. Black crappie, gizzard shad, osprey, bald eagle, ring-billed gull, and lesser scaup are often associated with larger lakes. Belted kingfishers, piedbilled grebes, green water snakes, striped mud turtles, chicken turtles, and Florida mud turtles are just as likely to utilize smaller ponds and marsh potholes. Because these areas possess minimal current flow, they are particularly sensitive to pollution from sewage, stormwater, or agricultural runoff. Such nutrient enrichment can easily exceed the assimilative capacity of ponds and lakes, resulting in algal blooms, aquatic weed infestations, and significant shifts in aquatic species composition, massive fish kills, and other problems associated with rampant eutrophication. Prevention of water degradation via floodplain preservation and pollution abatement are the most effective means of protecting these habitats.

#### **Rivers and Streams**

This habitat designation is also diverse, including drainage ditches, channelized streams, upland canal systems, and major rivers such as the Caloosahatchee. Although primarily freshwater habitats, salinity may increase substantially near Gulf or estuarine outfalls, and marine animals or vegetation may intrude far into the freshwater system. The brown water snake, coastal shiner, spotted sunfish, and Everglades

Pigmy sunfish are characteristic inhabitants of freshwater streams. Preservation of floodplain vegetation and water quality are necessary for maintenance of healthy stream systems. Because these watercourses provide most of the freshwater required to maintain the aesthetics and productivity of estuaries, they are vital to the commercial and recreational industries of the Florida coast.

# > COASTAL OR SALTWATER HABITATS

## Mangrove Swamps

These are brackish or salt water swamps occurring along low-energy coastlines and characterized by one or more of the red, black, and white mangroves. Buttonwood is also common, particularly at or above mean high water. Species composition, productivity, and ecological benefits associated with mangrove swamps vary widely with the tidal regime, substrate conditions, salinity, and degree of disturbance of the swamp or adjacent uplands. Red mangrove tends to dominate below mean low water, with black mangrove occupying the shallow intertidal area and buttonwood occupying the drier inner zone. White mangrove may occur throughout the swamp, or dominate landward of the black mangroves, but it is uncommon in the deeper, permanently inundated zone. Areas with irregular topography may exhibit little zonation, with the three mangrove species intermixed with no definite pattern.

Ground cover and understory vegetation are usually sparse to absent in undisturbed swamps, but may include glasswort, saltwort, cordgrass, or black rush. Sea-oxeye daisy, keygrass, saltgrass, sea myrtle, Brazilian pepper, and Australian pine often occur on disturbed sites such as mosquito control ditch berms and small landfills, and along the upland fringes of this wetland community.

Mangrove swamps provide habitat for a multitude of forage species including mosquitoes, small fishes, bivalve and gastropod molluscs, fiddler crabs, amphipods, and other small crustaceans. Other typical mangrove inhabitants such as the ornate diamondback terrapin, mangrove water snake, raccoon, opossum, bobcat, great blue heron, wood stork, and white ibis represent higher order consumers. Birds comprise the most diverse and numerous groups of larger animals inhabiting mangrove swamps. Herons including the little blue, green, Louisiana, great blue, and both the yellow-crowned and black-crowned night herons nest in mangrove habitats, as do the snowy, reddish, cattle, and great egrets. Roseate spoonbills, white ibis, wood storks, and double-crested cormorants also nest in mangroves. Other species characteristic of these swamps include the red-shouldered hawk, osprey, belted kingfisher, turkey vulture, black vulture, pileated woodpecker, fish crow, mangrove cuckoo, bluegray gnatcatcher, Carolina wren, Cuban yellow warbler, prairie warbler, and boat-tailed grackle. Many species are abundant in mangrove habitats as seasonal residents or migrants including the cardinal, robin, American redstart, palm warbler, black-throated blue warbler, and black-and-white warbler. Many of these birds are primarily associated with the waterward or landward swamp fringes.

