

## NATURAL RESOURCES WETLAND ECOSYSTEMS

### **A. Introduction**

Paynes Prairie is a 21,000-acre preserve that is among the most significant natural and historic areas in Florida. In 1774, noted artist and naturalist, William Bartram wrote a detailed description of this area. He called it the "great Alachua Savannah." Within this national landmark, twenty distinct biological communities such as wet prairie, pine flatwoods, hammocks, swamp and ponds, provide a rich array of habitats for animal life. Most of the animal life Bartram described may still be found here today, including sandhill cranes, eagles, hawks, waterfowl, wading birds, alligators and otters.

"Wetlands" is the collective term for marshes, swamps, bogs, and similar areas, including many of those found within the landscape of Paynes Prairie. Wetlands are found in flat vegetated areas, in depressions on the landscape, and between water and dry land along the edges of streams, rivers, lakes, and coastlines. Wetlands occupy a specialized niche between land and surface water, where the water table is usually at or near the surface, and plants and animals abound.

In their natural state, wetlands perform ecological functions that are vitally important to the environment and economic health of the nation and impossible or costly to replace. Nevertheless, wetlands historically have been viewed as mosquito-ridden wastelands and impediments to development because of their saturated and frequently flooded conditions. The importance of wetlands to fish and wildlife, clean water, and flood control has gone largely unappreciated as draining and filling operations have destroyed more than 50% of wetlands nationwide. At the time of the nation's settlement, wetlands represented approximately 221 million acres of the land area in the lower 48 states. By 1997, only 105.5 million acres remained, leaving just 47.7 % of the original wetland acreage. Wetlands now occupy about 5.5% of the land surface of the lower 48 states (Dahl 2000).

Wetland losses have varied over time. Between the mid-1950s and the mid-1970s, the nation experienced a net loss of 9 million acres of wetland, an area about twice the size of New Jersey. This represents an annual loss of approximately 458,000 acres. Agricultural development was responsible for 87% of the national losses while urban development and other development caused 8% and 5% of the losses, respectively.

During the period from 1986 to 1997, the estimated total net loss of wetlands was 644,000 acres, representing an annual loss of 58,000 acres. This is a significant decline in the rate of loss as compared to the period of 1950 to 1970. Between 1986-1997, urban development accounted for an estimated 30% of all losses, with agriculture responsible for 26%, silvicultural activities 23%, and 21% attributed to rural development (Dahl, 2000). The rate of loss to agricultural activities declined markedly during this period, which is attributed to the "Swampbuster" provisions of the 1985 Food Security Act and agricultural set-aside programs. Changes were made in farm policy after 1990 resulting in less focus on the protection of wetlands.

Historically, Florida's wetlands have followed national trends in being drained and filled for agriculture and urban uses. To illustrate, from 1780 to 1980, Florida lost 9.3 million acres or 46% of estimated wetlands acreage (Dahl, 1990). Since that time, regional studies indicate that continued development has led to further impacts to wetlands and surface waters. For example, an analysis conducted by the

SJRWMD found that 51,300 wetland acres within the district were lost to agriculture or development from 1984 to 1994 (OPPAGA, 2001). Loss and degradation of Florida's wetlands and their associated functions have contributed to problems, such as flooding, poor water quality, and habitat loss.

In recent decades, a number of federal, state, and local government programs have been developed for preserving wetlands. Although the rate of loss has slowed markedly, both conservation and regulatory approaches typically have not been effective in preventing continued, large and small-scale losses and degradation.

## **B. Importance of wetland ecosystems**

Many people use the terms functions and values interchangeably when discussing wetlands, even though functions and values are different. Functions are the physical, chemical, and biological processes occurring in and making up an ecosystem. Processes include the movement of water through the wetland into streams; the decay of organic matter; the release of nitrogen, sulfur, and carbon into the atmosphere; the removal of nutrients, sediment and organic matter from water moving into the wetland; and the growth and development of all the organisms that require wetlands for life.

Values are "an estimate, usually subjective, of worth, merit, quality, or importance" (Richardson 1994). Wetland "values" may derive from outputs that can be consumed directly, such as food, recreation, or timber; indirect uses which arise from the functions occurring within the ecosystem, such as water quality, and flood control; possible future direct outputs or indirect uses such as biodiversity or conserved habitats; and from the knowledge that such habitats or species exist (known as existence value) (Serageldin 1993).

The difficulty with determining the value of a wetland is that valuation can be a subjective assessment, particularly the valuation of indirect use, future use, or existence values. Some wetlands may have multiple uses or worth. Wetlands that are remote may not directly benefit any humans but may be critical, for instance, to the existence of a type of salamander. People may value the intangible fact that wetlands exist, but would not be able to place a price on them, perhaps feeling offended by the concept. In contrast, the value of estuaries in producing shrimp can be calculated based on the price of shrimp.

Conflicts may also arise between public and private valuation. For example, although an individual landowner may not receive the financial benefits of the wetland on his or her property, it may have worth to the town or county in improving public water quality or quantity. In more complex cases involving endangered wetland species found on private property, the government attributes a value to the preservation of the species and regulates the development of the private property, although the property owner may not value the organism at all or values it less than he does other possible land uses.

Within watersheds and ecosystems, human activities cause depletion and pollution. The watershed and its ecosystems sustain our way of life, regardless of our understanding of the biology, chemistry, and geology involved. However, when decision makers do not understand the basics of ecosystem functions and values, they may make choices that prevent ecosystems from fully functioning. The result may be long term and possibly irreversible changes. Such changes reduce the value of the ecosystem. They can even affect the economy. A familiarity with the functions and values of an ecosystem such as a wetland can improve decision making today and protect values that may be held by future generations as well.

## **1. Wetland functions**

Five important wetland functions are described below: hydrologic flux and storage; biogeochemical cycling and storage; biological productivity; decomposition; and community structure and wildlife support

### **a. Hydrologic flux and storage**

Functions of wetlands associated with hydrologic flux and storage include water balance, groundwater recharge, climate control, oxidation-reduction, and life support. Values of wetlands as a result of the functions of hydrologic flux and storage include: water quality, water supply, flood control, erosion control, wildlife support, recreation, culture, and commercial benefits.

Water balance: Wetlands play a critical role in regulating the movement of water within watersheds as well as in the global water cycle (Richardson 1994; Mitsch and Gosselink 1993). Wetlands, by definition, are characterized by water saturation in the root zone, at, or above the soil surface, for a certain amount of time during the year. This fluctuation of the water table (hydroperiod) above the soil surface is unique to each wetland type. Wetlands store precipitation and surface water and then slowly release the water into associated surface water resources, ground water, and the atmosphere (Taylor et al. 1990). See the Water Resources Section for more discussion of this topic.

Ground water recharge: Wetlands help maintain the level of the water table and exert control on the hydraulic head (O'Brien 1988; Winter 1988). This provides force for ground water recharge and discharge to other waters as well. The extent of ground water recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient (Carter and Novitzki 1988; Weller 1981). Ground water recharge occurs through mineral soils found primarily around the edges of wetlands, and particularly small wetlands (Verry and Timmons 1982). Researchers have discovered ground water recharge of up to 20% of wetland volume per season (Weller 1981).

Climate control: Climate control is another hydrologic function of wetlands. Many wetlands return over two-thirds of their annual water inputs to the atmosphere through evapotranspiration (Richardson and McCarthy 1994). Wetlands may also act to moderate temperature extremes in adjacent uplands (Brinson 1993).

Oxidation-Reduction: The fluctuating water levels that are characteristic of wetlands control the oxidation-reduction (redox) conditions that occur. These redox conditions governed by hydroperiod play a key role in: nutrient cycling, availability, and export; pH; vegetation composition; sediment and organic matter accumulation; decomposition and export; and metal availability and export.

When wetland soil is dry, microbial and chemical processes occur using oxygen as the electron acceptor. When wetland soil is saturated with water, microbial respiration and biological and chemical reactions consume available oxygen. This shifts the soil from an aerobic to an anaerobic, or reduced, condition. As conditions become increasingly reduced, other electron acceptors than oxygen must be used for reactions. These acceptors are, in order of microbial preference, nitrate, ferric iron, manganese, sulfate, and organic compounds.

Wetland plants are adapted to changing redox conditions. Wetland plants often contain aerenchymous tissue (spongy tissue with large pores) in their stems and roots that allows air to move quickly between

the leaf surface and the roots. Oxygen released from wetland plant roots oxidizes the rhizosphere (root zone) and allows processes requiring oxygen, such as organic compound breakdown, decomposition, and denitrification, to occur (Steinberg and Coonrod 1994).

*Life support:* Changes in frequency, duration, and timing of hydroperiod may impact spawning, migration, species composition, and food chain support of the wetland and associated downstream systems (Crance 1988). Normal hydrologic flux allows exchange of nutrients, detritus, and passage of aquatic life between systems.

#### b. Biogeochemical cycling and storage

Wetlands may be a sink for, or transform, nutrients, organic compounds, metals, and components of organic matter. Wetlands may also act as filters of sediments and organic matter. A wetland may be a permanent sink for these substances if the compounds become buried in the substrate or are released into the atmosphere; or a wetland may retain them only during the growing season or under flooded conditions. Wetland processes play a role in the global cycles of carbon, nitrogen, and sulfur by transforming them and releasing them into the atmosphere.

The values of wetland functions related to biogeochemical cycling and storage include water quality and erosion control.

*Nitrogen:* The biological and chemical process of nitrification/denitrification in the nitrogen cycle transforms the majority of nitrogen entering wetlands, causing between 70% and 90% to be removed (Reilly 1991; Gilliam 1994).

*Phosphorus:* Phosphorus can enter wetlands with suspended solids or as dissolved phosphorus. Removal occurs through use of phosphorus by plants and soil microbes; adsorption by aluminum and iron oxides and hydroxides; precipitation of aluminum, iron, and calcium phosphates; and burial of phosphorus adsorbed to sediments or organic matter (Richardson 1985; Johnston 1991; Walbridge and Struthers 1993). Wetland soils can, however, reach a state of phosphorus saturation, after which phosphorus may be released from the system (Richardson 1985).

