THE PENSACOLA BAY SYSTEM SURFACE WATER IMPROVEMENT AND MANAGEMENT PLAN

A Comprehensive Plan for the Restoration and Preservation of the Pensacola Bay System

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Developed by
the Northwest Florida Water Management District
under the auspices of
the Surface Water Improvement and Management Program
and in cooperation with
the Florida Department of Environmental Protection

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Printing:
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Program Development Series 97-2
October 1997

recycled paper

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The Pensacola Bay System SWIM Plan

Executive Summary

Mission: "Restore and preserve the Pensacola Bay system for the benefit of all by using a comprehensive, coordinated, and integrated watershed approach supported by local government and a well-informed public."

The Pensacola Bay system (PBS) has historically supported a rich and diverse ecology and provided substantial economic and quality-of-life benefits for the residents of northwest Florida. Over the last several decades, however, it has become apparent that the cumulative effects of a variety of human activities have acted to impair the system's ecology and diminish the benefits it provides. Such a situation, unfortunately, is common in Florida's surface waters. In response to statewide degradation of surface waters, the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act in 1987, directing the five water management districts to prioritize surface waters within their respective jurisdictions and to develop and implement plans to improve the quality of these waters and their associated resources. The SWIM Act also established the SWIM Trust Fund, to which annual appropriations could be made by the legislature for implementation of approved SWIM plans. Legislative appropriations for the SWIM program are now placed in the Ecosystem Management and Restoration Trust Fund.

The SWIM Program of the Northwest Florida Water Management District (NWFWMD) approaches water resource management from a watershed perspective. Thus, the Pensacola Bay system, with its associated tributaries and watershed, is recognized as an interdependent system. A watershed approach facilitates coordinated, cooperative management across jurisdictional lines and avoids fragmented, "piecemeal" management. It provides a mechanism, for example, for managing upstream activities in a manner consistent with downstream goals and for managing land use activities in a manner consistent with the uses and values of the aquatic system. This approach is also consistent with the Florida Department of Environmental Protection's Ecosystem Management initiative, as the PBS watershed boundary conforms with the Greater Pensacola Bay Ecosystem Management Area (EMA) delineation.

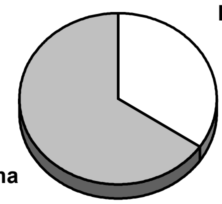
The Pensacola Bay System

The Pensacola Bay system includes three major river systems: the Escambia, Blackwater, and Yellow rivers. These, in turn, discharge into the estuarine component of the system, which includes Escambia Bay, Pensacola Bay, Blackwater Bay, East Bay, and Santa Rosa Sound. The system also includes smaller tributaries of these rivers and embayments, as well as the overall watershed. The watershed covers nearly 7,000 square miles, about one-third of which is in Florida. The entire system discharges into the Gulf of Mexico, primarily through a narrow pass at the mouth of Pensacola Bay.

The Pensacola Bay system has historically supported a rich and diverse ecology, productive fisheries, and considerable recreational opportunities. It has also provided an important resource for commercial shipping and military activities and has enhanced aesthetics and property values. Unfortunately, for many years, point and nonpoint source pollution, direct habitat destruction, and the cumulative impacts of development and other activities throughout the watershed have combined to degrade the health and productivity of much of the Pensacola Bay system. This degradation, in turn, has diminished the human benefits the system provides.

Priority Issues

The challenges facing the Pensacola Bay system may be summarized in the following broad issue areas.



Approximately Two-Thirds of the Pensacola Bay System Watershed is in Alabama

- Water and Sediment Quality. Nonpoint source pollution is carried into the Pensacola Bay system by stormwater runoff from such sources as urban and suburban lands, agricultural and forestry activities, dirt roads, pavement, construction sites, golf courses, and lawns. A number of point sources (industrial and domestic wastewater discharges) also discharge directly into waters of the Pensacola Bay system. This is a relatively low energy system with limited flushing, and pollutant loading has possibly been exceeding its assimilative capacity for decades. Following many years of such pollutant loading, sediments in portions of the system are altered in size and composition, enriched with nutrients, and contaminated with metals and toxic organic compounds.

- Habitat Quality. Benthic riverine and estuarine habitats have been, and continue to be, threatened by and degraded through sedimentation and deposition. Degraded water and sediment quality have also caused the degradation and loss of seagrass communities, other benthic habitats, and associated biological resources. Substantial areas of wetlands and other important habitats have been and continue to be lost throughout the watershed. These include tidal marshes, bayous, coastal strand communities, bottomland hardwood swamps, and other littoral and benthic habitats.

- Administration, Planning, and Coordination. The Pensacola Bay system watershed spans two states and is subject to the management and regulatory actions of numerous local governments and various state and federal agencies. Effective protection and restoration of the system requires coordination and cooperation with these entities, community organizations, and other resource management initiatives.

- Public Education and Awareness. If efforts to protect and restore the resource are to succeed, its values and vulnerabilities must be well understood by the public. This will both help individuals make informed personal decisions relevant to water resources and promote an understanding of resource management initiatives. This is particularly significant given the importance of voluntary participation and achieving consensus across diverse interests.

The interrelationships between and among these issues are important to understand. For example, poor water quality, originating from both point and nonpoint source pollution, has been a primary cause of the demise of seagrasses throughout much of the system and has also degraded other benthic and littoral habitat conditions throughout much of the riverine and estuarine system. Habitat destruction, in turn, adversely impacts water and sediment quality. Regulatory and other management activities simultaneously affect water quality, habitat, and adjacent land uses, and public education and awareness are prerequisite for the success of any resource management effort.

Progress and Revision of the Pensacola Bay System SWIM Plan

This SWIM Plan for the Pensacola Bay system is the latest revision of the plan originally approved in November 1988 and revised in November 1990. With this revision, the watershed and planning area boundary has been modified to include the Escambia, Blackwater, Yellow, Shoal, and East Bay rivers and the majority of Santa Rosa Sound. Additionally, the structure of the plan has been modified to improve readability and consistency between sections, projects have been updated, and their format has been revised.

Project work completed to date includes a review of the 1970s' Water Pollution Control Plan; preliminary nonpoint loading estimates; assessment of water quality data; analysis of historical tributary monitoring data; stormwater assessments for the Palafox/Coyle, Bayou Texar, and Bayou Chico watersheds; point source compliance assessment; Pensacola Bay system biological monitoring needs study; scientific literature review; an institutional and regulatory assessment; and initial work to protect Jones Swamp. A considerable portion of the project work described in the 1990 revision of the Pensacola SWIM Plan, however, was not completed due to funding limitations. Some of the projects detailed in this revision, therefore, entail implementation and/or completion of projects previously proposed.

This plan revision does not simply represent an incremental continuation of the previous revision, however. The current project plan has been revised to reflect past completion of project work; to better address priorities and needs as are currently understood; and to improve the linkage between issues, strategies, and projects. Additionally, implementation of the SWIM program requires a partnership with local governments, state and federal agencies, and community organizations. The institutional environment has changed significantly since 1990, however. The completion and implementation of local comprehensive plans, the adoption of Ecosystem Management by the Florida Department of Environmental Protection, and a number of other management and research efforts have been initiated and have thus necessitated a re-evaluation of management needs and strategies.

Management Strategies

The mission statement of the Pensacola Bay system SWIM program, as written above, was established through the efforts of the SWIM Technical Coordination Group (TCG), a subcommittee which was formed to provide a cross section of the Bay Area Technical Advisory Committee (TAC). This committee, which includes representatives of local governments, state and federal agencies, and community organizations, has worked closely with the NWFWMD in the development of this plan, and it will continue to be instrumental in its implementation.

The goals of the Pensacola Bay SWIM program, listed below, were developed by the SWIM TAC pursuant to the 1990 Plan revision and re-affirmed by the Bay Area TAC in 1996.

1. Minimize undesirable impacts on the riverine and estuarine system from adjacent upland portions of the watershed.
2. Attain and maintain water and sediment quality at levels that allow for the recovery and perpetuation of a healthy riverine and estuarine system.
3. Achieve heightened public awareness and coordinated management of the Pensacola Bay system, including integration of existing resource protection and restoration programs for accomplishing the aforementioned goals.

This SWIM plan includes four programs which are intended to address the challenges identified and achieve the goals established:

- Water and Sediment Quality Program. This program includes activities intended to reduce NPS pollution throughout the watershed, to identify needed reductions in pollutant loading, to identify effective management practices, and to assist local governments in their efforts to protect water resources. Additionally, it provides for working with local governments, state and federal agencies, and community organizations to implement stormwater retrofits and associated restoration actions for degraded basins.

- Habitat Quality Program. This program includes cooperative activities designed to protect existing habitats, restore degraded habitats, and develop a more complete understanding of the status and trends of the system so as to improve resource management.
- Administration, Planning, and Coordination Program. This program provides for coordination of a long-range strategy for restoration and protection of the system, participation in the ongoing resource management effort across all levels of government, use of SWIM to leverage other sources of funding, and measurement of progress in achieving objectives of the SWIM Plan.
- Public Education and Awareness Program. This program provides for promoting awareness of the values and vulnerabilities of the system, awareness of actions individuals may perform to protect the resource, and providing educational resources for both the community as a whole and to primary and secondary school educators

These programs are part of a strategy that is intended to include and support the efforts and initiatives of other state and federal agencies, as well as local governments and private nonprofit organizations. Each program includes projects which are designed both to achieve specific resource protection and restoration objectives and to improve our understanding of the system as a basis for management decision-making. It is important that priority projects be implemented in a coordinated manner, and that implementation be consistent with a watershed approach. For example, the benefits of discrete restoration activities would be extremely limited and ephemeral if needed retrofits and/or best management practices were not also implemented in the contributing basin to prevent continuing deposition of sediments, nutrients, and other pollutants.

Twenty projects are identified in this edition of the SWIM Plan. The following table lists the projects and indicates the proposed spending plan. It should be noted that this spending plan is provided for planning purposes only, and actual spending will vary depending on available funding during each year.

Pensacola Bay System SWIM Plan Proposed Three-Year Project Funding

ID#	PROJECTS	FY 1998-2000
	Nonpoint Source Program	
WSQ 1.0	Tributary Monitoring	$172,000
WSQ 2.0	Land Use/Loading Rate Analysis	$80,000
WSQ 3.0	Bayou Chico Restoration	$258,000
WSQ 4.0	Septic Tank Impact Assessment	$20,000
WSQ 5.0	Bayou Texar Retrofit	$75,400
WSQ 6.0	Gulf Breeze Bayous	$100,000
WSQ 7.0	Palafox/Cole Restoration	55,400
WSQ 8.0	Role of Bay Sediments	$92,100
WSQ 9.0	Pollutant Load Reduction Goals	$100,000
	Habitat Program	
HAB 1.0	Tidal Marsh Preservation	60,000
HAB 2.0	Bottomland Hardwood Preservation	$82,200
HAB 3.0	Biological Monitoring	$67,300
HAB 4.0	Circulation Study	$0
	Coordination Program	
APC 1.0	Administration and Planning	$56,400
APC 2.0	Institutional and Regulatory Assess.	$7,000
APC 3.0	Interstate Coordination	$87,600
APC 4.0	GIMS Integration and Coordination	$94,000
	Public Education and Awareness Program	
ED 1.0	Strategy Development	$10,000
ED 2.0	Media and Community Relations	$30,000
ED 3.0	WaterWays Video	$54,250
	Total Funding, Fiscal Years 1998-2000	$1,501,650

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INTRODUCTION

> ***Mission***
>
> *"Restore and preserve the Pensacola Bay System for the benefit of all by using a comprehensive, coordinated, and integrated watershed approach supported by local government and a well-informed public."*

The Pensacola Bay system Surface Water Improvement and Management (SWIM) Plan is intended to serve as a comprehensive plan for coordinated watershed management. Of the 14 SWIM priority waterbodies in the Northwest Florida Water Management District, the Pensacola Bay system is the third highest in priority. This SWIM Plan for the Pensacola Bay system is the latest revision of the plan originally approved in November 1988 and revised in November 1990. With this revision, the watershed and planning area boundary has been modified to include the Escambia, Blackwater, Yellow, Shoal, and East Bay rivers and the majority of Santa Rosa Sound. Additionally, the structure of the plan has been modified to improve readability and consistency between sections, projects have been updated, and their format has been revised. As before, this document describes the Pensacola Bay system, the issues facing it, and a strategy for addressing these issues and thus protecting and restoring the system. This plan includes specific projects and a plan for their completion over the next three years.

The term "plan" as used in this SWIM Plan refers to the comprehensive document developed pursuant to Section 373.455, Florida Statutes (F.S.) and specified by Section 62-43.039 Florida Administrative Code (F.A.C.). The plan includes background information, a general description of the waterbody, identification of major issues, identification of goals, and programs and projects to accomplish those goals. The term "program" refers to the specific set of strategies or projects proposed to solve a problem. Each project described is a specific set of activities or tasks (diagnostic, construction, management) towards program implementation.

Following this introduction, priority challenges facing the system are summarized, the institutional setting within which SWIM operates is described, past accomplishments of this program and other initiatives are described, the strategy of the current plan is described, and project descriptions are provided. A proposed three-year schedule for project implementation and associated funding requirements are also provided. Following this, the ecological setting of the system, including its watershed, is characterized.

The Pensacola Bay System

The Pensacola Bay system (also, PBS or "system") includes five interconnected estuarine embayments, including Escambia Bay, Pensacola Bay, Blackwater Bay, East Bay, and Santa Rosa Sound, and three major river systems: the Escambia, Blackwater, and Yellow rivers. The system also includes smaller tributaries of these embayments and rivers, as well as its entire watershed. The watershed covers nearly 7,000 square miles, about one-third of which is in Florida. This includes the majority of Escambia, Santa Rosa and Okaloosa counties, the northwest quadrant of Walton County, and a substantial portion of southern Alabama. The entire system discharges into the Gulf of Mexico, primarily through a narrow pass at the mouth of Pensacola Bay. Figure 1 illustrates the watershed as a whole, and Figure 2 shows details of the system within the Florida SWIM planning area.

Of the rivers, the Escambia River System is the largest, extending 240 miles from the north end of Escambia Bay and through Alabama to Bullock County as the Conecuh River. The drainage area of the Escambia River basin covers over 4,200 square miles, about 90 percent of which is within Alabama. The Yellow River extends from the eastern side of Blackwater Bay to a point northeast of Andalusia, Alabama — a distance of about 110 miles. Its drainage basin covers 1,365 square miles, with 64 percent located in northwest Florida. The Blackwater River drains approximately 860 square miles, of which 81 percent is in Florida's Santa Rosa and Okaloosa counties. Originating north of Bradley, Alabama, it flows about 60 miles and discharges into the northern end of Blackwater Bay. The estuarine component of the system extends approximately 20 miles inland from the Gulf of Mexico and covers approximately 144 square miles. Surface areas for the component embayments range from about 54 square miles for Pensacola Bay to about 10 square miles for Blackwater Bay.

The Pensacola Bay system is described in greater detail below, in the section entitled "Ecological Setting of the Pensacola Bay System."

Figure 1: Watershed of the Pensacola Bay System

Note: This map was prepared for information purposes and does not conform to National Map Accuracy Standards

Map by: Ferdouse S

11-03-002

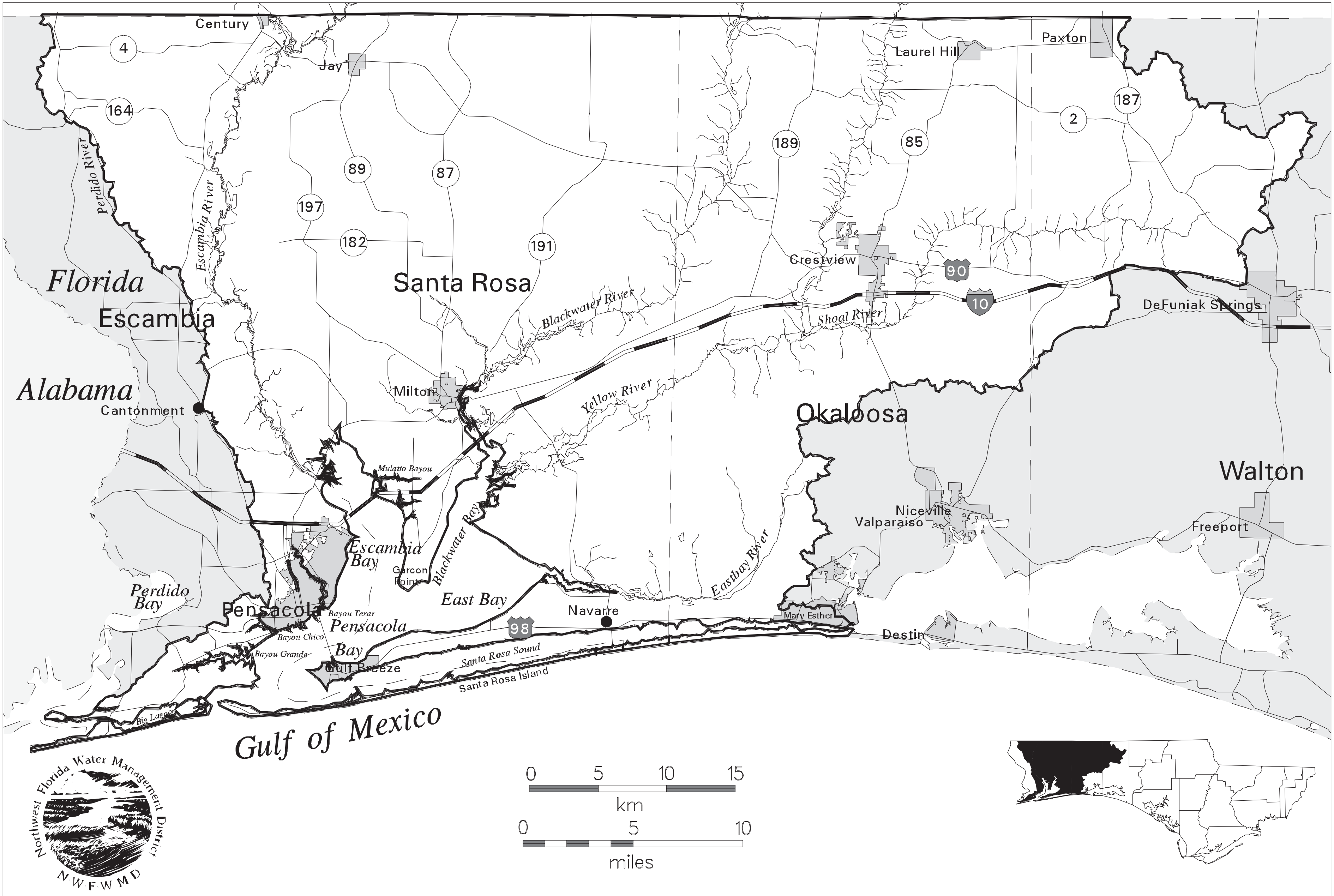

Figure 2: Features of the Pensacola Bay System Within Florida

Note: This map was prepared for information purposes and does not conform to National Map Accuracy Standards

Map by: Ferdouse S.

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Goals, Issues, and Programs of the Pensacola Bay System SWIM Plan

The overall purpose of the Pensacola Bay system SWIM Plan is to provide water quality and environmental resource protection and restoration, which, in turn, will provide economic and quality-of-life benefits for the region. The plan identifies problems and provides a strategy to address them and to manage the system on a watershed basis. This requires a regional and comprehensive approach to the management of the water and related resources within the basin.

Overall Goals of the Pensacola Bay SWIM Program

The goals of the Pensacola Bay SWIM program, written below, were developed by the SWIM TAC pursuant to the 1990 plan revision and re-affirmed by the Bay Area TAC in 1996. These goals are specific to the Pensacola Bay system, but are also intended to reflect the broader goals of the SWIM Program as a whole.

I. Minimize undesirable impacts on the riverine and estuarine system from adjacent upland portions of the watershed.

II. Attain and maintain water and sediment quality at levels that allow for the recovery and perpetuation of a healthy riverine and estuarine system.

III. Achieve heightened public awareness and coordinated management of the Pensacola Bay system, including integration of existing resource protection and restoration programs for accomplishing the aforementioned goals.

The SWIM Plan for the Pensacola Bay system has been organized to identify major issues facing the system and present management strategies to protect and restore water and related resources within the basin. Four priority issues have been identified, which include the array of interrelated challenges facing management of the Pensacola Bay system. These issues are:

1. Water and Sediment Quality;
2. Habitat Quality;
3. Administration, Planning, and Coordination; and
4. Public Education and Awareness.

To address the identified issues, the Pensacola Bay system SWIM plan includes four corresponding programs:

1. Water and Sediment Quality Program;
2. Habitat Quality Program;
3. Administration, Planning, and Coordination Program; and
4. Public Education and Awareness Program.

These programs are intended to address the identified, interrelated issues cooperatively with local governments, state and federal agencies, private nonprofit organizations, and the citizens of the watershed. To do so, each program includes specific projects which would be conducted through this program, cooperatively with other entities.

Surface Water Improvement and Management Program Overview

This plan has been developed in accordance with the Surface Water Improvement and Management (SWIM) Act, which was enacted by the Florida Legislature in 1987 and amended in 1989. The Act asserts that water quality in many of the state's surface waterbodies is degraded or is in danger of degradation. Where associated natural systems have suffered as a result of degraded water quality, so have aesthetics, recreation, wildlife habitat, drinking water, and associated economic resources. Causes of such degradation identified by the Act include point and nonpoint source pollution and destruction of natural systems which enhance water quality and provide habitat.

In response to the identified problems, the Florida Legislature directed the state's five water management districts to develop and implement plans to improve water quality and associated aspects of the state's surface waters. Before any plans could be developed, however, each district was required to determine which waterbodies were eligible for the SWIM program and then prioritize those waterbodies based upon the need for restoration and preservation. The only statutory constraint placed on eligibility is that waterbodies be of statewide or regional significance.

The NWFWMD completed the prioritization task with a report adopted by the District's Governing Board on April 28, 1988, and by the Department of Environmental Regulation (now Department of Environmental Protection) on May 16, 1988. The report included a prioritized list of 24 waterbodies. Preservation was identified as the primary requirement for all but one of these waterbodies. It was recognized, however, that some areas within all of the systems require some level of restoration.

In accordance with Chapter 373.453, F.S., the SWIM priority list must be reviewed and updated every three years. A weakness of the original SWIM priority list was that estuaries were listed separately from their major tributary rivers, a practice which could result in fragmented, incomplete, or otherwise uncoordinated management of integrated systems. In 1992, the District improved this situation by updating the priority list using a watershed approach.

This revision is reflected in the Pensacola Bay system SWIM Plan by the addition to the Pensacola Bay system SWIM planning area of the Escambia, Blackwater, Yellow, Shoal, and East Bay rivers and the majority of Santa Rosa Sound, as well as the watersheds of these individual waterbodies. This revision is expected to provide the basis for consistent watershed management across jurisdictional lines. It also provides a SWIM planning area that is consistent with the Department of Environmental Protection's Greater Pensacola Bay system Ecosystem Management Area (EMA).

Based on the priority list of waterbodies, the Act directs the District to develop SWIM plans, in priority order, to include activities, schedules, and budgets for preservation and/or restoration. The DEP, Florida Game and Fresh Water Fish Commission (FGFWFC), Department of Agriculture and Consumer Services (DACS), Department of Community Affairs (DCA), and local governments are cooperators in this process. Once developed, the plans are to be reviewed and, if needed, revised a minimum of once every three years.

The Act provides detailed direction as to the contents of SWIM plans. The following is an excerpt:

"These plans shall include, but not be limited to:

(a) A description of the waterbody system, its historical and current uses, its hydrology, and a history of the conditions which have led to the need for restoration;
(b) An identification of all governmental units that have jurisdiction over the waterbody and the land within a one-mile perimeter of the waterbody, including local, regional, state, and federal units;
(c) A description of adjacent land uses and those of important tributaries, point and nonpoint sources of pollution, and permitted discharge activities;
(d) A list of the owners of point and nonpoint sources of water pollution that are discharged into each waterbody and tributary thereto and that adversely affect the public interest, including separate lists of those sources that are:
    1. operating without a permit;
    2. operating with a temporary operating permit; and
    3. presently violating effluent limits or water quality standards.

    The plan shall also include a timetable for bringing all sources into compliance with state standards when not contrary to the public interest. This paragraph does not authorize any existing or future violation of any applicable statute or regulation and does not diminish the authority of the Department of Environmental Protection;
(e) A description of strategies and potential strategies for restoring the waterbody to Class III or better;
(f) A listing of studies that are being or have been prepared for the surface waterbody;
(g) A description of the research and feasibility studies which will be performed to determine the particular strategy or strategies to restore the waterbody;
(h) A description of the measures needed to manage and maintain the waterbody once it has been restored and to prevent future degradation; and
(i) An estimate of the funding needed to carry out the restoration strategies."

Chapter 62-43, Florida Administrative Code (F.A.C.) further defines the scope and format of SWIM plans.

SWIM Plan Development, Review, and Implementation

Local, regional, state, and federal interests play an integral role in the development and implementation of SWIM plans. Florida's growth management legislation, including the Florida State Comprehensive Planning Act of 1972 and Florida Regional Planning Council Act (Chapter 186, F.S.), the Local Government Comprehensive Planning and Land Development Act of 1985 (Chapter 163, F.S.), and the State Comprehensive Plan (Chapter 187, F.S.), as amended, provides a system in which state, regional, and local comprehensive plans are required to be consistent with each other. Because SWIM waterbodies normally lie within the jurisdiction of a number of local governments, this system is a primary mechanism by which SWIM waterbodies can be managed from a regional perspective, and by which the objectives of the SWIM program can be met in a coordinated and cooperative manner. From a planning perspective, the SWIM Plan must be consistent with the State Comprehensive Plan, state agency plans (including federally-mandated programs), and regional plans. Similarly, future revisions of local government comprehensive plans should reflect the goals and objectives of the SWIM Plan.

The Pensacola Bay system SWIM Plan is the result of a cooperative effort by representatives from government agencies, academia, and the private sector. The District Governing Board is required by the SWIM Act to hold a public workshop in the vicinity of the waterbody to obtain public input concerning the plan. The plan will be revised based upon this input, as well as state agency comments. At least 60 days prior to a public hearing, at which the District’s Governing Board will consider the plan for approval, copies must be provided to DEP, DACS, DCA, the FGFWFC, and all local governments. Before the plan is submitted for consistency review, DEP is required by Section 373.455, F.S. to make three specific determinations with which to judge the sufficiency of the plan:

(1) whether the costs identified in the plan are reasonable estimates of the actual costs;
(2) the likelihood that the plan will significantly improve or protect water quality and associated natural resources; and
(3) whether plan activities can be funded using available revenues from the SWIM Trust Fund or other funding which may be proposed by the Department, the District, or local governments.

The DEP will also review the proposed plan to determine its effects on state-owned lands and on marine and estuarine aquatic life and their habitats.

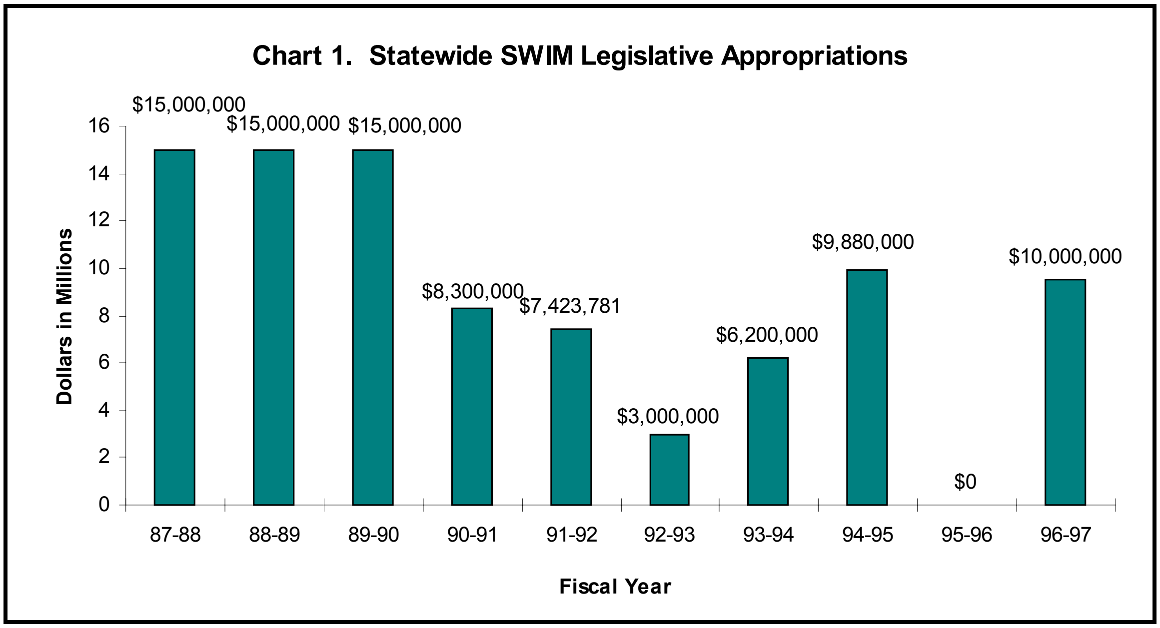
The FGFWFC, DACS, DCA, and local governments will review the plan based on their responsibilities and perspectives as outlined below:

(1) the FGFWFC will review the proposed plan to determine its effects on wildlife, freshwater aquatic life, and their habitats;
(2) the DACS will review the proposed plan to evaluate its effects on forestry and agricultural resources;
(3) the DCA will review the proposed plan to determine its consistency with the State Comprehensive Plan and its effects on Areas of Critical State Concern; and
(4) local governments will review the proposed plan to evaluate its effects on local resources.

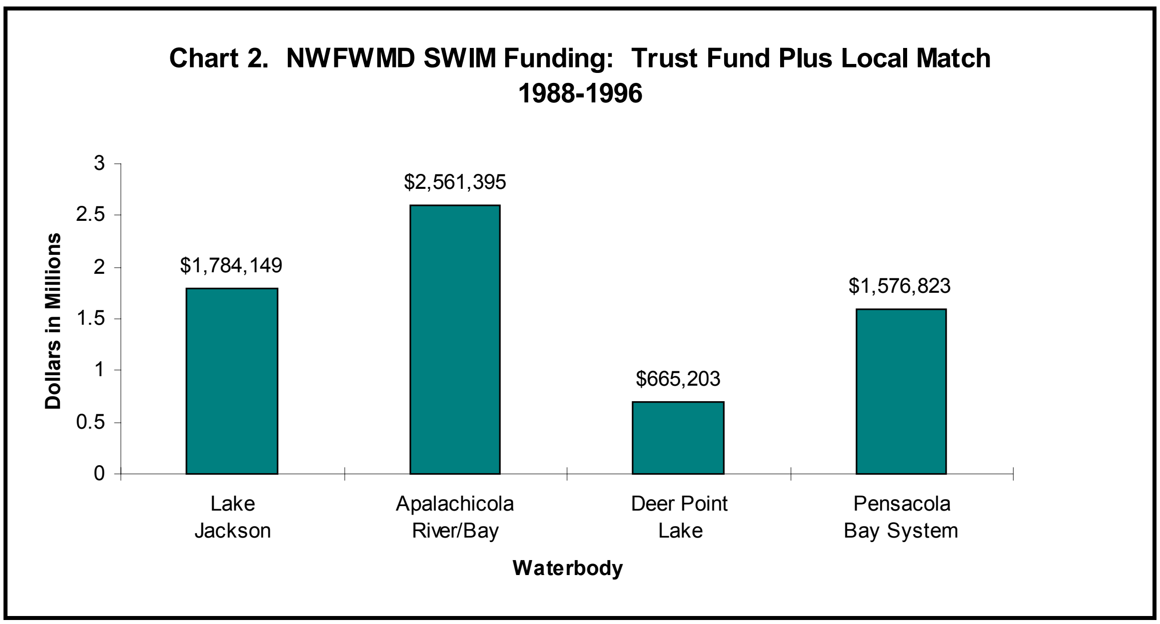
The SWIM Act provides for annual plan updates, if needed, as part of the budgeting process. This plan will be revised as needed to address changing management needs and the concerns of various affected entities.

SWIM Program Funding

Currently the SWIM program is funded primarily by legislative appropriation to the Ecosystem Management and Restoration Trust Fund, which is administered by the DEP Office of Water Policy. The NWFWMD is guaranteed at least ten percent of the Fund in any given year, with 50 percent available for statewide discretionary distribution. Funding for the SWIM program has been inconsistent and generally decreasing since 1987 (OPPAGA, 1995) (see Chart 1). This situation limits the overall effectiveness of the SWIM program by hindering long-term planning and delaying or precluding project implementation. Project planning and implementation are time-consuming, and monitoring of trends and progress are inherently long-term activities.



Spending on implementing SWIM plans at the NWFWMD has varied by waterbody, depending on system needs, local interest and participation, and availability of supplemental funds (Chart 2).



NWFWMD SWIM program expenditures include far more than SWIM Trust Fund dollars. A 20 percent local match (often split among local governments and the NWFWMD) is required to secure funds from the SWIM Trust Fund. Additional funding is derived from a variety of sources, including various state and federal granting agencies. For the Apalachicola River and Bay program, for example, the NWFWMD was able to convert the trust fund and local match investment of $2,561,395 into $12,971,244 between 1988 and 1994. Additional funding sources which contributed to this effort included the Georgia Department of Natural Resources, the U.S. Army Corps of Engineers, the Florida Advisory Council on Environmental Education (FACEE), Preservation 2000, the Marine Resources Conservation Trust Fund, and federal grants. Much of this additional funding may not have been available without the initial SWIM Trust Fund investment. State and federal grant money and other appropriations would not have been committed unless the SWIM planning process had already been in place and SWIM funds were available to meet match requirements.

PRIORITY ISSUES FACING THE PENSACOLA BAY SYSTEM

Priority Issues for the Pensacola Bay System

- Water and Sediment Quality. Nonpoint and point source pollution continue to degrade water and sediment quality throughout much of the Pensacola Bay system.
- Habitat Quality. Aquatic and wetland habitats throughout the system have been lost and degraded.
- Administration, Planning, and Coordination. Effective management of this system requires consistency and coordination across two states and a number of local governments, state agencies, and federal agencies.
- Public Education and Awareness. For efforts to protect and improve the quality of the Pensacola Bay system to succeed, the values and vulnerabilities of the system must be well understood by the public.