Mangrove swamps also provide many ecological benefits including buffering of storm tides and winds, shoreline stabilization, and vegetative filtration and assimilation of pollutants or nutrients contained in upland runoff. They also offer potential for use in municipal waste treatment facilities. The most significant single aspect of mangrove ecology, however, is contribution of detritus to the estuarine system and nearshore waters. Along with seagrass and salt marsh components, mangrove detritus forms the base of the food web which supports virtually the entire estuarine and nearshore

marine communities. Mullet, redfish, spotted sea trout, snook, tarpon, king mackerel, bluefish, mangrove snapper, stone crab, blue crab, pink shrimp, oysters and clams are but a few species sought by commercial or sport fishermen within the Region which are dependent upon this nutrient base. Non-tidal mangrove wetlands may significantly contribute to the estuarine system via heavy utilization by wading birds and other predators of forage fishes, fiddler crabs, and other primary consumers of mangrove detritus.

Destruction of mangrove wetlands has been a significant factor in the deterioration of south Florida's natural resources. Filling for residential or commercial use, ditching and drainage for mosquito abatement, and dredging of boat basins or channels are the main threats to this valuable habitat type. Although partially protected by state and federal regulations, these habitats are continually being disturbed by the above activities and by destruction of adjacent upland communities which have historically provided clean freshwater inflow.

## Salt Marshes

Salt marshes are found along gradually sloping, low-energy coastlines with salinities ranging from nearly fresh to full strength seawater. These marshes may intergrade into freshwater marshes in estuaries, and species composition varies with tidal regime, substrate conditions, pH, and other factors.

Smooth cordgrass occupies the deepest zone of the marsh, with blackrush dominating the wide midzone. Salt grass and slender cordgrass occur in the innermost zone which is only inundated by storm tides. This typical zonation may be indistinct or irregular, depending on substrate topography or disturbances such as ditching and diking. Sea myrtle, saltwort, sea-oxeye daisy, key saltgrass, glasswort, and other high marsh species may be encountered at landward fringes of the marsh, in salt barrens, in slightly elevated pockets, along low spoil ridges, and adjacent to mosquito ditches. Cabbage palm hammocks or spoil mounds with exotic vegetation such as Brazilian pepper and Australian pine may also be encountered. Mangrove swamps occupy most of the low-energy, undisturbed coastal area, but this association may be found around the region and as inclusions in fringe mangrove swamp.

Characteristic animals of salt marshes include the salt marsh snake, diamondback terrapin, Florida clapper rail, seaside sparrows, black-necked stilt, Marian's marsh wren, sharp-tailed sparrow, marsh rabbit, marsh rice rat, and raccoon. Many wading birds feed on the small crustaceans and fishes abundant in salt marshes.

The detrital production of salt marshes is substantial. Salt marshes, along with mangrove forests, are the most important emergent or terrestrial source of basic nutrients for the estuarine and nearshore food web.

The impacts of residential and commercial development on salt marshes are similar to those affecting mangrove swamps and other wetlands bordering developable uplands and open, navigable waters. Wetland development regulations apply also, but infringement in the high marsh zone, development of upland hammocks within marshes, and drainage via ditching for mosquito control have had significant impact. As with other coastal wetlands, salt marshes may be adversely affected by diversion of freshwater runoff or development of adjacent uplands.

# > DUNES, BEACHES, AND FLATS

## **Coastal Strand**

Coastal strand vegetation in Florida occurs primarily along high-energy shorelines, and is comprised of sandy beaches, the primary dunes, and associated scrubby backdune communities. These areas typically exhibit zonation, with sparse pioneer species such as sea oats, sea purselane and railroad vine predominant immediately landward of the barren, sandy beach zone. Behind this foredune is a somewhat more stable vegetative assemblage including saw palmetto, cabbage palm, seagrape, wax myrtle, scrub oak, and often Australian pine or Brazilian pepper. The more woody, stable backdunes may resemble sand pine scrub in general growth form, and to a certain extent, in species composition.