*Carbon:* Wetlands store carbon within peat and soil. Storing carbon is an important function within the carbon cycle, particularly given observations of increasing levels of carbon dioxide in the atmosphere and concerns about global warming. When wetlands are drained, the oxidizing conditions increase organic matter decomposition, thus increasing the release of carbon dioxide. When wetlands are preserved or restored, the wetlands act as a sink for carbon since organic matter decomposition is stable or slowed.

*Sulfur:* Wetlands are capable of reducing sulfate to sulfide. Sulfide is released to the atmosphere as hydrogen, methyl, and dimethyl sulfides or is bound in insoluble complexes with phosphate and metal ions in wetland sediments (Mitsch and Gosselink 1993). Dimethyl sulfide released from wetlands may act as a seed for cloud formation (Hader et al. 1991). Sulfate may exist in soils or may enter wetlands through atmospheric deposition.

*Suspended solids:* Wetlands perform the same function for our ecosystem as kidneys do for our bodies, in that they filter and remove pollutants. As water passes through a wetland, much of the pollution that is dissolved or suspended in the water becomes trapped by the wetland plants and soils. Stems and leaves provide friction for the flow of the water, thus allowing settling of suspended solids and removal of related pollutants from the water column (Johnston 1991). Wetlands may retain sediment in the peat or as

substrate permanently (Johnston 1991). Sediment deposition is variable across individual wetlands and wetland types, as deposition depends upon the rate and type of water flow (channelized or sheet flow), particulate size, and vegetated area of the wetland (Aust et al. 1991; Johnston 1991; Crance 1988; USEPA 1993c; Hemond and Benoit 1988).

*Metals:* All soils contain at least a low concentration of metals but in some locations human activities have resulted in metal levels high enough to cause health or ecological risks in water resources. Metals may exist in wetland soils or enter wetlands through surface or ground water flow. Wetlands can remove metals from surface and ground water as a result of the presence of clays, humic materials (peats), aluminum, iron, and/or calcium (Gambrell 1994). Metals entering wetlands bind to the negatively ionized surface of clay particles, precipitate as inorganic compounds (includes metal oxides, hydroxides, and carbonates controlled by system pH), complex with humic materials, and adsorb or occlude to precipitated hydrous oxides. Wetlands remove more metals from slow flowing water since there is more time for chemical processes to occur before the water moves out of the wetland. Burial in the wetland substrate will keep bound metals immobilized.

#### c. Biological productivity

Regular inputs of water, sediments, and nutrients cause most wetlands to be highly productive. In fact, wetlands are among the most productive ecosystems in the world (Mitsch and Gosselink 1993). Immense varieties of species of microbes, plants, insects, amphibians, reptiles, birds, fish, and other wildlife depend in some way on wetlands. Wetlands with seasonal hydrologic pulsing are the most productive.

Wetland plants play an integral role in the ecology of the watershed. Wetland plants provide breeding and nursery sites, resting areas for migratory species as well as rare and endangered species such as the wood stork and Florida sandhill crane, and refuge from predators (Crance 1988). Decomposed plant matter (detritus) released into the water is important food for many invertebrates and fish both in the wetland and in associated aquatic systems (Crance 1988). Physical and chemical characteristics such as climate, topography, geology, hydrology, and inputs of nutrients and sediments determine the rate of plant growth and reproduction (primary productivity) of wetlands (Brinson 1993; Mitsch and Gosselink 1993; Weller 1981; Crance 1988).

A wetland with more vegetation will intercept more runoff and be more capable of reducing runoff velocity and removing pollutants from the water than a wetland with less vegetation (Demissie and Khan 1993; Richardson and McCarthy 1994; NCDEM 1993). Wetland plants also reduce erosion as their roots hold the streambank, shoreline, or coastline.

Values associated with biological productivity of wetlands include: water quality, flood control, erosion control, community structure and wildlife support, recreation, aesthetics, and commercial benefits.

#### d. Decomposition

Decomposition rates vary across wetland types, particularly as a function of climate, vegetation types, available carbon and nitrogen, and pH (Johnston 1991). A pH above 5.0 is necessary for bacterial growth and survival (Richardson 1995). The nutrients and compounds released from decomposing organic matter may be exported from the wetland in soluble or particulate form, incorporated into the soil, or eventually transformed and released to the atmosphere. Decomposed matter (detritus) forms the base of the aquatic and terrestrial food web.

Decomposition requires oxygen and thus reduces the dissolved oxygen content of the water. High rates of decomposition -- such as occur after algae has bloomed -- can reduce water quality and impair aquatic life support.

e. Community structure and wildlife support

The inundated or saturated conditions occurring in wetlands limit plant species composition to those that can tolerate such conditions. Beaver, muskrat and alligators create or manipulate their own wetland habitat that other organisms, such as fish, amphibians, waterfowl, insects, and mammals can then use or inhabit (Weller 1981; Mitsch and Gosselink 1993).

Wetland shape and size affect the wildlife community and the wetland's function as suitable habitat (Kent 1994b; Brinson 1993; Harris 1988). The shape of the wetland varies the perimeter to area ratio. The amount of perimeter versus area has importance for the success of interior and edge species (Kent 1994b). Shape is also important for the possibility of movement of animals within the habitat and between habitats. Wetland size is particularly important for larger and wide ranging animals that utilize wetlands for food and refuge, such as black bear or moose, since in many locations wetlands may be the only undeveloped and undisturbed areas remaining.

Values associated with community structure and wildlife support in wetlands include: fish and wildlife support, recreation, aesthetics, and commercial benefits.

**2. Wetland values**

The following section describes several values associated with wetland processes: water quality; water supply; flood protection; erosion control; fish and wildlife habitat; recreation, aesthetics, cultural and scientific values; and commercial benefits.

a. Water quality

Wetlands help maintain and improve the water quality of our nation's streams, rivers, lakes, and estuaries. Since wetlands are located between uplands and water resources, many can intercept runoff from the land before it reaches open water. As runoff and surface water pass through, wetlands remove or transform pollutants through physical, chemical, and biological processes. For example, the Congaree Bottomland Hardwood Swamp in South Carolina removes a quantity of pollutants from watershed water resources equivalent to that which would be removed by a \$5 million water treatment plant (USEPA 1995). In another case, scientists estimate that a 2,500 acre wetland in Georgia saves \$1 million in water pollution control costs annually (OTA 1993).

*Nutrient removal:* Scientists have estimated that wetlands may remove between 70% and 90% of entering nitrogen (Reilly 1991; Gilliam 1994). Riparian forests can reduce nitrogen concentrations in runoff and floodwater by up to 90% and phosphate concentrations by 50% (Gilliam 1994). The estimated mean retention of phosphorus by wetlands is 45% (Johnston 1991). Wetlands with high soil concentrations of aluminum may remove up to 80% of total phosphorus (Peterjohn and Correll 1984; Richardson 1985; Gale et al. 1994; Walbridge and Struthers 1993).

Removal of Biological Oxygen Demand: Biological oxygen demand (BOD) is a measure of the oxygen required for the decomposition of organic matter and oxidation of inorganics such as sulfide. BOD is introduced into surface water through inputs of organic matter such as sewage effluent, surface runoff, and natural biotic processes. If BOD is high, low dissolved oxygen levels result. Low dissolved oxygen levels can lead to mortality of aquatic life. Wetlands remove BOD from surface water through decomposition of organic matter or oxidation of inorganics (Hemond and Benoit 1988). BOD removal by wetlands may approach 100% (Hemond and Benoit 1988).

Removal of suspended solids and pollutants: Suspended solids (such as sediment and organic matter) may enter wetlands in runoff, as particulate litterfall, or with inflow from associated water bodies. Sediment deposition in wetlands depends upon water velocity, flooding regimes, vegetated area of the wetland, and water retention time (Gilliam 1994; Johnston 1991). Sediment deposition in wetlands prevents a source of turbidity from entering downstream ecosystems. Typically wetland vegetation traps 80-90% of sediment from runoff (Gilliam 1994; Johnston 1991). Less than 65% of the sediment eroded from uplands exits watersheds that contain wetlands (Johnston 1991).

Other pollutants that impact water quality such as nutrients, organics, metals and radionuclides are often adsorbed onto suspended solids. Deposition of suspended solids, to which such substances are adsorbed, removes these pollutants from the water. Thus sediment deposition provides multiple benefits to downstream water quality (Johnston 1991; Hemond and Benoit 1988; Hupp et al. 1993; Puckett et al. 1993).

Removal of metals: Certain wetlands play an important role in removing metals from other water resources, runoff, and ground water (Owen 1992; Gambrell 1994; Puckett et al. 1993). Wetlands remove 20% - 100% of metals in the water, depending on the specific metal and the individual wetland (Taylor et al. 1990). Forested wetlands play a critical role in removing metals downstream of urbanized areas (Hupp et al. 1993).

Delfino and Odum (1993) found that lead leaking from a Florida hazardous waste site was retained at high levels by a wetland; less than 20 - 25% of the total lead in the soil and sediments was readily bioavailable. The majority of the lead was bound to soil and sediments through adsorption, chelation, and precipitation. Bioavailable lead was absorbed primarily by eel grass, which had bioaccumulated the majority of the lead. In another case, researchers found that wetland vegetation and organic (muck) substrate retained 98% of lead entering the wetland (Gambrell 1994).

Removal of pathogens: Fecal coliform bacteria and protozoans, which are indicators of threats to human health, enter wetlands through municipal sewage, urban stormwater, leaking septic tanks, and agricultural runoff. Bacteria attach to suspended solids that are then trapped by wetland vegetation (Hemond and Benoit 1988). These organisms die: after remaining outside their host organisms, through degradation by sunlight, from the low pH of wetlands, by protozoan consumption, and from toxins excreted from the roots of some wetland plants (Hemond and Benoit 1988; Kennish 1992). In this way wetlands have an important role in removing pathogens from surface water.