Overview

> "The sole category 2 (estuary with marginal and/or deteriorating water quality with respect to dissolved oxygen depletion) designation in Florida is the Pensacola and Escambia bays in the northeastern part of the Gulf of Mexico. This system was studied extensively in the 1970s by the U.S. EPA. At that time, significant releases of industrial chemicals and improperly treated sewage wastes occurred on a regular basis. The losses of seagrass beds and changes in the biological community structures of the bay were reported. Pensacola Bay was known throughout the nation as a prime white, pink and brown shrimping area as well as a sportfishing paradise. Thick mats of rotting vegetation were blamed on the chemical industries as were the hundreds of fish kills reported annually in this system. In Pensacola Bay, the shrimp landings declined from 902,000 pounds in 1968, to 236,000 in 1969, 52,000 in 1970, and 17,000 in 1971. In less than 20 years, the shrimp harvest had dropped to less than two-percent of its former level. The results of the combination of high waste discharges and poor circulation were severe dissolved oxygen depletion which resulted in many fish kills in the late 1960s and early 1970s. There were 41 fish kills in Escambia Bay in 1970 and 32 in Pensacola Bay. The number of dead fish were reported in miles in 1971: one square mile of dead fish in Mulatto Bayou and 10 miles of dead gamefish and menhaden along the eastern shore of the bay. In August and September 1972, 2 ¼ tons of fish were reported dying each day in Bayou Texar. Comparative studies suggest that nearly all the seagrass beds in the bay have been destroyed."

The above quotation (Windsor, 1985) briefly summarizes the historic decline of environmental quality within the Pensacola Bay system. The system decline, which apparently began in the 1960s, was largely attributed to industrial and domestic point source discharges. Public concern over the deterioration of the system resulted in a number of initiatives in the late 1960s and early 1970s, including academic research, conferences, and regulatory enforcement actions. One major research activity was the Escambia Bay Recovery Program implemented in the early 1970s by the U.S. Environmental Protection Agency (EPA). The EPA concluded that industrial and domestic point source discharges significantly contributed to the poor condition of the system. Following this, the EPA concentrated regulatory action on point source discharges, both adjacent to the bay and upstream along the Escambia and Conecuh rivers in Florida and Alabama. As a result of these actions, as well as state and federal enforcement that followed, large point source discharges to the system were improved to meet more stringent permitting criteria. The system has apparently responded with noticeable improvements in water quality and fewer fish kills.

One of the principal products of the Escambia Bay Recovery Program was the work of Olinger et al. (1975). This work characterized conditions in portions of the system as of 1975 and remains the most comprehensive analysis of the system that has been conducted to date. Of the numerous conclusions of this report, two are quoted below.

> Because of poor circulation and flushing characteristics, the assimilative capacity of the Pensacola Bay system is extremely limited, and the bay is barely able to assimilate natural inputs of nutrients and oxidizing materials.
>
> Most of the particulate material entering the Pensacola Bay system from point and nonpoint waste sources and tributary rivers are retained in the system.

Although conditions may have changed since 1975, the basic physical processes which control circulation and flushing in the system are unchanged. Thus, much of the system continues to be impacted by both point and nonpoint source pollutant loading. Such pollutant loading includes suspended sediments contributed by nonpoint sources throughout the basin, chronically-elevated nutrient levels, resuspension by wind events of previously deposited nutrients, and high turbidity. Data from Escambia and Pensacola bays, in particular, indicate that water quality problems persist. Urban bayous continue to have obvious, substantial problems with water and sediment quality, fish kills, etc. These result from urban stormwater runoff and, in Bayou Chico's case, a long history of waste disposal. Habitat loss and degradation continues and is accelerating in areas. Seagrasses have not significantly recovered, and increasing development pressure on estuarine shorelines causes additional habitat loss and nonpoint source pollutant loading.

Although limited aspects of these issues have been the focus of past research, the overall dynamics and functioning of this highly stratified, poorly flushed system are not understood such that the fate of an introduced contaminant may be accurately predicted. Although discharge limits for various contaminants have been in use for some time, the overall capacity of the system to assimilate waste and still function in a healthy manner remains unknown. More recent research has tended to be more site-specific and less comprehensive than that of the 1970s, and has generally failed to address the status of the system as a whole and its ability to cope with current loadings.

During the course of reviewing literature for the preparation of this SWIM Plan, portions of the Pensacola Bay system were identified as having persistent water quality problems, degraded habitat value, or both—or to be at risk of degradation. Some components of the system are so poorly understood, and some available information is so old, that meaningful management decisions are difficult to make. Data concerning circulation and flushing characteristics are generally inadequate, as are data and evaluations of historic and current conditions within Blackwater and East bays. When the principal work on this system was conducted in the 1970s, most effort was focused on Escambia Bay and, to a lesser extent, Pensacola Bay. To this date, much less is known about water and sediment quality in other portions of the system. According to Jones et al. (1992), information concerning the circulation in Blackwater and East bays is almost entirely inferred from data on Escambia and Pensacola bays. Finally, specific information is not available for most bayous. Very little quantification of their historic or current status is available. Intuitively, they play a significant role in the biological function of the system; however, with the exception of a few, very little is known about them. Additional research in these areas would substantially improve the understanding of the Pensacola Bay system.

Although this plan is intended to achieve the protection and restoration specifically of the Pensacola Bay riverine and estuarine system, it should be noted that protecting this resource, as well as other Gulf coastal plain rivers and estuaries, is essential to the protection of the Gulf of Mexico. Coastal waters in general and estuaries in particular are convergences of productivity within the Gulf of Mexico, and estuaries and associated salt marshes are among the most productive of all ecosystems. The Pensacola Bay system exports nutrients into the Gulf via a narrow pass at the mouth of Pensacola Bay and provides nursery and other habitat for a wide array of marine species. Coastal Gulf of Mexico waters, in turn, influence conditions within the estuary, combining with freshwater inflow to define circulation, salinity, and biota. To further illustrate the importance of estuaries, it is commonly reported that approximately 90 to 98 percent of commercially and recreationally important Gulf of Mexico species of fish and shellfish are estuarine dependent at some point in their life cycles.

Water and Sediment Quality

Problems with water quality in the Pensacola Bay system have been documented at least as far back as 1955, when bioassays indicated industrial waste discharges were affecting aquatic organisms in Escambia Bay (Murdock, 1955). Until the 1960s and 1970s, however, most people apparently perceived the system as being capable of assimilating all effects of area-wide growth. Fish kills, decreases in seafood landings, and the demise of seagrasses throughout the area, however, increased awareness of human impacts on the system and interest in abating them. By 1969, it was concluded that the assimilative and exchange capacity of Escambia Bay had been exceeded (Hopkins, 1969; Hopkins, 1973). As a result, the U.S. EPA initiated a series of investigations (EPA, 1971; Olinger et al., 1975) to assess the health of the system. Although the emphasis was on Escambia Bay, extensive work was also conducted on Pensacola Bay, along with minimal efforts on Blackwater and East bays. Many conclusions about Blackwater and East bays are therefore derived from inferred or extrapolated data from Escambia and Pensacola bays.

The Pensacola Bay system is a low energy system with sluggish currents that has been historically over used for waste disposal. Nutrients, suspended solids, and other contaminants continue to enter the system from point and nonpoint sources. Water quality generally tends to be fair to reasonably good under normal conditions. Sediment quality is questionable, however, with known areas of high nutrient and organic deposits. Grain sizes have also decreased throughout the system, changing the predominantly sand bottom to one with silts and clays.

The fate of constituents in sediments is poorly understood. The extent to which pollutants are altered (oxidation, reduction, transport) in the benthos and their disposition as they are suspended in the water column must be determined to adequately predict their impacts or the effectiveness of restoration activities. This information is also important for estimating the time required for the system to naturally cleanse itself. The poor understanding of the transport of bottom sediments is compounded by the limited information available to understand circulation. The ability of the system to move water (and the constituents suspended or dissolved in it) is of fundamental importance for water quality. Pollutants which fall out of solution are thought to be generally incorporated into the bottom sediments, although it is unclear how long they remain in the system. Toxic organic compounds such as polychlorinated biphenyls (PCBs) are also retained in the sediments, although their potential impact is not clearly understood. Resuspension of enriched and contaminated sediments by high winds and dredging may cause episodic water quality and biological impacts. These may be more significant during warmer months, due to the lower DO levels associated with elevated water temperatures.

Little is known on the overall hydrodynamics of the system. Most information describing currents in the estuary are based on inferred relationships with other parameters (chloride data, salinity data, sediment distribution, etc.). Although this information provides general insights, specifics on magnitudes and subtle directional variabilities are not available. Knowledge of these system characteristics are important, because material that is loaded into the system appears to remain within it, causing high organic and nutrient rich sediments, especially in the deeper, central parts of the bays.

Flushing of the estuarine system is constrained by stratification and entrainment. High river inflows increase flushing by increasing the energy in the system. Such discharge, however, also creates a more stratified flow field, which entrains bottom waters and reduces the exchange of dissolved oxygen, thus degrading water quality. Higher flow intuitively carries more sediments, which decreases light penetration and thus reduces the bottom area available for seagrass growth. Lower flows, on the other hand, are correlated with decreased stratification and increased exchange between layers, but less energy for flushing. Reduced discharge also reduces sedimentation, which allows more light penetration. Because of the large nutrient inputs into the system, however, the less turbid water also creates a better environment for algal blooms, which also limit light available for seagrasses.

Escambia Bay is the most highly stressed bay of the system. It receives the most significant permitted industrial discharges as well as pollutant load from the Escambia-Conecuh River System. Circulation is extremely limited, especially in the upper bays, and a large portion of pollutants adhere to suspended sediments and are deposited on the bottom. Escambia Bay sediments have the highest total organic carbon, TN and TP levels, as well as the greatest potential for toxic compound accumulations. Suspension of these sediments is, therefore, a serious concern. The upper portion of Escambia Bay has been described as being in a state of eutrophication. (U.S. Department of the Interior, 1970).

Blackwater and East bays remain the most unaffected from anthropogenic degradation. Growth in Santa Rosa County, however, is beginning to threaten these systems with increased stormwater runoff, gray water and septic tank effluent, and anticipated increases from STP discharges. Blackwater and East bays are lower energy systems than Pensacola and Escambia bays because of the lower river inputs and lower tidal exchange. This contributes to the potential of even greater water and sediment quality degradation in this part of the system. East Bay appears particularly vulnerable to the effects of growth and NPS pollution (Collard, 1991a).

Pensacola Bay benefits from the upper bays acting as sinks for those pollutants which originate in the upper watershed. Pensacola Bay also has a higher energy level and exchange rate with the Gulf. The watershed of this bay, however, is the most intensively developed portion of the system, and it is the source of a considerable amount of urban stormwater runoff.

It should be noted that natural events significantly affect water and sediment quality and combine with anthropogenic alterations and inputs to stress the system. Examples include precipitation and river discharge, which affect salinity, dissolved oxygen, and other parameters, but which also carry point and nonpoint source pollution. Tropical storms and hurricanes periodically directly impact water and habitat quality and cause pollutants entrained in the sediments to re-enter the water column. Red tides occasionally affect Gulf of Mexico and estuarine waters in the region. The latest event at the time of this writing was in the fall of 1996, when low levels of red tide were measured from Pensacola Bay (Edwards, 1997). During the spring and summer of 1996, large numbers of marine catfish died in eastern Gulf of Mexico waters, including within Pensacola Bay system waters. Although there were concurrent red tide outbreaks in the region, the catfish kills were assessed as being unrelated and possibly associated with viral infections (Edwards, 1997).

While steps have been taken to improve some aspects of the water quality in the system since the 1960s, the level of degradation remains high, and the system continues to exhibit signs of deterioration. Point source discharges and increased inputs of sediments, nutrients and other pollutants from nonpoint discharges continue to impair the system. This situation led to the establishment of the Escambia-Santa Rosa Coast Resource Planning and Management Committee in 1984 under the auspices of Chapter 380, Florida Statutes (F.S.). This Committee developed a plan for extensive studies of the system over a ten year period with the goal of establishing current ecological conditions and predicting growth pressures and future trends. The plan, known as the Bay Area Resource Inventory Program (BARIP), was finalized in 1986 by the University of West Florida in conjunction with the West Florida Regional Planning Council, University of Florida, and the NWFWMD. To date, BARIP has not been implemented. The Committee also developed and adopted a Resource Management Plan which includes zoning and has been implemented to protect water quality.

Nonpoint Source Pollution

Nonpoint source (NPS) pollution consists of pollution that is transported from a variety of sources to a receiving waterbody in a diffuse or dispersed manner. It is generally considered to include most sources of pollution that do not have a point outfall to a receiving waterbody (such as a discharge pipe). This type of pollution contributes a variety of pollutants and impacts the quality of the receiving waterbody in a number of ways. Frequently, nonpoint source pollution results from the interaction between land use practices and surface water hydrology within a watershed. Nonpoint source pollution can affect receiving waters in a number of ways. Stormwater runoff increases turbidity, which, in turn, decreases the amount of sunlight available for submerged vegetation. Other forms of aquatic life are also harmed by increased turbidity and sedimentation. Nonpoint sources of pollution, especially fertilizers and organic wastes, contribute nutrients and other oxygen demanding substances, which lower oxygen levels in receiving waters. Bacteria and viruses from septic tanks, boats, marinas, and urban runoff can contaminate shellfish resources and other organisms, inducing stress and disease.

There are a number of general classifications of nonpoint source pollution, which are typically characterized by the land use practices which result in the pollutant loading. These include urban stormwater runoff, agricultural and silvicultural nonpoint pollution, dredging and filling, septic tank leachate, contaminated groundwater seepage and associated overland flows, marinas, and various unpermitted sources of pollution. Each of these types of nonpoint pollution impacts the Pensacola Bay system.

Stormwater runoff from urbanized areas, roads, parking lots, construction sites, yards, etc. has a very significant impact on the Pensacola Bay system. The traditional emphasis of urban stormwater management has been to deal only with stormwater quantity-related issues at the local level. A consequence of this is that stormwater runoff is frequently routed to a receiving water with very little effort to improve its quality prior to discharge. Reducing the impacts of urban stormwater runoff would require increasing the amount which is allowed to infiltrate back into the ground water and improving the quality of the discharge. Components of this would include such measures as on-site and regional stormwater treatment, buffer zones, limiting impervious areas, grassed waterways, controlling fertilizer use, and construction site best management practices. Such measures are generally implemented by local governments through the adoption of comprehensive stormwater plans, the implementation of such plans, and the use of stormwater utilities or other means of dedicated funding.

Agricultural runoff is a significant source of sediment, nutrients, and pesticides. For example, the U.S. EPA has determined that 85 percent of all the nitrogen and 60 percent of all the phosphorus delivered to the Chesapeake Bay by the Susquehanna River come from cropland (U.S. EPA, 1983). Intensive forestry operations can cause severe sedimentation problems and can disrupt the pH of receiving waters. Also, removing trees from close to the edge of a waterbody eliminates the natural shading of the banks and may cause the average water temperature to increase. For both silviculture and agriculture, attempts at pollution abatement have historically centered around voluntary programs promoting the use of best management practices (BMPs). Recently initiated activities of the Natural Resource Conservation Service (NRCS) and Farm Service Agency (FSA), associated with the implementation of the Food Security Act and 1996 Farm Bill, have the potential to reduce nonpoint loadings from agricultural land uses, depending on the scale of their implementation. Evaluation of the impacts of these programs will be one component of the SWIM program for this watershed.

Dredge and fill activity creates and exacerbates NPS pollution through a variety of means. Fill dirt and excavated soil frequently runs off into surrounding waterbodies during excavation, filling, and related construction activities. Wetland conversion creates additional demand for new development, with resulting runoff and NPS pollution. Losses of wetlands reduces the capacity of the system to store runoff and flood waters and eliminates the filtering and nutrient cycling functions of the lost wetlands. Displacement of wetlands also causes hydrologic disruption of within the system. Dredging causes turbidity and deposition within the aquatic system and releases nutrients and contaminants into the water column. Related effects of dredge and fill activity are discussed in the Habitat Quality section.

Another source of nonpoint pollution, and one that is often a constituent of urban runoff, is septic tank leachate. Installation of septic tanks in soils with limited capacity for this use or inadequate maintenance can result in the contamination of surface waters by leachate. This is of particular importance near bayous and bays due to the susceptibility of shellfish to contamination from bacterial and viral pathogens, as well as public health concerns related to body-contact water sports. Soils bordering bays, rivers, bayous and other flood-prone areas often have severe limitations for use as septic tank absorption fields and sewage lagoon areas. As development continues in these areas, problems with surface water contamination will increase if adequate regulations and controls are not in place.

There are a number of domestic, industrial, and commercial retention and detention ponds, landfills, and storage tanks within the watershed. Some of these have a potential for discharging or leaking to ground waters. Depending on the type of contaminant, the hydrology, soil conditions, and the distance from surface waters, these groundwater discharges could have an impact upon surface waters. Holding ponds also affect surface waters via overflows during rain (or excessive inflow) events. Some facilities may have a potential to contaminate waters with hazardous wastes. Some hazardous waste sites have been identified and are regulated by DEP through the Resource Conservation and Recovery Act (RCRA) and underground storage tank programs. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is administered by the U.S. EPA. The Agrico and Escambia Wood Treating Company "Superfund" sites are located in downtown Pensacola. Contaminated ground water from these sites may affect Bayou Texar (see further description under "Additional Resource Management Initiatives") (Martin, 1997).

Marinas contribute NPS pollution both during construction and operation and are also of concern due to the susceptibility of shellfish and other marine life to contamination by the toxins and pathogens associated with marina-related discharges. Marina construction may result in turbidity and benthic deposition from construction activities and dredging. Chronic impacts which result from marina operations may include the following: 1) oils and greases and other hydrocarbons from fuel boat exhaust, fuel spills, and illegal bilge pumpouts; 2) solid waste from trash, fish carcasses, and solvents associated with boat maintenance (deck washing, hull cleaning, etc.); 3) heavy metal contamination from lead, copper, and other pollutants found in hull paints, anti-fouling chemicals, stormwater runoff, and engine exhausts; and 4) contamination from boat head facilities, which result in increased coliform bacteria, reduced dissolved oxygen, increased nutrients and biological oxygen demand, and general water degradation. Marinas are routinely permitted with provisions to ensure that facilities are maintained—vessels are not allowed to discharge; fish carcasses, food waste, litter, fuel, oil, grease, and other pollutants are not permitted to be disposed of into the water; waste containers are to be located along the docks; fish cleaning stations and restrooms are located on upland property; fuel dispensing facilities are to be equipped with automatic shut-off valves; and emergency cleanup equipment are supposed to be maintained on-site. These permit conditions, however, have failed to eliminate NPS pollution from marinas. Increased supervision and enforcement would assist further minimizing the adverse impacts from marinas.

The current shellfish harvesting area survey of the Pensacola Bay system (Hudson and Wiggins, 1996), lists five major marinas which are in or adjacent to shellfish harvesting waters in the system, with four of them located on the northern shore of Pensacola Bay between Bayou Chico and

Bayou Texar. A number of other arrays of docks and facilities used to serve boats are located throughout the system.

No comprehensive list of unpermitted facilities is available. Such facilities, however, may include seafood processors, petroleum facilities, construction sites, mining operations, etc., which are currently operating without a permit from DEP and which may be polluting surface waters. These may be point source discharge permits but are categorized as nonpoint sources until such time as they come under DEP's permit program.

An additional source of NPS pollution is atmospheric deposition. Nitrogen originates from a variety of sources within an airshed that is considerably larger than the watershed. Computer modeling suggests that utility and mobile (such as automobile exhaust) sources are approximately equally responsible for nitrate deposition in the eastern United States (Appleton, 1995). Atmospheric deposition has also been estimated as being responsible for approximately 27 percent of the nitrogen load within Tampa Bay (Greening, 1995). While the Pensacola Bay region may have fewer industrial air pollution sources than are in the vicinity of Tampa Bay, it does have a considerable, and increasing, number of automobiles and may be affected by a number of industrial and utility sources throughout its airshed.

The Florida Water Quality Assessment, 305 (b) Report (Hand et al., 1996) and the Florida Nonpoint Source Assessment (Livingston et al., 1988) describe NPS pollution impacts on the Pensacola Bay system and throughout the state. Following are general characterizations of NPS pollution impacts within the Pensacola Bay system.

Pensacola Bay Basin (including Pensacola, East, Escambia, and Blackwater bays and Santa Rosa Sound)

Nonpoint Source pollution contributes to water quality degradation and associated impacts on habitat and fisheries throughout the Pensacola estuarine system. Sustained historic degradation due to urban stormwater runoff and other nonpoint sources, as well as point sources, are identified in the Escambia and Pensacola bay basins, notably including Bayou Chico, Bayou Texar, Mulatto Bayou, and tributaries such as Jones and Carpenters creeks. Areas such as East Bay and Santa Rosa Sound have had better water quality but are identified as threatened by increasing residential and other development along the shorelines and inland within their watersheds. Golf courses are also identified as being sources of NPS pollution substantial enough to contribute to low DO, fish kills, and other impacts.

Escambia River Basin

Hand et al. (1996) describe certain tributaries of the Escambia River as suffering serious impacts from NPS pollution. Canoe and Pine Barren creeks suffer from runoff from farms and dirt roads. Additional tributaries identified as impacted by NPS pollution include Moore and Holly creeks, which receive agricultural runoff, and Sandy Hollow Creek, which disappeared after sedimentation filled its channel. Turbidity problems in the river have also been associated with gravel mining in the upper portions of the basin (Livingston et al., 1988).

Yellow River Basin

Hand et al. (1996) indicate that Trammel Creek receives runoff from the City of Crestview and that upper reaches of the Yellow River basin receive impacts from agricultural runoff (crop and livestock). Pond Creek and the Shoal River in the vicinity of Crestview are also noted as being impacted by nutrient, silt, and BOD loadings from nonpoint runoff. Additionally, livestock waste and sedimentation impact Horsehead Creek, borrow pit erosion and channel alteration impact Juniper

Creek, and additional ecological impacts were identified in Hurricane Creek below the Hurricane Lake impoundment (Hand et al., 1996).

Blackwater River Basin

Nonpoint source pollution impacts on the Blackwater River system are discussed by Hand et al. (1996) and Livingston et al. (1988). Gas pipeline construction was identified as causing turbidity, sedimentation, and habitat destruction. and pesticide waste discharges from a University of Florida Agricultural Research Center and wastewater sludge land application were identified as nonpoint pollution sources within the basin. A number of sub-divisions have been constructed within the Pond Creek watershed, which has proven susceptible to habitat and flow alterations and nonpoint source pollution, including oil and grease contamination. These new sub-divisions, between Pace and Chumuckla have created nonpoint source pollution problems, increasing erosion, flooding, and sedimentation within the area.

Point Source Pollution

The Pensacola Bay system has a long history of cultural impacts from a variety of uses. Point source discharges from domestic and industrial wastewater facilities have been particularly significant in the Pensacola Bay system. Point sources of pollution are those with a distinct, identifiable point of discharge (e.g., a pipe) to a waterbody. Two general categories of point sources are recognized: sewage treatment (domestic waste) and industrial facilities. In Florida, the DEP has statutory responsibility for regulating point sources of discharge.

The impacts of point source pollution on the Pensacola Bay system have been generally known for some time. The Escambia Bay Recovery Program, initiated by the EPA in the early 1970s, concluded that industrial and domestic point source discharges significantly contributed to poor conditions within the system. Subsequently, large point source discharges to the system were improved to meet more stringent permitting criteria. The Pensacola Bay system appears to have improved since that time, as demonstrated by fewer fish kills and noticeable improvements in water quality. The current condition of the system, however, remains far from optimal. Continuing point source discharges limit the restoration of water and habitat quality which may be expected.

Permitted domestic and industrial wastewater facilities located in the Pensacola Bay system watershed are listed and generally described in Table 1. In addition to these sources, provided by DEP, it has been suggested that two additional sites within the watershed should be considered and regulated as point sources. The first, an asphalt and cement plant, is located at the confluence of Pond Creek and the Blackwater River. The second is the Tiger Point golf course, upon which approximately 1 million gpd of municipal wastewater is sprayed, and from which runoff is directed into Santa Rosa Sound via several culverts and canals. The possibility of a future point source has also emerged, as Champion Paper Company is (at the time of this writing) considering options for relocating its discharge from Elevenmile Creek in the Perdido Bay basin. Possible discharge sites reported to be under consideration include Escambia Bay, in addition to a wetland treatment system.

Table 1. Permitted Domestic and Industrial Waste Facilities in the Pensacola Bay System Watershed

Name	Location		Design Capacity		Permit Status	Documented Problems	Comments
	N.LAT	W.LONG	MGD	Type			
Escambia Co. Domestic							
Azealea Trace STP	30°32'25"	87°12'12"	0.099	PP	P		
Bratt Elementary School	30°57'50"	87°25'45"	0.012	PP	P		
Town of Century	30°57'53"	87°15'28"	0.450	SW	P		
Main Street AWWT STP	30°24'27"	87°13'17"	20.000	SW	CO	3 (4/96)	
Moreno Courts	30°23'56"	87°16'29"	0.140	PP	P		
NAS Pensacola	30°21'47"	87°15'56"	4.000	SW	P		
Northview High School	30°58'03"	87°24'17"	0.280	PP	P		
Pensacola Beach WWTP	30°20'06"	87°07'56"	2.400	SW	P		
University of West Florida	30°32'47"	87°12'50"	0.500	DWL	TOP		
Escambia Co. Industrial							
B&L Catfish Farm	30°51'21"	87°19'07"		SWP	P		Fish farm permit
Boeckner Fish Farm	30°57'55"	87°29'56"		SWP	P		Fish farm permit
Campbell Sand & Gravel	30°58'48"	87°14'27"		ND	P		
Clark Sand Company				SWI	P		Sand mine permit
Clark Sand Company				SWI	P		Sand mine permit
Clark Sand Company				SWI	P		Sand mine permit
Green Fill Dirt, North	30°29'52"	87°16'02"		SWI	P		Sand mine permit
Green Fill Dirt, Marcus Point				SWI	P		Sand mine permit
Gulf Power Crist Steam	30°33'56"	87°13'35"	18.000	SW	P		
Mark Dunning Industries	30°21'37"	87°20'41"	0.001	ND	P		
Monsanto Company	30°35'31"	87°15'01"	27.000	SW	SW		
Outpost Equipment Rental				ND	P		
Puritan-Bennett Corporation	30°35'32"	87°14'55"	0.001	SW	P		
Sand and Dirt of Florida	30°45'20"	87°19'30"		SWI	P		Sand mine permit
U.S. EPA Laboratory	30°20'06"	87°09'05"	0.019	PP	P		
Westinghouse Electric	30°30'05"	87°13'01"		SWI	P		Shut down Spring 97
Bag It and Shag It #1	30°59'41"	87°15'33"		SWI	P		PET
Esc. Co. Sheriff's Dept.	30°26'32"	87°14'05"		SWI	P		PET
City Fuel Distrib. System	30°35'49"	87°19'56"		SWI	P		PET
Ross Select Foods				SWI	P		PET
Santa Rosa Co. Domestic							
Avalon Utilities	30°33'35	87°05'34"	0.100	IR	CO,RE	1, 3 (9/94)	
Berrydale Forestry Camp	30°54'00	87°01'25"	0.050	PP	P		
Highway 191 WWTP	30°34'40	87°02'18"	0.060	PP	P		
Holley-Navarre WWTF	30°24'53	87°54'21"	0.500	IR	PP		
Town of Jay STP	30°57'28	87°09'08"	0.060	PP	P		
City of Milton STP	30°37'03	87°02'07"	2.500	SW	P		
Navarre Beach STP	30°22'50	86°52'46"	0.900	SW	P		
Pace Water System WWTP	30°35'47	87°10'54"	1.000	IR	P		
I-10 Rest Area WWTP	30°35'31	87°55'55"	0.013	PP	P		
S.R. Industrial Park WWTF	30°37'40"	86°58'10"	0.030	PP	P		To tie into Milton WWTF
South S.R. Utilities System	30°22'44"	87°05'00"	2.000	IR	P		
NAS Whiting Field STP	30°41'59"	87°01'36"	0.870	SW	TOP		To tie into Milton WWTF
Santa Rosa Co. Industrial							
Ag. Rsch and Educ. Center	30°46'00"	87°08'40"	0.001	DF			
Air Products & Chemicals	30°35'00"	87°08'27"	1.500	SW			
Classic Auto SPA	30°23'16"	87°05'22"		ND			
Cytec Industries	30°34'21"	87°06'58"	5.500	SW	CO		
FL Gas Transmission	30°54'42"	87°53'12"	0.005	SW			
Golden Car Wash	30°36'12"	87°08'23"	0.002	DF			
M&L Sand Company				SWI			Sand mine permit
Navarre Bch Coin Laundry	30°24'15"	86°52'07"		DF			
Russell Sand Mine	30°35'03"	87°04'07"		SWI			Sand mine permit
Spot Free # 2	30°24'36"	86°52'10"	0.002	DF			PET
Bradshaw's #1	30°36'01"	87°09'27"		SWI			PET
Cook's Phillips 66	30°35'54"	86°09'42"		SWI			PET
Nugget Store #33	30°36'10"	86°06'51"		SWI			PET
Pace Cluster	30°35'55"	87°09'40"		SWI			PET

Table 1. Permitted Domestic and Industrial Waste Facilities in the Pensacola Bay System Watershed (continued)

Okaloosa Co. Domestic							
Baker High School	30^{0}47’35”	86^{0}40’47”	0.024	PP	P		
Crestview Industrial Park	30^{0}46’47”	86^{0}30’51”	0.100	IR	P	3 (4/95)	
City of Crestview WWTF	30^{0}43’45”	86^{0}35’40”	2.100	IR	RE	3 (10/94)	
I-10 Rest Area East STP	30^{0}44’43”	86^{0}30’58”	0.009	PP	P		
I-10 Rest Area West STP	30^{0}44’43”	86^{0}30’58”	0.009	PP	P		
Eglin AFB Aux Field 3 STP	30^{0}38’55”	86^{0}31’00”	0.125	IR	P		
Eglin AFB Aux Field 6 STP	30^{0}37’48”	86^{0}43’47”	0.072	IR	P		
Hurlburt Field	30^{0}26’23”	86^{0}40’11”	1.000	DWL	RE		
City of Mary Esther	30^{0}24’30”	86^{0}40’05”	1.100	IR	P		
Okaloosa Correctional	30^{0}41’51”	86^{0}31’42”	0.175	PP	P		
Russell F.W. Stephenson	30^{0}24’51”	86^{0}47’57”	1.000	PP	P		
Okaloosa Co. Industrial							
Baker Laundrette	30^{0}48’22”	86^{0}41’06”	0.001	DF	P		
Circle H Fish Farm	30^{0}59’23”	86^{0}38’50”		SWP	P		Fish farm permit
Louisiana Pacific Corp.	30^{0}43’25”	86^{0}41’00”		ND	P		
Johnson Petroleum Sites	30^{0}45’42”	86^{0}34’06”		SWI	P		PET
Twin Hills Lake	30^{0}45’39”	86^{0}33’58”		SWI	P		PET
Walton Co. Domestic							
City of Paxton WWTP	30^{0}57’16”	86^{0}19’26”	0.075	IR	P		
Green Acres Road WWTP	30^{0}43’48”	86^{0}21’40”	0.025	PP	P		

Source: Florida Department of Environmental Protection

Abbreviations and Symbols

Type of Facility
SW -Surface water discharge
SWI - Intermittent SW discharge
SWP - Periodic controlled SW disch.
IR - Spray irrigation to land
PP - Discharge to percolation pond
DF - Discharge to drainfield
ND - No discharge (recycle system)
PET - Petroleum cleanup site disch.
DWL - Wetland discharge
AWWT - Advanced Wastewater Treatment

Permit Status
P - Permitted without violations
WN - Warning notice
FO - Final order
CO - Consent order
AO - Administrative order
EP - Expired permit
TOP - Temporary operating permit
NP - Operating without permit
RE - Under renewal

Documented Problems
(1) Poor operation/maintenance
(2) Collection system inflow/infiltration
(3) Failed to meet water quality standards.

Sediment Conditions

In assessing ecological health, sediment quality must be considered along with water quality and biological productivity and diversity. Sediments integrate cumulative contaminant inputs into waterbodies and may be particularly degraded by long-term contamination (MacDonald, 1994). Thus, while a water quality assessment may indicate state standards are being met, for example, a concurrent sediment evaluation may reveal contamination (Seal et al., 1994).

Maintaining sediment quality is essential for ensuring suitable habitat for benthic life. Sediments provide habitat for spawning, incubation, plant growth, and other biological processes. The fine, contaminated sediments which result from years of stormwater runoff, however, are relatively unsuitable for much benthic life and may depress biological diversity and productivity. Sedimentation from runoff and erosion may degrade benthic habitat throughout the system and may directly harm aquatic life by suffocating benthic invertebrates and interfering with filter feeders. Contaminants may also accumulate in plant and animal tissue and cause acute and/or chronic toxicity (MacDonald, 1994). Sediment contamination may occur in the form of fine (silt/clay), relatively organic sediments; trace metals (cadmium, copper, chromium, lead, nickel, zinc); and toxic organic compounds such as dichlorodiphenyltrichloroethane (DDT), polychlorinated biphyenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

Both physical and biological forces shape sediment patterns. Sediments from the watershed are deposited into rivers and tributary streams. Estuarine embayments, in turn, receive some of these sediments via riverine discharge, as well as from adjacent lands and smaller tributaries. Deeper estuarine areas tend to act as sinks for fine organically enriched riverine sediments. Smaller embayments (bayous) also collect sediments derived from their individual basins. Sources of these sediments vary, and include natural erosion and sedimentation from agricultural sources, roads, urban runoff, and other sources. Fine, enriched sediments found in urbanized bayous, in particular, may derive from urban stormwater runoff.