Coastal strand habitat is important to neo-tropical migrant birds, birds that migrate to and through Southwest Florida from the Caribbean and Central and South America. Many of these birds nest in North American, but spend the winter in the tropics, and include warblers, tanagers, finches, buntings, flycatchers, wrens, bluebirds, sparrows, vireos, hummingbirds, orioles, swallows etc. The most visible of the Southwest Florida migrants include the swallow-tailed kite, peregrine falcon, and Chuck-will's widow. Some of these species stay in Florida and utilize pine flatwoods and wetland communities near the coast during the breeding season. But many of these species fly straight across the Gulf of Mexico, and must search coastal hammocks and strand for food to complete their migration further north. Protection of coastal wooded areas is essential to their survival.

Terns, gulls, plovers, and sandpipers are common along the sandy beach where they feed on small fishes and invertebrates, and where some species nest. Large inlet areas and undeveloped beaches are extremely important nesting and overwintering areas for listed species, including the snowy plover, least tern, black skimmer, Wilson's plover, and the threatened piping plover. Sea turtles also nest on such beaches, and raccoons and beach mice frequent this habitat. The scrubby backdunes support such animals as beach mice, gray foxes, bobcats, skunks, American kestrels, gopher tortoises, and the Chadwick cotton mouse.

The coastal strand is one of Florida's most valuable, unique, and seriously threatened natural communities. It is a dynamic, transient community composed of species able to withstand or rapidly recover from the severe stresses of wind, shifting saline soils, salt spray, lack of fresh water, and occasional storm surf or inundation. This system constantly shifts, retreating landward and advancing seaward in response to longshore currents, wind, waves, and changes in sea level. Man's disturbances through nearshore dredging, residential or commercial development on the duneline, and construction of inlets, jetties, and groins have upset these natural processes throughout Florida. This has resulted in the loss of many formerly beautiful beaches, endangerment of this unique and sensitive community, and the need for huge financial expenditures for inlet and channel maintenance, beach nourishment, and building or road restoration. This community, especially the sparse, herbaceous foredune association, is also extremely sensitive to trampling through recreational use. In addition, domestic cats may severely impact endangered beach mouse populations.

Because of the dynamic nature of coastal strand communities and the exorbitantly expensive means necessary to restore them once destroyed by development, it is far more judicious to protect beaches

and dunes by regulating recreational, residential, and commercial development along the coast. Existing regulations address these issues, but have thus far been insufficient to ensure the preservation of this unique natural resource.

## **Tidal Flats**

These areas are periodically inundated flats located at the mouths of rivers, near inlets, immediately waterward of salt marshes or mangrove forests, or in dredge spoil disposal areas. They range from transient, unstable areas used primarily by shorebirds and wading birds, to stable mudflats with extensive algal, mollusc, crustacean, and worm communities. Cuban shoalgrass, turtlegrass, red mangrove saplings, cordgrass, or other plants may occur sporadically, but these flats are generally devoid of vascular vegetation. Fiddler crabs, spider crabs, horseshoe crabs, quahog clams, oysters, slipper shells, barnacles, moon snails, various sponges, and numerous additional molluscs, crustaceans, and worms are often abundant in such habitats. These areas are important breeding areas for clams, scallops, and other commercially important shellfish species, and are heavily utilized by shorebirds and wading birds as feeding and loafing areas.

Tidal flats are primarily threatened by waterfront development trends. Dredging of flats for boat basins and channels and eliminating the "ugliness" and "unpleasant odors" associated with these habitats are often cited by developers as reasons for destruction of tidal flats. As with other landwater interface communities, destruction of adjacent uplands or wetlands can have significant impacts on the preservation and productivity of tidal flats.

## > BAYS AND ESTUARIES

The general characteristics of these habitats include shallow depth (less than twenty feet), good mixing of the water column, and flushing via tides and freshwater inflow. Salinity varies from freshwater to normal seawater, and may fluctuate seasonally. Mangroves, salt marshes, seagrass beds, phytoplankton, tidal flats, and oyster bars all play significant roles in estuarine ecology. Wildlife resources are abundant and diverse, with many commercial or sport fishes and crustaceans inhabiting these areas permanently or as juveniles. Many wading birds, waterfowl, and shorebirds winter, feed, and nest in these areas or on landward fringes and islands.