#### b. Water supply

Wetlands act as reservoirs for the watershed. Wetlands release the water they retain (from precipitation, surface water, and ground water) into associated surface water and ground water. In Wisconsin watersheds composed of 40% lakes and wetlands, spring stream outflows from the watersheds were 140% of those in watersheds without any wetlands or lakes (Mitsch and Gosselink 1993). Forested wetlands, kettle lakes and prairie potholes have significant water storage and ground water recharge (Brown and Sullivan 1988; Weller 1981). Forested wetlands overlying permeable soil may release up to 100,000 gallons/acre/day into the ground water (Anderson and Rockel 1991). Verry and Timmons (1982) studied a Minnesota bog which released 55% of the entering water to stream and ground water.

Ground water can be adversely affected by activities that alter wetland hydrology (Winter 1988). Drainage of wetlands lowers the water table and reduces the hydraulic head providing the force for ground water discharge (O'Brien 1988; Winter 1988). If a recharge wetland is drained, the water resources into which ground water discharges will receive less inflow, potentially changing the hydrology of a watershed (Brinson 1993; Winter 1988). Ewel (1990) calculated that if 80% of a 5-acre Florida cypress swamp were drained, available ground water would be reduced by an estimated 45%.

#### c. Flood protection

Wetlands help protect adjacent and downstream properties from potential flood damage. The value of flood control by wetlands increases with: (1) wetland area, (2) proximity of the wetland to flood waters, (3) location of the wetland (along a river, lake, or stream), (4) amount of flooding that would occur without the presence of the wetlands, and, (5) lack of other upstream storage areas such as ponds, lakes, and reservoirs (Mitsch and Gosselink 1993). The cost of replacing the flood control function of the 5,000 acres of wetlands drained each year in Minnesota was determined to be \$1.5 million (USEPA 1995).

Wetlands within and upstream of urban areas are particularly valuable for flood protection. The impervious surface in urban areas greatly increases the rate and volume of runoff, thereby increasing the risk of flood damage. The drainage of wetlands, the diversion of the Mississippi and Missouri Rivers from their original floodplains, and the development allowed in the floodplains over the past 100 years were partly responsible for the billions of dollars in damage to businesses, homes, crops, and property that occurred as a result of the Midwest flood of 1993 (OEP 1993).

During storm events, and shortly afterwards, we often face a surge of too much water. Fortunately, wetlands collect and store the excess stormwater that runs off uplands as well as the waters from flooding rivers. By providing temporary storage areas for this surplus water, wetlands slow down the rate at which the waters rise and reduce the maximum elevation of flood waters. This buffering capability helps to protect upland development from flood damage, thereby protecting against the loss of life and property. Wetland vegetation and gradually sloping topography also absorb much of the energy from fast flowing waters and waves, thereby protecting our shorelines from erosion.

#### d. Erosion control

By virtue of their place in the landscape, riparian wetlands, salt marshes, and marshes located at the margin of lakes protect shorelines and streambanks against erosion. Wetland plants hold the soil in place with their roots, absorb wave energy, and reduce the velocity of stream or river currents. Coastal wetlands buffer shorelines against the wave action produced by hurricanes and tropical storms (Mitsch

and Gosselink 1993). The ability of wetlands to control erosion is so valuable that states and landowners are restoring wetlands to control shoreline erosion in coastal areas (Lewis 1994).

e. Fish and wildlife habitat

Diverse species of plants, insects, amphibians, reptiles, birds, fish, and mammals depend on wetlands for food, habitat, or temporary shelter. Although wetlands make up only about 3.5 percent of U.S. land area, more than one-third of the United States' threatened and endangered species live only in wetlands (Mitsch and Gosselink 1993). An additional 20% of the United States' threatened and endangered species use or inhabit wetlands at some time in their life. Many of America's bird species utilize wetlands as sources of food, water, nesting material, or shelter. Migratory waterbirds rely on wetlands for staging areas, resting, feeding, breeding, or nesting grounds.

f. Recreation, aesthetics, culture, and science

Wetlands have archeological, historical, cultural, recreational, and scientific values. Societies have traditionally formed along bodies of water and artifacts found in wetlands provide information about these societies. Each person has his or her own opinion about the natural beauty of wetlands and the relative worth of that beauty. However, we know that waterfront property commands a premium price over otherwise similar, landlocked property partly because of these aesthetic qualities.

Wetlands offer people a sense of both beauty and well-being. It is comforting to spend time in these natural areas to enjoy the sounds, sights, and smells. Historically, painters and writers have used wetlands as their subject matter. Today, such artists are often joined by others with cameras and camcorders. The monetary value derived from the observation and photography of wetland-dependent birds by more than 50 million Americans is at least \$10 billion per year (USEPA 1994).

All revenue generated by people who camp, hunt, fish, canoe, sail, photograph nature, watch birds, or hike in and near wetlands must be included when figuring the economic benefits of wetlands. More than half of all U.S. adults hunt, fish, birdwatch or photograph wildlife, spending a total of \$59.5 billion annually (USEPA 1995). Waterfowl hunters spend over \$630 million annually to harvest wetland-dependent birds (OTA 1993).

Scientists value the processes of wetlands individually, particularly the role of wetlands in the global cycles of carbon, nitrogen, and water. Many scientists consider the removal of carbon dioxide from the atmosphere into plant matter and its burial as peat (sequestration) the most valuable function of wetlands (OTA 1993). Carbon sequestration is thought to be an important process in reducing the greenhouse effect and the threat of global warming.

g. Commercial benefits

Floridians depend on healthy and diverse populations of fish and wildlife, not only because they provide us with recreational opportunities and food, but also because they support our commercial fishing, tourism and recreation industries. Commercially important products harvested from wetlands include fish, shellfish, cranberries, timber, and wild rice, as well as some medicines derived from wetland soils and plants. Fish and shellfish species dependent on wetlands for food or habitat comprise more than 75% of the commercial and 90% of the recreational harvest (USEPA 1994; Feierabend and Zelazny 1987). Many mammals and reptiles harvested for their skins, including muskrat, beaver, mink, otter, and

alligator, require wetland habitats. The nation's harvest of muskrat pelts alone is worth over \$70 million annually, while the alligator industry is valued at \$16 million (Mitsch and Gosselink 1993; OTA 1993).

Wetlands containing timber comprise approximately 55 million acres (22 million hectares), with two-thirds of the acreage east of the Rocky Mountains (Mitsch and Gosselink 1993). Although historically the practice has been to clear-cut and drain the forests of the bottomland hardwood swamps, with proper management, the timber industry can harvest wetland timber with minimal adverse effect (Conner 1994; Shepard 1994). In addition, replicating wetland conditions may improve production of desired flood-tolerant pine and hardwood species by preventing competition by non-wetland species (Conner 1994).

### **C. Human impacts to wetlands**

We now know that wetlands are more sensitive to alterations than we once believed. Small changes in water levels or the influx of pollutants can have significant effects on the functions of wetlands. Although wetlands are good at filtering and attenuating pollutants, there are limits to these capabilities. If we overload these natural systems, not only will pollutants reach our own water bodies but the pollutants could damage the wetlands and reduce their filtering capacity. These areas must be protected from abuse and destruction in order to maintain a healthy environment. Major causes of wetland loss and degradation include hydrological alteration, urbanization (including development), marinas and boats, industry (including industrial development), agriculture and silviculture, mining, and atmospheric deposition.

#### **1. Hydrologic alterations of wetlands**

Wetlands form as a result of certain hydrologic conditions which cause the water table to saturate or inundate the soil for a certain amount of time each year. The frequent or prolonged presence of water at or near the soil (hydrology) is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Thus alteration of wetland hydrology can change the soil chemistry and the plant and animal community.

Alteration which reduces or increases the natural amount of water entering a wetland or the period of saturation and inundation can, in time, cause the ecosystem to change to an upland system or, conversely, to a riverine or lacustrine system. This alteration can be natural, such as through the successional process of stream impoundment by beavers or climate change. Wetland loss and degradation through hydrologic alteration by man has occurred historically through such actions as: drainage, dredging, stream channelization, ditching, levees, deposition of fill material, stream diversion, ground water withdrawal, and impoundment.

These alterations can destroy wetlands by adding too much water, removing too much water, altering the pattern of the materials imported into or exported from the wetland, or altering the frequency and duration of fluctuating water levels that are needed by certain types of wetlands. The altered flow patterns can also concentrate pollutants, cause erosion, cause sedimentation, and reduce valuable shallow water habitats. Habitat fragmentation, as wetlands are drained or hydrologically altered, may result in changes in species composition as wetlands species are replaced by upland species; loss of large, wide-ranging species; loss of genetic integrity when isolated habitats are too small to support viable populations; reduced populations of interior species that can only reproduce in large tracts; and increased numbers of competitor, predator, and parasite species tolerant of disturbed environments (Harris 1988; Fleming et al. 1994).

### a. Water diversion structures

Water diversion structures, such as canals (channels), ditches, and levees have been used to modify wetlands to achieve flood control, drainage, mosquito control, irrigation, timber harvest, navigation, transportation, and industrial activity (Mitsch and Gosselink 1993). Canals and channelization change the hydrology of wetlands and increase the speed with which water moves into and through wetlands. As a result, patterns of sedimentation are altered and wetland functions and values that depend on the normal slow flow of water through a wetland can be affected.

High sediment loads entering wetlands through channels, irrigation ditches and drainage ditches can smother aquatic vegetation, fill in riffles and pools, and contribute to increased turbidity (USEPA 1993a). Channelization and channel modification alter in-stream water temperature and diminish habitat suitable for fish and wildlife (USEPA 1993a). Normal sheet flow through wetlands is inhibited by the spoil banks that line a canal and by road embankments. Spoil banks and embankments also increase water stagnation. Channels often connect low-salinity areas to high-salinity areas, resulting in saltwater intrusion upstream, and causing species change and mortality of salt-intolerant vegetation.