Sediments in the Pensacola Bay system have been known to be subject to anthropogenic stresses for some time. Sediment loads and nutrient and contaminant enrichment in recent decades have increased from such sources as industrial, agricultural, and domestic sources; urban stormwater runoff; forestry; construction; and trawling (Collard, 1991a). Additionally, toxic organic compounds have been identified in the sediments of portions of the system. The poor flushing capacity of the estuarine component of the system and periodic resuspension from dredge and fill projects, barge traffic, and wind events enhance the vulnerability of sediments in the Pensacola Bay system.

A number of studies, beginning in the 1960s, have assessed sediment conditions in the estuarine component of the system. The major work was that accomplished by Olinger et al. (1975), which comprehensively characterized conditions in the estuarine component of the system, particularly Escambia Bay. This study recognized three major habitats with respect to sediment conditions: (1) a broad mud plain (70% of the bay bottom), (2) a transition zone of mud to sand with steep slopes, and (3) a sandy shelf around the bay margins. The mud fraction, as well as total nitrogen (TN), total phosphorus (TP), and total organic carbon (TOC) all increased with depth.

Sediment contamination by PCBs was first documented by Duke et al. (1970) in sediments of the Escambia River near the Monsanto plant outfall, following the report of a chemical spill in 1969. Olinger et al. (1975) identified PCBs at a number of sites in Escambia Bay, and noted that these tended to be associated with finer sediments. Core samples taken along the east and northeast shore of Escambia Bay yielded relatively high concentrations of PCBs as compared with those taken elsewhere. Later sampling conducted by DEP, NOAA, and Mote Marine Laboratory identified continuing contamination with toxic organic compounds within the system (discussed further below).

George (1988) assessed sediment conditions and compared them with conditions reported earlier. Grain size distributions were noted to have changed throughout the system over the past several decades, with the percentage of fine-grained sediments (clays and silts) increasing. The percentage of fine-grained sediments in East Bay was reported as doubling between 1968 and 1988. Such changes may be associated with deteriorating biological conditions and suggest that the impairment process experienced by Escambia Bay decades earlier could be replicated in East Bay (Collard, 1991a). George (1988) also reported relatively high TOC concentrations (average 2.4%) in PBS sediments. High concentrations of organics were identified around the confluence of East and Pensacola Bay.

Comparable assessments of sediment conditions in the riverine component of the Pensacola Bay system have not been completed. It is reasonable to expect substantial impacts, however. The river basins have experienced extensive logging over the past two centuries, and also receive nonpoint source pollution and sedimentation from agricultural areas, dirt roads, and runoff from communities in the watershed, as well as bank and gully erosion. Isphording et al. (1985) noted silt to be a major component of PBS river sediment loads. The Pond Creek basin (in the Blackwater River watershed) has been noted as being increasingly vulnerable to sedimentation from subdivision construction, and has previously been impacted by a pesticide spill (Hand et al., 1996). Canoe and Pine Barren creeks (Escambia River watershed) have been identified as suffering from agricultural and dirt road runoff, which have contributed to sedimentation and pesticide contamination. These, in turn, may have adversely affected biological productivity (Hand et al., 1996). Tributaries in the Yellow-Shoal Rivers watershed have been identified as being susceptible to sediment runoff from surrounding dirt roads and natural bank erosion.

Sediments in Bayou Chico and Bayou Texar have been identified as being degraded (Collard, 1991a; Glassen et al., 1977; NWFWMD, 1978; Seal et al., 1994). Bayou Chico was identified as harboring about two million cubic yards of sludge deposits, and its sediments were identified as being enriched with BOD, adenosine triphosphate (ATP), TOC, and hydrocarbon residues. Sediments in Bayou Texar were identified as being enriched from stormwater runoff and historic use as a domestic sewer (Collard 1991a). Other bayous in the PBS have not received the same level of attention; however, several of them may be subject to similar runoff and basin development conditions.

Distinguishing anthropogenic metal enrichment from natural background levels generally involves normalization using known relationships between metals of interest and common naturally occurring elements such as aluminum (FDEP, 1994). Toxic organic compounds are more easily attributed to pollution, because they are created primarily by human activities (FDEP, 1994). The presence of such compounds, however, does not necessarily indicate toxicity. Naturally occurring organic molecules enhance the bonding of sediments with organic contaminants and may thus reduce contaminant bioavailability (Seal et al. 1994). Observed organic contaminant values may be normalized to TOC as a means of assessing bioavailability.

The Florida Coastal Sediment Contaminant Atlas (Seal et al., 1994) summarizes sediment data collected by DEP, NOAA, and Mote Marine Laboratory since 1982. Fifty-four sites in the Pensacola Bay system SWIM planning area were assessed for metal enrichment, and thirty-six were assessed for the presence and bioavailability of organic contaminants. With the exception of two sites in the lower Escambia River, these sites are limited to the estuarine component of the system. Metal contaminant values were normalized to aluminum to distinguish anthropogenic enrichment from natural variability. Organic contaminant values were normalized to TOC to assess bioavailability.

Metal enrichment and contamination by toxic organic compounds were indicated at a number of sites throughout the system (Seal et al., 1994). The most enriched sites identified were in Bayou Chico, where two sites were found to have chromium and zinc enrichment more than ten times over expected values. Enrichment with cadmium, chromium, copper, mercury, and lead was identified as well. Moderate-to-high enrichment factors, particularly of cadmium, lead, and zinc, were also identified in sediments in Bayou Grande. Some enrichment with arsenic, lead, mercury, and zinc was identified in Pensacola Bay, and higher-than-expected values of mercury were identified from sediments collected at a site in the lower Escambia River. A number of sites contaminated with PAHs and PCBs were found in Escambia Bay, Pensacola Bay, Bayou Grande, and Bayou Chico. Pesticides were identified from two sites in Escambia Bay, and phenolic compounds were found at one site in Pensacola Harbor.

Sediment research within the Pensacola Bay system is currently being conducted by the U.S. EPA in support of efforts to develop and evaluate diagnostic indicators of ecological conditions.

Habitat Quality

The Pensacola Bay system has been subjected to chronic environmental stress from industrial and domestic discharges, NPS pollution runoff, and dredge and fill and other direct habitat displacement. Habitat quality and productivity have suffered and continue to suffer as a result. Seagrass communities have been profoundly impacted, wetland area continues to decrease, and riverine and estuarine benthic habitats have been stressed. Habitat quality is inherently interrelated with all other issues identified in this plan. All anthropogenic impacts, such as point and nonpoint source discharges and land development, as well as catastrophic storms and floods, affect habitats within the system. An understanding of the extent and magnitude of such impacts is necessary for effective restoration, protection, and management of biota and habitats. The Pensacola Bay system is composed of a number of habitat types, each sharing certain common characteristics and interrelationships. The watershed is a continuum from upland forests to aquatic systems. Habitat types include forests and other upland habitats, forested and herbaceous fresh and salt wetlands, and an array of aquatic communities.

Among the most notable habitat injuries within the Pensacola Bay system have been the widespread demise of submerged aquatic vegetation (seagrass beds) and the large variations observed periodically in the fish and shellfish industry (disease losses in the oyster fishery, fish kills, etc.). Reasons for these occurrences are unclear. The influx of pollutants and sediments, variations in salinity, habitat displacement, and increased stormwater discharges all have contributed collectively to the stress on these habitats. Not all habitats and associated biota have shown similarly dramatic effects. While emergent vegetation suffers from encroachment and from the effects of dredging and filling, protected marshes remain viable and healthy. Some biota, however, readily exhibit the effects of their habitat interrelationships. Bay scallops, for example, are scarce-to-nonexistent in most of the estuarine system due to the loss of seagrass communities. Another example has been the collapse of the shrimp industry following a spill of PCBs into the system in 1969. This collapse may have been due in part to toxicity from the spill and as a result of fishermen being driven from the vicinity by adverse publicity.

Inland and coastal wetlands throughout the watershed continue to be displaced and degraded through permitted and unpermitted dredge and fill activity. Recently, for example, increased development pressure has become focused on wetlands and other low-lying areas. In Escambia County, for example, developers appear to be running out of more suitable lands, and are turning to low-lying areas to take advantage of demand for new houses (Hu, 1997). Additionally, floodplain habitat is being converted to other land uses, which fragments and displaces habitat, degrades nearby habitats, and causes other problems (flooding, hazard risk, etc.) (FDEP, 1996). Substantial areas of floodplain and wetland in the watershed, however, have been acquired and protected via the Save Our Rivers and Preservation 2000 programs. In particular, the NWFWMD has purchased 44,277 acres of land along the Escambia and Yellow Rivers and within the Garcon Point peninsula.

In addition to direct losses, impacts of dredge and fill activities on wetlands include hydrologic disruption and degradation due to sedimentation and NPS pollution. The habitat value of these areas are greatly diminished due to fragmentation and ecological simplification. There are mitigation requirements in place designed to offset permitted losses. Restored and, especially, created wetlands, however, are commonly assessed as being functionally inferior to natural wetlands (e.g., Moy and Levin, 1991). Additionally, mitigation measures often amount to assurances to not impact additional wetlands, as opposed to actual creation or restoration. Efforts at tracking and long-term monitoring and oversight of mitigation projects may also be inadequate. The cumulative effects of years of dredge and fill activity are particularly severe. Even when individual actions seem insignificant, together with many other such actions, they adversely impact the system both by creating nonpoint source pollution and directly by habitat destruction.

The impacts of dredging in the aquatic system are variable and depend upon physical and biological factors, including circulation patterns, sediment characteristics and contamination, proximity to sensitive areas, distance from pollution sources, and season. They include both direct habitat destruction, and indirect impacts from sediment suspension. Chemical and geological characteristics and seasonal biological variations are important, including reproductive season and the timing of migrations and juvenile habitation. Populations are lower during the winter months because of the offshore migration of many species. In addition, the estuary is more heavily utilized by juvenile estuarine organisms in the spring, summer and fall. Oysters, for example, are especially susceptible to dredging impacts during spring, summer, and fall, which are spawning seasons for oysters. Galtsoff (1964) has demonstrated that one millimeter of sediment covering clutch material will prevent planktonic spat from setting. Additionally Loosanoff (1961) demonstrated that silt levels as low as 250 mg/L will significantly affect the development of oyster eggs. Seagrasses are impacted by dredging when sediment suspension degrades the optical characteristics of the water. Such impacts are particularly felt during the growing season. In addition to impacts from direct habitat loss and sediment suspension and settling, dredging makes contaminants entrained within the sediment available to the water column, which causes both nutrient enrichment and direct effects of toxic compounds.

Natural coastal communities are among the most threatened in Florida. Undeveloped and lightly developed areas along barrier islands are characterized by distinct zonation, from sandy Gulf beaches, through intermittent scrub along dune ridges and swales, to maritime forests, and finally to salt-tolerant herbaceous vegetation and limited emergent vegetation along the bay shore. Habitat loss, pollution, and reduced fish and wildlife populations and diversity result when shoreline development is unbroken by conservation areas or very low density buffer zones. Population growth and the increasing popularity of the Florida Panhandle as a residential and recreational destination has intensified competition for limited coastal resources. Across much of the region, government jurisdictions and private landowners have failed to plan for the coexistence of competing shoreline uses and functions.

The natural functions of the rivers and streams, their floodplains, and downstream estuaries are in part defined by and dependent upon the existing river flow regimes. If this regime is altered, either in terms of total discharge volume or in terms of the natural fluctuation cycle, an array of impacts can result. These include disruption of natural floodplain habitats, vegetation community changes, changes in the sources and availability of nutrients within the system, and changes in the salinity regime of the estuary. Each of these impacts, in turn, creates additional impacts on habitats, biota, and water and sediment quality. This is one means by which management decisions made outside of Florida can have major impacts on the system. New impoundments, new demands on water use, and changes in discharge regimes can significantly affect downstream conditions. Additionally, ground water withdrawal decisions may impact stream and wetland habitat. For example, smaller streams are often dependent on base flow from the Sand and Gravel Aquifer to maintain historic flows and habitat conditions.

Data on benthic macroinvertebrates suggest that biological communities in this system have been simplified and are characteristic of stressed ecosystems (Collard 1991a). Anecdotal evidence suggests that marine and estuarine fisheries have declined considerably since the 1950s. According to Collard (1991a), yields of crabs, shrimp, and oysters have declined steadily over several decades, and some of this decline seems to large and consistent to reasonably attribute to natural causes or cycles. Existing data and analyses are inadequate, however, to reliably assess fisheries trends (Collard 1991a). Assessment of fisheries and biological resources within the riverine portion of the system are particularly limited. Hand et al. (1996), however, indicates that sedimentation, turbidity, and pesticides may have adversely impacted fisheries. Additionally, the Escambia and Yellow rivers provide habitat for six recognized species of freshwater mussels which are classified as threatened or endangered (Deyrup, 1994). These populations are at risk from habitat degradation and destruction, including by dredging, channelization, sedimentation, and poor water quality.

The Escambia Bay Recovery Study (Olinger et al., 1975) is the most extensive document describing the natural history and decline of estuarine portions the Pensacola Bay system. It provides a detailed summary of chemical, physical, and ecological baseline which can be used to assess future trends.

In general, after many apparent changes, the system appears to be more stable. Nevertheless, many concerns remain, and numerous areas of inquiry should be further considered. For example, the widespread decline of seagrasses in the system is not adequately understood. Potential causes of habitat degradation, including nonpoint source pollution and permitted point source discharges within and outside of Florida, need to be assessed. Associated habitat and population impacts warrant additional consideration and, depending on funding, should be priorities for research and corrective actions. The method and scope of local participation in the resource protection and restoration process should also be more clearly defined. Additionally, maps of habitats and data from biological monitoring efforts should be incorporated into a GIS for presentation and illustration of changes over time.

Administration, Planning, and Coordination

Water resources are affected not only by such environmental factors as rainfall, topography, land cover, and geology, but by legal and institutional factors as well. Therefore, an understanding of the rules, regulations, policies, and programs that affect the Pensacola Bay system is essential for the development and implementation of an effective watershed management plan. Protection and restoration of the system requires coordination among the federal, state, regional, and local agencies with regulatory and management authority in the watershed.

Watershed management programs of a regional scale tend to face substantial institutional and jurisdictional challenges (Adler, 1996). The Pensacola Bay system watershed encompasses portions of 13 counties in two states and is a management responsibility of a number of state and federal agencies and local governments. Management of this system therefore requires communication and coordination across all of these institutions. The Pensacola Bay system has largely avoided very substantial upstream-downstream conflicts and jurisdictional turf battles. Inherent interjurisdictional issues are continually present, however. These include, for example, balancing wastewater treatment needs of upstream communities with water quality needs of downstream users. Additionally, the potential exists for future conflicts, since goals and priorities will never be entirely consistent across all institutions.

There is also a paradox between large- and small-scale water resource management. Large-scale, interjurisdictional management is necessary to manage a system in a holistic manner. Management at the sub-watershed level, however, may be more efficient. At this level, there is more detailed knowledge of specific conditions, and localized knowledge and interest may more easily be taken into account (Adler, 1996). Ideally, the SWIM program should be capable of management at both levels. While the overall focus of the program is at the "big picture," watershed level, it should also provide for addressing more localized problems—particularly where they affect the system as a whole. One way for the SWIM program to do this is to promote and support local resource management efforts. While SWIM funding alone is insufficient to comprehensively implement all worthy projects throughout the watershed, local governments may be capable of funding and implementing construction and other projects with some SWIM support.

Effective interstate communication and coordination is particularly important for the Pensacola Bay system SWIM program. Not only is the majority of the watershed north of the state line, but land use practices, water quality standards, and management programs all differ between Florida and Alabama. Possible improvements to the quality of the system in Florida are limited unless the overall management effort extends into Alabama. There is substantial interest in protecting and enhancing water resources among Alabama residents, and water resource management efforts are ongoing through such agencies as the Alabama Department of Environmental Management. In developing interstate coordination, it is also important to work in cooperation with federal resource management agencies with responsibilities spanning the region.

Additional watershed management needs include coordination with the Bay Area Technical Advisory Committee (TAC), which also serves BARC and Ecosystem Management and is made up of representatives of various jurisdictions in the watershed, resource management agencies, and other technical experts. The TAC should continue to play an integral role in the development and implementation of the SWIM plan by providing a forum for agency and technical review and input. An active TAC also helps maintain other agency and jurisdiction commitments to watershed management.

Additionally, non-SWIM funding, such as various grant programs, should be explored as a means of augmenting the SWIM program and enhancing intergovernmental coordination. An integrated plan for measuring the progress of the watershed management effort should be developed and implemented. This includes substantive progress, such as trends in water quality, biological productivity, and public awareness; and procedural progress, including cross jurisdictional coordination and citizen participation. Finally, because watershed management is an ongoing process, it must provide for periodic updates of the management plan to reflect changing conditions and priorities.

Specific issues that must also be considered to achieve adequate management of the system include the following.

- Environmental protection rules, regulations, and criteria may be perceived as either inadequate or excessive in different quarters of society and the economy.
- Rule enforcement and permit compliance may be inadequate and/or inconsistent across regulatory agencies. Examination of this issue should include consideration of the number of violations, their nature, and the sufficiency of staff resources provided for enforcement.
- Resource management may be inconsistent across various agencies. Regulatory and management programs have been developed incrementally and programmatically to address specific problems as they have been identified. The resulting process may be inefficient, sometimes inequitable, duplicative, and unnecessarily expensive. Interagency consensus and cooperation must be improved for the resolution of inconsistencies when two or more agencies have overlapping responsibilities.
- Awareness and technical knowledge may be inadequate among elected officials, citizens, and administrative officials to facilitate informed decision making. Problems and possible solutions should be better understood across lines of responsibility and discipline.
- Research initiatives of different institutions should be coordinated. A number of state agencies, federal agencies, and universities conduct research on various aspects of the system. These activities should be coordinated to maximize the benefit obtained and to reduce duplication of effort.
- Restoration and protection initiatives of different institutions should be similarly coordinated. Such initiatives are being conducted by various state, federal, and local entities. Collaboration is necessary both to ensure technical sufficiency and to ensure that funds are used efficiently in this time of resource scarcity. Cooperation across various organizations also helps significantly increase the level of expertise available to consider various problems.
- The management program must be flexible and able to adapt to the ever-changing political and social climate, as well as to changing levels of funding.
- The is a need to develop appropriate success criteria and measure the success of the program
- To accomplish the mission of this plan, as well as those of related initiatives, a long-term strategic plan with appropriate goals and milestones should be developed.

Public Education and Awareness

For efforts to protect and improve the quality of the Pensacola Bay system to succeed, the values and vulnerabilities of the system must be well understood by the public. This is particularly true given the importance of voluntary participation and achieving consensus across diverse interests. Only if the public is well informed can it participate effectively in the decision-making process. Many citizens may be unaware of the potential environmental impacts of certain activities, or of the benefits of others. Additionally, communication and education are necessary to ensure that all interests are adequately informed and represented. Information about all SWIM program activities should be communicated to the public, and all data and reports should be available to interested parties. Additionally, enhanced primary and secondary educational opportunities are important to provide for future generations of informed decision-makers. General educational needs for management of a surface water system include the following:

- awareness of the values and vulnerabilities of natural resources, including aquatic habitats, wetlands, and threatened and endangered species;
- awareness of simple behavioral changes which may help protect the quality of the system;
- understanding of the concept of watershed management and its importance for maintaining the health of the system;
- awareness of the problem of nonpoint source pollution and alternatives for managing and treating stormwater runoff;
- awareness of the potential impacts of certain recreational activities and precautions which may prevent or minimize such impacts;
- access to educational resources and activities which assist primary and secondary school educators; and
- access to educational resources and activities for the community as a whole.

It would be helpful for public and policy-maker education if research activities would be conducted to qualitatively and quantitatively explore the human benefits provided by the Pensacola Bay system. This could include survey research to identify the relative popularity of recreational and other activities conducted on the system and the direct and indirect economic benefits which result from these activities. Additionally, the intangible and monetary benefits provided by the system could be explored, including aesthetic and other quality-of-life benefits provided to residents, the importance of the resources for property values and other economic factors, and the adverse effects a serious decline in environmental quality would have on all of these.

Summary of Priority Issues

The preceding discussion described the challenges facing protection and restoration efforts for the Pensacola Bay system. These challenges are summarized below under the four interrelated issue areas.

Issue 1 — Water and Sediment Quality

Nutrient and sediment discharge via stormwater runoff from urban watersheds - Uncontrolled urban stormwater runoff impacts much of the system, particularly several bayous, other estuarine areas, and river waters in the vicinity of several communities. Stormwater contributes excess nutrients and sediments to receiving water bodies, which results in depressed dissolved oxygen levels, nutrient enrichment, and excessive sedimentation, among other impacts.

Excessive sediment and nutrient loading from throughout the watershed - In addition to the impacts of urban stormwater runoff, the system receives a considerable sediment load from throughout the watershed. This sediment load originates from various sources including dirt roads and agricultural and silvicultural activities. Nutrient loading originates from these sources, urban runoff, and point sources. Results include increased turbidity, trophic enrichment, and degradation of benthic habitat. Excess nutrient loading, combined with poor circulation and flushing, has resulted in the eutrophication of parts of this system.

Degraded sediments - In many areas, sediments are enriched by nutrients contaminated with toxic organic compounds and metals, and differ in composition from natural conditions (smaller grain size; higher clay and silt fractions). This system-wide degradation has resulted in poor benthic habitat conditions and may continue to affect water quality through resuspension and other means. The mechanisms by which poor sediment conditions continue to cause impacts are poorly understood, however, as are potential methods for restoration.

Issue 2 — Habitat Quality

Loss of seagrass beds - Seagrass communities have greatly declined in area and quality throughout the estuarine component of the system. This decline has occurred over the last 30 years and has been accompanied by a significant decline in various components of the estuarine biota that are dependent on these communities. Seagrass communities are notable due to their importance to biological diversity and productivity and their vulnerability to even subtle anthropogenic impacts. If the quality of this system is to ever approach its former condition, some degree of seagrass recovery is essential.

Habitat loss and degradation - Various habitats have been degraded and lost throughout the system. These include tidal marshes, seagrass and other benthic communities, bottomland hardwoods and other forested wetlands, and other communities. Much of this loss is due to the cumulative impacts of development and is not directly recoverable. Only improvements in environmental quality and compensatory actions can mitigate these losses.

Impacts on fisheries and other biological, economic, and recreational resources - In addition to and, in part, as a consequence of habitat loss and degradation, there has been a historical decline in fisheries (shrimp, scallops, oysters, and fish) and the economic and recreational benefits they provide. These fisheries at one time provided a significant benefit to the local economy.

Issue 3 — Administration, Planning, and Coordination

Consistency among government agencies - Because management of the system encompasses actions of various state and federal agencies and numerous local governments, effective intergovernmental communication and coordination are required to ensure that management efforts are complementary, resources are employed efficiently, and redundancy is avoided.

Interstate coordination - Regulations, standards, and management programs differ between Florida and Alabama. As the majority of the watershed is north of the state line, improvements to the quality of the system in Florida may be limited unless the overall management effort extends into Alabama. It is also very important to work in cooperation with federal resource management agencies with responsibilities spanning the region.

Awareness and technical information for informed decision-making - Decisions regarding the system are made at all levels of government. It is important that potential impacts of such decisions be understood. Those who make management decisions which impact the system must have access to the best information currently available.

Adequacy of existing rules - Rules and regulations must be adequate to facilitate protection and improvement in water and sediment quality and wetland resources. Many improvements thus far realized result from previous regulatory actions. There may be a lack of consensus as to whether the current regulatory framework is sufficient to provide for further improvements.

Adequacy of existing enforcement and compliance - Regulations must be enforced and complied with for regulatory programs to be successful. If they are not, continuing improvements in surface water and sediment quality may be unlikely.

Issue 4 — Public Education and Awareness

Public Education and Awareness - For efforts to protect and improve the quality of the Pensacola Bay system to succeed, the values and vulnerabilities of the system must be well understood by the public. This is particularly true given the importance of voluntary participation and achieving consensus across diverse interests.

INSTITUTIONAL SETTING FOR THE MANAGEMENT OF THE PENSACOLA BAY SYSTEM

Institutional Setting of the Pensacola Bay System

- Local Governments. The watershed includes portions of four counties in Florida, nine counties in Alabama, and a number of municipalities.
- Regional Agencies. Regional agencies with responsibilities for management of this system include the West Florida Regional Planning Council and Northwest Florida Water Management District.
- State Government. Within Florida, several state departments, divisions within them, commissions, and a state university have responsibilities for management and regulation and conduct scientific research. A parallel structure exists within Alabama.
- Federal Government. Several federal departments, services and agencies within them, and the U.S. Environmental Protection Agency all have management, regulatory, and research responsibilities for resources of the Pensacola Bay system.
- Resource Protection Designations. Portions of the watershed are managed as public lands. Waters within the system are classified to protect their "present and future most beneficial use," and some waters have additional legal protection as Outstanding Florida Waters.

Overview

Management of the Pensacola Bay system is accomplished through a composite of the laws, regulations, and activities of numerous jurisdictions and public and private sector organizations. The watershed is within two states, includes all or portions of 13 counties, and is affected by the activities of state and federal agencies, local governments, non-governmental organizations, and numerous private companies and individuals. All of these have various, complementary roles and responsibilities in the overall management of the Pensacola Bay system.

It is important to recognize that the SWIM program alone cannot nearly accomplish all of the objectives identified within this plan. The SWIM program may, however, provide a framework for cross-jurisdictional watershed management, accomplish model and demonstration projects, and provide "seed" money for the initiation of basinwide restoration and protection. Additionally, through the SWIM program, the Northwest Florida Water Management District participate in partnerships with local governments and state and federal agencies to share in the costs of larger projects. The NWFWMD may also provide technical assistance and design work for capital-intensive projects. The Pensacola Bay system SWIM program will be implemented in cooperation with ongoing federal, state, local, and private resource management efforts, including those of the DEP Ecosystem Management initiative, the Bay Area Resource Council (BARC), and local community organizations. Through these programs are opportunities for diverse interests to participate in the management process and the development and implementation of management initiatives, including the SWIM plan.

Local Governments

Florida's portion of the Pensacola watershed includes portions of four counties and 13 incorporated communities, each of which have enacted a variety of plans, ordinances, and regulations. Types of plans, ordinances, and regulations common to most local governments include:

- comprehensive plans;
- zoning and land development codes;
- flood protection ordinances;

- permit requirements for construction and septic systems;
- stormwater management requirements;
- infrastructure planning and development;
- utilities, including potable water, wastewater treatment, solid waste, and stormwater; and
- subdivision regulations.

Local government comprehensive plans are intended to guide future development and so "preserve and enhance present advantages; encourage the most appropriate use of land, water, and resources, consistent with the public interest; overcome present handicaps; and deal effectively with future problems that may result from the use and development of land within their jurisdictions" (Section 163.3161(3), F.S.). The comprehensive planning process is also intended to enhance intergovernmental coordination. In accordance with Chapter 163, F.S. and Rule 9J-5, F.A.C., all comprehensive plans must have the following elements:

- Future Land Use;
- Traffic Circulation;
- Mass Transit;
- Ports, Aviation, and Related Facilities;
- Housing;
- Sanitary Sewer, Solid Waste, Drainage, Potable Water, and Natural Groundwater Recharge;
- Coastal Management (coastal counties);
- Conservation;
- Recreation and Open Space;
- Intergovernmental Coordination; and
- Capital Improvements.

Each element must include goals, objectives, and policies along with supporting data, analysis, and maps. Local comprehensive plans are subject to review to ensure consistency with the State Comprehensive Plan (Chapter 187, F.S.) and the requirements of Chapter 163, F.S.

Escambia and Santa Rosa counties and the cities of Pensacola and Gulf Breeze have entered into an interlocal agreement to provide each of these entities the opportunity to review development proposals which affect the Pensacola estuarine system. The agreement is also intended to ensure that adequate sites for water-dependent uses are available, estuarine pollution is minimized, runoff is controlled, living marine resources are protected, natural hazards are reduced, and public shoreline access is maintained. The agreement provides impact analysis criteria for review of proposed developments which exceed development thresholds for the watershed and the corresponding coastal high hazard area. Additionally, Escambia and Santa Rosa counties adopted the *Escambia/Santa Rosa Coast Resource Management Plan* (ESRCRMP) (1985). This document was developed to provide for well-planned growth in the coastal areas of these counties such as would protect natural resources, public facilities, and economic resources. An objective of the Escambia County Comprehensive Plan Future Land Use Element is to maintain consistency with the ESRCRMP, and the land development code of that county is required to be consistent with the ESRCRMP.

The relative coverage of the Pensacola Bay system watershed is illustrated by Chart 3. Approximately 65 percent is within Alabama. In Florida, Santa Rosa County covers approximately 15 percent of the overall watershed. Okaloosa and Escambia counties cover approximately 11 and five percent respectively, and Walton County covers approximately four percent.

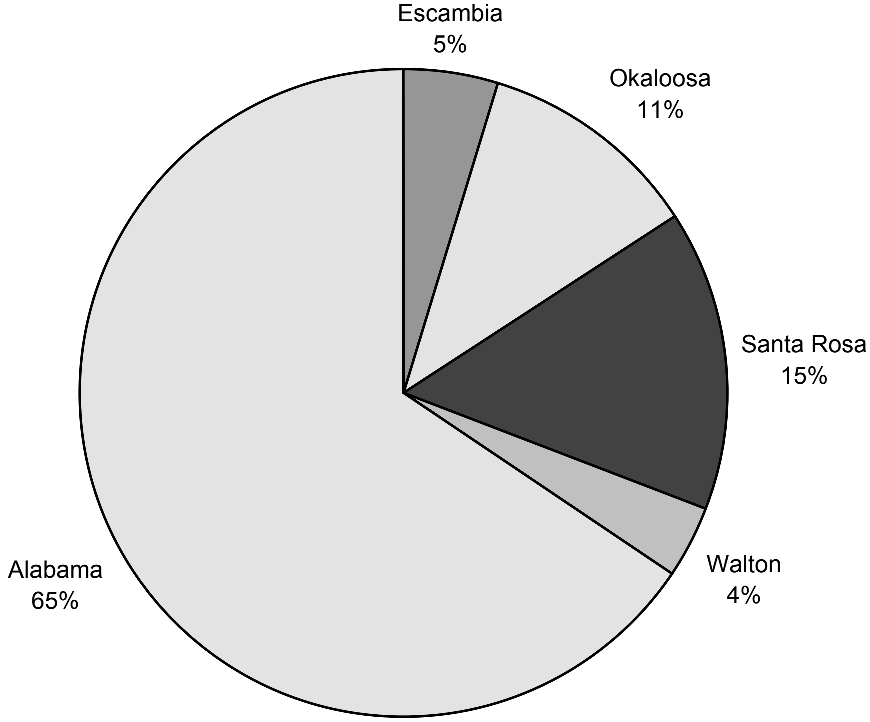


Chart 3. Percent Coverage of the Pensacola Bay System Watershed

It should be cautioned that the percent of the watershed covered by a jurisdiction does not solely indicate its importance to management of the system. Activities conducted in upstream counties, for example, may affect water quality throughout the downstream portions of the system. Jurisdictions which directly border specific waterbodies, however, may have greater immediate impact on certain water and habitat quality parameters within those waterbodies. Additionally, within each jurisdiction, resource characteristics and vulnerabilities differ, as does the potential for detrimental activities. As problems are identified, it is important to determine whether they are due primarily to systemic or more localized stresses.

Escambia County

Escambia County covers approximately 664 square miles, of which approximately 331 are within the Pensacola Bay system watershed. Escambia County includes the western portion of the Pensacola Bay system watershed in Florida and borders the Escambia River to the east. Also within the county are several major bayous of Pensacola and Escambia bays, Pine Barren Creek, and smaller tributaries. Conservation lands in Escambia County include portions of the Escambia River Water Management Area (WMA) and Gulf Islands National Seashore, the La Floresta Perdida and Blackwater Game Wildlife Management areas, and Big Lagoon State Recreation Area (Perdido Bay). Incorporated cities within Escambia County include Pensacola and Century.

Santa Rosa County

Santa Rosa County lies east of Escambia County and borders the Escambia River to the west. With the exception of a narrow coastal strip which drains directly to the Gulf, all of this county's approximately 1,016 square miles are within the Pensacola Bay system watershed. Santa Rosa County includes portions of Escambia and Pensacola bays, East Bay, most of Santa Rosa Sound, and portions of Blackwater and Yellow rivers and their tributaries. Conservation lands in Santa Rosa County include Garcon Point and Blackwater River State Park, along with portions of the Escambia River and Yellow River WMAs, Gulf Islands National Seashore, Blackwater River State Forest, and the Blackwater Game Wildlife Management Area. Some Eglin AFB lands are also managed to protect natural resources. Incorporated Santa Rosa County cities within the Pensacola Bay system watershed include Gulf Breeze, Jay, and Milton.

Okaloosa County

Okaloosa County covers approximately 936 square miles to the east of Santa Rosa County. Approximately 749 square miles of the county are within the Pensacola Bay system watershed. Okaloosa County encompasses portions of the Yellow and Shoal rivers and their tributaries and the eastern portion of Santa Rosa Sound. Conservation lands in Okaloosa County include portions of the Yellow River WMA, Blackwater River State Forest, and Blackwater Game Wildlife Management Area. Additional state recreation area lands within Okaloosa County are outside the Pensacola Bay system watershed. Substantial portions of Eglin AFB are also managed to protect natural resources. Incorporated Okaloosa County cities within the Pensacola Bay system watershed include Mary Esther, Laurel Hill, and Crestview.

Walton County

Walton County covers approximately 1,066 square miles, of which approximately 250 are within the Pensacola Bay system watershed. Walton County is adjacent to Okaloosa County and includes a portion of the Shoal River and a number of its tributaries. Walton County contains a substantial area of state, federal, and private conservation land. With the exception of a portion of Eglin AFB, however, most of this is outside of the Pensacola Bay system watershed. The incorporated community of Paxton lies within the watershed.

Escambia County Utilities Authority

Responsibilities of the Escambia County Utilities Authority (ECUA) include domestic wastewater collection and treatment, potable water treatment and distribution, and residential and commercial sanitation collection within Escambia County. The ECUA also provides drinking water to the City of Gulf Breeze In performing these responsibilities, the Authority has accomplished a number of innovative environmental protection and restoration initiatives. These include wetland restoration, wellhead protection, re-use of treated wastewater, septic tank abandonment through sewer line extension, and, with the NWFWMD, development and application of a three-dimensional Sand and Gravel Aquifer model.