Seagrass beds are important to estuarine areas and the coastal ecology. These seagrasses play a vital role in producing detrital food for the estuary. They also give protection to young organisms, provide a substratum for various marine organisms, and harbor diverse bottom animals. Such communities have been damaged through the development of waterways, abuse by motorboats, and sediment runoff from land development.

# > OTHER NATURAL COMMUNITIES

The Florida Natural Areas Inventory's "Guide to Natural Communities of Florida" lists the natural communities of Florida and their relative rarity and threat. Most important are communities ranked S1 Critically Imperiled (because of extreme rarity, 5 or fewer occurrences or very little remaining area, or especially vulnerable to extinction) and S2 Imperiled (because of rarity, 6 - 20 occurrences or little remaining area, very vulnerable). The region contains a limited number of these communities as shown below in Table 89.

TABLE 89 COMMUNITIES									
Scrub	S2	Dry Prairie	S2						
Beach Dune	S2	Floodplain Marsh	S2						
Coastal Berm	S2	River Floodplain Lake	S2						
Coastal Strand	S2	Aquatic Cave	S2						
Shell Mound	S2	Worm Reef	S1						
Pine Rocklands	S1	Algal Bed	S2						
Rockland Hammock	S2	Seagrass Bed	S2						

## **Rare and Endangered Vegetative Communities**

In 1979, the State of Florida passed legislation known as "Preservation of Native Species of Flora," contained in Section 581.185 F.S. The regulations are limited, however, and only specify that "with regard to any plant listed as an endangered plant on the Regulated Plant Index, as provided in rules of the department (Agriculture and Consumer Services), it is unlawful for any person to willfully destroy or harvest any such plant on the private land of another or on any public land without first obtaining the written permission of the landowner or legal representative of the landowner and a permit from the department as provided in this section." The purpose for the law was to curb the loss of these species by uncontrolled collection. Orchids, ferns, and bromeliads were primary targets for these collectors.

The Southwest Florida Region is within the range of many of these species, most notably the orchids, ferns, and bromeliads mentioned above. The ranges for many of these plants are located in the Big Cypress area in Collier County, especially in and near the Fakahatchee Strand.

The official State of Florida list for endangered, rare, threatened species, and species of special concern is constantly under review and revision. The latest update for plants and animals (prepared by the Florida Game and Fresh Water Fish Commission, June 1, 1994) is in the Appendix.

Rare plant communities in the Southwest Florida region include tropical hardwood hammock, coastal strand, high marsh, sand pine scrub, and xeric oak scrub. The tropical elements of some hardwood strand found in Hendry and Collier counties, most notably in the Fakahatchee Strand, also are extremely rare and unique.

Protection of native species and rare plant communities cannot rest on the state statutes. Acquisition by federal, state, and local agencies of selected areas in which endangered plant species occur, proper management for their encouragement and protection, and public education on the characteristics of the flora and fauna of these areas and the importance of their protection, are all necessary if Florida is to retain its unique botanical heritage.

## > WILDLIFE

Southwest Florida supports a diversity of wildlife, augmented through the migratory patterns of many different birds and fish. The species for which the area is known include the alligator, the

manatee, the tarpon, the wood stork, the pink shrimp, and the Florida panther. (For a list of rare and endangered species in the Region, refer to Appendix V-3.) Perpetuation of these species has been attempted through the allocation of land and water areas for wildlife preservation and conservation. These areas include Everglades National Park, Big Cypress National Water Preserve, six national wildlife refuges (Island Bay, Caloosahatchee, Pine Island, Matlacha Pass, Panther/Ten Thousand Islands, and J. N. "Ding" Darling), two large state parks (Myakka and Collier-Seminole), eight aquatic preserves (Cape Haze, Matlacha Pass, Pine Island Sound, Charlotte Harbor/Gasparilla Sound, Estero Bay, Lemon Bay, Rookery Bay, and Cape Romano/Ten Thousand Islands), two state preserves (Fakahatchee Strand and Charlotte Harbor), and one wildlife management area (Cecil M. Webb). Also included in the Region's protected areas for wildlife are Rookery Bay (a national estuarine sanctuary) and Corkscrew Swamp Sanctuary, founded by the National Audubon Society. Proposed acquisition areas include the Charlotte Harbor flatwoods, Myakka Prairies, and Belle Meade CARL areas. Mitigation parks for specific wildlife species, such as the gopher tortoise and scrub jay, include the Hickey Creek and Amberjack Slough projects.