### b. Impoundments

Impoundment of natural wetlands for stormwater management or wildlife and habitat management may exploit one function of wetlands at the expense of others (USEPA 1993a; Mitsch and Gosselink 1993). Impoundment alters the natural wetlands' hydrology and decreases water circulation. Decreased water circulation causes increased water temperature, lower dissolved oxygen levels, and changes in salinity and pH; prevents nutrient outflow; and increases sedimentation (USEPA 1993a). Sedimentation reduces the water storage capacity, smothers vegetation, reduces light penetration, reduces oxygen content and affects the entire ecosystem richness, diversity, and productivity. Toxic substances, adhering to sediments, may accumulate in impoundments as a result of decreased water circulation and bioaccumulation of contaminants by wetland biota may occur.

## 2. Urbanization

Urbanization is a major cause of impairment of wetlands (USEPA 1994). Urbanization has resulted in direct loss of wetland acreage as well as degradation of wetlands. Degradation is due to changes in water quality, quantity, and flow rates; increases in pollutant inputs; and changes in species composition as a result of introduction of non-native species and disturbance. The major pollutants associated with urbanization are sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, hydrocarbons, bacteria, and viruses (USEPA 1994). These pollutants may enter wetlands from point sources or from nonpoint sources. Construction activities are a major source of suspended sediments that enter wetlands through urban runoff.

### a. Impervious surfaces

As roads, buildings, and parking lots are constructed, the amount of impervious surface increases. Impervious surfaces prevent rainfall from percolating into the soil. Rainfall carries sediments, organic matter, pet wastes, pesticides and fertilizers from lawns, gardens, and golf courses, heavy metals, hydrocarbons, road salts, and debris into urban streams and wetlands (USEPA 1993a; USEPA 1993c). Increased salinity, turbidity, and toxicity; and decreased dissolved oxygen, all affect aquatic life and, therefore, the food web (Crance 1988). Excessive inputs of nutrients can lead to eutrophication or result in the release of pollutants from a wetland into adjacent water resources (USEPA 1993a).

As runoff moves over warmed impervious surfaces, the water temperature rises and dissolved oxygen content of the runoff water decreases (USEPA 1993c). Increased water temperature, as well as the lower dissolved oxygen levels, can cause stress or mortality of aquatic organisms. Rising water temperatures can trigger a release of nutrients from wetland sediment (Taylor et al. 1990). For example, as temperature rises, sediments release phosphorus at an exponential rate. Thus water temperature increases can lead to eutrophication.

Impervious surfaces decrease ground water recharge within a watershed and can reduce water flow into wetlands (USEPA 1993c). Significant increases in stormwater peakflow rates, and longer-term changes in wetland hydrology, as a result of stormwater discharge, can cause erosion and channelization in wetlands, as well as alteration of species composition and decreased pollutant removal efficiency (USEPA 1993a; USEPA 1993c). Changes in frequency, duration, and timing of the wetland hydroperiod may adversely affect spawning, migration, species composition, and thus the food web in a wetland as well as in associated ecosystems (Crance 1988; USEPA 1993c).

b. Wastewater and stormwater

Wastewater treatment plant effluent and urban stormwater are a source of pollutants that continue to degrade wetlands (USEPA 1994). The "aging" of wetlands can occur when wetlands filter organic matter. "Aging" is the saturation of the ecosystem by nutrients and heavy metals over time that results in the reduced effectiveness and degradation of the wetland (Mitsch and Gosselink 1986). Wastewater and stormwater can alter the ecology of a wetland ecosystem if high nutrient levels cause extended eutrophication and metals cause plant and aquatic organism toxicity (Ewel 1990). Iron and magnesium, in particular, may reach toxic concentrations, immobilize available phosphorous, and coat roots with iron oxide, preventing nutrient uptake.

Urban and industrial stormwater, sludge, and wastewater treatment plant effluent, rich in nitrogen and phosphorus, can lead to algal blooms in estuaries. Algal blooms deplete dissolved oxygen, leading to mortality of benthic organisms. Some algae are toxic to aquatic life (Kennish 1992). Excess algae can shade underwater sea grasses, preventing photosynthesis and resulting in sea grass death (Batiuk et al. 1992; USEPA 1994).

c. Roads and bridges

Roads and bridges are frequently constructed across wetlands since wetlands have low land value. It is often considered to be more cost effective to build roads or bridges across wetlands than around them (Winter 1988). Roads can impound a wetland, even if culverts are used. Such inadvertent impoundment and hydrologic alteration can change the functions of the wetland (Winter 1988). Road and bridge construction activities can increase sediment loading to wetlands (Mitsch and Gosselink 1993). Roads can also disrupt habitat continuity, driving out more sensitive, interior species, and providing habitat for hardier opportunistic edge and non-native species. Borrow pits (used to provide fill for road construction) that are adjacent to wetlands can degrade water quality through sedimentation and increase turbidity in the wetland (Irwin 1994).

The maintenance and use of roads contribute many chemicals into the surrounding wetlands. Herbicides, soil stabilizers, and dust palliatives used along roadways can damage wetland plants and the chemicals may concentrate in aquatic life or cause mortality (USEPA 1993a). Runoff from bridges can increase loadings of hydrocarbons, heavy metals, toxic substances, and deicing chemicals directly into wetlands

(USEPA 1993a). Bridge maintenance may contribute lead, rust (iron), and the chemicals from paint, solvents, abrasives, and cleaners directly into wetlands below.

The effects of new roadways through wetlands are apparent beyond the right-of-way. The cleared alignment allows light to penetrate into the adjacent forested wetlands. This degrades wetlands by causing these areas to become hotter and dryer than normal. It also provides a vector for invasive and nuisance plants and animals to penetrate into the previously undisturbed interior of the wetlands. The possibility of vehicular collisions with animals crossing the road is a constant threat to many common wildlife species, as well as threatened and endangered species. For some species a filled roadway becomes an insurmountable barrier. In those cases, the new structure divides the wetlands into smaller habitats, which may not be large enough to support the existing populations.

#### d. Sanitary landfills

Landfills can pose an ecological risk to wetlands. Landfill construction may alter the hydrology of nearby wetlands. Leachate from solid waste landfills often has high biological oxygen demand (BOD), and ammonium, iron, and manganese in concentrations that are toxic to plant and animal life (Lambou et al. 1988). Sanitary landfills may receive household hazardous waste and some hazardous waste from small quantity operators, as well as sewage sludge and industrial waste. Although regulated (under RCRA Subtitle D), these facilities may not always be properly located, designed, or managed, in which case some surface water contamination may occur. Researchers who conducted a study of the proximity of 1,153 sanitary landfills to wetlands in 11 states, found that 98 percent of the sanitary landfills were 1 mile or less from a wetland, and 72 percent were 1/4 mile or less from a wetland (Lambou et al. 1988).

#### e. Non-native plants and animals

As a result of disturbance and habitat degradation, wetlands can be invaded by aggressive, highly-tolerant, non-native vegetation, such as purple loosestrife (*Lythrum salicaria*), water hyacinth (*Eichornia crassipes*), and salvinia (*Salvinia molesta*), or can be dominated by a monoculture of cattails (*Typha spp.*) or common reed (*Phragmites spp.*) (McColligan and Kraus 1988; Weller 1981; Mitsch and Gosselink 1993). Particularly in constructed wetlands, including restored wetlands, non-native and tolerant native species may outcompete other species leading to a reduction in species diversity.

Non-native species may be introduced on purpose. For example, water hyacinth has been noted for its ability to sequester nutrients and is used for wastewater purification (Mitsch and Gosselink 1993). Water hyacinth and similar species can rapidly fill a wetland and are a threat to water quality in some areas.

Carp and nutria are two introduced exotic animal species that degrade wetlands (Mitsch and Gosselink 1993). Carp, introduced for recreational fishing, severely increase the turbidity of water resources. Nutria, introduced for their pelts, are rodents that voraciously eat, as well as destroy, freshwater and coastal wetland vegetation. Domestic and feral cats can be extremely damaging as they prey on wetland birds.

#### f. Mosquito control programs

Mosquito control efforts in urbanized and resort communities has resulted in wetlands loss and degradation through drainage, channelization, and use of toxic pesticides.

### **3. Docks and piers**

Docks and piers can eliminate submerged vegetation by reducing light penetration. Wood preservatives in the pilings contain toxic materials that can leach into the water. Marina construction and dredging activities can contribute suspended sediments into waters adjacent to wetlands. Even if a dock is situated and constructed in such a way as to avoid any significant direct impacts, the boats using the dock can cause propeller dredging in nearby grass beds, leach toxic materials from the anti-fouling hull paint, and collide with fish and wildlife. Intense boating activity increases turbidity and degradation of wetlands (USEPA 1993a).

### **4. Industry**

Adverse effects of industry on wetlands can include: reduction of wetland acreage, alteration of wetland hydrology due to industrial water intake and discharge, water temperature increases, point and nonpoint source pollutant inputs, pH changes as a result of discharges, and atmospheric deposition. Petroleum hydrocarbon inputs from runoff, or from upstream releases can alter reproduction, growth, and behavior of wetland organisms, and can result in mortality. Plants suffocate when oil blocks their stomata (Dibner 1978).

Polynuclear aromatic hydrocarbons (PAHs) are extremely toxic compounds that can enter wetlands through industrial effluent and atmospheric deposition. PAHs concentrate in sediments and thus contaminate benthic organisms (Kennish 1992). Fish contaminated with PAHs exhibit external abnormalities, such as fin loss and dermal lesions.