Bay Area Resource Council

The Bay Area Resource Council (BARC) provides a local institutional framework to develop and implement management strategies for the system. The BARC currently has representation from Santa Rosa and Escambia counties and the cities of Pensacola, Gulf Breeze, and Milton. A Technical Advisory Committee (TAC), made up of representatives of state, regional, and local governments, and universities assists the council in decision-making. Members of this TAC also serve as the SWIM TAC. In addition, BARC has a Citizens Education and Advisory Committee consisting of members from the general public and civic groups and advisory members from government agencies.

Alabama Local Governments

The Alabama portion of the Pensacola Bay system watershed covers approximately 4,491 square miles and includes portions of Covington, Escambia, Conecuh, Butler, Crenshaw, Pike, Bullock, Montgomery, and Coffee counties. Cities in the Alabama portion include Brewton, Evergreen, Andalusia, Greenville, Troy, and Luverne.

Regional Agencies

Northwest Florida Water Management District

In addition to implementing the SWIM program, the NWFWMD administers permitting programs for consumptive water use, management and storage of surface waters, well drilling and operation, and artificial recharge. The NWFWMD serves the 15 western-most counties of the state and the western portion of Jefferson County. Consumptive water uses permitted by the NWFWMD which could affect management of the Pensacola Bay system include irrigation and public water supply. Additionally, through the Save Our Rivers and Preservation 2000 programs, the NWFWMD has purchased 44,277 acres of land along the Escambia and Yellow rivers and within the Garcon Point peninsula. These lands are managed to protect the ecological resources of the system, to preserve natural floodplain functions, and to provide for continued public access and use. Uses provided for include hunting, fishing, canoeing, camping, education, and research. The NWFWMD may provide payments in lieu of taxes to reimburse counties for lost ad valorem taxes on lands acquired under the Save Our Rivers and Preservation 2000 programs and thus removed from county tax rolls. To qualify, counties must have a population of 75,000 or less and levy an ad valorem tax of at least 9 mills. Annual payments may be made for up to ten consecutive years. Pursuant to Section 373.4137 and in consultation with state and federal agencies and local governments, the NWFWMD is responsible for developing and periodically updating a regional mitigation plan to address the impacts of state transportation impacts incurred by the Florida Department of Transportation. The NWFWMD is also responsible for implementation of the approved plan and for ensuring mitigation requirements are met.

West Florida Regional Planning Council

The West Florida Regional Planning Council (WFRPC) is the regional planning body serving the seven western-most counties of the state, including the Pensacola basin. The WFRPC provides assistance to local governments in planning and grant writing, coordinates DRI reviews, reviews local government comprehensive plans, and prepares and adopts the Strategic Regional Policy Plan (SRPP). The WFRPC also staffs the local emergency planning committee, the Pensacola Bay Area Resource Council, and three metropolitan planning organizations.

State Government Agencies and Activities

Following are some of the state laws and regulations that are directly relevant to management of the Pensacola Bay system. Numerous agency rules have been adopted to implement these statutes.

- Chapter 161, F.S. Beach and Shore Preservation;
- Chapter 163, Sections 163.3161-163.3243, F.S. Local Government Comprehensive Planning and Land Development Regulation Act;
- Chapter 186, F.S. Florida State Comprehensive Planning Act;
- Chapter 187, F.S. State Comprehensive Plan;
- Chapter 258, F.S. State Parks and Preserves;
- Chapter 259, F.S. Land Acquisitions for Conservation or Recreation;
- Chapter 373, F.S. Water Resources;
- Chapter 380, F.S. The Florida Environmental Land and Water Management Act; and
- Chapter 403, F.S. Environmental Control.

Many state agencies have management responsibilities for Pensacola Bay resources. These include the Office of the Governor, the Department of Environmental Protection, the Department of Agriculture and Consumer Services, the Marine Fisheries Commission, the Florida Game and Fresh Water Fish Commission, the Department of Community Affairs, the Department of Transportation, the Department of State, and the Department of Health.

Office of the Governor

The Office of the Governor is responsible for ensuring coordination between state agencies involved in the protection and management of the Pensacola Bay system and for ensuring that these activities are consistent with the State Comprehensive Plan. The Office of the Governor may also become involved in efforts at interstate coordination and communication.

Florida Department of Environmental Protection

The Florida Department of Environmental Protection (DEP) is responsible for regulating air, water, wastewater, stormwater, and hazardous waste pollution through a permitting and certification process. The Department also provides oversight of the SWIM program statewide. Florida's environmental resource permits (ERP) are administered by DEP, with cooperation by other agencies and the U.S. Army Corps of Engineers. The Department also implements the Outstanding Florida Waters (OFW) program, enforces water quality standards throughout the state, and administers aquatic preserves. Additional functions for which DEP is responsible are coordinated through the following divisions and bureaus of the Department.

Office of Water Policy

Administration and oversight of the SWIM program is conducted by DEP's Office of Water Policy. Staff review SWIM plans, provide technical assistance to water management districts, and administer SWIM funding through the Ecosystem Management and Restoration Trust Fund.

Division of Administrative and Technical Services

This division is responsible for the management of mineral resources, oil and gas exploration, and geological studies.

Division of Water Facilities

This division is responsible for permitting public drinking water and wastewater treatment facilities. This division is also responsible for the development and implementation of water quality management programs. It coordinates with U.S. EPA on the NPDES program, administers the Clean Water Act Section 319 Nonpoint Source Management Program in Florida, administers the state water quality classification system, maintains the state water quality database, and publishes a report on the status of Florida's surface waters (the "305 (b)" report). The Bureau of Submerged Lands and Environmental Resources reviews applications for activities that require environmental resource permits and approval for use of state-owned submerged lands. The Bureau of Beaches and Coastal Systems is responsible for erosion control, hurricane protection, coastal flood control, shoreline and offshore rehabilitation, and the regulation of construction and other activities which are likely to affect the physical condition of the beach and shore. The Bureau of Mine Reclamation is responsible for activities relating to mine reclamation.

Northwest District Office

The Pensacola Bay system is within the area served by DEP's Northwest District office, located in Pensacola. The Pensacola Bay watershed has been delineated for management under the Department's ecosystem management initiative. This initiative is designed to facilitate a cooperative, watershed-based approach to environmental protection which should complement the SWIM program. The Northwest District reviews applications for stormwater permits, wetland resource permits, and approval for use of state-owned submerged lands. The Northwest District office also enforces point source discharge permits, administers water quality and other resource monitoring activities, and has initiated a variety of resource enhancement projects within the Pensacola Bay system, such as an effort to establish and restore *Ruppia maritima* seagrass beds.

Division of State Lands

This division is charged with overseeing uses, sales, leases, and transfers of state-owned lands. The division includes the Bureau of Aquatic Plant Management, which is responsible for the control of exotic aquatic plants and administration of permit requirements for the transfer of aquatic plants.

Division of Recreation and Parks

State park lands within the Pensacola Bay system watershed include Blackwater River State Park and Fort Pickens State Park.

Division of Law Enforcement

The Florida Marine Patrol (FMP) is responsible for enforcing the laws of the state of Florida as they apply to the estuarine waters of the Pensacola Bay system. The FMP is charged with conducting boat safety inspections and checking boat registrations as well as enforcing fish catch limits. The FMP also investigates illegal dumping from boats in the bay and from land adjacent to the bay. The Bureau of Emergency Response is the pre-designated state on-scene coordinator for oil spills and similar hazardous material emergencies.

Division of Marine Resources

This division is charged with preserving, managing, and protecting the state's marine resources; regulating activities of fishermen and others taking marine resources from state waters; issuing licenses and permits for the taking of marine species; and maintaining statistical records. The Shellfish Environmental Assessment Section (SEAS) is responsible for classification and management of shellfish harvesting areas. The section manages shellfish resources, monitors water quality and red tides, and conducts shoreline surveys to locate and evaluate potential pollution sources. For the Pensacola Bay system, SEAS performs oyster habitat creation and enhancement and conducts periodic assessments of point and nonpoint source pollution throughout the watershed. The Florida Marine Research Institute (FMRI) administers the Fisheries Independent Monitoring Program and specific directed studies, including development of seagrass propagation techniques, shoreline habitat sensitivity indices, and GIS data layers for marine waters.

Aquatic Preserves

The Pensacola Bay system includes the Yellow River Marsh and Fort Pickens State Park Aquatic preserves. Section 258.36, F.S., directs that "...state-owned submerged lands in areas which have exceptional biological, aesthetic, and scientific value..." be set aside as aquatic preserves for the benefit of future generations. In general, the following provisions apply to aquatic preserves:

- no further sale, lease, or transfer of state-owned submerged lands unless it is in the public interest;
- no bulkhead line waterward of mean high water with the exception of those required by roads or bridges in the public interest for which no reasonable alternative exists;
- no oil or gas drilling;
- no dredging or filling, with limited exceptions provided under Section 258.42 (3), F.S.;
- no mineral excavation;
- no structures other than private docks; commercial docks in the public interest; utility crossings, navigational aids, or shore protection structures as provided under Section 258.42 (3), F.S.; and
- no waste or effluent discharges inconsistent with the purposes of the preserve.

Additionally, management regulations are to be conducted in "such a manner as not to unreasonably interfere with lawful and traditional public uses…such as sport and commercial fishing, boating, and swimming" (Section 258.43(3), F.S).

Florida Department of Agriculture and Consumer Services

The Florida Department of Agriculture and Consumer Services (DACS) regulates the purchase and use of restricted pesticides and helps with soil and water conservation activities of the Soil and Water Conservation Districts and Agricultural Extension Agencies.

<u>Division of Forestry</u>

The Division of Forestry manages state forest lands. Within the Pensacola Bay system watershed, these include lands within the Blackwater River State Forest. The Division of Forestry also provides oversight of the implementation of Best Management Practices (BMPs).

Florida Department of Transportation

The Florida Department of Transportation (DOT) is responsible for interstate and interregional transportation systems in Florida. The Department also assists in meeting local transportation needs by providing technical and financial assistance to local governments and metropolitan planning organizations (MPOs). As a developer of major linear features, FDOT plays an important role in protecting wetlands and other sensitive resources and in mitigating impacts. With the enactment of Section 373.4137, Florida Statutes, wetland impacts from state transportation projects shall be funded by FDOT and implemented by DEP and the water management districts. The Department is responsible for annually submitting to DEP and the water management districts an inventory of habitats which may be impacted in the first three years of the adopted work program.

Florida Marine Fisheries Commission

The Florida Marine Fisheries Commission (MFC) regulates the harvest of marine life. Its seven-member board is appointed by the Governor to represent various interests affected by marine resources regulation. Their authority covers gear specifications, prohibited gear, bag limits, size limits, species that may not be sold, protected species, closed areas, quality control codes, harvesting seasons, special considerations related to egg-bearing females, and oyster and clam relaying. The MFC is required to make annual recommendations to the Governor and Cabinet regarding marine fisheries research priorities.

Florida Game and Fresh Water Fish Commission

The Florida Game and Fresh Water Fish Commission (FGFWFC) has a five-member appointed commission and has regulatory and management jurisdiction over game and non-game wildlife and freshwater aquatic life. The Commission reviews projects and permit applications which may affect fish and wildlife habitat. It monitors fish and wildlife populations and habitat quality within the watershed, manages wildlife management areas, and coordinates non-game wildlife management and endangered species protection. The Division of Wildlife is also responsible for designating Critical Wildlife Management Areas to protect designated species.

Florida Department of Community Affairs

The Department of Community Affairs (DCA) is the lead state planning agency. The DCA coordinates the review and approval of Local Government Comprehensive Plans and is responsible for coordinating Developments of Regional Impact (DRI) and administering Areas of Critical State Concern (ACSC) and the Florida Coastal Management Program (FCMP). The DCA reviews Land Development Regulations (LDRs) in instances where it is believed that the local government has failed to adopt the required regulations or it is alleged that the adopted regulations are inconsistent with the local comprehensive plan. Other DCA responsibilities include coordinating the state clearinghouse and FCMP consistency review of proposed federal actions. The DCA administers the Florida Communities Trust (FCT) program. This program provides grants, matching grants, loans, and technical assistance to local government for the purpose of acquiring lands and otherwise implementing the Conservation, Recreation, Open Space, and Coastal Management elements of their comprehensive plans. The DCA is also the lead state emergency management agency. It operates the Emergency Operations Center (EOC) and coordinates training, preparedness, and post-disaster relief efforts for natural and technological (oil spills, etc.) disasters.

Florida Department of Health

Septic tank permitting is administered at the state level by the Department of Health so as to protect human health and water quality. The Department is also involved in water quality monitoring, particularly for bacteria, at public recreation beaches. These programs are in partnership with county governments.

Florida Department of State

The Department of State is responsible for the protection of cultural resources, including archaeological sites and historic landmarks.

University of West Florida

The University of West Florida (UWF) Institute for Coastal and Estuarine Research conducts research and restoration activities in northwest Florida estuaries and other waterbodies, including the Pensacola Bay system and tributary streams. The Institute's Wetland Research Laboratory conducts additional activities relating to natural and constructed wetlands. The University is participating with DEP in a project to establish *Ruppia maritima* seagrass communities in conjunction with protective artificial reef structure in the Pensacola Bay system.

Alabama State Agencies

Alabama agencies with responsibilities for management of the Pensacola Bay system its watershed include the Department of Environmental Management, which is responsible for point and nonpoint source pollution management and permitting, and the Department of Conservation and Natural Resources. The Game and Fish Division of the Department of Conservation and Natural Resources is responsible for management of wildlife habitat and populations, game and nongame fish, and fish and wildlife research. Alabama's Department of Economic and Community Affairs plays a large role in its economic development which, in turn, is tied to the region's use and availability of water resources.

Federal Agencies and Activities

Several federal agencies participate in the management of the Pensacola Bay system. Federal laws relevant to management of the Pensacola Bay system include:

- Coastal Zone Management Act of 1972 (Amended 1990).
- Coastal Barrier Resources Act of 1982.
- National Flood Insurance Act of 1968.
- Clean Water Act of 1977 (Amended 1987).
- National Environmental Policy Act of 1969.
- Endangered Species Act of 1973 as amended.

U.S. Department of the Interior

U.S. Geological Survey

The U.S. Geological Survey (USGS) performs surveys, investigations, and research pertaining to topography, geology, and mineral and water resources, and collects and publishes water resource data. The Biological Resource Division of the USGS (formerly the National Biological Service) is the biological research arm of the Department of the Interior. The mission of this division is to assess the status and trends of the nation's biological health.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) reviews proposed federal actions and permits under the Fish and Wildlife Coordination Act. The USFWS is charged with protection and recovery of threatened and endangered species under the Endangered Species Act, and with the management of migratory birds under the North American Migratory Bird Treaty.

Gulf Islands National Seashore

Gulf Islands National Seashore includes major barrier island units on Santa Rosa Island and Perdido Key, as well as the peninsular Naval Live Oaks unit just east of Gulf Breeze. The National Seashore both protects natural barrier coastal ecosystems and provides a recreational resource for residents and visitors.

Minerals Management Service

The Minerals Management Service (MMS) is responsible for the regulation of oil and gas wells on the Outer Continental Shelf (OCS). Federal jurisdiction of submerged OCS lands begins at the outer limit of state waters (approximately 10.4 miles off Florida's Gulf coast) and extends to 200 nautical miles from the coast (the limit of the U.S. EEZ).

U.S. Department of Agriculture

Natural Resource Conservation Service

Formerly the Soil Conservation Service (SCS), the Natural Resource Conservation Service (NRCS) promotes the use of conservation practices on private lands and provides technical assistance to reduce soil losses and otherwise protect natural resources while maintaining or improving agricultural productivity and profitability. Much of the technical assistance provided by the NRCS helps improve water quality by minimizing runoff and erosion, minimizing pesticide overspray and fertilizer losses, maintaining vegetated buffer strips, etc. The NRCS helps farmers develop conservation plans for highly erodible lands.

Farm Service Agency

Formerly the Agricultural Stabilization and Conservation Service (ASCS), the Farm Service Agency (FSA) conducts a number of programs which protect water quality and conserve natural resources. Among these are the Agricultural Conservation Program (ACP) and Conservation Reserve Program (CRP). The ACP is a cost-sharing program which helps farmers put highly erodible land into conservation use and/or implement BMPs. The CRP provides funding to take highly erodible land out of production and convert it into conservation land use. The FSA also works with agencies and farmers to develop county conservation plans.

U.S. Department of Defense

U.S. Navy

The U.S. Navy is a major presence within the Pensacola Bay system watershed, both as an economic and national defense resource, and as an owner and manager of a substantial area of land. Naval Air Station (NAS) Pensacola covers approximately 5,600 acres in Escambia County, on the western shore of Pensacola Bay. The Naval Air Station accomplishes important training missions, including in aviation, officer candidate preparation, and technical specialties. Whiting Field occupies approximately 3,595 acres in Santa Rosa County and also supports aviation training activities. The Navy manages natural resources on its lands consistent with the accomplishment of its missions and is also responsible for stormwater management, wastewater treatment, and other resource protection functions.

U.S. Air Force

Approximately 230,929 acres of Eglin AFB and Hurlburt Field are within the Pensacola Bay watershed. The primary mission performed at Eglin AFB is development and testing of conventional munitions and sensor tracking systems (Eglin AFB, 1993). Hurlburt Field is the home of the Special Operations Command. The mission of Eglin AFB's natural resource program is to "support the Air Force's mission through responsible stewardship of the installation's natural resources utilizing integrated natural resources management and principles of ecosystem management to ensure ecosystem viability and biodiversity while providing compatible multiple uses" (Eglin AFB, 1993). Eglin AFB has made significant accomplishments in restoring and protecting endemic natural communities. In addition, the reservation supports multiple uses which complement the military mission, including forestry and outdoor recreation.

U.S. Army Corps of Engineers

The Army Corps of Engineers (COE) regulates activities in water and wetlands under four separate, but related laws: Rivers and Harbor Act of 1899, as amended, Federal Water Pollution Control Act of 1972, Clean Water Act of 1977, and Marine Protection Research and Sanctuaries Act of 1972. The COE's major responsibilities in the Pensacola basin are maintenance of congressionally-authorized navigation channels, pollution abatement, maintenance of water quality, and enhancement of fish and wildlife. Pensacola Bay system navigation projects which have been performed by the COE include maintenance of channels for the Pensacola Harbor and entrance channel, the entrance to the Bayou Chico channel and turning basin, and emergency dredging of the Bayou Texar navigation channel. Under Section 404 of the Federal Water Pollution Control Act of 1972, the COE has regulatory authority over dredge and fill activities. The agency is also involved in permitting placement of dredge and fill materials in navigable waters and adjacent wetlands. In addition, the COE provides some funding for aquatic plant control in navigable public waters.

U.S. Department of Transportation

U.S. Coast Guard

The U.S. Coast Guard is responsible for regulation of boating safety, search and rescue, interdiction of narcotics importation, fisheries enforcement in the U.S. Exclusive Economic Zone (EEZ), and a variety of other activities for protection of the nation's coastline. The Coast Guard regulates construction of structures such as bridges, causeways, and aerial utilities which may pose navigation hazards and addresses commercial navigation safety issues. The Coast Guard also responds to oil spills and releases of hazardous substances and marine debris.

U.S. Department of Commerce

National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) records commercial fish landings, enforces national fishery laws, and protects vital fishery resources in federal waters. The Environmental Assessment Branch comments on federal permit applications which may adversely impact fishery resources.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA), Office of Coastal and Resources Management (OCRM) administers the Coastal Zone Management Act (CZMA) at the federal level. The CZMA recognizes competing demands on limited coastal resources and encourages coastal states to develop Coastal Management Plans (CMPs) to ensure the beneficial use, protection, and development of the coastal zone. As incentive for the states, the CZMA empowers them with review authority of proposed federal actions. Actions found inconsistent with approved state programs may be modified or blocked. Additionally, states with approved programs are eligible for federal coastal zone management funding. The OCRM administers Coastal Zone Enhancement Grants to states with approved CMPs, exercises oversight and approval over state CMPs, and exercises joint oversight with EPA over the Coastal Nonpoint Pollution Control Program. The Office of Oceanography and Marine Assessment, Ocean Assessment Division (OAD) conducts research, assessment, and monitoring activities on environmental quality issues in estuaries. Through its National Status and Trends Program (NS&T), OAD is conducting a nationwide monitoring program to assess chemical contamination in estuaries throughout the country. With the National Coastal Pollutant Discharge Inventory, OAD determines sources and analyzes the composition of discharged pollutants in estuaries. The OAD also has a National Estuarine Inventory which characterizes the physical and hydrologic features of the nation's estuaries and coastal areas. The National Estuarine Research Reserve (NERR) program, originally the National Estuarine Sanctuaries program, was established in 1972 with the enactment of the Coastal Zone Management Act. Under this program, matching funds are provided to support the establishment of research facilities and educational programs. There are currently 21 National Estuarine Research Reserves, not including Pensacola Bay.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) is responsible for the control and abatement of air, water, noise, solid waste, toxic waste, and radiation pollution. The EPA has delegated authority to the Florida DEP for hazardous waste cleanup, public drinking water systems, and point source pollutant discharges. The EPA exercises oversight of state programs such as wetland dredge and fill permitting and nonpoint discharge elimination. The EPA also provides overall coordination for the Gulf of Mexico Program, a cooperative effort involving five states, 11 federal agencies, and two countries. The general objective of this program is to protect, restore, and enhance coastal and marine waters of the Gulf of Mexico and adjacent lands and to protect the quality of recreational use and economic vitality. Specific issue areas addressed by the program include nutrient enrichment, coastal erosion, marine debris, habitat degradation, freshwater inflow, public health, and living aquatic resources. The EPA coordinates the National Estuary Program (NEP), which was established by Congress in 1987 as part of the Clean Water Act. This program is designed to facilitate cooperative public-private efforts to protect and restore the health of estuaries while supporting associated economic and recreational resources. Currently 21 estuaries (not including Pensacola Bay) are part of the NEP. The EPA Office of Research and Development (ORD) has initiated the Environmental Monitoring and Assessment Program—Estuaries (EMAP-E) to quantitatively assess pollution and the success of pollution control in near coastal waters. Additionally, the EPA administers the national Nonpoint Source Management Program, established in 1987 under Section 319 of the Clean Water Act. This program provides for states to develop NPS assessments and management programs to reduce NPS pollutant loadings in problem areas using BMPs and other measures. The programs must be watershed-based to the maximum extent practicable. Federal matching funds are available for states with approved programs.

Community Associations and Other Private Initiatives

Private organizations play an instrumental role in management and protection of the resources of the Pensacola Bay system. Among the contributions of these organizations are elevating resource issues on the public agenda, providing guidance and insight to resource management agencies, and participating in the planning and implementation of specific projects. A few of the private initiatives active within the Pensacola Bay system watershed are the Bayou Chico Association, the Bayou Texar Foundation, and the Santa Rosa Sound Coalition.

Special Resource Management Designations

Public Land Ownership

Agencies managing public lands within the Pensacola watershed include the NWFWMD, DACS (Division of Forestry), DEP (Division of Recreation and Parks), the U.S. Department of the Interior (Gulf Islands National Seashore), and the U.S. Department of Defense. Public lands are used for a variety of purposes, including, but not limited to, resource management. Descriptions of land management objectives and activities are contained within the discussion of individual agencies and organizations.

The Land Management and Advisory Council (LMAC) is an interagency committee which advises the Board of Trustees (Governor and Cabinet) on the management of natural resource lands administered by state agencies. All management agencies must submit management plans to LMAC within one year after a lease is signed for lands 160 acres and greater. The LMAC has approval/disapproval/deferral authority delegated to it by the Trustees.

Outstanding Florida Waters (OFW)

Rule 62-302.700, F.A.C. directs that the “highest protection” be provided to waters designated as OFW. No degradation to water quality is allowed in these waters other than as provided in Rule 62-4.242 (2) and (3), F.A.C. Within OFWs, dredge and fill activities may not be permitted unless they are deemed “clearly in the public interest” (Section 403.918, F.S.).

Waters within the Pensacola Bay watershed that are designated as OFW include waters within state parks and recreation areas, aquatic preserves, other designated special waters, the National Seashore, and lands acquired under the Environmentally Endangered Lands, Conservation and Recreation Lands (CARL), and Save Our Coast programs (program areas). Specific OFWs within the Pensacola Bay SWIM planning area include the following:

- Blackwater River;
- Shoal River;
- Blackwater River State Park;
- Escambia Bay Bluffs Program Area;
- Milton to Whiting Field Program Area;
- Fort Pickens State Park Aquatic Preserve;
- Yellow River Marsh Aquatic Preserve; and
- Waters within Gulf Islands National Seashore.

Classification of Surface Waters

The state's surface waters have been classified according to their "designated use," which is defined as their "present and future most beneficial use" (Chapter 62-302, F.A.C.). Waters are classified I through V, with Class I generally having the most stringent standards and Class V the least. Classifications and designated uses are:

- Class I – Potable Water Supplies;
- Class II – Shellfish Propagation or Harvesting;
- Class III – Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife;
- Class IV – Agricultural Water Supplies; and
- Class V – Navigation, Utility, and Industrial Use.

Most of the tributaries, lakes, and a portion of the bays within the Pensacola Bay system are Class III waters. Exceptions to this are portions of Pensacola Bay, Santa Rosa Sound, and Blackwater Bay and most or all of Escambia Bay and East Bay and some of their tributaries, which are Class II. Class II waters are those which either actually are or potentially have the capability of supporting recreational and commercial shellfish propagation and harvesting.

ACCOMPLISHMENTS OF THE PENSACOLA BAY SYSTEM SWIM PROGRAM: 1990 - 1996

Accomplishments of the Pensacola Bay System SWIM Program

This is the second revision of the Pensacola Bay system SWIM Plan following its initial approval in 1988. There have been a number of accomplishments under the previous plan revision, although much of the project work previously approved has not been completed due to funding limitations. Past planning and project accomplishments provide a foundation for the current plan.

Overview

The Pensacola Bay system SWIM Plan was adopted in November 1988, and progress has been made toward implementation of elements within the plan. This section provides brief, project-by-project reports of implementation activities. Additionally, Table 2 summarizes activities conducted under the 1990 SWIM plan and indicates relationships with the current project plan.

Although funding limitations prevented fully implementing the plan, the completion of project work as outlined has been essential to determining a future course of action. Project work completed includes a review of the 1970s' Water Pollution Control Plan; preliminary nonpoint loading estimates; assessment of water quality data; analysis of historical tributary monitoring data; stormwater assessments for the Palafox/Coyle, Bayou Texar, and Bayou Chico watersheds; point source compliance assessment; Pensacola Bay system biological monitoring needs study; scientific literature review of the Pensacola Bay system; interstate coordination; an institutional and regulatory assessment; and initial work to protect Jones Swamp. This work was accomplished in partnership with other organizations, including the City of Pensacola, Escambia County, the Bayou Chico Association, Bayou Texar Association, the Bay Area Resource Council, the University of West Florida, and the U.S. Environmental Protection Agency, the Florida Department of Environmental Protection, and the Florida Communities Trust program.

Accomplishment of this work has also been helpful for recognizing activities taking place in the watershed outside of the SWIM management framework. By the time of the 1990 plan revision and the 1993 SWIM priority list update, it had become apparent that a more integrated management approach should be applied to SWIM planning and project work. Thus, the program began to focus on enhanced strategies for comprehensive watershed management and protection.

During fiscal years 1993-94, funding limitations resulted in little progress for the Pensacola Bay system program. The District, however, was able to focus efforts on reviving the program for future work and completing project work that had been initiated previously. One of the key elements in developing a successful future program was the building of community and local government support for watershed management. This was accomplished with the help of the City of Pensacola and Escambia County which, in recognition of the importance of future work planned under SWIM, committed to matching funds in the upcoming fiscal year.

In 1995, significant progress was made towards obtaining funding for preferred restoration alternatives developed under the SWIM program. Although the Pensacola Bay system SWIM program continued to be hampered by a relatively low level of funding, it was evident that past SWIM efforts, with the support and cooperation of local governments and other agencies, began to come to fruition. Much of the progress is attributable to close coordination between local governments and agency staff, as well as the development of a sound technical basis prior to recommending implementation funding.

Also in 1995, technical assistance was provided to Escambia County and the City of Pensacola to obtain grants for the construction of stormwater treatment facilities in the Bayou Chico and Bayou Texar watersheds. The proposed stormwater treatment facilities will provide for the retrofit of existing development in the basin which occurred before state and local stormwater treatment regulations were implemented. In July 1995, the Department of Environmental Protection announced that the projects for both bayous were approved and that construction would be funded through the Florida Pollution Recovery Program. Facility design activities (described below) continue through SWIM.

Assistance was provided to Escambia County in submitting a Preservation 2000 grant application to the FCT for the preservation of the Jones Creek Swamp, part of the Bayou Chico watershed. The District also submitted a separate proposal to the U.S. Environmental Protection Agency in support of this preservation effort. Both grants were awarded. The total value of these grants to Escambia County and the City of Pensacola is $1.7 million. Future efforts under SWIM will be used to help match the grants awarded. None of these grants would have been possible without the previous technical studies conducted through the SWIM program. Implementation of these restoration and preservation projects will help improve the quality of water and estuarine habitats of the Pensacola Bay system.

Project Accomplishments and Linkage With Current Project Plan

The current project plan has been revised to reflect past completion of project work; to better address priorities and needs as are currently understood; and to improve the linkage between issues, strategies, and projects. Because many projects described in the previous plan revision were not completed due to limitations in funding and staff resources, they are continued with this revision. The project numbering system has also been simplified. Additionally, the Nonpoint and Point Source programs have been combined into a single Water and Sediment Quality program. During the development and review process of this plan revision, it became apparent that the linkage between issues, strategies, and projects could be improved. Following this, and due to the completion of earlier point source-specific tasks, it became apparent that point and nonpoint sources and their impacts should be considered in an integrated manner (most water and sediment quality projects, for example, cannot be categorized as either point or nonpoint projects, to the exclusion of the other).

Table 2 links current projects with those previously planned and initiated. The discussion following the table amplifies specific past project accomplishments.

Table 2. Summary of 1990 Pensacola SWIM Plan Project Accomplishments and Relationships with Current Plan

1990 SWIM Plan Project Number	Project Name in 1990 SWIM Plan	Major Project Tasks Completed Since Adoption of 1990 SWIM Plan	New Project Number (work planned as a result of recommendations from previous project work or tasks remaining from the 1990 SWIM plan)
NP-01.1	Review of 208 Plan	All tasks were completed including a Report: Review of the Pensacola Bay System Nonpoint source 208 Plan Methodologies (1993). A range of loading rates, problems with the quality of historical data, and the need for new data were discussed.	WSQ 1.0 through WSQ 7.0, APC 1.0 through APC 4.0. All tasks are new, as there are no remaining tasks from the 1990 SWIM plan project.
NP-01.2	Nonpoint Loading Rate Analysis	Report Complete: Preliminary Nonpoint Source Loading Rate Analysis (1994).	The approach to developing a detailed land use and loading rate analysis recommended in the 1994 report has been incorporated primarily into WSQ 2.0. All other WSQ projects and APC 3.0 and APC 4.0 should help support work under WSQ 2.0. WSQ 2.0 now supports efforts to protect riverine water quality as well as estuarine water quality.
NP-02.1	Assessment of Existing Water Quality Data	Report Complete: Analysis of the Suitability of Existing STORET Data for Loading Calculations in the PBS (1992).	Difficulties in the use and a lack of quality control in the STORET data have been considered in the development of project WSQ 1.0.
NP-02.2	Tributary Monitoring	No major tasks completed. Preliminary site reconnaissance and discussion with the FGFWFC and Blackwater River State Forest staff were conducted.	All tasks in NP-02.2 have now been incorporated into WSQ 1.0. WSQ 1.0 is now a higher priority, because it places emphasis on the need to address riverine water quality as well as loading into the estuarine system.
NP-03	Role of Bay Sediments in Water and Habitat Quality	Only Non-SWIM funded efforts by US EPA, ECUA, and NWFWMD to evaluate sediment and water quality were completed.	WSQ 8.0 utilizes US EPA, ECUA, and other study results to consider the health of the system, effects of storms and other events, and future monitoring needs. WSQ 8.0 was designed to address ongoing research efforts and better define management objectives as a result of this research.

Table 2: Summary of Project Plans and Accomplishments of the 1990 Pensacola SWIM Plan and Relationships With Current Project Plan (continued)

NP-04.1	Bayou Chico Restoration Project	Reports Completed: Stormwater Assessment of the Bayou Chico Watershed (1993), and Bayou Chico Sediment and Water Quality Data Report (1994). These document stormwater retrofit and other watershed and in-estuarine restoration needs.	Currently ongoing tasks in the project NP-04.1 of the old SWIM plan, including tasks 9,10,11,12,13 have been incorporated into WSQ 3.0 - Bayou Chico Restoration.
NP-04.2	Implementation of Restoration Alternative for Bayou Chico	Efforts to obtain funding for watershed protection and restoration and to evaluate estuary restoration have begun.	All tasks under NP-04.2 have been incorporated into WSQ 3.0, Bayou Chico Restoration.
NP-05.1	Bayou Texar Watershed Project	Non-SWIM funded efforts completed, including hydrologic data collection and modeling, water quality sampling, and identification of stormwater facility site needs.	Tasks remaining under NP-05.1 have been deferred, since the City of Pensacola and Non-SWIM funded efforts by the NWFWMD have been completed.
NP-05.2	Stormwater Treatment Facilities For Bayou Texar	A detailed design for retrofitting a facility on Carpenters Creek has been developed, and a grant has been obtained for construction of the project.	All tasks under NP-05.2, including technical assistance for developing and implementing a Stormwater Retrofit program, have been incorporated into WSQ 5.0.
NP-06.1	Palafox/Coyle Stormwater Assessment	Reports completed: Stormwater Assessment of the Palafox Watershed (1993) and Stormwater Monitoring Assessment of the Coyle Watershed (1995). These provide guidance for improved stormwater management and the design of stormwater treatment facilities.	See NP-06.2 below.
NP-06.2	Implementation of Restoration Alternatives for the Palafox and Coyle Watersheds	No tasks have been completed with SWIM funds under this project.	All tasks under NP-06.2 have been incorporated into WSQ 7.0.