Wide-ranging animal species present a major challenge for regional planners. The fact that they are wide ranging typically means that large amounts of acreage (or water area) must be available for use as habitat without excessive use by man, in such a way as that prey (or other food) species can remain available even when the habitat is being used by man. Additionally the land (or waterbody) must be developed in a way that wildlife may pass through on their way to adjacent available habitat without being slaughtered by cars, trucks, boats or barges.

Two recently completed efforts provide a good inventory of public and privately owned natural systems for the general protection for sustainable populations of the Region's listed plant and animal species. The first study involved the Florida Panther titled "Florida Panther Habitat Preservation Plan: South Florida Population," prepared by the Florida Panther Interagency Committee. This plan inventories Existing Conservation Lands in public ownership, Priority 1 Habitat and Priority 2 Habitat. Priority 1 Habitat are lands most frequented by the Florida Panther and are of high quality. Priority 2 Habitat are lands less frequented by Florida Panthers and/or are lower quality as habitat. The lands are shown on Map 13.

# MAP 13 - PANTHER PRIORITY LANDS MAP

"Closing the Gaps in Florida's Wildlife Habitat Conservation System: Recommendations to Meet Minimum Conservation Goals for Declining Wildlife Species and Rare Plant and Animal Communities", was prepared by the FGFWFC. This study inventories existing conservation lands in public ownership, as does the Panther Plan and identifies Strategic Habitat Conservation Areas, generally in private ownership. According to the report, Strategic Habitat Conservation Areas depict lands need to meet minimum conservation goals for the following; 1) 30 species of wildlife inadequately protected by the system of conservation lands; 2) high quality sandhill sites; 3) high quality scrub sites; 4) high quality pine rockland sites; 5) high quality examples of tropical hardwood hammocks; 6) bat maternity caves and roost caves; 7) wetlands important to the breeding success of eight species of wading birds, and; 8) lands important to the long term survival of 105 globally rare species of plants. These Strategic Habitat Conservation Areas and Existing Conservation Areas are shown on Map 14.

Also presented is <u>BIODIVERSITY HOT SPOTS</u> Map 15. This map represents areas with a high degree of overlap for 54 declining species of wildlife plus known occurrences of flora, fauna, & natural communities. Map 16 <u>PRIORITY WETLANDS FOR LISTED SPECIES</u> represents wetland habitats critical to 33 wetland-dependant species of vertebrates listed as endangered, threatened, or species of special concern. Priority wetlands were identified using known occurrence records, species range maps, and vegetative cover derived from 1985-1989 Landsat Thematic Mapper Imagery. Species overlap indicates the number of wetland- dependant listed species whose ranges co-occur.

Similar information for West Indian Manatee also exists. The Florida Fish and Wildlife Conservation Commission have extensive information on Manatee use areas, boat traffic, and Manatee mortality. An approved Manatee protection plan currently exists for Collier County and is currently under development within the remaining of Southwest Florida's coastal counties. The latest information on manatee mortality is contained in Table 90.

Lee County leads all other west coast counties in the number of deaths in the categories of other human (11), dependant calves (107), other natural (150) and undetermined decomposed (142) and undetermined (56). Other known human-related causes of death include ingestion of monofilament line, pieces of plastic, entanglement with blue crab traps lines, ropes, gillnets and other nets used to catch fish (Beck and Barros, 1991). In Lee County, a significant portion of the Caloosahatchee River is closed to net fishing; however, this closed area supports a blue crab fishery.