### **5. Agriculture**

Historically, agriculture has been the major factor in freshwater and estuarine wetland loss and degradation. Although the passage of the Food Security Act of 1985 "Swampbuster" provision prevented the conversion of wetlands to agricultural production, certain exempted activities performed in wetlands can degrade wetlands:

- harvesting food, fiber, or forest products;
- minor drainage;
- maintenance of drainage ditches;
- construction and maintenance of irrigation ditches;
- construction and maintenance of farm or forest roads;
- maintenance of dams, dikes, and levees;
- direct and aerial application of damaging pesticides; and
- ground water withdrawals.

These activities can alter wetlands hydrology, water quality, and species composition. Excessive amounts of fertilizers and animal waste reaching wetlands in runoff from agricultural operations, including confined animal facilities, can cause eutrophication.

Wetlands provide critical habitat for waterfowl populations. The drainage of U.S. and Canadian prairie potholes for agricultural production has been linked to a concomitant 50% - 80% decline in waterfowl populations since 1955 (USEPA 1995; DU 1995). Since the Swampbuster legislation was promulgated, the waterfowl population has begun to increase. Swampbuster rendered drainage of prairie potholes costly,

and encouraged farmers to allow prior converted wetlands to revert to their previous natural wetland state and to construct farm ponds or restore marshes. Duck populations in 1994 increased by 24% over 1993 populations, and were the highest since 1980, when duck populations had plunged to a low (USEPA 1995).

a. Toxic compounds

Irrigation ditching can increase contamination of wetlands receiving irrigation drainage water, particularly where soil is alkaline or contains selenium or other heavy metals (Deason 1989). Agricultural pesticides entering wetlands in runoff, as well as through atmospheric deposition, may bioaccumulate in fish and other aquatic organisms (Kennish 1992).

b. Grazing

Grazing livestock can degrade wetlands that they use as a food and water source. Urea and manure can result in high nutrient inputs. Cattle traffic may cause dens and tunnels to collapse. Overgrazing of riparian areas by livestock reduces streamside vegetation, preventing runoff filtration, increasing stream temperatures, and eliminating food and cover for fish and wildlife. As vegetation is reduced, streambanks can be destroyed by sloughing and erosion. Streambank destabilization and erosion then cause downstream sedimentation (Kent 1994b). Sedimentation reduces stream and lake capacity, resulting in decreased water supply, irrigation water, flood control, hydropower production, water quality, and impairment of aquatic life and wetland habitat (USEPA 1993b).

The economic losses attributed to the reduced quality and quantity of water and habitat from overgrazing of riparian wetland vegetation is more than \$200 million (USEPA 1993b). The depletion of vegetation from riparian areas causes increased water temperatures and erosion and gully formation, prevents runoff filtration, and eliminates food and cover for fish and wildlife (USEPA 1993b). If stocking of livestock is well managed, grazing can coexist with wetlands, benefiting farmers and increasing habitat diversity.

c. Silviculture/timber harvest

If best management practices are used and careful monitoring occurs, silviculture and timber removal may only minimally affect some wetland functions. Habitat and community structure, however, still may be seriously degraded.

Drainage, clearing, haul road construction, rutting, and ditching of forested wetlands, all may affect wetlands in some way, although the impact may only be temporary. Since timber removal generally occurs in 20-50 year rotations, careful harvest may not be a permanent threat to wetlands. Adverse effects of timber harvest can include a rise in water table due to a decrease in transpiration, soil disturbance and compaction by heavy equipment, sedimentation and erosion from logging decks, skid trails, roads, and ditches, and drainage and altered hydrology from ditching, draining, and road construction (Shepard 1994). By utilizing best management practices, hydrology and biogeochemical processes of wetlands may be altered for only one to three years following timber harvest (Shepard 1994).

Pesticides and fertilizers used during silvicultural operations can enter wetlands through runoff as well as through deposition from aerial application. Fertilizers may contribute to eutrophication of wetlands.

## **6. Mining**

Phosphate mining has resulted in the loss of thousands of acres of wetlands in central Florida (Mitsch and Gosselink 1993). Other types of mining operations can also degrade wetlands through hydrologic alterations, high metal concentrations, and/or decreased pH.

Acid drainage from active and abandoned mines causes extensive ecological damage. Acid mine drainage introduces high levels of acidity and heavy metals into the wetland environment through runoff and through direct drainage from mines into wetlands. The acidity and the high metal concentrations alter the biotic community composition and can result in mortality (Lacki et al. 1992; Mitsch and Gosselink 1993). Although natural wetlands may have the capacity to buffer some of the acidity and absorb a certain amount of the pollutants, over time, the assimilative capacity will be saturated (Kent 1994; Wieder 1994).

## **7. Atmospheric deposition**

Nitrous oxides, sulfurous oxides, heavy metals, volatilized pesticides, hydrocarbons, radionuclides, and other organics and inorganics are released into the atmosphere by industrial and agricultural activities, and from vehicles. These compounds can enter wetlands through wet and dry atmospheric deposition and can adversely affect aquatic organisms and the terrestrial organisms that feed on them.

## **D. Wetland-upland transition zone**

The major structural components of an ecosystem, including energy, chemicals, and organisms, are connected by the systems of energy flow and nutrient recycling (Taylor et.al. 1999). As described above, the existence of wetlands and the functions they perform is, to a large degree, a direct result of the surrounding upland areas that they support. In fact, the area immediately adjacent to wetlands is often a transition zone between wetlands and uplands and exhibits vegetation, soils and hydrologic characteristics that are similar yet intermediate between wetlands and uplands.

Interactions between wetland and upland habitats can be a major factor in determining the amount of energy and nutrients in these systems and how the energy and nutrients are used. Wetlands provide habitat for many species of birds, mammals, reptiles, fish, amphibians, and a variety of invertebrates. These species feed and breed in wetlands, then spend time in adjacent upland habitats where they defecate, die, and become food for upland animals, adding both energy and organic matter to the upland community. Surface runoff then carries the organic and mineral material back into wetlands. The exchange provides important nutrients for both systems.

Wetlands also provide critical habitat components for species generally considered strictly terrestrial. A typical direct upland and wetland linkage occurs when a species resides and feeds in one of these two habitats and breeds in another. For example, aquatic turtles reside in wetlands and open water areas, but require adjacent uplands for nesting. Many amphibians, such as tree frogs, have the opposite pattern. The disruption or elimination of one habitat destroys the linkages that provide essential elements for species survival and could have drastic effects.

It long has been regarded that the highest plant species diversity occurs in transition zones between wetlands and uplands (JEA 2000). Studies of Florida landscapes indicate that plant species diversity is higher in transition zones than either the adjacent wetland or upland (JEA citing Clewell et al. 1982;

Gross 1987; Hart 1984). Likewise, wildlife species richness also shows direct spatial relationships to the increased diversity of the transition zone. Vickers et al. (1985) found that species richness and abundance of amphibians and reptiles were greater along the edge of six wetlands in north central Florida than in either the wetland or upland habitat. Harris and Vickers (1984) found that virtually all mammals reside in transition zones because it easily allows them to take advantage of both habitats. When water levels rise in wetlands, wildlife movement to peripheral areas also increases, suggesting the importance of transition zones in providing refuge for wildlife.

Alterations disrupting the flow of energy and nutrients between uplands and wetlands decrease the ability of each habitat to function normally. Disturbance and alteration of the transition zone and adjacent upland can result in elimination of wildlife species that utilize both uplands and wetlands, a loss in plant species diversity, an increase in sedimentation and erosion into the wetland, and alteration in hydrologic patterns within both the upland and wetland. Increases in runoff and pollutants associated with urbanization and agriculture stress wetland systems, thus threatening the functioning of the system as a whole.

The differences between developed lands and natural ecological areas are significant, and the more intensely developed or altered, the greater the differences (JEA 2000). Frequently, native vegetation on developed lands is removed and replaced with non-native ornamentals, soil drainage is altered, soils become compacted and covered with impervious materials, and wildlife species are displaced by human activities. The gradient in intensity of noise, waste, temperature, light, structure, and activity from developed to undeveloped lands is intense. In this edge between development and natural areas, water runoff carries sediments, nutrients, and pollutants. Noise and activities from development intrudes into the edge and interferes with wildlife activities. Wildlife populations also suffer greatly from predation from pets such as cats and dogs that are allowed to roam unconstrained, and from nest predation from animals such as the brown-headed cowbird that flourishes in disturbed habitats and limits the breeding success of less common, more vulnerable birds.

The preservation of linkages between uplands and wetlands is essential for protecting the structure and function of wetland systems, as well as the unique transitional zone between wetland and upland systems. For this reason, it is important to maintain native upland communities as well as wetlands, although the latter have received the most attention in recent years. This may be particularly true since upland areas have fewer limitations to development, and are thus the first to be subjected to developmental pressures.

One tool for preserving these linkages is the creation of buffer zones to separate developed upland areas from wetland systems, provided the buffer zone's size is determined scientifically. Although buffer zones can protect some of the aquatic and terrestrial linkages, they will not protect them all. For example, the importance of the amphibian component of a wetland's contribution to local energy cycles extend far beyond its borders. Some frogs and toads utilize habitat surrounding their breeding ponds up to a distance of 2 km (1.24mi). A buffer of 2 km around a small pond to protect this food web interaction would encompass over 3,000 acres. Since small wetlands tend to be scattered widely over the landscape, an upland of this size set aside to completely protect this linkage would not be realistic in a typical development, but might be in a large, intact area such as a mitigation bank.

As we learn more about wetland functions we realize the challenges in preserving them. Our ability to predict the effects of upland habitat loss on wetland habitats must be improved to provide a scientific basis for sound natural resource management decisions. Only then can these decisions reduce or eliminate the negative impacts caused by urban, suburban, and rural growth.

## **E. Status of wetlands in Alachua County**

In the 1991 Comprehensive Plan, wetlands communities are discussed in the context of natural communities and are defined as those areas that are inundated by surface or ground water with a frequency and duration sufficient to support, and which under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated or seasonally saturated soil conditions. Wetland systems are defined by hydrology, soils, and vegetation and usually appear as transitional areas between terrestrial and aquatic communities or as isolated communities perched within the uplands. Because hydrologic data are often unavailable, wetlands in Alachua County are usually identified based upon floral composition and extent of hydric soils.