Table 2: Summary of Project Plans and Accomplishments of the 1990 Pensacola SWIM Plan and Relationships With Current Project Plan (continued)

NP-07	Septic Tank Impact Assessment	No work has been performed under NP-07; however, a number of septic tank issues have been identified under NP-04.1, AP-01.0.	All tasks under NP 07 have been deferred. The project WSQ 4.0 replaces NP -07.
PT-01.1	Point Source Evaluation-Compliance Assessment	A working paper: "Point Source Assessment of the Pensacola Bay System (1991)" was completed. Other efforts have been to meet with FDEP staff to discuss point source compliance issues throughout NWFL.	All point source evaluation tasks, including an inventory of existing point sources are now covered under one point source project—WSQ 9.0. The working paper recommendations were used in part to develop the project plans for WSQ 9.0.
PT-01.2	Evaluation of Wasteload Allocations	Efforts were limited to the initial review of water quality data.	All tasks under PT-01.2 except water quality sampling tasks have been incorporated as a part of WSQ 9.0.
HA-01	Biological Monitoring Needs Assessment	Reports Completed: The PBS Biological Trends and Current Status and Management Options for the Pensacola Bay System (1991).	Recommendations from the reports completed under HA-01 have been used to develop the Biological Monitoring project—HAB 3.0.
HA-02.1	Preservation of Emergent Saltmarsh Habitat	None.	HAB 1.0 replaces HA-02.1. The overall strategy is to consider cumulative impacts and develop a more system-wide and comprehensive approach to habitat protection.
HA-02.2	Experimental Seagrass Planting	None.	None.
HA-02.3	Refurbishment of Oyster Bar Habitat	None.	None.
HA-02.4	Biological Monitoring Project	None.	HAB 3.0 and APC 4.0 replaces HA-2.4.
HA-02.5	Preservation of Bottomland Hardwood and Other Important Habitats	Preservation of the 1,300 acre Jones Creek wetland is ongoing.	HAB 2.0 and APC 4.0 replaces HA-02.5. The overall strategy is to consider cumulative impacts and development through a state- and federally-supported system-wide and comprehensive approach to habitat protection. In addition, the project provides technical assistance to local governments on wetland protection issues.
HA-03.1	Review of Scientific Literature	Report Completed: A Literature Based Review of the Physical, Sedimentary, and Water Quality Aspects of the PBS (1992).	Recommendations from the 1992 report have been used to develop projects such as HAB 3.0, HAB 4.0, WSQ 8.0, and WSQ 9.0.

Table 2: Summary of Project Plans and Accomplishments of the 1990 Pensacola SWIM Plan and Relationships With Current Project Plan (continued)

HA-03.2	Initial Hydrodynamic Model Application	A non-SWIM funded preliminary hydrodynamic model analysis was performed.	Results of this analysis have been used to develop the project HAB 4.0.
HA-03.3	Circulation Studies of the Pensacola Bay system	None.	HAB 4.0 replaces HA-03.3.
AP -01	Administration and Planning	Adopted 1990 Plan and ongoing efforts.	APC 1.0 replaces AP -01; however, the two projects are essentially synonymous.
AP-02	Interstate Coordination Project	Interstate coordination efforts have been conducted to a limited extent under AP-01 and through other SWIM waterbody programs. This includes contact with Alabama State Agencies and review of Federal programs under the US EPA and NRCS.	APC 3.0 replaces AP-02.
AP-03	Institutional/Regulatory Assessment	A SWIM-funded WFRPC Report was completed.	Due to a number of new programs and institutional arrangements since the inception of the PBS SWIM plan, there is a recognized need for continued interagency coordination and assessment of ongoing activities effecting the management of the system. APC 2.0 replaces AP-03.
E-series	Public Education and Awareness	Efforts were limited to meetings with local officials, educators and citizens, and support for media coverage of events regarding SWIM program activities.	ED 1.0, ED 2.0, and ED 3.0 replaces all E-series projects.

NP-01 Nonpoint Assessment

Review of 208 Plan (NP-01.1). The 208 study is a comprehensive study of the system conducted by the West Florida Regional Planning Council in the late 1970s. The 208 study evaluated nonpoint sources of pollution by quantifying the pollutant loadings and described both urban and rural sources. A lack of funding prevented any major implementation of the 208 study recommendations to address the nonpoint source pollution problems. A review of the existing 208 Plan was completed in 1990, and a draft copy was circulated for District review. In 1992, the 208 study review was updated to consider local comprehensive planning ordinances and regulations from Escambia and Santa Rosa counties which may have been implemented as a result of the 208 plan recommendations. In 1993, a final report entitled Review of the Pensacola Bay System Nonpoint Source 208 Plan Methodologies (NWFWMD, 1993) which reviewed the 208 study planning objectives of the late 1970s was released. The main benefit of this review was to provide insight and guidance for future plans with respect to the management of the PBS as well as address the major limitations of the 208 planning efforts. The need for an accurate and complete environmental database and a monitoring program to assess the effectiveness of or need for pollution abatement measures and controls is recommended in this report.

Nonpoint Loading Rates (NP-01.2). In 1990, efforts were begun to estimate loading rates on all watersheds in Escambia and Santa Rosa counties using GIS-produced land use and basin maps. Final analyses were completed in April 1991, and, in 1992, a draft report was submitted to DER and the PBS TAC for review. The report documents the results of the preliminary loading rate analysis as outlined in the SWIM plan and provides coarse estimates of nonpoint source pollution loading from Escambia and Santa Rosa counties. The report also discusses the usefulness of land use loading rate analysis techniques, future research, and stormwater sampling and management as a planning tool. As part of the regional scale loading rate analysis, a sensitivity analysis was performed on roadways to consider the importance of roads on a regional scale. In 1994, a final report entitled Preliminary Nonpoint Source Loading Rate Analysis of the Pensacola Bay System (Hunner et al., 1994) documenting preliminary loading rates used in the Pensacola Bay area was released. The report discusses the limitations of the loading rate estimates made and needs for future water quality monitoring and land use loading rate analysis in the area. The need for using “actual” versus “potential” land use data is emphasized.

NP-02 Tributary Monitoring

NP-02.1 Assessment of Existing Water Quality Data. The project was initiated to assess the suitability of existing water quality data for nonpoint loading calculations for the Pensacola Bay system. The analysis centered on examining National Stream Quality Accounting Network (NASQAN) data for the Escambia and Yellow rivers. In 1990, a preliminary report analyzing existing STORET data was completed and submitted for review. At the beginning of 1992, the final report entitled Analysis of the Suitability of Existing STORET Data for Loading Rate Calculations in the Pensacola Bay System (Roaza and Pratt, 1992) was revised and distributed. The report summarizes several key observations including a lack of flow data and limited sampling at various flow regimes which suggest historical data is severely limited for the purpose of undertaking loading estimates.

NP-02.2 Tributary Monitoring. This project proposes to establish water quality monitoring sites based upon information contained in the report produced by project NP-02.1. To date this project has not been implemented.

NP-03 Role of Bay Sediments in Water and Habitat Quality

This project proposes to conduct experiments to examine the exchange of pollutants from sediments into the water column in order to determine the relative impact of contaminated sediments on the overall status of the PBS. To date this project has not been implemented.

NP-04 Bayou Chico Restoration Project

NP-04.1 Bayou Chico Restoration Project. Stormwater and tidal station maintenance and data collection were conducted throughout 1990 at three stormwater flow monitoring stations and two tidal stations. Gage height data generated from these stations was incorporated into District databases. In late July, sediment and water quality sampling were conducted in the bayou, and stormwater sampling was initiated. Stormwater management models were also developed, and salinity and circulation data were collected for a preliminary hydrodynamic model application. Work was initiated on documentation of the results of modeling efforts. Work was also initiated on the application of the stormwater model to identify restoration alternatives for the Bayou Chico watershed. Activities performed in 1992 included completion of the draft Stormwater Report, internal review of the draft, and submission of it to DER for review. In 1993, a final report for the Bayou Chico stormwater assessment (Stormwater Assessment of the Bayou Chico Watershed) (Pratt et al., 1993) was completed. The report provided important information on surface water discharges to the bayou and a sound basis for making future recommendations for providing stormwater treatment in the watershed.

Stormwater retrofit activities conducted for the bayou since 1993 include the detailed design of a stormwater retrofit facility and development of conceptual plans for watershed restoration. In addition, progress was made on compiling information on the quality of Bayou Chico bottom sediments. In 1994, a data report, entitled Bayou Chico: Sediment and Water Quality Report (Wood and Bartel, 1994), was completed. Efforts continued to consider the feasibility of estuarine restoration alternatives for Bayou Chico as well as those for stormwater treatment. The removal of bottom sediments at selected sites from the bayou has been the primary focus of this effort. Several meetings were held with residents from the local community surrounding the bayou who expressed strong support for the implementation of restoration work. In 1995, discussions continued with residents, Bayou Chico community officials, and multiple agencies including the U.S. Army Corps of Engineers to coordinate possible restoration activities. Retrofit facility design work continues, in partnership with the Bayou Chico Association and the local government.

NP 04.2 Implementation of Restoration Alternatives for Bayou Chico. The goal of this project is to implement a preferred restoration alternative(s) to mitigate the effects of uncontrolled urban stormwater runoff on Bayou Chico. To date this project has not been implemented, although detailed engineering design work has commenced for one sub-watershed in the northeast portion of the basin to use grant funding from the Florida Pollution Recovery Program.

NP-05 Bayou Texar Watershed Project

NP-05.1 Development of Stormwater Management Plan for Bayou Texar. This project entailed collecting watershed data and calibrating and applying a hydrologic watershed model. Most of this project has been implemented through non-SWIM funded activities.

NP-05.2 Bayou Texar Stormwater Treatment Facility. Work on this project was initiated in 1996. The project is a cooperative effort involving the City of Pensacola, Escambia County, the Florida Department of Environmental Protection, and the District to make improvements within the Bayou Texar watershed. Funding for construction was obtained through a grant award from the Florida Pollution Control Recovery Program. As match towards the grant award, the SWIM Program is providing detailed engineering design work for retrofit of a water control structure at the I-110 crossing of Carpenters Creek to increase the storage/detention capacity of a detention area upstream of the structure. Progress made thus far includes development of funding agreements and preliminary design.

NP-06 Palafox and Coyle Watersheds Project

NP-06.1 Palafox/Coyle Stormwater Assessment. In January 1990, two stormwater flow monitoring stations were installed and stormwater station maintenance and data collection were conducted throughout the year. Work was conducted on the analysis of land use-loading rate relationships in the Palafox watershed. A percent impervious calculation of the Palafox and Coyle watersheds was also completed, and application of the Stormwater Management Model (SWMM) was initiated. The preliminary model application was undertaken to develop time-step lengths for the sampling sequences of automated water quality sampling stations. In 1992, a draft report on the 3,300-acre Palafox watershed was completed and submitted to DER for review. The final report, Stormwater Assessment of the Palafox Watershed (Guo and Pratt, 1993), includes the results of the calibrated SWMM developed for stormwater management in the basin, a loading rate analysis, and the results of stormwater flow and water quality sampling programs. The report provides recommendations for retrofitting the watershed with regional facilities for stormwater treatment. Work also continued on a pollutant loading rate analysis and water quality data report for the Coyle watershed. In 1994, a final report for the Coyle watershed was released which describes the pollutant loading rate analysis and water quality data.

NP-06.2 Implementation of Restoration Alternatives for Palafox/Coyle. This project proposes to evaluate the results of the Palafox and Coyle stormwater study to characterize the requirements of the structural alternative and develop the best practical locations for the treatment facility. To date this project has not been implemented.

NP-07 Septic Tank Impact Assessment

The objective of this project is to assess the significance of this source of pollution relative to other sources of pollution that impact the system and to reduce the amount of nutrients entering the system from failed or failing septic tanks. To date this project has not been implemented.

PT-01 Pensacola Bay System Point Source Evaluation

PT-01.1 Compliance Assessment. From January until June of 1990, sources of point source information were identified through project research and incorporated into a preliminary Pensacola Bay watershed point source assessment. Following incorporation of comments received, as well as additional data, a final paper entitled Point Source Assessment of the Pensacola Bay System: A Working Paper (Wiley et al., 1990), was completed. The project was closed in 1993 following the recommendation for development of a District-wide review procedure for future point source regulatory issues. This procedure may be beneficial in the review of future point source permit applications within the PBS.

PT-01.2 Evaluation of Wasteload Allocations. In 1993, initial project efforts focused on the assembly of available information, coordination efforts with DEP staff, and development of detailed project plans. In 1994, staff continued to review available information which could be used in the development of wasteload allocations and to coordinate with the DEP staff on project development.

HA-01 Pensacola Bay System Biological Monitoring Needs Assessment

An extensive data and literature review entitled The Pensacola Bay System: Biological Trends and Current Status (Collard, 1991a) was developed on-contract by Dr. Collard of the University of West Florida. This review focused on biological and ecological studies and reports associated with the PBS and trends which may be derived. The biological, ecological, and chemical trends assessment included maps of historical seagrass distribution and comprehensive appendices documenting data trends on fisheries, aquatic habitat, emergent vegetation, and seagrasses. A final report entitled Management Options for the Pensacola Bay System: The Potential Value of Seagrass Transplanting and Oyster Bed Refurbishment Programs (Collard, 1991b) described and assessed proposals for habitat restoration and biological monitoring.

HA-02 Improvement and Monitoring of Habitat and Biota

HA-02.1 Preservation of Emergent Salt Marshes. In 1993, project activities were redirected to take a broader look at preservation activities from a comprehensive management perspective. This involves approaching salt marshes from a system-wide basis, while tracking site-specific activities. It also promotes enhanced lines of communication with state and federal initiatives for preservation and restoration. In 1994, project activities were limited to review of existing maps and geographical databases that may be useful for developing a comprehensive management approach and tracking the status of salt marshes on a system-wide basis.

HA-02.2 Experimental Seagrass Planting. This project has not been implemented.

HA-02.3 Refurbishment of Oyster Bar Habitat. This project has not been implemented.

HA-02.4 Biological Monitoring Project. This project has not been implemented.

HA-02.5 Preservation of Bottomland Hardwoods and other Important Habitats. In 1992, a research evaluation was performed for Escribano (Santa Rosa County), Freeman and Harris (Walton County) properties. Purchase of these properties was recommended based on their excellent condition and the existence of at least one state-threatened plant species on two of the tracts. Escribano Point was subsequently placed on the District's Priority Acquisition List. Initial resource assessment conducted under this project ultimately resulted in the approval of the primary Garcon

Point acquisition. In 1993, activities were limited to map reviews of the Jones Creek watershed, which was recommended for preservation in the Bayou Chico Stormwater Assessment report. In 1995, project activities focused on development of grant applications in cooperation with Escambia County, the Florida Communities Trust program, and The Nature Conservancy to provide technical data and funding for the acquisition of the 1,300-acre Jones Swamp area as a preserve.

HA-03 Circulation Studies of the Pensacola Bay System

HA-03.1 Review of Scientific Literature of the Pensacola Bay System. Under this project, a review and compilation of existing research was conducted. The final report, A Literature Based Review of the Physical, Sedimentary, and Water Quality Aspects of the Pensacola Bay System was completed in 1990 and revised in 1992 (Jones et al., 1992).

HA-03.2 Initial Hydrodynamic Model Application. The development of the bathymetry and grid, as well as initial test runs, were conducted in 1990 with non-SWIM funds.

HA-03.3 Circulation Studies of the Pensacola Bay System. To date this project has not been implemented.

AP-01 Planning and Administration

Ongoing activities have included coordination with outside agencies and oversight of specific project work. In 1993, the process of updating the SWIM plan was initiated. This, however, was later put on hold in order to focus available resources toward completing ongoing projects and reports. The completed reports provided an informational resource for ongoing management needs and developing a future project plan. Efforts in 1994 continued to emphasize completing reports from ongoing projects. Planned priorities in 1995 included completing the SWIM plan revision; however, funding of the project became critically short. Limited efforts continued for development of detailed work plans for SWIM project work under the current plan and for coordination of multiple agency activities. Interagency communication activities included meeting with local officials, community officials, and members of the Bay Area Resource Council to secure funding support for ongoing restoration activities. Efforts in 1996 emphasized developing a draft SWIM plan revision, including meeting with local governments, other state and federal agencies, and the TAC so as to more comprehensively address relevant issues.

AP-02 Interstate Coordination Committee

This project provides for designated individuals from the states of Alabama and Florida to meet and discuss mutual areas of interest, land use and water management practices, address major problems, and develop strategies for alleviating those problems. This specific project has not yet been implemented due to funding limitations; however, coordination and communication with Alabama officials have been initiated through implementation of other SWIM plans.

AP-03 Institutional/Regulatory

In 1993, this project was reactivated to integrate new programs into the SWIM PBS management strategy. In 1994, additional programs were identified for inclusion in the SWIM Pensacola Bay system management strategy. These programs, which had not previously been included in the PBS SWIM plan, included the U.S. EPA NPDES program, federal maximum daily pollutant load requirements (TMDLs), local government comprehensive plans, state requirements for establishing pollutant load reduction goals (PLRGs), and mitigation banking.

E-01 Public Education Working Group

This project has not been implemented.

E-02 Printed Materials

Activities in 1991 included revisions to the Pensacola Bay System SWIM Plan, development of original artwork for the plan cover, and printing the plan.

E-03 Media Relations

In 1990, District staff participated in a live radio call-in show "Our Bays and Bayous" with WSRE-TV in Pensacola.

E-04 Corporate/Private Sponsorship

This project has not been implemented.

E-05 Miscellaneous Awareness Activities

In January 1990, a field trip to Bayou Chico, Pensacola Bay, and Bayou Texar was conducted. City and county officials, neighborhood association heads, local media, District governing board members, and other resource agency staff participated in the event. In 1994, staff developed revisions for the public awareness and education portions of the PBS SWIM Plan. Staff also interviewed local teachers and interacted with the Escambia County Utilities Authority's education program and with the Marine Task Force to discuss ideas for the public awareness and education strategies.

E-06 School Programs

This project has not been implemented.

E-07 Educational Materials

This project has not been implemented.

E-08 Outdoor Education Displays

In 1990 a SWIM Program exhibit was displayed at the Pensacola Seafood Festival and Earth Day.

E-09 Community Activities

This project has not been implemented.

E-10 Public Awareness Survey

This project has not been implemented.

ADDITIONAL RESOURCE MANAGEMENT INITIATIVES: 1990 - 1996

Additional Resource Management Initiatives Important to the Pensacola Bay System

A number of important resource management initiatives in addition to SWIM have been conducted for and/or are ongoing within the Pensacola basin. Along with accomplishing specific objectives, these initiatives help define the course and framework for the overall, multi-agency and multi-jurisdictional effort which comprises the management of this system.

Many of the initiatives described below are cooperative, multi-party (public and private) initiatives. Although they are not specifically SWIM projects, for example, SWIM has funded component activities of several of them. Project funding is included where available.

Ecosystem Management (DEP)

In response to Chapter 93-210, Laws of Florida, which made it the policy of the Florida Legislature to “protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs,” the Florida DEP established the Ecosystem Management Implementation Strategy (EMIS) in 1995 (Barnett et al., 1995; DEP 1995). The Department’s working definition of ecosystem management is “...an integrated, flexible approach to management of Florida’s biological and physical environments—conducted through the use of such tools as planning, land acquisition, environmental education, regulation, and pollution prevention—designed to maintain, protect, and improve the state’s natural, managed, and human communities (Barnett et al., 1995).” The EMIS recognized the importance of stewardship—that is, a sense of ownership and responsibility for our land, air, water, and other resources—as a key to successful implementation ecosystem management. The strategy identifies and describes four cornerstones of ecosystem management as follows.

a) *Place-Based Management* focuses on areas or places of sufficient size to address major hydrological and ecological connections. These Ecosystem Management Areas (EMAs) can include urban, rural, developed, and undeveloped lands. Specific environmental issues are identified and addressed by local EMA teams, participation on which is voluntary and open to all.

b) *Common Sense Regulation* is primarily concerned with environmental results. It recognizes that traditional regulatory programs are valuable and should not be abandoned; however, it also recognizes the need to find and facilitate workable alternatives which provide incentives for the regulated public to voluntarily go beyond compliance to active stewardship.

c) *Cultural Change* involves attitudes of both agency employees and the citizens of the state. Ecosystem management encourages non-adversarial, voluntary partnerships between government and the citizenry and emphasizes the importance of informed and active citizens for the achievement of positive, long-term environmental results.

d) *Foundations for Ecosystem Management* include science and technology, environmental education, employee training, program audit and evaluation, related factors which create an environment in which ecosystem management may occur.

The Greater Pensacola Bay EMA was identified by the Northwest District office of DEP. It corresponds with the revised Pensacola Bay system SWIM watershed.

Local Comprehensive Planning (Local Governments; Florida DCA)

County and municipal governments in Florida's portion of the Pensacola Bay watershed have adopted and implemented local comprehensive plans in accordance with Chapters 168 (Local Government Comprehensive Planning and Land Development Regulation Act), 186 (Florida State Comprehensive Planning Act), and 187 (State Comprehensive Plan), Florida Statutes, and Rule 9J-5, Florida Administrative Code. Local comprehensive plans guide future development within lands of local government jurisdiction and thus have the potential to profoundly affect the future quality of water and related natural resources. Components of local comprehensive plans are described below in the "Ongoing Resource Management Activities" section.

Point Source Discharge Improvements (DEP; Local Governments)

The point source permitting program, administered by the Florida DEP, is a continuing process of upgrading point sources and, encouraging and assisting the conversion of surface water discharges to upland, reuse discharges. Examples of improvements since the last SWIM plan include the abandonment of the East Milton Elementary School discharge (connected to the City of Milton sewage treatment plant), the conversion of the City of Crestview discharge to upland spray irrigation, and the abandonment of the Warrington surface water discharge (Smith, 1997). Additionally, the Whiting Field surface water discharge will be abandoned in the near future when effluent will be diverted to the City of Milton. No new major surface discharges have been permitted in the system.

National Pollutant Discharge Elimination System (NPDES) Nonpoint Permitting (U.S. EPA; Local Governments; DEP)

Section 402 of the 1987 Clean Water Act established permit requirements for certain municipal and industrial stormwater discharges. Under Phase I of the program, NPDES permits are required for municipal storm sewers serving populations greater than 100,000 people, as well as industrial stormwater discharges. Escambia County and the City of Pensacola applied for a joint permit under this program. Under Phase II of the program, scheduled for implementation in 2001, local governments with populations over 10,000 may also have to enter into a revised permit process.

Local Government Stormwater Management and Treatment Plans (Local Governments)

Escambia County and the City of Milton have recently completed and implemented stormwater master plans, which include identification of drainage basins, structures, and needed improvements. Additionally, Escambia County has passed a sales tax of one cent per gallon of gas, a portion of which goes to help pay for stormwater management and treatment.

Superfund Site Identification and Restoration (U.S. EPA; City of Pensacola)

According to Martin (1997), Agrico and Escambia Wood Treating Company Superfund sites are located within ¼ mile of each other in downtown Pensacola. Contaminants from both sites include dioxins, furans, benzo(a)pyrene and other PAHs, arsenic, fluoride, pentachlorophenol, and diedrin. The Agrico site is currently being cleaned up by Conoco, Inc. under the supervision of EPA Region IV. No remediation is currently taking place at the Escambia Wood Treating Company. The EPA is considering relocating the community adjacent to the site prior to site cleanup. Contaminated groundwater plumes from the two sites have joined and are flowing towards Bayou Texar and will eventually impact Pensacola Bay (Martin, 1997).

Eglin-Blackwater-Conecuh Connection (Several Public and Private Organizations)

An interagency/interstate partnership was formed when The Nature Conservancy, Champion International Corporation, Conecuh National Forest (Alabama), Blackwater State Forest, Eglin AFB, the NWFWMD, and the Florida DEP joined in an effort to protect approximately 840,000 acres of public and private land, primarily in the Pensacola Bay system watershed. This agreement is expected to result in consistent, regional ecosystem level management of interrelated and relatively unbroken Gulf Coastal Plain habitats, including longleaf pine forest, wetlands, rivers, lakes, and estuarine habitat.

Seagrass Propagation and Enhancement (DEP NW District and UWF)

The Department of Environmental Protection, Northwest District has implemented tissue culture propagation for the seagrass *Ruppia maritima* and has transferred planting units to a number of sites in the Pensacola Bay system. Some seagrass transplant sites were established in conjunction with artificial reefs developed by the University of West Florida Institute for Coastal and Estuarine Research. The reefs are intended to provide new habitat for aquatic organisms, as well as protection for planted seagrasses.

Scallop Resource Monitoring and Enhancement (DEP NW District)

The DEP Northwest District has initiated an effort to monitor and enhance scallop resources in the Pensacola Bay system. The existing program has three components: (1) annual adult bay scallop inventory; (2) ongoing spat/larvae inventory; and (3) transplanting.

Creation and Enhancement of Oyster Reefs (DEP SEAS)

Appropriations are granted by the Florida Legislature on a yearly basis to provide for shellfish enhancement statewide. When funding is available for the Pensacola Bay system, the DEP SEAS conducts oyster resource enhancement by laying clam shell or fossilized oyster shell to provide suitable substrate for new or enhanced oyster beds.

Garcon Point Ecosystem Land Acquisition (NWFWMD)

Beginning in 1992, the NWFWMD acquired over 1,900 acres on Garcon Point. This property is a mosaic of primarily wet prairie, cypress dome/strand, and pine flatwoods. Management activities include a prescribed burning and habitat maintenance measures. As access is developed, the property will be available for passive recreation activities and environmental education. Santa Rosa County will donate an additional 166 acres to the District as mitigation for a dredge and fill permit. Initial restoration activities planned for this property include removal of 50 percent of the pine plantation which now occupies the site and a prescribed burn for fuel reduction.

Yellow River Water Management Area Acquisition (NWFWMD)

Over 8,000 acres of Yellow River floodplain was acquired in 1994. This area runs along approximately 19 miles of floodplain on the north side of the river in Okaloosa and Walton counties. These lands are managed for water resource protection, ecological protection and restoration, and public recreation.

Lower Escambia River Floodplain Hydrologic Restoration (NWFWMD)

The 34,231-acre Escambia River Water Management Area (WMA) is managed for purposes as described under the Yellow River WMA. Recent hydrologic restoration and enhancement activities were completed on approximately 73 acres of the property in the Escambia River floodplain in Santa Rosa County. Six low water crossings were established on an old logging road spur in order to reduce upstream impoundment effects caused by road fill.

Jones Swamp Wetlands Preserve (Escambia County, NWFWMD, FCT-Preservation 2000, and U.S. EPA)

This project involves the acquisition of approximately 1,300 acres of wetlands, floodplains, uplands, and creek frontage in the Jones Swamp area of the Bayou Chico watershed. Completion of the project will help protect the bayou and Pensacola Bay waters by precluding new nonpoint sources of pollution, preserving a range of natural wetland functions, and preventing habitat loss. Additionally, public acquisition of these lands will provide new opportunities for passive recreation and environmental education. Grant application and administration activities for this project have been funded via SWIM.

Bayou Chico Sediment Detention Facility (DEP; Escambia County)

A sediment detention facility was constructed by Escambia County, with a grant from DEP, west of “W” Street within Bayou Chico. The facility is being maintained by Escambia County.

Federal Agriculture Improvement and Reform Act of 1996 (USDA; Soil and Water Conservation Districts)

Conservation provisions of the 1996 Farm Bill are described below (USDA, 1996).

a) Environmental Quality Incentives Program (EQIP). This new program consolidates the functions of four existing programs and is designed to target assistance to meet water quality goals or to other locally-identified conservation priority areas. Funding within this program is for technical assistance and cost sharing.

b) Wetlands Reserve and Conservation Reserve Programs. These were revised to increase flexibility and extended to the year 2002.

c) Wildlife Habitat Incentives Program. This new program provides funding to help landowners improve habitat on private lands.

d) Emergency Watershed Protection Program. This existing program was amended to allow the purchase of floodplain easements.

e) Flood Risk Reduction Program. This new program was established to allow farmers to receive payments on lands with high flood potential if they agree to forego certain other USDA program benefits.

f) Conservation of Private Grazing Land. This new initiative provides technical and educational assistance to assist management of the nation’s grazing lands.

g) National Natural Resources Conservation Foundation. This nonprofit corporation was created to fund research, education, and demonstration projects related to conservation.

h) State Technical Committees. Membership was broadened to include agricultural producers and others.

i) Conservation Farm Option. This option was created for producers of wheat, feed grain, upland cotton, and rice who are eligible for Agriculture Market Transition Contracts. Landowners may consolidate CRP, WRP, and EQIP payments into one annual payment. Participants enter into a ten-year contract and agree to adopt a conservation plan.

j) Interagency Wetlands Memorandum of Agreement. This MOA revised the definition of agricultural land to include rangeland, native pastureland, livestock production land uses, and tree farms, as well as cropland and pastureland.

k) Existing Swampbuster and Wetlands Provisions. These were revised, including by expanding the areas where mitigation can be used and adding flexibility to mitigation standards.

Research Conducted by the University of West Florida

The University of West Florida Institute for Coastal and Estuarine Research (ICER) continues to conduct a variety of research and restoration activities on the Pensacola Bay system. A biophysical (bathymetry, sediments, and macroinvertebrates) monitoring study at outfall sites in Bayou Texar is nearing completion. This project is being conducted cooperatively with the City of Pensacola and Louisiana State University and is scheduled for completion in August 1997. The university is also completing a study of sedimentation in Carpenters Creek and is at the approximate mid-point of a two-year study of water quality in Santa Rosa Sound. This project is being conducted on contract from the National Park Service and includes quarterly grab sampling at 52 stations.

Research Conducted by the U.S. Environmental Protection Agency

The U.S. EPA is conducting diverse research, some of which is within the Pensacola Bay system, with the objective of developing and evaluating diagnostic indicators of ecological conditions. A multi-year study of the environmental effects of two golf courses located in Gulf Breeze was initiated in 1995. One of these courses is treated with spray irrigation, and both are treated with fertilizers, pesticides, etc., as are common to golf courses. Analyses conducted as part of this study include sediment toxicity, nutrient enrichment, and in-situ biological effects (Lewis, 1997). Additional work being conducted by the EPA's Gulf Breeze Laboratory includes sediment analysis of the lower Escambia River and upper Escambia Bay, assessment of NPS pollution on Bayou Texar, and development of a nutrient budget and model for the system.

STRATEGY OF THE PENSACOLA BAY SYSTEM SWIM PLAN

Strategy of the Pensacola Bay System SWIM Plan

Implementation of the SWIM Plan is accomplished via projects encompassed within four programs which correspond to the issue areas previously identified:

- Water and Sediment Quality Program
- Habitat Quality Program
- Administration, Planning and Coordination Program
- Public Education and Awareness Program

The strategy and objectives of the current plan have evolved as progress has been made, as conditions in the watershed have changed, and in response to changes in management and regulatory programs of other agencies and local governments. As described in the plan introduction, the goals of the Pensacola Bay SWIM program, as established and approved by the TAC, are as follows.

I. Minimize undesirable impacts on the riverine and estuarine system from adjacent upland portions of the watershed.

II. Attain and maintain water and sediment quality at levels that allow for the recovery and perpetuation of a healthy riverine and estuarine system.

III. Achieve heightened public awareness and coordinated management of the Pensacola Bay system, including integration of existing resource protection and restoration programs for accomplishing the aforementioned goals.

In order to attain these broad goals, the strategy of this plan is to work with state and federal agencies, local governments, and citizens to:

(a) restore conditions in degraded portions of the riverine and estuarine system;

(b) mitigate past injuries to the system;

(c) prevent future degradation by minimizing point and nonpoint source pollution and habitat degradation and loss; and

(d) continually improve the scientific foundation for informed decision-making.

Implementation of this strategy requires multi-organizational collaboration in technical expertise and resources, coordination across different areas of responsibility, and coordination in funding (i.e., pooling resources to achieve shared objectives). Additionally, planning, prioritizing, and implementing projects requires close coordination with the TAC, as well as local governments; community organizations; and state, regional, and federal agencies.

On the following pages are outlines of the four implementation programs: water and sediment quality; habitat quality; administration, planning, and coordination; and public education and awareness. These include amplifications of goals as they apply to the individual programs, discussions of issue-specific strategies, identification of challenges facing individual programs, descriptions of objectives, and lists of projects which support the attainment of the objectives. Implementation of this strategy should accomplish the goals of the Pensacola Bay system SWIM program. It should be noted, however, that full implementation is restricted by available funding levels. Project descriptions are provided in the section which succeeds this one.

FIGURE 3. Goals, Challenges, Programs, and Objectives of the Pensacola Bay System SWIM Plan

GOALS

I. Minimize undesirable impacts on the riverine and estuarine system from adjacent upland portions of the watershed.

II. Attain and maintain water and sediment quality at levels that allow for the recovery and perpetuation of a healthy riverine and estuarine system.

III. Achieve heightened public awareness and coordinated manage-ment of the Pensacola Bay System, including integration of existing protection and restor-ation programs for accomplishing the aforementioned goals.

CHALLENGES

Water and Sediment Quality

* NPS pollution originates from urban lands, new development, and agricultural and other activities.
* Point sources continue to load pollutants into the system.
* Sediments are contaminated by nutrients, metals, and toxic organic compounds.

Habitat Quality

* Benthic riverine and estuarine habitats have been and continue to be degraded.
* Degraded water and sediment quality and other impacts have caused widespread losses to seagrass communities.
* Wetland and other imporant habitats continue to be lost and degraded.
* Poor habitat quality has reduced species richness and numbers.

Administration, Planning and Coordination

* Intergovernmental coordination must ensure consistency and efficiency.
* Regulations, standards, and manage-ment programs differ between Florida and Alabama.
* Regulatory enforcement and compliance must be adequate and consistent.
* Implications of decisions must be understood at all levels of government.
* Progress and effectiveness must be reliably measured.
* Given ongoing levels of effort, many improvements may not be evident over the near-term.