When viewing these maps and other information, it is clear that only a partnership between public agencies and private organizations and land owners can implement this level of management, especially on lands that are not currently owned by the public, or that are not listed on current land acquisition programs or included in designated aquatic preserves.

Further information can be obtained about wildlife in Southwest Florida at the following Internet location: <u>http://fcn.state.fl.us/fwc/pubs/pubs.html</u>

		Ν	IANATI	EE MOI	TABI RTALITY I	.E 90 BY COU	NTY, 19	75 – 2000*		
		Watercraft	Flood	Other	Dependant	Natural Cold	Other	Verified, Not	Undetermined	
County	Total	Related	Gate	Human	Calf	Stress	Natural	Recovered	Decomposed	Undetermined
Charlotte	130	34		1	18	3	30	2	27	15
Collier	355	98		6	51	5	56	13	80	46
Glades	71	24	23	1	3		4	1	10	5
Hendry	4	2					1		1	
Lee	635	125	1	11	111	12	155	17	147	56
Sarasota	100	21			25	2	24	3	20	5
Total	1295	304	24	19	208	22	270	36	285	127

\*Year 2000 numbers include through May only Source: Florida Fish and Wildlife Commission

# MAP 14 - STRATEGIC HABITAT AND CONSERVATION AREAS



Source: Florida Fish and Wildlife Conservation Commission

# **MAP 15 - BIODIVERSITY HOT SPOTS**



Source: Florida Fish and Wildlife Conservation Commission



# **MAP 16 - PRIORITY WETLANDS FOR LISTED SPECIES**

Source: Florida Fish and Wildlife Conservation Commission

## > THE COAST

## **Coastal Waters**

The coastal waters of Southwest Florida are the Region's most abundant water resource, providing a valuable contribution to the economy. These waters are essential to tourism, recreation, commercial fishing, and the aesthetic characteristics of the Region. The benefits of the coastal waters are augmented due to the configuration of the coastline with its many bays, inlets and islands. The long interface between the land and the sea, which also serves as a mixing bowl for freshwater from the land and highly saline water from the Gulf, is very productive in vegetation and wildlife. This coastal interface represents roughly fifteen percent of the total coastline of the state (Table 91).

TABLE 91								
COASTLINE, SO	<b>COASTLINE, SOUTHWEST FLORIDA</b>							
County	Length (Miles)							
Charlotte	219.8							
Collier	675.2							
Glades								
Hendry								
Lee	589.6							
Sarasota	192							
Region	1676.6							
State	10,931.50							
Source: Marina Siting Sur	vey, SWFRPC, p. 3.							

## **Barrier Islands**

Southwest Florida is fortunate in its abundance of barrier islands which form a chain from northern Sarasota County to southern Collier County (Map 17). Barrier islands are characterized as dynamic, low-lying, narrow strips of sand which possess the ability to migrate with changes in sea level. Aesthetically pleasing, they play a significant role in the area's tourism economy. Yet, aside from their aesthetic appeal, they serve important environmental functions. They protect the mainland from major storm damage, as well as act as a buffer for sensitive estuarine ecosystems. They also provide a habitat for wildlife and vegetative communities (Appendix).

#### **MAP 17 - BARRIER ISLANDS**



BARRIER ISLANDS SOUTHWEST FLORIDA REGION

#### Passes, Inlets, and Bays

The barrier islands are separated from each other by bodies of water known as passes or inlets. These openings enable the flushing of the various bay systems as well as the movement of marine life and nutrients from the protected estuaries to the more open water of the Gulf.

The bays of Southwest Florida act as estuaries and havens for many species of aquatic flora and fauna. Major bay systems include Charlotte Harbor, Lemon Bay, Sarasota Bay, and Estero Bay (Map 12).

#### **Marine Environments**

A detailed description of the Region's marine systems is presented earlier in this document.

#### Salinity Regime

In Southwest Florida, the salinity pattern of estuaries can vary depending upon seasonal rainfall and the annual tidal cycle. When tidal fluctuations are small, as in this region, the importance of freshwater inflow to the horizontal mixing of fresh and saline waters is greatly magnified.