Wetlands communities occurring in the County include hydric hammock, wet flatwoods, wet prairie, baygall, seepage slope, bottomland forest, floodplain swamp, strand swamp, basin marsh, basin swamp, bog, depression marsh, and dome swamp. Descriptions of these communities are provided in the Natural Communities portion of the data and analysis.

Wetlands in Alachua County have been mapped variously by the U.S. Department of the Interior, Fish and Wildlife Service, National Wetlands Inventory; the Natural Resource Conservation Service; the U.S. Geological Survey; and the Suwannee River and St. Johns River Water Management Districts. These mapping efforts are adopted by reference in Comprehensive Plan policies and are available for viewing at the Alachua County Department of Growth Management or the Alachua County Environmental Protection Department.

Geographic Information Systems representations of these maps appear in the Conservation Map Series (see Maps 35-38). It must be noted that these maps, in most cases, were prepared from aerial photographs with limited ground proofing. Therefore, mapped locations of wetlands should be regarded as a guideline only, to be accompanied by ground proofing in a development context.

Wetland types and general distribution in the county have not changed significantly; however, there has been a net loss of wetlands quality and extent as a result of agricultural and development activities occurring since 1991. There has been some incremental net loss of wetlands, primarily consisting of (1) loss of isolated wetlands less than one-half acre in size (which currently are exempt from state, regional, and local regulation); (2) minor impacts such as from roads and driveway crossings; (3) minor non-permitted activities; and (4) conversion to row crops, improved pasture, and pine plantation (there is no measure of the extent of loss from these causes as most agricultural activities are not required to go through the development review process). There also has been some degradation of wetlands quality or function due to loss of connectivity with associated upland communities as a result of adjacent development. Impacts causing functional degradation include, for example, loss or restriction of normal water flows, fire control, water quality impacts, and spread of invasive plant species such as air potato, Chinese tallow, Japanese climbing fern, chinaberry, and tarrow.

There is presently no ready measure of wetlands loss as a result of development. A better tracking process would be helpful to identify acreage of wetlands impact, buffer areas, and mitigation projects.

In 2000, the St. Johns River Water Management District (SJRWMD) performed a brief Geographic Information Systems examination of visible wetlands impacts in Alachua County from 1990 to 2000 ([GIS Project Summary, Alachua County Wetlands Impacts – 1990 to 2000](#)). Based on National Wetland Inventory maps using 1984 source material, the SJRWMD determined that Alachua County has about 120,000 acres of total wetlands (wetlands plus water bodies). Of this total, approximately 29,000 acres

are water bodies, which can vary in areal extent with weather cycles, leaving about 91,000 acres in wetlands. “Loss,” for purposes of the analysis, was defined as conversion to a more intensive use, such as urbanization or intensive agriculture.

The study concluded that, although no significant losses were observed using the study method, there may be many small impacts to wetland edges and to small (less than half acre) wetlands that did not show up, due to the resolution of the imagery and the speed and scale at which it was viewed. The study also indicated that impacts to hydrology due to surface draining or water table drawdowns are known to occur in some locations. They were not visible, however, on aerial photos unless they resulted in gross changes to the vegetation community or land use. Other possible reasons for the observance of relatively few losses may include the availability and preference of uplands for development purposes in the central and western part of the County. As stated in the evaluation, it may also reflect a greater local regulatory commitment to wetlands protection, as the Surface Waters and Wetlands Ordinance has been in effect and enforced since 1992.

Wetland gains are generally the result of converting agriculture or silviculture back to wetlands hydrology and vegetation. The gain noted in this study was primarily due to public purchase and restoration of prior muck farm acreage at the southeast corner of Orange Lake, encompassing roughly 985 acres.

This is not necessarily a long-term trend. Development pressures on wetland areas are increasing. Also, hydrologic changes in some areas may convert wetlands to an uplands jurisdictional status, subject to development, and not protected by wetland regulations. It was observed in the study that such hydrologic changes may already have occurred in some areas.

The study concluded that functional impacts that are not considered “loss” also have occurred. These are significant, and fall under two main categories of impacts caused by vegetation management in and adjacent to wetlands.

- Silvicultural impacts – Tree harvesting was delineated on about 1,150 acres of wetlands, primarily hardwood swamps and cypress. In most cases these operations indicated good management practices. Some cases appeared to be clearcut, leaving more damage to the vegetation. The impacts were concentrated in certain areas and, where combined with adjacent upland forest removal, indicated significant adverse ecological impacts may have occurred in those areas.
- Impacts from adjacent land use – Uplands adjacent to wetlands have been cleared in many areas since 1990. In many cases, the clearing is routine harvesting of timber, after which regeneration takes place. In other cases, upland forest has been cleared for use as open space, pasture, or transition to more intensive development. There were too many cases of adjacent impacts to be delineated within the scope of the study. Adjacent development is particularly injurious to native habitat functions.

Upland habitats have been extensively developed for residential and agricultural use in Alachua County, often right up to the wetland boundaries, which may well have resulted in degradation and loss of the values for which wetlands were protected in the first place.

## **F. Protecting wetland ecosystems**

Good planning and design are the best approaches to reduce or eliminate many of these adverse effects on wetlands. Of course, the best approach is to avoid wetlands in the first place. However, if that is not possible, regulatory programs at the federal, state, regional, and local levels have been established to review these kinds of activities and to prevent or minimize damage to wetlands or water quality.

### **1. Why activities are regulated**

Although wetlands serve society in many ways, the nature of wetland benefits is such that the owners of wetlands usually cannot capture the benefits for their own use or sale. Just as the benefits of wetlands are utilized by people other than the property owner, likewise, the adverse impacts of wetland degradation and destruction are felt by people other than the property owner. Placing fill in a floodplain will cause higher flood waters and degraded water quality to be transmitted downstream with the flowing waters. Eliminating the vegetation in a freshwater marsh will reduce the number of fish and wildlife that will breed and migrate, thereby reducing the species that are captured or enjoyed by others. In such cases, it is clear that what happens on an individual's property will affect the public as a whole. That is why the people of Florida have authorized regulatory agencies to oversee wetland activities and prevent the wholesale destruction of these valuable areas, as has occurred in a bygone era.

### **2. Florida's wetland protection programs**

The Florida Department of Environmental Protection (FDEP), the five water management districts (WMD), many local governments, and the U.S. Army Corps of Engineers share the responsibility for protecting wetlands in Florida. This is done both through regulatory (permitting) and land stewardship programs.

FDEP's 1996 Water Quality Assessment for the State of Florida, Section 305(b) Main Report warns that Florida's 11 million acres of wetlands are threatened by urban and agricultural growth. To address the problem, surface water and wetlands permitting underwent major revisions. In October of 1995, a new Environmental Resource Permit merged with and replaced FDEP's dredge and fill Wetland Resource Permits and the WMDs' Management and Storage of Surface Water Permits. FDEP does not use the federal methodology for delineating wetlands but has adopted its own, which must be used by all local, state, and regional agencies. The landward extent of a wetland is defined by the dominance of plant species, soils, and hydrologic evidence of regular or periodic saturation or inundation with water.

Wetlands are regulated at the state level through the Environmental Resource Permit (ERP) program, which went into effect in 1995. Five agencies administer the ERP program using an activity-based split of responsibilities, which is spelled out in operating agreements between the FDEP and the WMDs. The ERP program is designed to ensure that activities in uplands, wetlands, and other surface waters do not degrade water quality (such as through loss of wetlands, improper construction techniques in waters, or discharges of improperly treated runoff), cause flooding (such as by changing off-site runoff characteristics), or degrade habitat for aquatic or wetland dependent wildlife. Staff at the FDEP and WMDs can answer questions and help applicants determine the appropriate agency for any given application.

### **3. Sovereign submerged land approvals**

If any ERP activities are located on sovereign (state-owned) submerged lands, the applicant will also need permission from the land owner (the State) to use these lands. This permission is known as proprietary authorization. The regulatory and proprietary reviews for an ERP project are linked so that they are conducted concurrently. However, activities that are eligible for a noticed general permit or an exemption are not linked in this way.

### **4. Local protections: Alachua County**

Local governments are key players in comprehensive wetland protection. Compared to programs of broader geographic scope, strategic wetland plans adopted at the local government level offer advantages such as: more diverse protection capabilities, such as water management, land use, and zoning authority; landscape-scale consideration of wetland functions and values, allowing prioritization of protection and restoration efforts; ability to plan acceptable mitigation banking activities, and to coordinate with other environmental protection and efforts and local programs, such as wildlife corridors, greenways planning, riparian protection, and floodplain regulation; and the provision of greater predictability to wetland permitting programs, and overall, a more proactive approach to wetland protection.

#### **a. Regulations**

Prior to 1992, wetlands delineation and protection were addressed in Alachua County on a case-by-case basis through the development review process pursuant to applicable Water Management District and FDEP regulations and county policy as contained in the Comprehensive Plan. The County was hampered in its efforts to protect wetlands because there was no formally adopted local regulation or ordinance implementing its authority. In many cases, the County was forced to defer to state or regional regulations which didn't always sufficiently address local concerns.

In 1992 the Surface Waters and Wetlands Ordinance was adopted to provide local regulatory authority over these resources in Alachua County. In 1994, a unified statewide methodology for the delineation of the landward extent of wetlands was adopted (see ss. 373.421, 373.019(17), FS; ch. 62-340, FAC), preempting the county from delineating wetlands using any other methodology.

The County's basic approach to wetlands protection emphasizes avoidance and minimization of any wetland impact; mitigation is required where impact is unavoidable. Additionally, local regulations require undisturbed upland buffers of varying widths adjacent to wetlands. Minimal impact activities and activities that serve an overriding public purpose are allowed subject to certain criteria. We believe that this approach has been successful over the last 10 years in preventing significant losses of wetlands, largely due to a strong regulatory commitment to wetlands protection. Nonetheless, implementation over the last 10 years has demonstrated areas where the local regulations can be improved.