Public Education and Awareness

* The values and vulnerabilities of the system must be well-understood by the public.

OBJECTIVES

Water and Sediment Quality Program

* Reduce NPS pollution from urban runoff and from agricultural and silvicultural activities, dirt roads, and other rural sources.
* Develop a realistic approach to mitigating the adverse impacts of contaminated sediments, restoring such sediments, and minimizing further degredation.
* Work with DEP to reduce point source pollution and to identify system-wide pollutant loading. In conjunction with nonpoint source pollution assessment efforts, this should facilitate the establishment of TMDLs and PLRGs.

Habitat Quality Program

* Protect and maintain existing aquatic, wetland, and associated upland habitats.
* Facilitate the restoration of seagrasses, wetlands, riparian communities, and other habitats.
* Facilitate the restoration and protection of fisheries and other biological, economic, and recreational resources.
* Develop a more complete understanding of the biological status and trends of the system, and use this to facilitate biological monitoring and assessment for management purposes.

Administration, Planning, and Coordination Program

* Coordinate a long range strategic plan for the restoration and protection of the system, including tracking and budgeting program implementation and periodically revising the plan.
* Provide technical information and expertise necessary to address the problems facing the Pensacola Bay System
* Participate in the ongoing resource management effort spanning all levels of government.
* Use SWIM to augment the basic program level of effort and funding to permit a more comprehensive implementation.
* Measure and assess progress in achieving objectives of the SWIM Plan.

Public Education and Awareness Program

* Promote an awareness of the values and vulnerabilites of the system.
* Promote an understanding of the concept of watershed management and its importance for maintaining the health of the system.
* Promote awareness of potential impacts of personal actions and an understanding of actions individuals may perform to protect the resource.
* Provide educational resources and activities for both the community as a whole and to primary and secondary school educators.

PROJECTS

WSQ 1.0: Tributary Monitoring

WSQ 2.0: Land Use Loading Rates Analysis

WSQ 3.0: Implementation of Restoration Alternatives for Bayou Chico

WSQ 4.0: Septic Tank Impact Assessment

WSQ 5.0: Bayou Texar Retrofit Project

WSQ 6.0: Gulf Breeze Bayous Restoration Planning and Implementation

WSQ 7.0: Implementation of Restoration Alternatives for Palafox\Coyle Habitiats

WSQ 8.0: Role of Bay Sediments in Water and Habitat Quality

WSQ 9.0: Pollutant Load Reduction Goals

HAB 1.0: Preservation of Tidal Marsh Habitat

HAB 2.0: Preservation of Bottomland Hardwoods and Other Important Habitats

HAB 3.0: Biological Monitoring

HAB 4.0: Circulation Study of the Pensacola Bay System

APC 1.0: Administration and Planning

APC 2.0: Institutional and Regulatory Assessment

APC 3.0: Interstate Coordination

APC 4.0 Geographic Information Management System Integration and Coordination

ED 1.0: Education and Awareness Strategy Development

ED 2.0: Media and Community Relations

ED 3.0: Waterways Video for the Pensacola Bay System

Water and Sediment Quality Program

Goals: This program is derived from and supports the attainment of all three goals: minimizing adverse impacts from activities in the watershed (Goal I), attaining and maintaining water quality which will support good habitat quality (Goal II), and working in coordination with other agencies to support water and sediment quality protection and restoration (Goal III).

Strategy: Work with state and federal agencies, local governments, and citizens to implement a watershed approach to addressing point and nonpoint source pollution. This should include (a) restoring conditions in degraded portions of the riverine and estuarine system, (b) mitigating past anthropogenic injuries to the system, and (c) minimizing point and nonpoint source pollution so as to prevent future degradation.

Challenges:

I. Nonpoint source (NPS) pollution continues to degrade water and sediment quality throughout the system.

A. Substantial urban runoff continues to originate from developed areas, particularly the Pensacola metropolitan area.

B. An increasing amount of NPS pollution is coming from formerly rural areas, such as the Gulf Breeze peninsula and Santa Rosa Island.

C. Basin-wide NPS pollution continues to enter the system from such sources as dirt roads and agricultural and silvicultural lands.

II. Continuing pollutant loading from point sources may impede total pollutant load reductions as may be necessary to facilitate restoration and protection of water and habitat quality.

III. Sediments within portions of the system are enriched with nutrients, metals, and/or toxic organic compounds. Sediments in formerly less-impacted areas, such as East Bay, are becoming increasingly degraded. Contaminants in the sediments degrade benthic habitat and may be resuspended due to storms, sustained winds, boat traffic, and dredging.

Objectives:

I. Reduce NPS pollution from urban runoff and from agricultural and silvicultural activities, dirt roads, and other rural sources. This involves the following elements.

A. Identify sources of loadings of nutrients, suspended solids, and other pollutants into the system, including via major rivers and smaller tributaries and from urban areas. This should help facilitate the establishment of PLRGs and TMDLs.

B. Identify reductions in nonpoint source pollutant loading which are needed to support the goals of this SWIM Plan. This should include establishing PLRGs for portions and reaches of the system, in accordance with Chapter 62-40, F.A.C.

C. Identify measures and follow-strategies which will facilitate the achievement of the needed pollutant load reductions. This should be accomplished through the other elements and objectives of this program. Measures considered should include the full range of possibilities, from intensive retrofit work to the use of vegetated buffers and an array of urban, agricultural, and silvicultural BMPs.

D. Assess the effectiveness of management practices, including BMPs and conservation plans, so as to recommend optimal implementation in the PBS watershed.

E. Encourage and assist local governments in efforts to effectively implement water resource protection as they carry out their land use planning responsibilities.

F. Work with local governments, state and federal agencies, and community organizations to implement stormwater retrofits for degraded reaches, bayous, and other areas. This includes prioritizing and selecting sub-basins for developing and implementing stormwater and retrofit plans for these sub-basins. This will generally include the following steps:

1. collection of rainfall, tide, and stormwater quality and quantity data;
2. land use characterization, including percent impervious surface and ownership;
3. inventory of existing drainage system components;
4. assessment of existing long-term management plans;
5. detailed design of improvements to stormwater treatment and management systems; and
6. identification of funding and proceeding with implementation in cooperation with local governments and other agencies.

G. Further develop the technical information which will allow local governments, as well as state agencies, to make informed land use and other decisions so as to protect water resources.

II. Develop a realistic approach to mitigating the adverse impacts of contaminated sediments, restoring such sediments, and minimizing further degradation.

A. Determine the conditions under which contaminated sediments may degrade the ecology of the Pensacola Bay system, both on a continuing and an episodic basis.

B. Use the information developed through past and ongoing sediment research to develop restoration alternatives and management strategies. Proceed with implementation as these alternatives and strategies are identified.

III. Work with DEP to reduce point source pollution and identify system-wide pollutant loading. In conjunction with nonpoint source pollution assessment efforts, this should facilitate the establishment of TMDLs and PLRGs.

A. Inventory and quantify existing point source discharges.

B. Work with DEP to develop strategies to reduce point source pollutant loading.

C. Determine appropriate pollutant loading limits and reduction targets which will allow achievement of other SWIM objectives.

Projects:

WSQ 1.0, Tributary Monitoring (objectives I and III)

WSQ 2.0, Land Use Loading Rate Analysis (objectives I and III)

WSQ 3.0, Implementation of Restoration Alternatives for Bayou Chico (objectives I and II)

WSQ 4.0, Septic Tank Impact Assessment (objective I)

WSQ 5.0, Bayou Texar Retrofit Project (objectives I and II)

WSQ 6.0, Gulf Breeze Bayous Restoration Planning and Implementation (objectives I and II)

WSQ 7.0, Implementation of Restoration Alternatives for Palafox/Coyle Watersheds (objectives I and II)

WSQ 8.0, Role of Bay Sediments in Water and Habitat Quality (objectives I and II)

WSQ 9.0, Pollutant Load Reduction Goals (objectives I, II, and III)

Habitat Quality Program

Goals: This program is derived from and supports the attainment of all three goals, including minimizing adverse impacts on habitats from activities in the watershed (Goal I), attaining and maintaining water quality which will support habitat quality (Goal II), and working in coordination with other agencies to support resource protection and restoration (Goal III, in part). This includes restoration and protection of the ecology of the Pensacola Bay system, so it will sustain its diverse array of aquatic, wetland, and associated upland habitats.

Strategy: Work with state and federal agencies, local governments, and citizens to (a) minimize future habitat loss and degradation within the riverine and estuarine system, (b) mitigate past losses and degradations, and (c) restore degraded habitats.

Challenges:

I. Benthic riverine and estuarine habitats have been, and continue to be, degraded through sedimentation and deposition. Such impacts result in alteration of sediment size and composition, nutrient and metal enrichment, accumulation of toxic organic compounds, and the exclusion of populations of aquatic organisms from areas which previously supported them.

II. Degraded water and sediment quality have caused widespread losses of seagrass communities and associated biological resources throughout the Pensacola Bay system.

III. Substantial areas of wetlands and other important habitats have been and continue to be lost throughout the watershed.

IV. Poor water quality conditions degrade benthic habitats and periodically deny their use to aquatic species. Episodic events result in direct mortality to such species.

V. Much habitat loss and degradation has resulted from the cumulative impacts of development and is not directly recoverable. Only improvements in environmental quality and compensatory actions can mitigate these losses.

Objectives:

I. Protect and maintain existing aquatic, wetland, and associated upland habitats—avoiding cumulative as well as individual or catastrophic losses.

    A. Identify environmentally-sensitive and important lands that should be preserved or restored.

    B. Implement a cooperative, basin-wide strategy to achieve the protection and restoration of important habitats, including via acquisition and a variety of less-than-fee alternatives.

    C. Identify practices which could be employed on private and public lands to reduce impacts on aquatic habitats, wetlands, and important upland habitats. Develop recommendations for and pursue the implementation of such practices within the Pensacola Bay system watershed.

    D. Work with other agencies and land owners to ensure lands are managed appropriately for the protection and restoration of habitats.

II. Facilitate the restoration, including area coverage and quality, of seagrasses, wetlands, riparian vegetation, and other habitats.

    A. Through the Water and Sediment Quality program, provide for water and sediment quality improvement and protection, such as will permit the healing and/or active restoration of habitat.

B. Work with local governments, state and federal agencies, and other initiatives to conduct restoration and mitigation activities where feasible.

III. Facilitate the restoration and protection of fisheries and other biological, economic, and recreational resources. This objective should be accomplished concurrently and, in part, as a result of the accomplishment of habitat protection and restoration.

IV. Develop a more complete system-wide and comprehensive understanding of the biological status and trends of the system, and use this to facilitate continuing biological monitoring and assessment for management purposes.

A. Collaborate with state and federal agencies and universities to identify and use appropriate biological and other criteria to both assess ecological health and measure the success of management efforts.

B. Develop an understanding of how circulation to allow us to (a) estimate the likely success of various management and restoration proposals, and (b) identify the most efficient management options for protecting and restoring habitat and related resource conditions.

Projects:

HAB 1.0, Preservation of Tidal Marsh Habitat (objectives I, II, III, and IV)

HAB 2.0, Preservation of Bottomland Hardwood and Other Important Habitats (objectives I, II, III, and IV)

HAB 3.0, Biological Monitoring (objective IV)

HAB 4.0, Pensacola Bay System Circulation Study (objective IV)

Administration, Planning, and Coordination Program

Goal: This program is derived from and supports the attainment of the third goal: achieving the coordinated management of the Pensacola Bay system. This requires developing and maintaining effective intergovernmental communication and coordination so as to ensure that various management and regulation efforts are complementary, resources are employed efficiently, and redundancy is avoided.

Strategy: Work with state and federal agencies, local governments, and citizens to (a) coordinate resource management and regulation initiatives at all levels of government, (b) promote consistent management across state lines, and (c) provide mutual assistance.

Challenges:

I. Because watershed management encompasses the actions of various state and federal agencies and numerous local governments, communication and coordination among these entities must be adequate to ensure that efforts are complementary, resources are employed efficiently, and redundancy is avoided.

II. Regulations, standards, and management programs differ between Florida and Alabama, and interstate communication and coordination mechanisms are not inherent to state resource management agency activities.

III. Rule enforcement and permit compliance must be adequate and consistent to allow attainment of water and sediment quality and habitat quality objectives.

IV. Potential impacts of decisions must be understood at all levels of government.

V. It is important to measure progress in achieving objectives of the SWIM Plan for such reasons as the limited nature of funding and staff resources, the need to achieve and maintain optimal effectiveness, and the need to facilitate communication of progress to program constituents (citizens, elected officials, etc.).

VI. While many improvements may anticipated, some may not be evident for many years.

Objectives:

I. Coordinate a long-range strategic plan for restoration and protection of the Pensacola Bay system, including tracking and budgeting the overall program implementation and periodically revising the plan.

II. Provide the technical information and expertise necessary to adequately address the problems facing the Pensacola Bay system.

III. Participate in the ongoing resource management effort spanning all levels of government. This includes the following.

   A. Work with the Bay Area TAC to plan and implement SWIM and provide technical review of and assistance for other projects and proposals.

   B. Work to enhance functional relationships between the SWIM program and other initiatives, including BARC, Ecosystem Management, community initiatives, local governments, and others which are integral to management of the PBS.

   C. Work with and assist local governments to effectively implement water resource protection as they carry out their various responsibilities.

   D. Work with various state and federal resource management agencies to achieve shared and mutually-supportive objectives.

IV. Develop and promote effective coordination between the two states encompassing the Pensacola Bay system watershed. This includes the following elements.

A. Work with the State of Alabama to achieve consistent regulation and management across state lines.

B. Form partnerships to implement watershed-wide initiatives.

C. Identify restoration, management, and research projects which are needed to facilitate effective watershed management.

D. Develop a long-term coordination mechanism for management of the Pensacola Bay system.

V. Use SWIM to augment the basic program level of effort and funding to permit more comprehensive implementation. This includes developing grant proposals and other multi-agency efforts.

VI. Identify and implement a methodology to measure and assess progress in achieving objectives of the SWIM Plan.

Projects:

APC 1.0, Administration and Planning (objectives I, II, III, V, and VI)

APC 2.0, Institutional and Regulatory Assessment (objectives III and IV)

APC 3.0, Interstate Coordination (objective IV)

APC 4.0, Geographic Information Management System Integration and Coordination (objectives II and III and Public Education and Awareness objective IV)

Public Education and Awareness Program

Goal: This program is derived from and supports attainment of the public awareness element of the third goal. To do so, it must facilitate widespread understanding of the values and vulnerabilities of the Pensacola Bay system and encourage participation in the resource management process across diverse interests.

Strategy: Work with state and federal agencies, local governments, and citizens to provide useful and interesting information to the public which will (a) increase awareness of personal actions which may help protect and restore the resource, (b) enable people to participate in the resource management process, and (c) provide an understanding of watershed management and its importance for maintaining the health of the system.

Challenges:

I. If efforts to protect and restore the resource are to succeed, its values and vulnerabilities must be well understood by the public, both to permit individuals to make informed personal decisions relevant to water resources and to promote an understanding of resource management initiatives.

Objectives:

I. Promote an awareness of the values and vulnerabilities of the system, including aquatic habitats, wetlands, and threatened and endangered species. This, as well as the following objectives, may be achieved through a variety of means, including the following.

   A. Develop positive relationships with the news media, and provide information concerning Pensacola Bay system resources, resource management needs, and activities of the SWIM program and related initiatives.

   B. Host community workshops to provide insights about issues affecting management of the Pensacola Bay system, the role of individuals in preserving and restoring the system, and technical information for informed decision making.

   C. Develop and distribute specific communication products, including video productions and publications, as well as providing information to the public via the Internet and other means.

II. Promote an understanding of the concept of watershed management and its importance for maintaining the health of the system. This may be achieved through a variety of means, including those discussed under the first objective.

III. Promote awareness of potential impacts of personal actions and an understanding of actions individuals may perform to protect the resource. This may be achieved through a variety of means, including those discussed under the first objective.

IV. Provide educational resources and activities for both the community as a whole and to primary and secondary school educators. This may also be achieved through a variety of means, including those discussed under the first objective.

Projects:

ED 1.0, Education and Awareness Strategy Development (objectives I, II, III, and IV)

ED 2.0, Media and Community Relations (objectives I, II, and III)

ED 3.0, Waterways Video for the Pensacola Bay System (objectives I, II, III, and IV)

PROJECT PLAN

Timeline and Proposed Funding

The projects described in this section are designed to implement the strategies described in the previous section. The implementation timeline is an estimate provided for planning purposes and is limited based upon SWIM funding expectations. Thus, initiation of many projects is delayed into the future. If funding is limited below the figures provided in Table 3, implementation of a number of projects will be further delayed.

Table 3. Pensacola Bay System SWIM Plan Proposed Project Funding

ID#	PROJECTS	FY 1997-98	FY 1998-99	FY 1999-2000
	Water Quality Program			
WSQ 1.0	*Tributary Monitoring*	$52,000	$60,000	$60,000
WSQ 2.0	Land Use/Loading Rate Analysis	$20,000	$30,000	$30,000
WSQ 3.0	*Bayou Chico Restoration*	$138,000	$90,000	$30,000
WSQ 4.0	Septic Tank Impact Assessment	$0	$0	$20,000
WSQ 5.0	*Bayou Texar Retrofit*	$35,400	$40,000	$0
WSQ 6.0	Gulf Breeze Bayous	$0	$40,000	$60,000
WSQ 7.0	*Palafox/Cole Restoration*	$25,400	$30,000	$0
WSQ 8.0	Role of Bay Sediments	$12,100	$40,000	$40,000
WSQ 9.0	PLRGs	$40,000	$40,000	$20,000
	Habitat Program			
HAB 1.0	Tidal Marsh Preservation	$0	$30,000	$30,000
HAB 2.0	*Bottomland Hardwood Preservation*	$12,200	$40,000	$30,000
HAB 3.0	*Biological Monitoring*	$12,300	$25,000	$30,000
HAB 4.0	Circulation Study	$0	$0	$0
	Coordination Program			
APC 1.0	*Administration and Planning*	$16,400	$20,000	$20,000
APC 2.0	Institutional and Regulatory Assess.	$0	$7,000	$0
APC 3.0	*Interstate Coordination*	$12,600	$25,000	$50,000
APC 4.0	*GIMS Integration and Coordination*	$33,500	$37,000	$23,500
	Public Education and Awareness Program			
ED 1.0	Strategy Development	$0	$10,000	$0
ED 2.0	Media and Community Relations	$0	$15,000	$15,000
ED 3.0	*WaterWays Video*	$44,250	$5,000	$5,000
	Total	$454,150	$584,000	$463,500

Projects identified in italics are considered high priority projects due to their status as continuation projects initiated under the previous plan revision, and/or through consensus of the TAC and participation by local governments and local community organizations. It is expected that these projects will be given priority in the event of very limited SWIM funding.

Project Interdependence

Strategies and projects are organized within the most appropriate programs. Because different resource issues are inherently interrelated, however, many strategies are mutually supportive, and different programs and projects provide benefits across several issue areas. To assist in identifying projects with multiple benefits, Table 4 lists the projects and indicates for which issues they may have direct or indirect benefits.

Table 4. Direct and Indirect Benefits of Proposed Projects

#	Project	Nonpoint	Point Source	Habitat	Coord.	Public Ed.
	Water Quality Program					
WSQ 1.0	Tributary Monitoring	✔	✔	✔	i	i
WSQ 2.0	Land Use/Loading Rate Analysis	✔		i	i	i
WSQ 3.0	Bayou Chico Restoration	✔	i	✔	i	i
WSQ 4.0	Septic Tank Impact Assessment	✔		i	i	i
WSQ 5.0	Bayou Texar Retrofit	✔		✔	i	i
WSQ 6.0	Gulf Breeze Bayous	✔	i	✔	i	i
WSQ 7.0	Palafox/Cole Restoration	✔		✔	i	i
WSQ 8.0	Role of Bay Sediments	✔	✔	✔	i	i
WSQ 9.0	PLRGs	✔	✔	i	i	
	Habitat Program					
HAB 1.0	Tidal Marsh Preservation	i		✔	i	i
HAB 2.0	Bottomland Hardwood Preservation	i		✔	i	i
HAB 3.0	Biological Monitoring	i	i	✔	i	i
HAB 4.0	Circulation Study	✔	✔	✔	i	i
	Coordination Program					
APC 1.0	Administration and Planning	✔	✔	✔	✔	✔
APC 2.0	Institutional and Regulatory Assessment	i	i	i	✔	i
APC 3.0	Interstate Coordination	i	i	i	✔	i
APC 4.0	GIMS Integration and Coordination	✔	✔	✔	✔	✔
	Public Education and Awareness Program					
ED 1.0	Strategy Development	i	i	i	i	✔
ED 2.0	Media and Community Relations	i	i	i	i	✔
ED 3.0	WaterWays Video	i	i	i	i	✔
✔=direct benefit; i=indirect benefit						

Project Participants

Full implementation of many, if not most, of the projects described herein cannot be achieved without participation by a number of other organizations. Additionally, the SWIM program may participate through these projects in other initiatives within the watershed. Basin retrofits and other structural restoration work in particular cannot be accomplished through the SWIM program alone. SWIM funding is inadequate to complete major construction work, and most problems are inherently interjurisdictional in terms of both causes and effects. Additionally, DEP policy limits the use of SWIM funds for local stormwater master planning and requires varying levels of local match for the construction of stormwater treatment facilities (Twachtmann, 1990). Local governments with a stormwater utility are required to provide at least 50 percent of the funding for facility construction, and those lacking such a utility are required to provide at least 75 percent of the funding. Additionally, the NWFWMD is required to provide for an additional 20 percent. Due to its funding limitations, however, the NWFWMD has typically requested that local governments help provide for this portion of the funding as well.

A number of state and federal agencies, regional entities, local governments, and community organizations have been instrumental in the implementation of previous SWIM project work, and they are expected to continue to do so. These organizations have participated in planning and implementation of project work and have shared in the costs of implementation. Specific project participants are not listed in the individual project descriptions which follow, because past experience has demonstrated that participants may change during the life of a project. It could also be expected that some participants not cited in individual project descriptions could later emerge as major participants. Below, however, is a list of some of the organizations which are expected to be instrumental in the implementation of many of these projects:

- Escambia, Santa Rosa, Okaloosa, and Walton counties;
- Cities of Pensacola, Milton, Gulf Breeze, and possibly other municipalities;
- Bayou Chico Association;
- Bayou Texar Foundation;
- Primary and secondary schools;
- University of West Florida;
- University of Florida, Institute of Food and Agricultural Sciences (IFAS);
- Florida Department of Environmental Protection;
- Florida Department of Community Affairs;
- Florida Department of Agriculture and Consumer Services;
- Bay Area Resource Council;
- West Florida Regional Planning Council;
- Florida Game and Fresh Water Fish Commission;
- State of Alabama (through interstate coordination);
- U.S. Environmental Protection Agency;
- U.S. Fish and Wildlife Service;
- Gulf Islands National Seashore; and
- U.S. Department of Agriculture, Natural Resource Conservation Service and Farm Service Agency.

Other organizations, including, but not limited to, any mentioned in the “Institutional Setting” section could also participate in project implementation. It should also be noted that the TAC, with representation from many organizations, plays an essential role in the planning, prioritization, implementation, and review of projects.

Project Descriptions

Descriptions of the projects included within this revision of the Pensacola Bay system SWIM plan are provided on the following pages. Projects identified as “priority” under the proposed funding tables are expected to receive funding even in the event of very limited SWIM funding. This is based upon such reasons as their status as continuation projects from the previous plan revision, statutory requirements, consensus of the TAC, and/or participation by local governments and local community organizations.

WSQ 1.0 Tributary Monitoring

The project will provide for monitoring and analysis of water quality from Pensacola Bay system tributaries in Escambia, Santa Rosa, Okaloosa, and Walton counties. This monitoring and analysis will be designed to enhance the existing understanding of the out-of-state pollutant load contribution, as well as pollutant loading rates from Florida's portion of the watershed. It will also include coordination of efforts with federal agencies and Alabama state agencies to compile and assess available data and to better understand the potential for improvements in upstream water quality.

Implementation will include water quality and flow monitoring from stations in the Escambia, Blackwater, and Yellow river basins. Emphasis will be placed on the Escambia River basin due to its large discharge, high pollutant and suspended solid load, and its large watershed outside Florida. The results of this project will be useful for quantifying basin-wide NPS pollutant loading, establishing pollutant load reduction goals (PLRGs) and Load Allocations (LAs), updating point source Waste Load Allocations (WLAs), and evaluating the effectiveness of nonstructural nonpoint source pollution prevention alternatives. The project may also provide data which are useful for designing habitat restoration projects and developing and refining watershed pollution abatement strategies.

Tasks

1. Select river and tributary sites for monitoring based on previous nonpoint loading rate analyses and other project results. In doing so, coordinate with the DEP, the FGFWFC, other agencies, and local governments to ensure multiple-agency objectives are considered.
2. Identify sampling and analysis methodologies, and develop a quality assurance plan.
3. Identify a baseline of ongoing state, federal, and local management programs for NPS pollution control and abatement activities which have been implemented in the watershed.
4. Identify existing data and analysis from biorecon and water quality monitoring conducted by DEP, the Bream Fishermen Association, the NRCS, and other sources. Evaluate the possibility of using other sources of baseflow data for analyses conducted under this project.
5. Conduct storm and baseflow monitoring of water quality and flow. Use this to develop pollutant loading rates.
6. In conjunction with WSQ 2.0, characterize relationships between nonpoint and point source loading and land uses, BMPs, and other activities ongoing in the selected sub-basins.
7. In conjunction with other projects, evaluate the need for establishing PLRGs and TMDLs for the watershed and specific rivers and reaches, and develop recommendations for an appropriate method for doing so.
8. Develop recommendations for enhancing cooperative implementation of state, federal, and local water resource protection programs, including enhanced implementation of BMPs.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$52,000	$60,000	$60,000

Note: Priority project

WSQ 2.0 Land Use and Loading Rate Analysis

The land use analysis will provide a foundation for many restoration, planning, and acquisition projects detailed in the SWIM plan. Prior to identifying specific watershed management measures, it is necessary to accurately assess activities and growth pressures within the watershed. The need for a more refined and universally applied land use data set was identified during previous efforts, such as the 208 planning initiative. Existing and historic land use and vegetation cover data layers will be developed using a universal classification system across government jurisdictional boundaries. The layers will be developed from recently-completed data, provided by DEP, as well as digital ortho-photographic quadrangles which have also recently been made available. Products developed through this project will be in a geographical information system (GIS) and will be made available in digital files for use by local governments, as well as other agencies and the public. Additional activities will include development of a watershed build-out future land use map using local government future land use maps, identification of environmentally sensitive areas (considering existing and planned future development), identification of trends, and recommendations concerning future build-out. Coordination will occur with other agencies to avoid duplication and to maximize efficiency.

Tasks

1. Use recent land use data and digital ortho-photo quads to develop land use and land cover layers for the Pensacola Bay system watershed.
2. Assess available land use data for Alabama to consider integration with Florida data to develop an assessment of basin-wide land use trends and NPS pollutant loading.
3. Obtain the best available watershed water quality data to estimate land use loading rates representative of local conditions. This should be conducted in conjunction with WSQ 1.0.
4. Review and assess available data to characterize NPS loading from areas with specific land use practices (e.g., golf courses irrigated with reuse water, dirt roads, urbanized basins, etc.).
5. Select and apply an appropriate loading rate model for sub-watershed analysis.
6. Prepare future land use and cover layers based on build-out projected in local government comprehensive plans.
7. Develop a comparison of existing and future conditions, including a trend analysis and an identification of potential problem areas.
8. Evaluate implementation of management activities, including BMPs, land development regulations, and other land use practices and management activities.
9. Perform environmental sensitivity analysis, and provide:
   a) identification of areas and specific basins where NPS pollution is likely to be significant, based on current land use practices;
   b) recommendations for strategies and BMPs for reducing NPS pollution in identified areas;
   c) identification of areas which may become NPS pollution problem areas, if built-out continues according local government future land use and zoning maps; and
   d) recommendations for protective measures, which, if implemented concurrent with new development, would reduce the potential NPS pollution loading.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$20,000	$30,000	$30,000

WSQ 3.0 Implementation of Restoration Alternatives for Bayou Chico

The intent of this project is to continue assisting the local government with implementation of alternatives for reducing urban stormwater runoff into Bayou Chico and mitigating its effects. A series of recommendations were developed following a stormwater assessment of the bayou, which included protection of wetlands in the Jones Creek basin and construction of stormwater treatment facilities for the urbanized portion of the basin. This project is intended to accomplish the facility construction recommendation. Assistance provided through SWIM includes identification and evaluation of alternatives for stormwater capture and treatment, sediment removal, circulation improvement, and development of detailed designs for retrofit facilities. A Florida Pollution Recovery Program grant has been approved for facility construction funding. Implementation of this project is integrated with stormwater planning and implementation activities of the local government, which include cost sharing and planning for this project.

Tasks

1. Assist in the development and implementation of a watershed management plan for the basin.
2. In doing so, consider other sources of nonpoint pollution in addition to stormwater (e.g., nitrate loading from ground water).
3. Collaborate and coordinate with local governments and state and federal agencies in the evaluation and implementation of in-estuarine restoration alternatives, including those which would enhance circulation and flushing and restore sediment quality.
4. Conduct feasibility and benefits analysis and an environmental evaluation of preferred restoration alternatives.
5. Prepare work plans and appropriate documentation of the major construction components of this effort.
6. Encourage public participation and other agency involvement in the development of final work plans.
7. Develop detailed designs for implementation of restoration and retrofit alternatives.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$138,000	$90,000	$30,000

Note: Priority project

WSQ 4.0 Septic Tank Impact Assessment

The objective of this project is to assess the significance of septic tanks as sources of surface water pollution of the Pensacola Bay system. This will be accomplished by comparing the relative significance of pollution from these systems to other sources within the watershed. The ultimate objective of the project is to provide information which can be applied to reduce the quantity of nutrients and pathogens entering the system due to failed or inadequate septic systems. The project will incorporate DEP, DOH, and ECUA data related to on-site treatment systems. Field data will be collected in selected areas. These include specific watersheds, bayous, and shellfish harvesting areas of the Pensacola Bay system. Other information sources include GIS databases and hydrogeologic data collection and analyses. Following completion of this assessment, target areas will be identified for specific remedial work. Project activities will be closely coordinated with ECUA and other local utilities involved in the provision of wastewater treatment services.

Tasks

1. Contact cooperating agencies, and compile existing information and data which are useful for identifying problem areas and issues.
2. Target specific areas for monitoring the extent of pollutant loading from septic tanks.
3. Develop a sampling strategy and obtain water quality and flow data as needed to better define the aerial extent and loading of contaminants from septic tanks.
4. Establish priority areas where remedial work or elimination of on-site disposal systems would be most beneficial to the water resources in the Pensacola Bay system.
5. Recommend, support, and assist in coordinated efforts to control or eliminate discharges from on-site sewage disposal systems in problem areas.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$0	$20,000

WSQ 5.0 Bayou Texar Retrofit Project

This project is the continuation of an ongoing effort to develop stormwater retrofit facilities and identify and compare in-estuarine alternatives for restoring and preserving the bayou. The overall effort to protect and restore the bayou include initiatives of the city of Pensacola, Escambia County, Florida DOT, University of West Florida, U.S. EPA, and DEP. Previous analyses of the Bayou Texar/Carpenters Creek basin have identified alternatives for reducing pollutant loading and sedimentation from stormwater runoff. This project will focus on continuing efforts to support efforts to implement these alternatives and thus retrofit the basin with stormwater treatment facilities and sedimentation controls. Assistance provided through SWIM includes identification and evaluation of alternatives for stormwater capture and treatment, feasibility assessment, and development of detailed designs for retrofit facilities. A Florida Pollution Recovery Program grant has been approved for facility construction funding. Implementation of this project is integrated with local government stormwater planning and implementation activities, which include cost sharing and planning for this project.

Tasks

1. Complete detailed design and construction of I-110 multi-agency stormwater retrofit project.
2. Complete a list of and map potential interagency watershed restoration projects in coordination with the City of Pensacola and Escambia County stormwater management programs.
3. Provide updated technical data, mapping products, and other assistance as needed to help the City of Pensacola and Escambia County initiate and manage bayou restoration work.
4. Evaluate water quality and monitoring data recently collected for applicability to the development of management alternatives and an overall plan for bayou restoration.
5. Quantify in-stream and upland sources of sediment to the bayou, and evaluate alternatives for reducing sediment loading.
6. Design sediment controls for Carpenters Creek and other sediment source problem areas.
7. Develop a nutrient budget for the bayou for use in consideration of alternative solutions to nutrient loading and such related problems as poor circulation, depressed dissolved oxygen levels, and fish kills.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$35,400	$40,000	$0

Note: Priority project

WSQ 6.0 Gulf Breeze Bayous Restoration Planning and Implementation

This project is intended to (1) evaluate anthropogenic impacts on water and habitat quality in the series of embayments within the city of Gulf Breeze; (2) evaluate the feasibility of alternatives for correcting identified problems; and (3) develop recommendations for designing, funding, and implementing preferred restoration alternatives. Ultimately, this project will facilitate the design and implementation of corrective actions, including enhanced urban best management practices and construction of new facilities. Following the design phase, sources of funding will be identified, and implementation and monitoring processes should commence. Waterbodies and basins of interest include the series of embayments located immediately west of the southern foot of the Highway 98 bridge, Old Navy and Butcherpen coves, English Navy Bay, and other embayments and features along the Gulf Breeze peninsula.