Most Southwest Florida estuaries are located at the mouths of major rivers, behind barrier islands. There is a tendency for the salinity levels in these partially enclosed areas to exceed that of seawater, particularly during the dry season when there is little or no freshwater inflow. Because tidal influences are also small, flushing of the estuary does not occur and the water can become relatively stagnant.

The ability of an estuary to act as a barrier to predator species is mostly due to horizontal salinity gradients. Saltwater is more dense than freshwater. As a result, salinity in an estuary generally tends to increase with depth. A reduction of freshwater to the estuarine environment alters the salinity gradient. This can cause a change in resident marine species and organisms, with the potential to change total biomass production and composition.

An increase in freshwater flow into the estuarine system can also be harmful. It is believed that a relationship exists between large, abnormal inflows of freshwater and the occurrence of red tides. Red tides can cause considerable damage to fisheries. The seasonal variation of salinity in Southwest Florida estuarine systems is, under normal circumstances, predictable. Many marine species adapt by changing location, but some species have adapted physiologically, thereby enabling them to tolerate salinity changes. This regular seasonal variation has become important to the character of the near shore environment of the Region.

Although extreme changes in the salinity regime have and do occur naturally, they occur only in short intervals, with no lasting impact on the environment. Human-induced stresses, however, can be devastating. Diverting or damming river flow can permanently alter the estuary, possibly leading to its destruction or the disappearance of marine species. Stormwater runoff, naturally impeded by swamps, marshes, and upland vegetation, enters the estuary rapidly when channeled directly into the system by culverts, concrete, or pavement--a common situation in the urban environment. This water not only upsets the salinity balance, but it also carries pollution, which is harmful to the

estuary. These changes affect flora as well as fauna. Salt marsh, mangroves, and marine meadows depend upon the delicate balance of freshwater and saltwater in the estuarine environment (Snedaker et al, 1977).

#### Economically Important Marine Species

All marine animals, which impact the food chain, have important economic value. Monetary values, however, can only be assigned to the species that humans pay to catch or to eat. In Southwest Florida, the annual economic value of these species is significant. A more detailed discussion of fishery economies can be found in Part III, Economic Systems.

In Southwest Florida, economically valuable marine species can be broadly divided into two classes: sport fish and commercial species. Important sport fish include tarpon, snook, redfish, and spotted sea trout. Commercially valuable fish include black mullet, flounder, cobia, pompano, spotted sea trout, lane snapper, mangrove snapper, and tripletail. Oysters and other shellfish harvested from the estuaries are also a sizeable regional resource, but the most economically valuable marine species in Southwest Florida is shrimp (Charlotte Harbor: A Florida Resource, 1978; National Marine Fisheries Services, 1985).

#### Outstanding Florida Waters and Aquatic Preserves

Twenty-two areas in Southwest Florida are designated as Outstanding Florida Waters. Nine of these are the estuarine environments of Cape Romano/Ten Thousand Islands, Pine Island Sound, Matlacha Pass, Estero Bay, Cape Haze, Charlotte Harbor, Lemon Bay, Sarasota Bay, and Rookery Bay. All of these estuarine Outstanding Florida Waters, except Sarasota Bay, are also designated as Aquatic Preserves. These areas are considered Regionally Significant Natural Resources and are shown on Map 6 of Volume II, of the Regional Strategic Policy Plan.

#### **Development** Pressures

Land development activities, along with associated wastes, have caused varying degrees of degradation of marine flora and fauna. While the development industry has attempted to meet the ever-present demands of the population for waterfront living, much of the Region's marine resources have been severely impacted by dredge and fill activities and bulkheading. These activities have led to an overall degradation of the quality of coastal waters, along with a great reduction of marine fauna population in some areas.

Recent environmental legislation has led to improved quality in some water bodies. Destructive dredge and fill activities are now highly restricted. Review and analysis of waterfront development has become much more sophisticated. This should improve the inter-relationship between development and marine resources.

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