An applicant for development of a property that contains any portion of a wetland or wetland buffer must design and locate that development to avoid impact to the wetland and buffer wherever possible. When the applicant submits an application for land use change, zoning change, or Development Review Committee approval, the applicant is required to perform a natural resources inventory of the property. This is a site-specific analysis that includes delineation of the wetland and buffer, an assessment of the existing quality and characteristics, an evaluation of the impact of the proposed activity, a discussion of

proposed measures to protect or mitigate anticipated impacts, and a plan for maintenance and monitoring of the wetland and buffer.

If the inventory indicates that there are portions of the property which do not contain wetland and buffer areas, the applicant will only be approved for a plan under which all development is located outside of the wetland and buffer. If the applicant proposes activity that impacts a wetland or buffer, the applicant must demonstrate that they have made every effort to avoid and to minimize the adverse impact. Development must be located so that it occurs in the least sensitive portion of the wetland and buffer area, and the impact area is limited to the rate of ½ acre per 10 acres. In addition, the applicant must show that the impact is “justified” for one of three reasons: the activity is a minimal impact activity (e.g. installation of navigational aids; small-scale nature trails, docks smaller than 1,000 square feet in size); or, the activity is in the overriding public interest (e.g. cleanup of hazardous materials spill, removal of non-native invasive species, fighting wildfires); or, all economically beneficial or productive use of the property is otherwise precluded. An applicant’s desire to maximize the density or intensity of development is not sufficient justification for impact to a wetland or buffer.

Finally, before any impact is allowed, the applicant must submit and commence implementation of a plan for mitigation of any adverse impacts to the wetland and buffer. New policies provide specific standards for mitigation, including minimum mitigation ratio guidelines, intended to allow flexibility while ensuring quality mitigation plans. Should recently contemplated rule changes at the state level preempt the County’s ability to regulate one or more aspects of wetland mitigation, comprehensive plan amendments will be needed.

#### *Minimizing and mitigating impacts*

Unless exempted, any adverse impacts to wetlands must first be avoided or minimized. If these impacts are unavoidable, then the applicant must take mitigating actions to offset the adverse impacts of the proposed activity.

There are many ways to minimize the damaging effects of construction or other activities on wetlands and other surface waters. For example, the key to preventing damage from sewage and industrial waste is proper treatment and disposal. Better yet, conservation and pollution prevention may reduce the need for the discharge in the first place. Stormwater runoff is now the largest source of water pollution in Florida. Retaining and detaining stormwater runoff helps to reduce the pollutants discharged from this source. The adverse effects of docks may be reduced by selecting alignments that avoid submerged or shoreline vegetation or allow more light penetration, by extending docks to depths where dredging is not needed to allow boat access and mooring, and by using alternative building materials that don’t give off toxic chemicals. The impacts from road construction can be reduced by selecting the least damaging alignment and by building a bridge rather than a filled causeway to cross wetlands or other surface waters.

Mitigation requires those who must work in wetlands to make up for any damage caused by their work. For example, the applicant who cannot build on their property without encroaching into the edge of a cypress dome may be causing an unacceptable loss of wetlands. Mitigation requires the applicant to compensate for this loss by restoring a filled wetland, enhancing a degraded wetland in an adjacent cypress dome, or purchasing wetlands or associated uplands for protection of comparable ecological benefits. Also, mitigation may include activities on or off the impacted site. However, before any mitigation can be contemplated or accepted, the applicant must first attempt to eliminate or reduce their impacts.

## Buffers

If a property is located next to a wetland or water body, a strip of upland must be left in its natural state between the wetland and any area of land disturbance. The buffer is intended to provide the upland habitat that is needed by many aquatic or wetland animals. The undisturbed soil and vegetation in these areas also helps to stabilize the wetland habitat and filter the runoff from your yard. Generally, vegetation may not be altered in the buffer except as part of a responsible stewardship or management plan that promotes buffer functions and values. Invasive, non-native plants may be removed and replaced with native vegetation. Yard trimmings and clippings may not be dumped in the buffer area. If you live along the waterfront, the natural slope of the shoreline must be protected.

A recent JEA report presents the scientific methodology for calculating buffer zone widths necessary for protecting wetland habitat, minimizing sediment transport, and minimizing groundwater withdrawal in wetlands of St. Johns County (JEA et.al. 2000). The report represents the culmination of a significant body of literature that has been developed in Florida and other parts of the country over time. Although produced for St. Johns County, the report, in addition to numerous other studies on buffers and specific species, is applicable to Alachua County because wetland types, habitats, wildlife species, and soil types are substantially similar (Brown 2001).

Upland vegetative buffers are widely regarded as necessary to protect wetlands, streams, and other aquatic resources. However, buffer size requirements typically have been established by political acceptability, rather than scientific merit. This often leads to insufficiently buffered aquatic resources and the false perception that the resources are being properly protected from potential impacts. Numerous scientific studies have shown that relatively wide buffers (150 to more than 300 feet) are necessary to protect wetlands. (JEA et.al. 2000). A dilemma exists. Undersized buffers may place aquatic and wetland resources at risk, while buffers that are sufficiently large to provide full protection may unrealistically deny landowners use of their land. Therefore, it is important to determine the minimum buffer width necessary for protection of most of the resources, or the most sensitive of the resources.

Three goals have been identified and used to determine buffer sizes: protection of wildlife habitat; minimization of sediment transport into wetlands; and minimization of groundwater drawdown in wetlands. The JEA report (2000) concludes that a minimum of 300 feet is necessary to reasonably protect a viably functioning wetland ecosystem. A 300-foot buffer would protect approximately 50% of the wetland-dependent wildlife species in freshwater wetlands, and protect water quality from sedimentation by coarse and fine sands. In some site-specific cases, such as with silt or clay soils, or from large draw-down structures, a greater buffer distance would be necessary to protect the wetland.

Any reduction in the buffer width below 300 feet can impose adverse impacts to the wetland, particularly to the wetland-dependent wildlife species that require a wide surrounding upland area in which to feed, forage, and use as protection from human disturbance. Lesser alternatives would still provide some protection to wetlands; however, any reduction can result in adverse impacts to wildlife populations, as well as degradation of water quality from deposition of fine sediments. The County has chosen an alternative to one large buffer distance. This alternative is intended to provide flexibility while accommodating private property concerns.

Buffers are required in Policy 3.6.8 to protect wetlands and surface waters from adverse impacts of development (e.g. dredging, filling, excavation, land clearing, tree cutting, construction of structures, installation of utilities, roads, septic tanks, etc.). Relevant Best Management Practices may substitute for policy-identified buffers in the cases of agricultural and silvicultural activities.

The County's new policy requires buffers to be determined case-by-case depending on what is demonstrated to be scientifically necessary to protect natural ecosystems from significant adverse impact. Buffer widths continue to be determined based on site specific considerations, such as type of development and potential for adverse impacts; natural community type and hydrologic or management requirements; buffer area characteristics and function; and the presence of rare, threatened, or endangered species of plants and animals.

The 35-foot minimum buffer width identified in the 1991 Comprehensive Plan has been removed. The following buffer widths apply unless scientific information is presented for a particular site that demonstrates a larger or smaller buffer width is appropriate to protect the wetland ecosystem from significant adverse impact: 75 feet from ordinary wetlands and surface waters, 200 feet from Outstanding Florida Waters, and 300 feet from areas where rare, threatened, or endangered species have been documented within 300 feet of a wetland or surface water. This approach is intended to provide the flexibility to adapt to special circumstances. For example, a 75 foot buffer may not be warranted in the case of a severely degraded wetland, or artificial wetland surrounded by uplands with little habitat value. The policy allows for reduction where scientific demonstration indicates smaller buffer is sufficiently protective. Conversely, buffer width may need to be widened where relevant data indicate that the default width is inadequate. In addition, if the buffer precludes all economically viable use of a particular property, limited development may be allowed within the buffer.

The buffer distance is measured from the outer edge of the wetland jurisdictional line. The buffer area must be clearly depicted on all site plans, development plans, and other documents submitted to the County for review of development, zoning approval, or land use change. In cases where the buffer is allowed to be reduced in a given area, a larger buffer than that specified in other areas of the development may be required in order to compensate for the reduction.

Native, undisturbed vegetation must be retained within the designated buffer area in order to maximize the habitat benefits to wetland-dependent wildlife species. Buffer areas that are devoid of natural associations of native vegetation should be restored with appropriate native vegetation. Planting of trees, shrubs, and non-woody species should mimic natural systems in the immediate area in terms of density and types of vegetation. Plantings should occur in staggered, random, and clumped patterns to reflect a more natural appearance.

Agricultural and silvicultural activities are allowed within the buffer provided they are conducted in accordance with relevant Best Management Practices (BMPs). Silvicultural BMPs require special management zones (SMZs) adjacent to streams, lakes, sinkholes, and wetlands. SMZs are based on the size and type of the water body, and soil type and slope.

In conjunction with BMPs, Policy 4.7.5 retains the requirement from the 1991 Comprehensive Plan that silvicultural activities maintain the overall ecological integrity of the wetlands community. This includes maintaining habitat for listed species populations onsite, planning harvests for varying age and height diversity, and maintaining natural hydrology. The requirements in this policy essentially parallel those in the BMPs, but are more explicit in identifying habitat protection as a performance standard. The need for habitat protection has been outlined in numerous studies, as discussed in more detail in other sections of this analysis. As JEA asserts (2000), by far the most common cause of wildlife population decline is alteration of the natural landscape through construction, agricultural and silvicultural activities. Given the mandate of the State Comprehensive Plan to protect and acquire habitat/ecosystems, we must be proactive in addressing habitat destruction and degradation.