Tasks

1. Identify and evaluate existing data and literature available for the bayous and their vicinity, as well as uplands and wetlands within the bayou basins. Develop a water quality and stormwater flow database for bayou basins for use in a nonpoint source loading assessment.
2. In cooperation with the local government, update existing storm drainage schematic maps, estuarine habitat maps, and existing and future land use maps for the study area.
3. If existing data are inadequate, plan and implement water quality and flow data collection at selected locations.
4. Analyze data to identify water quality parameters of concern and to quantify local contributions of pollutants to the system.
5. Evaluate potential problems with existing environmental controls, including cross-connections, eroding or deteriorating stormwater conveyance systems, rate control problems, and other deficiencies in design or maintenance which may affect water quality and quantity.
6. Evaluate existing urban BMPs and the potential for enhanced BMP implementation.
7. Characterize remaining estuarine and shoreline habitats and evaluate problems and restoration opportunities.
8. Identify and evaluate potential corrective measures, and identify those with the highest possible water quality and habitat benefits. This should comprehensively include both stormwater management strategies and habitat restoration alternatives.
9. Develop an interpretive report with recommendations for corrective actions, including stormwater retrofits, implementation of urban BMPs, and local nonpoint source pollution reduction programs.
10. Work with local governments to implement corrective actions, including facilities and urban BMPs, to retrofit areas of existing development.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$40,000	$60,000

WSQ 7.0 Implementation of Restoration Alternatives for Palafox/Coyle Watersheds

This project will focus on developing detailed designs of stormwater treatment facilities for the purpose of retrofitting the Palafox and Coyle sub-watersheds. The detailed design work will follow management recommendations developed through previous analyses of these subwatersheds. Future SWIM funds, as well as other state and federal sources of funding and local match, will be sought for construction of designed projects.

Tasks

1. Analyze drainage pathways, land uses, and property ownership within the basins, and identify potential sites for stormwater treatment facilities.
2. Assess the feasibility of each of the identified sites. This should include land acquisition costs and evaluation of the engineering advantages or shortcomings of each site.
3. Develop funding sources for land acquisition and facility construction in cooperation with the City of Pensacola and Escambia County.
4. Provide technical assistance as required for land acquisition and site development.
5. Use public lands and/or acquire land as necessary, and commence with treatment facility designs, including providing cost estimates for the final design and construction phases.
6. Design and implement nonstructural improvements, as well as recommended structural measures, to minimize pollutant loading to the treatment facility and ultimately to the bay.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$25,400	$30,000	$0

Note: Priority project

WSQ 8.0 Assessment of the Role of Sediments in Water and Habitat Quality

The importance of enriched and contaminated bottom sediments as sources of pollutant loading to the Pensacola Bay system is unknown. Effects on water and habitat quality, for example, of sediment resuspension caused by common wind driven events, dredging, and occasional large storms are poorly understood. As a result of this general lack of knowledge of the long-term effects of sediment contamination, it is difficult to predict the likelihood of success of restoration or preservation efforts.

This project will investigate long-term impacts of poor quality sediments on the Pensacola Bay system, identify additional data needs, and provide management alternatives. The project will rely on recent data collection efforts of the U.S. EPA, DEP, UWF, NWFWMD, and others. Comparisons will be made among various data sets to assess sediment and water quality trends and management implications. The results of this assessment, rather than being research oriented, are intended to better define what state and local management objectives and strategies should be for maintaining or improving the health of the system.

Tasks

1. In cooperation with agencies involved in sediment data collection, obtain and review available sediment quality databases.
2. Identify areas of known or suspected sediment enrichment and contamination, and characterize the constituents involved.
3. Assess the overall quality and usefulness of available sediment data.
4. Use available data and analysis tools to characterize the system-wide and spatial effects of contaminants which originate in the sediments.
5. Attempt to identify trends in the sediment and water quality data obtained.
6. Prepare resource management recommendations based on the current knowledge of sediment conditions.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$12,100	$40,000	$40,000

WSQ 9.0 Pollutant Load Reduction Goals (PLRGs)

An objective of the Point Source Program under the previous Pensacola SWIM Plan revision was the establishment of upper limits on point source pollutant loading which would allow for the restoration, conservation, and preservation of a healthy estuarine system. With the integrated (point and nonpoint) Water and Sediment Quality Program of the current plan revision, this objective is incorporated along with the objective of establishing upper limits on NPS pollutant loading. Accomplishing these objectives, via this project and in conjunction with WSQ 1.0, 2.0, and 8.0 and efforts of the Department of Environmental Protection, would require the evaluation of Waste Load Allocations (WLAs) and establishment of pollutant load reduction goals (PLRGs) in accordance with Rule 62-40, F.A.C. Accomplishment of these should also help facilitate the establishment of Total Maximum Daily Loads (TMDLs).

Elements of this process will include an evaluation of the adequacy of existing WLAs, which will be an integral part of eventual TMDLs, and the process for establishing them. Developing the NPS side of the equation will include identifying needs for PLRGs and an appropriate methodology for establishing them. Doing so should also help facilitate developing Load Allocations (LAs), the NPS pollution element of TMDLs. The process will include review of technical data and criteria and existing water and sediment quality data, as well as the identification of additional data needs. Accomplishment will require close coordination with state and federal regulatory authorities. Benefits will include improved lines of communication across programmatic boundaries and a better understanding of the overall needs of the system. This understanding should include sensitivity to economic constraints and previous regulatory limitations which have led to negotiated discharge limits. The conclusion of this process will be comprehensive pollutant loading limits which will permit the achievement of water quality and water resource goals of the state, as well as of the Pensacola Bay system SWIM program.

Tasks

1. Identify federal and state wasteload allocation requirements, procedures used in establishing allocations, and existing allocations.
2. Evaluate (in coordination with DEP) the wasteload allocation process, as well as specific allocations in relationship to possible criteria for establishing TMDLs.
3. Assess the need for PLRGs, per Rule 62-40, F.A.C. Identify a feasible and appropriate method for establishing PLRGs. Identify the relationship between the PLRG development process and the process planned for establishment of TMDL load allocations.
4. Evaluate existing water and sediment quality data to (1) summarize pollutant loading into the system and its effects, (2) assess effects of existing allocations on the system, and (3) identify any additional data needs for development of PLRGs and TMDLs.
5. Develop recommendations for revisions to the wasteload allocation process (if any) as well as recommendations for developing PLRGs and TMDLs.
6. Integrate the results of the wasteload allocation analysis into the existing permitting process and initiate implementation of recommendations for the development of PLRGs and TMDLs.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$40,000	$40,000	$20,000

HAB 1.0 Preservation of Tidal Marsh Habitat

To prevent the continuing decline and allow for the restoration of tidal marsh habitat in the PBS, a comprehensive management approach is needed. This approach requires the development of a region-wide program so that critical areas of wetlands and surrounding shoreline areas can be identified and a comprehensive program for funding, acquisition, restoration and preservation can be developed. This project includes delineating areas for preservation or possible restoration (using existing data as possible) and following through with the identification an implementation of strategies to protect such areas. Delineation may include review of existing information from a variety of sources and integration into GIS layers. Creation of protective buffer zones, integration with other initiatives, support for experimental planting programs, pursuit of grants for acquisition or other protection means, and other multi-agency efforts will be considered. As an ongoing activity, the project will help to implement programs for acquisition or less-than-fee protection, as well as restoration and monitoring. In addition to protection of sensitive lands, implementation of this project should result in improved conditions for fish, invertebrates, waterfowl, and terrestrial species. These efforts will be conducted in cooperation with ongoing programs of local governments and state and federal agencies to restore wetland and associated resources. Some examples of funding sources to augment SWIM for implementation include P2000, various state and federal grant sources, mitigation, and local government programs.

Tasks

1. Delineate areas of tidal marsh habitat in the project area that could be preserved and/or restored, including areas currently at risk of significant alteration or destruction.
2. Implement a basin-wide strategy to achieve marsh conservation, restoration, and creation. This includes consideration and incorporation of existing public and private efforts to achieve marsh protection and restoration, including land acquisition by purchase or gift and conservation easements. This may also incorporate mitigation for permitted wetland impacts.
3. Identify BMPs which could be employed on private and public lands to reduce impacts on wetlands and associated upland and aquatic habitats. Develop recommendations for the implementation of such practices within the Pensacola Bay system watershed.
4. Develop plan for the management of protected habitats and the restoration of altered habitats. The should consider cumulative impacts and the identification of priorities for protection and restoration efforts.
5. Implement acquisition or less-than-fee protection through cooperative efforts with local governments, other agencies, and private entities.
6. Develop and implement management and restoration plans upon protection of conservation and/or restoration lands. These should include provision for recreational access in addition to restoration objectives.
7. Assess the long-term success of restoration actions.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$30,000	$30,000

HAB 2.0 Preservation of Bottomland Hardwood and Other Important Habitats

This project provides technical assistance and continued support for the efforts of communities in the Pensacola Bay watershed, as well as state and federal agencies, to protect and restore wetland resources, including in support of efforts to accomplish local comprehensive plan objectives for preservation of environmentally-sensitive lands. In addition to protection of sensitive lands, implementation of this project should result in improved conditions for fish, invertebrates, waterfowl, and terrestrial species. The project will provide for identification and implementation of alternatives to preserve and restore important wetland areas throughout the watershed. This includes technical assistance for preparation of grant applications and management plans, direct funding support, development of mapping layers to identify critical areas, and development of local programs for wetland protection. Examples of funding sources to augment SWIM for implementation include P2000, state and federal grant sources, mitigation, and local government programs. The Jones Creek wetland acquisition initiative provides one model of how this type project may work in concert other agencies and local governments.

Tasks

1. Identify environmentally-sensitive and important lands that should be preserved or restored, including bottomland hardwood forests, other floodplain and riparian habitats, riverine corridors, and other important habitats currently at risk of significant alteration or destruction.
2. Implement a basin-wide strategy to achieve the conservation, restoration, and potentially creation of wetland and other important habitats. This includes consideration and incorporation of existing public and private efforts to achieve protection and restoration, including land acquisition by purchase or gift and conservation easements. This may also incorporate mitigation for permitted wetland impacts.
3. Identify BMPs which could be employed on private and public lands to reduce impacts on wetlands and associated upland and aquatic habitats. Develop recommendations for the implementation of such practices within the Pensacola Bay system watershed.
4. Assist with development of grant applications, plans for acquisition and management of preserved habitats, and plans for the restoration of altered habitats.
5. Facilitate acquisition or less-than-fee protection through cooperative efforts with local governments, other agencies, and private entities.
6. Develop and implement management and restoration plans upon protection of conservation and/or restoration lands. These should include provision for recreational access in addition to restoration objectives.
7. Assess the success of ongoing preservation and restoration actions initiated through the SWIM program.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$12,200	$40,000	$30,000

Note: Priority project

HAB 3.0 Biological Monitoring

Collard (1991a) generally described the PBS as suffering from chronic anthropogenic impacts which have profoundly altered sediment, water, and habitat quality. Biological effects have been severe: diversity and biomass are low, benthic faunal populations are depauperate, and seagrasses and other key habitats do not appear to be recovering. In recent years, however, various structural and nonstructural initiatives to reduce point and nonpoint source pollution and direct habitat impacts have been attempted. The results of these efforts must be assessed to facilitate both incremental and comprehensive improvements in resource management. Limitations in the scope and usability of existing data also need to be addressed. Additionally, the Florida DEP has developed methods for stream condition index (SCI) and more limited Biorecon assessments. The Department is proceeding to implement Biorecon assessments of streams in the Pensacola Bay system watershed. Similar methods for estuarine and wetland environments are also being developed. The U.S. EPA has also been conducting research to identify biological criteria for monitoring and assessing ecological health.

This project is intended to build upon the work of Collard (1991a) and, in doing so, achieve the following objectives: (1) make specific recommendations for long-term biological monitoring, (2) assess biological responses to corrective and restorative actions which have been implemented, and (3) make recommendations for continued and refined corrective and mitigative actions. Additionally, the project is intended to incorporate planning, implementation, and assessment of biological monitoring being developed and implemented by the DEP, EPA, and other agencies.

Tasks

1. Identify indicators and assess procedures which would be useful for both long-term biological monitoring and assessments of specific corrective actions. This task should apply the results of Collard (1991a) and recognize recent efforts of the U.S. EPA, DEP, and other agencies to establish assessment methodologies for the PBS and other systems.
2. Develop recommendations for long-term monitoring, describing both methodologies and responsible entities. Completion of this task should address, to the extent practical, deficiencies in data availability and usability identified by Collard (1991a).
3. Compile existing data and collect new data to assess biological responses to past and ongoing efforts to improve water, sediment, and habitat quality. This may incorporate criteria established by the U.S. EPA Aquatic Ecological Criteria Research Program and Florida DEP.
4. Work with other agencies to implement new monitoring and assess collected data.
5. Develop analyses and recommendations for short- and long-term monitoring needs and recommendations for new or revised restoration and management efforts.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$12,300	$25,000	$30,000

Note: Priority project

HAB 4.0 Pensacola Bay System Circulation Study

This project is intended to provide for the assimilation of extensive data for the purpose of comprehensively managing the Pensacola Bay system. The project provides the "Big Picture" with regard to circulation in the system, and it provides an analysis tool for establishing PLRGs, assisting in the development of TMDLs, and revising regulatory standards within an ecosystem or watershed management framework. The project will help provide a more comprehensive understanding of the physiochemical characteristics of the system, including flushing potential, assimilative capacity, and cumulative effects, and will help evaluate interstate contributions of pollutant loads. The project would apply recent physical, chemical, and biological data collected by the U.S. EPA and other institutions which have been actively involved in collecting data on the system. For both data integration and design purposes, this project requires cooperation and coordination among state and federal regulatory, research, and resource management programs.

Tasks

1. Define specific data collection objectives and circulation study using preliminary hydrodynamic model development and input from agencies, universities, and local entities.
2. Use geographic and remote sensing data to further develop the understanding of surface circulation patterns. Consider alternatives for such analysis, including analyzing sediment movement during ambient and post-storm conditions and across several seasons and tracking chlorophyll_a during warm months.
3. Develop a data collection network in cooperation with local, state, and federal agencies and universities.
4. Install monitoring stations for collecting velocity, flow direction, temperature, salinity, and turbidity data.
5. Analyze data to identify circulation patterns in the system and verify the existing hydrodynamic model of the system.
6. Provide model simulation results to fully describe the flushing and circulation characteristics of the system, interactions with freshwater flows, and improved understanding of biological relationships with salinity patterns.
7. Provide interpretive reports including technical information and the results of the model analysis.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$0	$0

Note: Although it is expected that funding from the SWIM program will not be available, completion of this project is considered important to the development of PLRGs and assessment and planning of restoration efforts. Thus, implementation may proceed if additional funding is identified.

APC 1.0 Administration and Planning

The plan administration project will include planning and oversight over projects and the program budget. This project also includes coordination with the Bay Area Resource Council (BARC), including the TAC and Citizens Education Advisory Committee (CEAC), as well as with the SWIM Technical Coordination Group (TCG) and the Department's Ecosystem Management initiative. Through this process, coordination between the SWIM program and other government and private initiatives should be enhanced. Additional activities conducted via this project include the development of grant applications, other efforts to identify supplementary implementation funding, coordination with various public and private entities, development of plan updates, and other administrative activities. Additionally, a methodology will be identified and implemented to assess progress in achieving objectives of the SWIM Plan. It is important to measure this progress for a variety of reasons, including the limited nature of funding and staff resources, the need to achieve and maintain optimal effectiveness, and to facilitate communication of progress to program constituents (citizens, elected officials, etc.). This will be a continuing effort throughout the life of the Pensacola Bay system SWIM program.

Tasks

1. Meet regularly with the TAC and coordinate with the activities of the BARC and ecosystem managers to review and discuss progress towards fulfillment of SWIM objectives.
2. Work with representatives of local governments, federal, state, and regional agencies and the private sector to promote effective and coordinated management of the PBS in a manner consistent with the objectives of the SWIM plan.
3. Seek funding support from various sources to help supplement SWIM funding and enhance long-term planning and implementation initiatives.
4. Manage funding and personnel to implement the SWIM plan.
5. Track plan implementation efforts and monitor the progress of plan implementation.
6. Identify criteria and measures for progress assessment, potentially including trends in public awareness; biological, physical, and chemical indicators; institutional factors (e.g., permit compliance and the implementation of comprehensive plans); and restoration of localized resources. Evaluate incorporation of the DEP Pensacola Bay system Environmental Indicator System for this purpose.
7. Periodically update or amend the plan.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$16,400	$20,000	$20,000

Note: Priority project

APC 2.0 Institutional and Regulatory Assessment

This project provides for an ongoing effort to integrate the SWIM program within the changing framework of state, regional, federal, and local management and regulatory activities, as well as the activities of community and environmental organizations and other components of the overall management of the Pensacola Bay system. Initiatives, plans, ordinances, rules, regulations, and policies will be reviewed to better understand the effectiveness of programs to preserve and restore the natural resources and functions of the PBS. Emphasis will be placed on assessment of and development of effective working relationships with recent programs and legislation (e.g., Ecosystem Management, 1996 Farm Bill, NPDES Nonpoint, implementation of local comprehensive plans, etc.). Activities of local governments will also receive emphasis, as these are the most likely to have substantial impact on the management of the system through land use development regulations, zoning, and comprehensive plans. Additional emphasis, in conjunction with APC 3.0) will be placed on interstate management. Efforts will also be directed at better understanding the effectiveness of new programs as a feedback loop to the overall management of the PBS.

Tasks

1. Identify new initiatives and changing roles and responsibilities of agencies, governments, community organizations, and other entities active within the Pensacola Bay system watershed.
2. Where changes have occurred or as otherwise needed, obtain programmatic information to facilitate development and improvement of collaborative working relationships, as well as assessment of consistency with efforts to restore and protect the system.
3. Work to enhance functional relationships between the SWIM program and other initiatives, including BARC, Ecosystem Management, community initiatives, local governments, and others which are integral to management of the PBS.
4. Review and assess current responsibilities and activities of resource management agencies and other entities active within the basin. Where possible, include identification of specific measures of performance.
5. Develop recommendations for improved resource management in general, and implementation of the SWIM plan in particular, based on the changing institutional and resource management environment.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$7,000	$0

APC 3.0 Interstate Coordination

The objective of this project is to improve coordination and cooperation between Florida, Alabama, and federal agencies to facilitate effective management of the Pensacola Bay system on a watershed basis and to ultimately achieve SWIM goals of protecting and restoring the system. The general strategy of this project is to develop a partnership between state and federal agencies with a mutual interest and understanding in watershed protection measures. Such a partnership will enhance cooperation between the two states and will enhance the exchange of technical and institutional information. This effort will allow designated representatives of Florida, Alabama, and federal agencies to meet and assess mutual areas of interest, consider priorities, discuss land use and water management practices, cooperatively pursue major challenges, and develop strategies for alleviating problems in a collaborative manner. Joint efforts by local governments on a watershed-wide basis will also be supported through this process.

Tasks

1. Initiate communication between Florida, Alabama, and federal agencies with the objective of developing an effective mechanism for managing the system on a watershed basis so that the needs of upstream and downstream users are recognized and met.
2. Review rules, enforcement, and other resource management measures which have the potential to function in a consistent manner across state and agency lines.
3. Recommend further research and other projects needed to facilitate effective watershed management.
4. Form partnerships as needed to implement watershed-wide initiatives.
5. Design and work to achieve a long-term coordination mechanism for management of the Pensacola Bay system.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$12,600	$25,000	$50,000

Note: Priority project

APC 4.0 Geographic Information Management System Integration and Coordination

Geographically-oriented information management systems (GIMS), including geographic information systems (GIS) and various user applications, are capable of providing significantly improved spatial and temporal analysis tools for water resource management. They may also help develop a shared vision between agencies responsible for various aspects of resource management. This project will help to promote the use of this technological advancement through the District's GIS facilities and the formation of partnerships and linkages with other agencies with similar capabilities or needs. Integration of available databases and reduced duplication of effort will, in turn, provide for more effective management and better information for the decision-making process.

Tasks

1. Design a GIMS based on user needs and designated data types for ecosystem research and management of the PBS. Design specifications should include a "point and click" menu style multi-user interface.
2. Develop a database index and GIS with layers such as base maps, transportation routes, hydrography, soils, ecological associations, benthic habitats, political subdivisions, topography, bathymetry, etc..
3. Collect and store existing maps, digital data, and relational databases in electronic format to meet management, study, and educational needs. Data included should ultimately include the full range of geographic, water quality, and biological data which has been and continues to be collected in the watershed. Work closely with other agencies and the Interagency Geographic Information Board to avoid duplication.
4. Apply specific applications to meet user needs, including map layer displays, queries, and statistical summaries of stored data, and environmental overlay analyses.
5. Make GIS and related data and products available to local governments, schools, and the public via a variety of means, including direct transfer, Internet access, etc.
6. Maintain and update the GIMS system for continued use.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$33,500	$37,000	$23,500

Note: Priority project

ED 1.0 Education and Awareness Strategy Development

The purpose of this project is to achieve heightened public awareness of the Pensacola Bay system through development of a coordinated and integrated approach for implementation of a Pensacola Bay system Public Education and Awareness Program. The project requires input from state agencies, local governments institutions of higher learning, school districts, the business community, and civic groups. To maximize educational opportunities and public awareness, a strategy is needed specifically meets the public awareness and education needs in the Pensacola Bay system area. Support from the BARC Citizens and Education Advisory Committee and Technical Advisory Committee and coordination with existing communication and education networks is key to the implementation of this project.

Tasks

1. Outline important issues identified to help develop an education and awareness strategy.
2. Identify potential audiences. These may include virtually every sector of the public, including children, teachers, builders, realtors, homeowners, etc.
3. Obtain public input and define the general educational requirements of the public for the resolution of issues related to environmental quality.
4. Determine the specific audiences to be targeted and what educational methods are likely to work best.
5. Evaluate printed materials, community activities, educational programs, displays and other projects that have been used with other programs to determine which of them would work best with the Pensacola Bay system.
6. Solicit information from other governmental agencies and organizations on their ideas for projects.
7. Prepare a strategic plan that coordinates public education and awareness activities with the SWIM program and encourages increased membership and involvement of citizen organizations.
8. For specific projects outlined seek funding and participation by cooperating agencies and private interests to implement each project.
9. Maintain active staff involvement for program feedback.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$10,000	$0

ED 2.0 Media and Community Relations

This project is intended to use media and community relations as an inexpensive means to foster awareness and appreciation of the system, understanding of the issues affecting it, and awareness of initiatives for improved resource protection and management. To do this, this project will provide for dissemination of information through a variety of media, such as newspapers, publications, radio, television, community forums, and workshops. Such information will help inform area residents about the value of the Pensacola Bay system, watershed management, pollutant discharges, stormwater runoff and treatment, loss of habitat and biological resources, preservation and restoration activities, regulatory and management programs, and behavioral and activity changes that can help improve the system's quality.

Tasks

1. Work with local officials and organizations to foster relationships with the media and solicit media assistance as needed.
2. Work with newspapers, broadcast stations and other media outlets, organizations, and businesses as needed.
3. Develop articles for publication in newspapers and magazines, news and feature stories for broadcast on radio and television, and public service announcements for all media and community forums and workshops.
4. Host community forums and workshops to provide greater knowledge about issues affecting management of the Pensacola Bay system, the role of individuals in preserving and restoring the system, and awareness and technical information for informed decision-making.
5. Provide information to the media about the system and resource management initiatives.
6. Keep a record of all the products of this project to assist in the evaluation of PBS education and awareness programs.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$0	$15,000	$15,000

ED 3.0 WaterWays Video for the Pensacola Bay System

Through this project, the District will produce an educational video to provide an overview of basic environmental concepts, local environmental concerns, and footage of Pensacola-area waterbodies. As part of the *WaterWays* program, the video may be used separately or in conjunction with existing environmental education curricula. It will have the potential to reach large, diverse audiences and will be distributed to schools, libraries, and other organizations. The *WaterWays* educational program, designed for middle school students, includes student workbooks, teacher guides, and a region-specific video. It uses a local perspective to promote a broad, general understanding of concepts and issues related to water management and resource preservation. Since the inception of this program, it is estimated that more than 5,000 students have been reached annually in the Pensacola area.

Tasks

1. Make initial arrangements with appropriate contractors and personnel for video production.
2. Meet with the BARC, CEAC, other citizen groups, government officials, and other interested parties to coordinate the video production and receive feedback on local issues.
3. Develop a shot list and locations for videography.
4. Develop and review the script.
5. Review and revise rough and final edits, and distribute the video for public use.

Schedule and Budget

FY 97-98	FY 98-99	FY 99-00
$44,250	$5,000	$5,000

Note: Priority project

ECOLOGICAL SETTING OF THE PENSACOLA BAY SYSTEM

Description of Component Rivers and Embayments

Riverine Component

The major river systems within the Pensacola Bay system are the Escambia, Blackwater and Yellow rivers, including their tributaries and watersheds. These rivers travel south through the northwest portion of the Florida Panhandle and empty into the estuarine component of the system. Predominant land uses within the riverine watershed include forestry, agriculture, military, and public conservation and recreation, as well as residential and other urban land uses around several communities. Much of the economic base of this area is provided by the extraction of natural resources, primarily timber and agriculture, as well as indirect economic benefits provided by military activities and the service sector. Major public land holdings within Florida's portion of the riverine watershed include portions of Elgin AFB and Blackwater River State Forest.

Relatively little published characterization is available on the rivers of the Pensacola Bay system and their basins. Bass (1990) described fish assemblages in the Escambia River and characterized the hydrology and habitats of that river. Bass and Hitt (1977) evaluated the Blackwater River System by segment, including physical characteristics, water quality, and species identification. The Yellow River Marsh Aquatic Preserve Management Plan (DNR, 1991) describes habitats of the lower Yellow River, as well as portions of Blackwater and East bays. A general description of the ecology of the Florida Panhandle, including the rivers of the Pensacola Bay system, is provided in Wolfe et al. (1988). Livingston et al. (1988) and Hand et al. (1996) provide general descriptions, including basic characteristics and descriptions of anthropogenic impacts. Basic characteristics of Florida river systems are also provided by the Florida Water Resources Atlas (Fernald and Patton, 1984) and The Florida Rivers Assessment (FREAC, 1989). The U.S. Army Corps of Engineers (1980) assessed water resources within the Escambia and Yellow River basins, including water quality, flood control and damage, land uses, conservation efforts, and recreation facilities. This assessment also offered alternative plans for federal, state and local water resource planning.

The rivers of the Pensacola Bay system vary considerably in length, basin size, and type (see Table 5). The Escambia River is among the largest alluvial rivers in the state, and is part of a major interstate system. The Blackwater River is a smaller, blackwater system, and the Yellow-Shoal River system is intermediate in size and also influenced by drainage from wetlands as well as runoff and ground water (Hand et al., 1996; Fernald and Patton, 1984). The Blackwater, Yellow, and Shoal rivers have also been classified as sand-bottom streams, whereas the Escambia River is classified as a large river (Nordlie, 1990).

Table 5. Selected Attributes: Rivers of the Pensacola Bay System

River	Length (mi)	Watershed Area (square miles)	Average Annual Discharge (cfs)	Floodplain Forest (acres)
Escambia	240	4,223	6,300[1]	40,164
Blackwater	62	860	342[2]	9,984
Yellow	110	1,365	1,181[3]	31,782
Shoal	50	499	1,104[4]	no data

[1]near Century
[2]near Baker
[3]near Milligan
[4]near Crestview
Source: Fernald and Patton, 1984.

Escambia River. Originating in Alabama as the Conecuh River, the Escambia River travels south approximately 240 miles before discharging into Escambia Bay. The river basin drains a total of 4,223 square miles, 425 of which are within Florida. The Escambia River is the fourth largest in the state in terms of discharge, with an average annual discharge of 6,300 cubic feet per second (cfs) (Fernald and Patton, 1984). Seasonal fluctuations are large, with floods commonly occurring in winter and early spring and low flows generally occurring from late spring through autumn (Bass, 1990). Flows originate primarily from rainfall, with some groundwater contribution via scattered springs and seepage from surficial sands (FREAC, 1989). Measurements at Century, Florida, near the Alabama state line, indicate a seven-day, ten-year low flow to be approximately 800 cubic feet per second (cfs) and mean flow of over 6,500 cfs (Olinger et al., 1975). The U.S. Army Corps of Engineers, monitoring at Century, FL, estimated annual runoff values around 21.95 inches (U.S. Army Corps of Engineers, 1980). Pine Barren Creek is the river's largest tributary within Florida, draining approximately 98 square miles. Tidal influence causes river level fluctuations at least ten miles upriver. During periods of low flow, a salt wedge extends upriver from Escambia Bay for about seven miles at high tide (Musgrove et al., 1965). Total dissolved solids, resulting from limestone outcroppings in Alabama, reach above 100 parts per million (ppm) at Century (Musgrove et al., 1965), but tributaries in Florida tend to dilute this influence downstream.

The Escambia River is described as a classic alluvial river (Fernald and Patton, 1984). As such, it carries a heavy sediment load and has substantial variation in flows and a diversity of associated aquatic and wetland habitat types. The river is slightly acidic (mean pH 6.4) (Bass, 1990). The upper river (within Florida) is sand-bottomed, with sand bars and beaches forming along the inside arcs of river bends. According to Bass (1990), in-stream vegetation tends to be lacking, with habitat primarily provided by snags, exposed tree roots, and undercut banks. Bottomland hardwood forest and oxbow lakes border the main river, although pine forest also occupies much of the riparian zone. The lower river is influenced by tides, and is bordered by emergent marshes as well as patches of swamp. In 1980, primary land uses in the basin included forestry, which accounted for 71.6 percent of the area, and agriculture, which accounted for another 14.5 percent (U.S. Army Corps of Engineers, 1980).

Characteristic species of fish reported by Bass (1990), include warmouth (*Lepomis gulosus*), largemouth bass (*Micropterus salmoides*), and channel catfish (*Ichthyomyzon punctatus*). Threatened, endangered, or otherwise sensitive species supported by the Escambia River system include the crystal darter (*Ammocrypta asprella*), Gulf sturgeon (*A. oxyrhynchus desotoi*), harlequin darter (*Etheostoma histrio*), saltmarsh topminnow (*Fundulus jenhunsi*), bluenose shiner (*Pteronotropis welaka*), and several freshwater mussels. The basin supports populations of the Florida black bear (*Ursus americanus floridanus*), southeastern American kestrel (*Falco sparverius paulus*), bald eagle (*Haliaeetus leucocephalus*), gopher tortoise (*gopherus polyphemus*), osprey (*Pandion haliaetus*), and egrets (*Egretta*), among other sensitive animal and plant species. Biological resources are described in greater detail in following sections.

The Escambia is among the more impacted rivers in the region. It receives industrial and domestic waste discharges, as well as substantial nonpoint source pollution. Additionally, the lower river has been dredged for navigation purposes, and two dams are upstream in Alabama (Bass, 1990). Bass (1990), however, describes fish populations and water quality in the river in general as being in a state of recovery. Impacts affecting the Escambia River and water quality are described in greater detail below.

Blackwater River. Originating in Bradely, Alabama, the Blackwater River travels south approximately 62 miles prior to discharging into Escambia Bay. The river drains approximately 860 square miles, approximately 700 of which are within Florida, and has an average annual discharge of approximately 342 cfs (Fernald and Patton, 1984). Average depths are between two and 15 feet, and widths tend to vary between 110-300 feet (Bass and Hitt, 1977). The major source of flow is groundwater discharge, with a smaller contribution from surface runoff (Livingston et al., 1988). Water samples taken near Baker indicate generally acidic conditions, periodically falling below 6.0 pH (U.S. Army Corps of Engineers, 1980). Lower portions of the river have a tidal range of approximately two feet, and saltwater intrusion has been identified six miles upstream. Principal tributaries of the river include Big Juniper Creek, Big Coldwater Creek, and Pond Creek. Primary land uses within the basin include forestry (76.6%) and agriculture (18.8%) (U.S. Army Corps of Engineers, 1980). The Blackwater River is designated an Outstanding Florida Water (OFW), and is among the most popular waterbodies in the state for canoeing and other recreational activities.

The aptly named Blackwater River and its tributaries drain acidic flatwoods and other wetlands, as well as being influenced by discharge from the Sand and Gravel Aquifer (Hand et al., 1996). The river tends to exhibit a reddish color, due primarily to the presence of tannic and organic acids (FREAC, 1989). The upper Blackwater River and its tributaries Big Juniper Creek, Sweetwater Creek, and Big Coldwater Creek have been described as swift, relatively shallow, and sand-bottomed (Bass and Hitt, 1977). Aquatic vegetation is sparse, and some habitat cover is provided by snags, fallen trees, and undercuts. In the 1970s, only the upper reaches of this system were assessed as having adequate cover for fish habitat (Bass and Hitt, 1977). The lower Blackwater River is tidally influenced with moderate currents. Substrates are more fine and organic, and emergent and submergent species of vegetation are more common. Pond Creek is similar to the lower Blackwater River, with lower reaches tidally-influenced. Currents are moderate, substrates range from sand to mud, and emergent and submergent species of vegetation are common. Bass and Hitt (1977) further describe a series of lake-like freshwater and brackish basins along the lower river. Aquatic vegetation is abundant in these basins, substrates tend to be rich and organic with sand along some shorelines, and currents are nonexistent except when associated with tidal fluctuation.

Characteristic fish species reported by Bass and Hitt (1977) include spotted bass (*Micropterus punctulatus*), sailfin shiner (*Pteronotuopis hypselopterus*), chain pickerel (*Esox niger*), and largemouth bass (*Micropterus salmoides*). The Blackwater River system supports the endangered blackmouth shiner *(Notropis melanostomus*). Among the sensitive species living in the watershed are the red cockaded woodpecker (*Picoides borealis*), Florida pine snake (*Pituophis melanoleucus mugitus*), eastern indigo snake (*Drymarchon corais couperi*), osprey (*Pandion haliaetus*), Florida black bear (*Ursus americanus floridanus*), and the white-topped pitcher plant (*Sarracenia leucophylla*) (Cox et al., 1994).

The lower Blackwater River system receives discharges from domestic wastewater treatment facilities, and portions of the system are subject to impacts from nonpoint source pollution. Water quality in general has been characterized as excellent; however, and much of the river basin is protected by conservation lands. Anthropogenic impacts on the Blackwater River are described in greater detail in following sections.

<u>Yellow and Shoal Rivers</u>. The Yellow River originates in Covington County, Alabama and travels 92 miles to Blackwater Bay in Florida. The river travels through the Western Highlands in parts of Alabama and Okaloosa County, Florida, creating bluffs reaching 40 feet in some areas (Livingston et al., 1988). The river drains generally from the east/northeast and has a drainage basin of 1,365 square miles, of which about 860 are within Florida. The river floodplain is generally about two miles wide and has an extensive floodplain forest. Fluctuations due to tidal effects are noticeable nearly 19 miles upstream. The Yellow River is described as a sand bottom river and is characterized by shallow clear-tan waters. It has an average annual discharge of approximately 1,500 cfs 40 miles above the mouth (Hand et al., 1996).