## b. Private land conservation tools

Natural resource protection goals can be achieved by providing options and incentives to landowners that allow for the prudent use of productive agricultural land. There are numerous state and federal financial and technical assistance programs available to landowners whose property possess certain natural values. A series of successful private land conservation efforts has illustrated that landowners can achieve natural resource protection and economic goals. Historically, many options have been used, both individually and in combination. Three types of assistance are described below.

### Financial incentives

Financial incentives include cash benefits, limited development opportunities, cost sharing, tax incentives, wildlife agreements, and conservation management agreements. Some programs which have been successful in Alachua County include: the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Agricultural Conservation Program (ACP), Forestry Incentives Program (FIP), Forest Stewardship Program (FSP), Stewardship Incentives Program (SIP), and American Farmland Trust (AFT). These programs are described briefly below,

The major goals of the CRP include reducing soil erosion and sedimentation, improving water quality, maintaining fish and wildlife habitat, and providing support income to farmers. Lands in the CRP cannot be tilled or grazed until the end of a 10-15 year contract. In return, farmers receive annual rental payments for the land, cost-sharing, and technical assistance to plant vegetation for conservation.

The WRP is a voluntary program offering landowners a chance to receive payments for restoring and protecting wetlands on their property. The program offers landowners cost-share funds under three options: permanent easements (payment in an amount up to the agricultural value of the land, plus 100% of the restoration costs), 30-year easements (payment up to 75% of what would be paid for permanent easement, plus 75% of restoration costs), and restoration cost-share agreements of a minimum 10-year duration (payment of 75% of the cost of restoration activity). The landowners will maintain full control over access and use of the easement lands, and may lease the land, for hunting, fishing, and other undeveloped recreational activities. Compatible uses, such as cutting hay, grazing livestock or harvesting wood products, may be allowed if they are fully consistent with protection and enhancement of the wetland. Other agencies and private conservation organizations may provide additional assistance for easement payment and wetland restoration costs as a way to reduce the landowner's share of the costs.

The ACP encourages voluntary compliance with federal and state requirements for solving point and nonpoint source pollution problems on farms. ACP provides 50-75% cost-share funds for approved practices providing long term and community-wide conservation benefits. Practices that can help fund wetlands and riparian area wetland restoration and enhancement include: establishment of permanent vegetative cover, buffer strips, permanent wildlife habitat, shallow water areas for wildlife, integrated crop management, and source reduction of agricultural pollutants. The applicant must own between 10 and 1,000 acres to be eligible. The ACP agreements can be for one year or more, with maximum cost-share of \$3,500 per year. Farmers may enter into pooling agreements to jointly solve mutual conservation problems, such as restoration of a wetland covering portions of several properties.

The FIP is the major U.S. Department of Agriculture forest tree planting program and can be used to help restore wooded wetlands. The FIP provides technical and cost-share assistance to landowners participating in any one of four eligible forestry practices: tree planting, improving a stand of forest trees, site preparation for natural regeneration of trees, and special forestry practices. All FIP practices require a

minimum 10-year maintenance agreement, with maximum cost share of \$10,000 per year (not to exceed 65% of the actual, average, or estimated cost of performing the practice). Eligibility is limited to landowners of 10 to 10,000 acres.

The FSP provides technical assistance to help landowners protect and enhance their timber, fish and wildlife habitat, water quality, wetlands, and recreational and aesthetic values of their property. The SIP provides cost-share assistance to private landowners for implementing the management plans developed under the FSP. There are eight major categories for funding: management plan development, reforestation and afforestation, forest and agroforest improvement, windbreak and hedgerow establishment, riparian and wetlands protection and improvement, fisheries habitat enhancement, wildlife enhancement, and forest recreation enhancement. Cost-share is authorized for purchase, installation, and establishment of plant materials, streambank stabilization, fencing, and restoration of natural hydrology. Eligible landowners must own 1,000 acres or less of qualifying land, and funded practices must be maintained for a minimum of 10 years. Payments may not exceed \$10,000 per year (up to 65% cost-share).

The AFT is a non-profit organization that works with farmers, business people, legislators, and conservationists to encourage sound farming practices and preserve America's most critical agricultural resources. AFT's Forest Legacy Program purchases easements to conserve environmentally important forest lands, often including wetlands, threatened with conversion to other uses. The program also encourages individuals owning farms threatened by development to donate their lands to AFT. Landowners may retain lifetime use of the property, while receiving significant income and estate tax deductions. Upon receiving the donated property, AFT will sell the farm with conservation easements to guarantee the preservation of the property, using proceeds to protect other threatened farms.

### Education and outreach

There are numerous education and outreach opportunities for marketing voluntary wetlands conservation programs. The Cooperative Extension Service educates citizens to apply practical, research-based knowledge to critical issues, including wetlands conservation, which face individuals, families, communities, and global partners. The total extension effort is accomplished through a large informal network of county and regional offices that offer seminars, workshops, publications, volunteer training and other assistance to educate citizens. Additional programs can be found by contacting the local Cooperative Extension agent.

Technical assistance is available from several sources in wetlands creation and restoration, landowner master plans, management of wildlife, forestry and agriculture. Land users may request technical assistance from the Natural Resource Conservation Service (formerly the Soil Conservation Service) through local soil and water conservation districts. Technical assistance and information is available for: making wetlands determinations; developing conservation plans; providing income-producing alternatives for use and management of wetlands; providing information on plant materials for wetland planting; and providing soil surveys and information for identifying, planning, and managing wetlands.

AFT conducts on-farm research and demonstration projects with grass-roots sustainable agriculture organizations and farmers to develop and encourage the use of sound environmental farming practices. AFT also provides advice to private landowners on ways to include conservation strategies in land use and estate plans for farmers, and accepts donations of land and conservation easements.

The Nature Conservancy (TNC) runs Natural Area Registries to honor private landowners of outstanding natural areas, such as bogs and other wetlands, for their commitment to the survival of the land's natural heritage. This is a voluntary, non-binding, and non-regulatory program. There is no payment involved in enlisting the property. In joining the Registry, the owner commits to preserving and protecting the area to the best of their ability, notifying TNC of any threats to the area, such as pollution, rights-of-way, or drainage; and notifying TNC of any intent to sell or transfer ownership. With the owner's permission, TNC will visit the registered area annually to assess changing conditions and identify new threats. In conjunction with the Registry, TNC also provides private landowners with information on additional programs for protecting wetlands (such as acquisition, conservation easements, bargain sale, donation, and other voluntary agreements), best management practices, and other relevant scientific information.

#### Private industrial programs

The American Tree Farm System is a nationwide organization which recognizes landowners for quality forest management on their property. A forest management plan will be developed based on landowner objectives and the property recognized as a pioneer tree farm. On a periodic basis, the property will be reinspected by a professional forester, and, if outlined management plans are implemented, the property will be recognized as a certified Tree Farm. There is no cost for the owner to participate. Eligibility requires 10 or more acres of woodland, managed for forest products, wildlife, water protection, and aesthetics. Please see the Agricultural and Silvicultural Practices section for further discussion of private forest certification programs.

The Wildlife Habitat Council (WHC) is a non-profit membership organization established by conservation groups and corporations to encourage and assist companies in enhancing their lands for the benefit of animal and plant life. Projects aim at physically improving wildlife habitat on private lands and fostering environmental awareness among company managers, employees, and the local community. Participants gain technical habitat management skills as well as greater awareness of the interconnection of ecologic, economic, and social elements within an ecosystem. When a plan is implemented, the WHC certifies completion and maintains a "Registry of Certified Corporate Wildlife Habitats." Habitats are certified through review and documentation of active management programs and must re-qualify every two years.

#### Homeowner stewardship

Here are a few tips on how you can practice environmental stewardship in your home and neighborhood and protect wetlands and water quality. You can reduce erosion by mulching, or planting ground cover over exposed soil in heavily trafficked areas, flower beds, and shaded areas. Re-vegetate bare patches of soil, and recycle the vegetation rather than piling, raking, or blowing leaves or grass clippings into the streets where they will wash into streams or lakes. Let rain water soak into the ground rather than letting it run off your property on impervious surfaces. Direct runoff from your roof through gutters and drain spouts to the lawn or garden, and not to the paved driveway or parking lot. Limit paved areas, and consider using flagstones or pervious materials that allow water to soak into the ground.

Use fertilizers and pesticides wisely. Nationally, lawns guzzle water, and use up to 10 times as much chemical and pesticide per acre than an equal area of cropland. U.S. lawns absorb more synthetic fertilizer each year than India applies to all of its food crops. Use compost and mulch (such as grass clippings or leaves) to reduce your need for fertilizers and pesticides. Never apply fertilizers or pesticides on bare ground or eroded areas, or near a well, waterbody, or wetland. Better yet, instead of using pesticides, buy disease and pest-resistant plants.

There still are 1.6 million septic tanks in use in Florida. Septic tanks are an acceptable means of sewage treatment in some locations, but when they are crowded together in subdivisions, if the soils aren't appropriate, and when the septic tanks are not kept up properly, they can become a major source of pollution. Keep the septic system clear of trees and large shrubbery – roots will clog the drainfield. Never dispose of household or other chemicals down the drain. Have the tank checked annually, and pump out surface scum and sludge about every three years. Septic tanks should be used only where there is no alternative. If a sewer system is available, hook up to it.

There are numerous publications which contain additional suggestions on good environmental stewardship practices on these topics and more, including car care, boating tips, and recreation. There are several good wetlands sites on the internet. Three very good sites that contain links to other wetland sites are:

The U.S. Fish and Wildlife Services' National Wetlands Inventory page at <http://www.nwi.fws.gov>

The U.S. EPA's Wetland page at <http://www.epa.gov/owow/wetlands>

The Society of Wetland Scientists' list of wetland-related internet sites at <http://www.sws.org/wetlandsweblinks.html>

Copies of state laws and application forms are available from:

Any of the DEP District Offices: <http://www.dep.state.fl.us/org/district.html>

Any of the WMDs: <http://www.dep.state.fl.us/org/water.html>

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