The principal tributary of the Yellow River is the Shoal River, which originates in northern Walton County and discharges an annual average of 1,104 cfs into the Yellow River south of Crestview (Fernald and Patton, 1984). Titi and Turkey creeks are tributaries of the Shoal River. In 1980, about 78 percent of the Yellow-Shoal River basin was reported as forested, with another 18 percent under agricultural use (U.S. Army Corps of Engineers, 1980). The portion of the basin under residential, commercial, and other development, however, has increased since that time, notably in the vicinity of Crestview. The lower portion of the Yellow River, as well as portions of Blackwater and East bays, are managed as the Yellow River Marsh Aquatic Preserve. The Shoal River and waters within the aquatic preserve are designated as Outstanding Florida Waters (OFWs). Both the Yellow and Shoal rivers are prone to flooding during the winter and spring months, and experience high discharge rates between November and June (U.S. Army Corps of Engineers, 1980).

Common fish species supported by the Yellow River system are similar to those described above for the Escambia and Blackwater rivers. Some of the species identified by Eglin AFB (1993) included speckled madtom (*Noturus leptacanthus*), redbreast sunfish (*Lepomis auritus*), and chain pickerel (*Esox niger*). Biological resources are described in greater detail in following sections.

Like other systems, the Yellow River system is subject to impacts from a variety of nonpoint sources of pollution, as well as potentially by drainage from domestic and industrial wastewater reuse facilities. Urban runoff from the vicinity of Crestview has also been described as problematic for the Shoal and Yellow rivers. Water quality in the Yellow River system, however, has been assessed as generally “excellent” (Hand et al., 1996).

Estuarine Component

The five estuarine embayments of the Pensacola Bay system (Pensacola Bay, Escambia Bay, Blackwater Bay, East Bay, and Santa Rosa Sound) are subject to very low-energy diurnal tides that cause an average water level fluctuation of about 1.5 feet (DNR, 1976; DCA, 1986). These fluctuations are subject to significant variation due to changing tide/wind/inflow interactions. The normally low tidal range limits flushing within the system. Little and Quick (1976) estimated that 18.8 percent of the system's water volume is exchanged with each tide cycle, and about 18 days are required to flush the entire system. However, others (e.g., Olinger et al., 1975) have computed flushing times for Escambia Bay (separately) to be normally about 34 days and sometimes up to 200 days. Waters discharging from the Escambia River have been estimated to require two to seven days to reach the mouth of Pensacola Bay, riding over the deeper, more saline waters of the system. The system is generally stratified, resulting from this outflow of less dense fresh water from the rivers over denser, marine salt water. The stratification is characterized by both the salinity and, frequently, temperature gradients. In Pensacola and Escambia bays, the salinity of the upper layer is normally less than ten parts per thousand (ppt), while bottom layers may be more than two or three times that amount (U.S. EPA, 1971).

Table 6. Surface Area and Mean Depth of the Bays and Selected Bayous of the Pensacola Bay System

Water Body	Surface Area (mi^2)	Mean Depth (ft.)
Pensacola Bay	54.1	19.5
Bayou Grande	1.5	9.0
Bayou Chico	0.4	6.0
Bayou Texar	0.6	6.1
East Bay	43.9	7.9
East Bay Bayou	1.7	3.9
Escambia Bay	36.0	8.0
Mulatto Bayou	0.3	4.9
Blackwater Bay	9.8	6.3
Catfish Basin	0.3	3.9
Santa Rosa Sound	42.4	8.9

Adapted from Olinger et al., 1975.

A fairly extensive and diverse body of literature regarding the Pensacola Bay estuarine system has been steadily building, particularly since the late 1960s. This body of literature and, in particular, existing databases, are fragmented and inconsistent, however (Collard, 1991a). Collard (1991a) identifies specific deficiencies in research and databases.

The major work on the system is that conducted by Olinger et al., (1975). This interdisciplinary study characterized the system, including sediment conditions, water quality, circulation, and biological resources. Additional descriptions of sediment conditions have been provided by Horvath (1968), U.S. EPA (1971), Glassen et al. (1977), the NWFWMD (1978), Young (1981), Isphording et al. (1983), McAfee (1984), Science Applications International Corporation (1986), George (1988), and Seal et al. (1994). Descriptions of tidal and circulation conditions in the system are provided by Marmer (1954), Ellis (1969), Hopkins (1969), Provost (1971), Gallagher (1971), U.S. EPA (1971), McNulty et al. (1972), Edwards (1976), and Ketchen and Staley (1979). Descriptions of water quality in the system include those of Hopkins (1969), U.S. Department of the Interior (1970), U.S. EPA (1971), Hannah et al. (1973), Glassen et al. (1977), Young (1981; 1985), Shuba (1981), and Hand et al. (1996). Some of the descriptions of the faunal assemblage of the system include those provided by Cooley (1978), Little and Quick (1976), Young (1981), Butts and Ray (1986), Collard (1989), and Hudson and Wiggins (1996). Descriptions of submerged and emergent vegetation in the Pensacola Bay system are provided by Hopkins (1973), Rogers and Bisterfield (1975), Stith et al. (1984), and Shambaugh (1986). Jones et al. (1992) reviewed literature on physical, sedimentary, and water quality characteristics of the system, and Collard (1991a) provided a literature-based review of the biological status and trends of the system.

The Pensacola Bay system supports an array of biological communities and species characteristic of a northern Gulf of Mexico estuary. Estuarine habitats include tidal flats, benthic microalgae communities, seagrass beds, oyster beds, tidal marshes, and planktonic and pelagic communities. These resources in the Pensacola Bay system have been subject to sustained anthropogenic stress for some time. Seagrasses, for example, were formerly abundant in this system but have functionally "disappeared" from the system since the mid-1970s, with the exception of Santa Rosa Sound (Collard, 1991a; 1991b). Biological resources supported by the Pensacola Bay system are described in greater detail below.

<u>Pensacola Bay</u>. Pensacola Bay borders the City of Pensacola to the north, Escambia Bay to the east, Big Lagoon to the west, and the Gulf Breeze Peninsula and Santa Rosa Island to the south. Pensacola Bay provides the system's outlet to the Gulf of Mexico through an approximately ½ mile wide pass (Caucas Channel). Sources of water to the bay include component rivers of the system via adjacent bays, the Gulf of Mexico, and several bayou basins, including Bayou Grande and Bayou Chico. Pensacola Bay is the deepest of the component bays of this system, with an average depth of 19.5 feet (Olinger et al., 1975).

Pensacola Bay is normally stratified, and often strongly so. McNulty et al. (1972) reported surface salinities near the Pensacola municipal pier to range as low as 0.6 ppt, with bottom salinities up to 25 ppt. Bottom salinity generally has a small range of variability, while surface salinity may range from virtually fresh to nearly the salinity of sea water. Circulation in this bay is not as well documented as in Escambia Bay, although tidal flushing is more pronounced than in Escambia, East, and Blackwater bays. Incoming (high tide) waters tend to move along the bottom into the bay and then eastward along the southern part of the bay. On an outgoing tide, surface waters tend to move toward the pass from the more northerly and western portions of the bay (Reidenauer and Shambaugh, 1986). Olinger et al. (1975) found that circulation within the bay could be strongly influenced by surface winds, with effects not necessarily limited to the upper layers.

Pensacola Bay receives nonpoint source contributions via surface water runoff from the City of Pensacola, as well as NAS Pensacola and surrounding unincorporated areas. Point source discharges include the Main Street and NAS Pensacola wastewater treatment plants. Component bayous, formerly centers of productivity in the system, are now among the most anthropogenically stressed. Most act as sinks for sustained urban runoff and other NPS pollution, and Bayou Chico has also received substantial historic point source discharges.

Escambia Bay. Escambia Bay is situated between the City of Pensacola to the west, the Garcon Point peninsula to the east, and the Escambia River delta to the northwest. The primary source of water in the bay is the Escambia River. Other sources in upper Escambia Bay include the Pace Mill Creek and Mulatto Bayou drainage basins, among others. Sources of water in lower Escambia Bay include the river via upper bay and the Indian Bayou, Trout Bayou, and Bayou Texar basins.

Tidal flushing in Escambia Bay is considered poor, and sediments are highly organic. Circulation is most strongly influenced by inflow from the Escambia River, as well as from winds, and tides. There is a net southward flow of river water along the western shore, with more saline water intruding along the eastern shore. This tends to produce a generally counterclockwise circulation pattern (Hudson and Wiggins, 1996). High tides, low river discharge, and strong surface winds (especially southeast and southwest winds) tend to decrease stratification, while the reverse of these conditions increases it. Railroad and highway bridges may inhibit flushing and exchange between the upper and lower bay, and surface wind effects may also influence circulation in upper portions of the bay.

Escambia Bay is among the most anthropogenically stressed components of the Pensacola Bay system. It has historically received substantial industrial and domestic wastewater discharges, and is still affected by surface water discharges and reuse sources in the vicinity of the bay, as well as from the Escambia River basin. The bay also receives NPS pollution from the City of Pensacola, unincorporated areas, and the river basin. Bayous, such as Texar and Mulatto, are also impacted by NPS pollution, and Bayou Texar may also be threatened by contaminated plumes from two U.S. EPA designated Superfund sites (Martin 1997).

Blackwater and East Bays. Blackwater Bay is at the mouth of the Blackwater River and borders the Garcon Point peninsula to the west. This bay receives discharge from the Blackwater River. East Bay is immediately downstream of Blackwater Bay and receives inflow from Blackwater Bay, the Yellow River, and the East Bay River, which flows from the east. East Bay is bounded to the south by the Gulf Breeze peninsula.

According to Hudson and Wiggins (1996), circulation in Blackwater and East bays tends to be counterclockwise. Generally, fresh water from the Blackwater and Yellow rivers flows south along the western shore of East Bay, and more saline waters flow northward along the eastern shore. The importance of winds on circulation and mixing are enhanced during periods of low flows. Vertical stratification of these waterbodies has been noted, as well as mixing of Blackwater, Escambia, and Pensacola bay waters with the waters in East Bay. These bays are shallow, with relatively organic sediments—although composition at specific sites may vary from sand to mud (Collard, 1991a; Bass and Hitt, 1977). Aquatic vegetation varies, with most associated with tidal marshes at mouths of the Blackwater and Yellow rivers.

Although Blackwater and East bays have been described as the most unaffected estuarine portions of the system from anthropogenic degradation, they have also been described as the most vulnerable to future degradation (Collard, 1991a). This, in part, is because these bays are lower in energy and tidal flushing than other estuarine portions of the system. Nonpoint source pollution may be increasing residential and commercial development in Santa Rosa County, and the system also receives discharges from several point sources.

Santa Rosa Sound. Santa Rosa Sound is a lagoon between the mainland and Santa Rosa Island which connects Pensacola Bay in the west with Choctawhatchee Bay in the east. The sound extends approximately 57.9 km along an east-west orientation, varying in width between 0.32 and 3.5 km (FDEP, 1993). Most waters within the sound are designated as Class II, and waters within the National Seashore are designated OFW. The Intracoastal Waterway (ICW) transects the sound and supports moderate commercial barge traffic.

According to the Florida Marine Research Institute (FDEP, 1993), the Navarre Bridge Causeway divides the sound into nearly equal sized eastern and western regions and contributes to a bi-directional tidal flow. Salinity and depth are fairly uniform throughout the sound, with mean annual values of 24 ppt and 2.7 m respectively. Santa Rosa Sound receives little fresh water inflow (Hand et al., 1996).

Santa Rosa Sound is notable as being the site of the most diverse and stable seagrass beds within the Pensacola Bay system. Anthropogenic stresses on the lagoon's environment include NPS pollution and habitat loss resulting from increasing development on Santa Rosa Island and along the U.S. Highway 98 corridor. The Navarre Beach and Pensacola Beach WWTPs discharge to the sound (Hand et al., 1996). The sound also receives runoff from several golf course, including effluent from spray irrigation with treated municipal wastewater.

Physical Setting

Climate

Primary factors affecting climatic conditions within the basin area include latitude and proximity to the Gulf of Mexico. The climate of the basin is humid subtropical with generally warm temperatures. Monthly averages range from 52°F in January to 85°F in July and August. Humidity is relatively high (averaging 74 percent), and winds are normally from the north/northwest in fall and winter and the south/southwest in spring and summer. Annual rainfall in the area has ranged from less than 29 inches to more than 90 inches, with an average of about 64 inches. Rainfall events are heaviest in July, August, and September and lightest in October and November. Extended droughts are infrequent, while shorter droughts are rather common. Both, however, impact surface water flows within the basin. The longest period without measurable rainfall was 48 days, from September 23 to November 9, 1952.

Soils

There are eight major types of soils in the basin. These range from excessively drained soils which contain large amounts of sand to the poorly drained soils of freshwater swamps and tidal marshes which consist mostly of organic material and clay. The most permeable soils are located in an area south of an imaginary line which would extend from Pensacola to the northeast corner of Santa Rosa County. The soils in this area, with the exception of those found in the river valleys, are characterized as predominantly sandy. Soils north of this area normally consist of more organic matter and are of moderate permeability. Throughout the basin, the soils occupying the lower elevations are the least permeable. These areas are found in the freshwater swamps along the Escambia River, Yellow River, and East Bay River; the saltwater tidal marshes located at the head of Blackwater Bay; and on Garcon Point. Suitability for development is limited in these areas due to slow soil percolation rates.

Physiography

The Pensacola Bay system lies within the Coastal Plan province, which is underlain chiefly by beds of sand, silt, limestone, and clay that dip gently seaward. The Escambia, Blackwater, and Yellow river basins, including much of Escambia, Santa Rosa, Okaloosa, and Walton counties, are within the

Western Highlands. This is a subsection of the Northern Highlands, which is a band of relatively high elevation land which spans the northern Panhandle. The Northern Highlands are underlain by the Citronelle formations, ancient delta deposits of clays, clayey sands, and gravel.

The estuarine embayments are within the Gulf Coastal Lowlands subdivision. The lowlands are a series of parallel terraces rising from the coast in successively higher levels. They formed during the Pleistocene Epoch (Great Ice Age) when fluctuating sea levels were associated with the growth and melting of ice caps. Dunes, barrier islands, beach ridges, and other topographical features were stranded inland as seas receded. Land surfaces of the lowlands are generally level and less than 100 feet above sea level. Substantial areas are less than 30 feet above sea level and are characterized by extensive wetlands. Higher elevations are present in the general area of Pensacola, on the west side of Pensacola and Escambia bays.

Most of the southern boundary of Escambia and East bays is formed by the Gulf Breeze Peninsula, a sandy coastal barrier feature. The southern boundary of the entire system is formed by Santa Rosa Island, which is approximately 50 miles long and varying between approximately 1,000-1,500 feet wide (Otvos, 1982; cited in Morang, 1992). The island is made up of Holocene quartz sands, between 15 and 30 feet thick, overlying a Pleistocene core.

Geology

The area surrounding the Pensacola Bay system is underlain by a veneer of Pleistocene terrace deposits overlying Tertiary beds of sand, silt, and limestone which dip southwestward at 30 to 40 feet per mile (Marsh, 1966). Stratigraphically, these sediments are referred to as undifferentiated alluvium and terrace deposits underlain by the Citronelle Formation. The uppermost part of this sequence forms the Sand-and-Gravel Aquifer. Major tributaries of the system are incised into the Sand-and-Gravel Aquifer. Groundwater flow from this aquifer discharges to these tributaries and to the bay.

Marsh (1966) also suggests that three marine surfaces of Pleistocene age can be recognized in the area; the Pamlico terrace at 30 feet, the Penholoway terrace at 70 feet, and a seaward sloping upland surface whose altitude ranges from about 60 to 200 feet. Remnants of these terraces are preserved as upland plateaus, flat-topped hills, and low coastal plains.

Santa Rosa Island is considered a classic example of bay barrier bar with a straight seaward margin. The island is about half a mile wide and has sand dunes as high as 50 feet above sea level. Two backshore terraces can be observed, one slightly above the other. Martens (1931) considered them to have been generated by storms.

The sand and mud sediments of the Pensacola Bay system were deposited as a result of erosion throughout the watershed which has taken place since the Pleistocene Epoch. During the Pleistocene, the Citronelle deposits were reworked and intermixed with marine terrace deposits (Marsh, 1966). These marine deposits, as well as Miocene and Pleistocene terrace deposits, are now eroding and, therefore, control the mineralogy of the bay sediments. Because each of the streams passes largely through Neogene Coastal Plain formations, the bay's sediments consist almost entirely of sand, silt, and clay eroded from these older units (George, 1988). The annual sediment load estimated by the National Ocean Service (1987) is 1.08 million tons/year, and its sediment inflow is 154.5 tons/year/square mile of drainage area.

The mineral suite for the Pensacola Bay system is made up of largely reworked, stable, heavy minerals dominated by zircon, tourmaline, staurolite, and kyanite. Unstable heavy minerals, such as hornblende, garnet, pyroxene, and epidote are essentially lacking. Clay mineral analyses indicate that the Escambia River carries mainly kaolinite, with lesser amounts of montmorillonite, vermiculite, illite, and gibbsite (Isphording et al., 1989). The deposition of sediments in the Pensacola Bay system has significantly changed over recent time. This change is partially described from borings made by the Florida State Road Department during construction of local bridges (Horvath, 1968). Borings were taken at the Santa Rosa Bridge near Navarre (17 borings to 65 feet), Pensacola Bay Bridge (6 borings from 100 to 108 feet), Escambia Bay Bridge (27 borings from 100 to 130 feet), and Blackwater Bay Bridge (12 borings to 65 feet). Borings generally indicate a vegetative, "muck" layer as deep as 60 feet with cleaner fine to coarse sands below. These deposits are vegetative evidence of plant growth at a lower stand of sea level (approximately 6,000 years ago). All contain intermittent layers of silt and clay.

The changes in the sedimentary regime of the system are primarily due to the geologically recent rise in the sea level. The presence of silty clays, similar to the central bay floor sediment today (in bore holes from Santa Rosa Sound), suggests that the present sediments were deposited on bay-lagoon deposits behind late Pleistocene barrier islands further off shore. The transition from probable bay sediments below, to barrier island lagoon sediments above (muck), occurs at about 55 feet below sea level.

Water Quality Characterization

The water quality of the estuarine portion of the Pensacola Bay system has been the subject over the years of a number of studies and monitoring efforts. Some were required by point source permits, some were initiated because of a recognition that out-of-state pollution sources may impact Florida waters, and some were initiated as academic research and routine state and federal monitoring efforts. Reidenauer and Shambaugh (1986) described a problem associated with using the results of multiple, unrelated assessments: "The interpretation and compilation of available water quality data was hampered in many instances by difficulties encountered with different sampling techniques and analyses used by various investigators in addition to unrecorded physical conditions at the time of sampling and sampling stations not in the same location in many cases, contributing to additional variability in the results."

Characterizing water quality within the riverine component of the system is also difficult, not primarily due to multiple, inconsistent methods, but rather due to a general lack of information. Few complete assessments have been completed, particularly for the Yellow River system.

While some areas of the system remain relatively pristine (perhaps portions of the Blackwater and Yellow river systems), others (Escambia Bay) exhibit consistently degraded water quality as a result of nonpoint and point source discharges, and others (Bayou Chico) have been degraded to such an extent for such a long period of time that they are in need of significant restoration. Other waterbodies, such as East Bay and Santa Rosa Sound appear vulnerable to increased degradation due to increasing development and NPS pollution.

<u>Escambia River</u>

The Escambia River is among the more impacted waterbodies in the region. It receives industrial and domestic waste discharges, as well as substantial nonpoint source pollution. Additionally, the lower river has been dredged for navigation purposes, and two dams are upstream in Alabama (Bass, 1990).

According to Bass (1990), the Escambia River is slightly acidic (mean annual pH 6.4), tends to maintain adequate dissolved oxygen levels (annual mean 8.1 mg/l; annual range of 5.3-10.4 mg/l), and tends to have relatively low levels of dissolved solids and nutrients. Annual water temperatures were reported as ranging from eight to 29 degrees Celsius. Bass (1990) notes the historic impacts on this river system of industrial and domestic wastewater discharges, but describes the past two decades as a period of recovery for both water quality and fish populations.

According to Hand et al. (1996), water quality in the Escambia River basin as a whole is generally good; however, most tributaries appear to be threatened, and a couple were identified as moderately impaired. The Canoe Creek and Pine Barren Creek basins were described as suffering from agricultural and dirt road runoff, and Sandy Hollow Creek disappeared due to sedimentation. Sedimentation, turbidity, and pesticides are identified as potentially contributing to declining fisheries. Ferry Pass Bayou and Governors Bayou are moderately affected by the introduction of nonpoint runoff (Livingston et al., 1988). Fly ash disposal, generated during power production, has been linked to declining water quality levels in the Governors Bayou portion of the basin. The Escambia River is also susceptible to stormwater runoff from four major highways (I-10, U.S. 90, S.R.184, and S.R. 4) (FREAC, 1989).

Yellow and Shoal Rivers

Hand et al. (1996) characterizes the Yellow River system as having generally “excellent” water quality. Like other systems, the Yellow River is impacted by a variety of nonpoint sources of pollution, as well as potentially by drainage from domestic and industrial wastewater reuse facilities. Trammel Creek, which receives runoff from the City of Crestview and, until recently, received a WWTP discharge, was assessed as having nutrient and turbidity problems. Crestview recently removed its discharge from the creek and now disposes of it via an upland sprayfield. Other tributaries described as impacted by NPS pollution include Pond Creek, the Shoal River in the vicinity of Crestview, Horsehead Creek, Juniper Creek, and Hurricane Creek.

Blackwater River

Water quality in the Blackwater River basin was assessed by Hand et al. (1996) as “excellent.” The lower Blackwater River system receives discharges from domestic wastewater treatment facilities, and portions of the system are impacted by nonpoint source pollution. High concentrations of nutrients, chlorophyll, BOD in Clear Creek have been attributed to discharge from the Whiting Field WWTP. Water quality problems in the lower river and Blackwater Bay have been also associated with effluent from the Milton Wastewater Treatment Plant (FREAC, 1989). Much of the river basin is protected by conservation lands.

Bass and Hitt (1977) evaluated water quality in the Blackwater River System by segment. Some of the results are described as follows. Lower river and estuarine waters are less acidic than upstream waters, although they tend to remain less than neutral in pH. Mean dissolved oxygen values at stations on the river ranged from 7.3 to 9.3 ppm, with the highest mean value observed in the heavily vegetated Wright basin. The mean DO value in Pond Creek was 8.4, and that of Big Coldwater Creek was 8.8 ppm. The highest DO levels in the basin, in addition to the Wright basin, were measured in Sweetwater and Big Juniper Creek, where mean values by station ranged from 9.2 to 9.3 ppm. Temperatures measured in the system ranged from 6.0^{o} to 29.0^{o} Celsius. Nitrate nitrogen values varied irregularly through the system. The highest annual mean concentration was measured at two Big Coldwater Creek stations (0.59 and 0.38 ppm, respectively), and the lowest were observed in the outer bay (0.07 ppm). Average values were measured in Pond Creek at 0.28 ppm, and in Juniper Creek at 0.06-0.09 ppm. Ammonia values were low throughout the system, with annual mean values ranging from 0.02 to 0.06 ppm. Total phosphate levels were considered low throughout the system 0.03 -0.10 ppm, and orthophosphate levels were uniform with an annual mean of 0.01 ppm.

Escambia Bay

Of the components of this system, Escambia Bay is generally recognized as having the most significant water quality limitations. This is due to a number of factors, including: contaminant loading by interstate flow of the Escambia-Conecuh River System; sewage treatment plant (STP) inputs;

industrial discharges within and outside the Florida portion of the Escambia River watershed; and basin-wide nonpoint inputs.

The interstate nature of the problem of water quality degradation in Escambia River and Bay was typified by a series of conferences that were held in 1962, 1970, 1971 and 1972 (U.S. EPA, 1972). It was recognized at that time that the system was suffering from excessive organic and nutrient loadings, fish kills and other symptoms of ecological degradation. Hopkins (1969) examined dissolved oxygen (DO), nitrate-nitrogen, and thermal effluents from electrical power generation and industrial discharges. He also investigated the nature of the deeper estuarine waters. He noted low DO levels in the water and indicated that the assimilative capacity in upper Escambia Bay had been greatly exceeded and went on to recommend that nutrient sources entering the bay be discontinued. Hopkins (1973) studied the valuable marine resources of Escambia Bay adjacent to Escambia and Santa Rosa counties and made recommendations concerning their conservation.

The U.S. Department of the Interior (1970) conducted an extensive examination of the effects of pollution on water quality in the Escambia River and Bay. This study, a result of a request from the Governor of Florida, said that the upper section of Escambia Bay was in a state of accelerated eutrophication based on unstable DO variations, high carbon, nitrogen, and phosphorus concentrations, and oxygen-demanding sludge deposits. It also noted that the piles of the L & N railroad bridge inhibited flushing and exchange between the upper and lower bay. The presence of sludge deposits in the bay south of the railroad bridge also degraded water quality. Also documented in the report was the industrial discharge of acrylonitrile (vinyl cyanide), and the relationship of this material to fish kills was questioned.

At the time of the study, the major dischargers of carbonaceous waste were Monsanto, American Cyanamid and Container Corporation of America. Escambia Chemical (now Air Products), Monsanto and American Cyanamid were the principal contributors of nitrogenous wastes, with the Pensacola Northeast STP also contributing. Phosphorus was discharged periodically by Escambia Chemical and Monsanto, but the Pensacola Northeast STP was also named as a significant source. Waste abatement procedures and practices were called for, along with various other actions (removal of the L & N bridge, construction of secondary sewage treatment facilities at the Town of Century, etc.). Toxic wastes, possible constituents of the various industrial discharges, were discussed, but only the presence of acrylonitrile, sodium thiocyanate, and diphenyl oxide were documented. The possibility of toxic effects from the sodium thiocyanate, which releases cyanide in the presence of free chlorine, was discussed, and the reduction of acrylonitrile discharges into the system was called for. Other toxic materials, notably PCB have also affected the system, primarily from an accidental spill discovered in 1969, from the Monsanto plant heat exchangers (Duke et al., 1970). The presence of this material in the sediments (now essentially absent from the water column) of Escambia Bay still presents a possible threat to the health of the system. Its concentration and extent are poorly known, but its release (through dredging, storm-induced resuspension, etc.) remains a concern. Subsequent information regarding PCBs in the water of the Pensacola Bay system is notably lacking in the literature. In the 1975 Olinger et al. study, the most comprehensive documentation of the water quality of the Pensacola Bay system, it was noted that Escambia Bay had the highest total nitrogen (TN) content of the bays in the system, but that TN content of the bay decreased by 50 percent during the period 1967-1974. A later report by the DEP (Young, 1985) contradicted this trend when it noted that the discharges of nitrogenous wastes to the Escambia River and Bay, including the possible release of these compounds from the nitrogen-rich sediments, still posed significant problems to the water quality of the system.

Phosphorus, while found in significantly lower concentrations than nitrogen, is present in quantities sufficient for nuisance algal blooms (> 0.05 mg/L). This condition, based on a recent report by Young (1985), is in contrast to the Olinger et al. (1975) report, in which total phosphorus (TP) values throughout the entire Pensacola Bay system were consistently below 0.05 mg/L. Olinger et al. went on to state that the total phosphorus in Escambia Bay had decreased about 75 percent between

1969 and 1974. During the study period (1974) the mean TP in Escambia Bay was 0.028 mg/L, significantly below the recommended upper limit. If recent data are correct, efforts to determine causes of apparent increases and to identify methods of decreasing TP in the bay should be initiated. Although substantial efforts to reduce nutrient loading have been initiated, recent information (DER, 1988) suggests a trend of continued increases of TN and TP in Escambia Bay, with the greatest concentrations along the northeastern shore of Escambia Bay. Concentrations may be decreasing to the south of this area and into Pensacola Bay, which indicates either assimilation by biological processes, sedimentary incorporation, or advection due to circulation (DER, 1988). In either case, nitrogen remains an extremely important pollutant in the Escambia Bay, and its presence, both historic and contemporary, is well documented. Phosphorus, on the other hand, is most likely the limiting nutrient, and, since it is present in relatively small quantities, excessive algal blooms and accelerated eutrophication are probably deterred because of it. In addition to inducing algal blooms and decreasing DO, elevated phosphorus levels directly stress benthic organisms and fish. This may lead to disease, predation, and a decreased competitive capacity.

Organic carbon is present in the water and sediments of Escambia Bay. It is a component of normal biological processes and, unfortunately, is also in several point source industrial waste discharges. Quantities in excess of 2 mg/L are considered problematic. Olinger et al. (1975) indicated that total organic carbon (TOC) throughout the entire Pensacola Bay system uniformly exceeded this quantity. Escambia and Blackwater bays were about equal in TOC, followed by East and Pensacola bays. It is interesting to note that Olinger et al. (1975) did not observe the distinct patterns of TOC concentrations due to waste discharges as one would expect. Nevertheless, TOC is high throughout the system.

As a result of the abundant organic constituents in the water column and the sediments, Escambia Bay experiences wide variations in DO. During the summer, when algal and microbial activity are greatest, dissolved oxygen (DO) is depressed, especially in the bottom portions of the bay. This was documented earlier by Hopkins (1969) with DO values as low as 0.44 mg/L and which were generally below the recommended 4 mg/L standard. The U.S. Department of the Interior (1970) description was consistent with this condition, as it found similar low concentrations of DO and indicated that 60 percent of the area above the L & N bridge exhibited DO levels less than 4 mg/L. It further indicated that benthic oxygen demand was the major factor affecting the bottom DO in Escambia Bay. It also said that 57 percent of the sediments in the area north of the railroad bridge had an organic content greater than three percent, with some areas in the vicinity of the industrial outfalls having sediments containing up to six percent organic content. Olinger et al. (1975) noted that the DO concentrations in Escambia Bay appeared to improve from 1969 through 1974, and that wide variations in DO demand were not the norm. Two incidents were observed, however, these were attributed to benthic oxygen demand rather than to water mass movement (U.S. Department of the Interior, 1970). Olinger et al. (1975) also noted the correlation between vertical stratification of salinity and DO and indicated that very little exchange occurred between those layers. Associated with this study, Olinger et al. (1975) also noted that mean ultimate biochemical oxygen demand (BOD) and rate constants determined in the study were not conclusive with respect to excessive BOD levels and that there was no clear indication of either improving or deteriorating conditions in Escambia Bay.

<u>Pensacola Bay</u>

Pensacola Bay, south of Escambia Bay, is the most urbanized of the system bays. It receives runoff and discharges from the City of Pensacola, the associated Naval Air Station, Bayou Grande, Bayou Chico and Bayou Texar. The most significant point source discharges are the Main Street and Naval Air Station STPs. The most significant of these is the Main Street Plant, with its discharge via an outfall into the bay. Recent data (DER, 1988) indicate that, although Pensacola Bay is under some anthropogenic stress, it is not presently in danger of eutrophication. The Florida DER (1988) noted that algal growth was limited by phosphorus, even though nitrogen values were excessive. It is noteworthy that average values for the sampling stations from this study were above the 0.36 mg/L recommended limit for TN. This is in contrast with the Olinger et al. (1975) data, in which only two of the mean nitrogen concentrations failed to meet this standard. Phosphorus levels generally met the criteria for the state water quality standards (DER, 1988). This is consistent with the TP in Pensacola Bay reported by Olinger et al. (1975), who found that all means but two were below the criteria for TP (0.05 mg/L). DO was also acceptable, although two DO values failed to meet state standard of 4 mg/L (FDER, 1988).

Olinger, et al. (1975) did not extensively examine the DO in Pensacola Bay, because they believed that part of the data was questionable due to failure of a DO probe. They did indicate, however, that in other studies conducted in 1969, 29 percent to 74 percent of the samples from Pensacola Bay failed to meet the 4 mg/L standard. Young (1985) indicated that only one station at one point in time failed to meet the criteria. Although enough samples were not available to test the significance of a trend, the data may indicate that the bay was showing improvement.

In a maintenance dredging study (FDER, 1988) conducted on the Port of Pensacola, it was reported that releases from STPs were not causing a substantial impact on water quality, but that elutriate tests conducted on the sediments from those areas showed that some anthropogenic heavy metal, nutrient and organic inputs may be present. Only mercury exhibited concentrations in significant quantities, and these may have resulted from faulty analytical procedures. DER (1988) did note, however, that the elutriate tests showed that large nitrogen releases in the form of ammonia could occur during dredging. This study, conducted to help determine regulatory benchmarks for the permitting of dredging in ports, presents a picture of the water quality in at least a portion of Pensacola Bay in sharp contrast to what is observed in Escambia Bay. This is also in sharp contrast to Bayou Chico, in which the sediments are degraded to the point that dredging them may present significant environmental constraints (Brinson and Keltner, 1981). The FDER (1988) study also provides additional information (while not directly stated) that phosphorus is limiting in this system and efforts to maintain the present low level of this element are important in the overall and long-term health of the system and in the prevention of "classic" eutrophication problems.

It is possible to conclude that Pensacola Bay has reasonably good water quality, even considering its urbanized nature and its point source inputs. Recent efforts at controlling and upgrading existing point source discharges appear to be exerting positive effects on the bay. Pensacola Bay benefits from Escambia Bay functioning as a sink, coupled with the higher tidal exchange in the bay due to its proximity to the Gulf of Mexico.

<u>Blackwater and East Bays</u>

These bays, while large spatial components of the Pensacola Bay system, are in many cases in sharp contrast to Escambia and Pensacola bays. Their tributary streams have fewer domestic sewage treatment plant point sources and only one permitted industrial discharge. Of these, the cities of Milton and Crestview represent the most significant pollutant sources. The remaining pollutant sources of significance are the stormwater drainage from Whiting Field, Locklin Lake (formerly heavily polluted by sewer line and lift station failure and since upgraded) and the general drainage from the surrounding agricultural lands.

Dissolved oxygen levels in these bays are fair, with values often falling below the state standard of 4 mg/L in deeper areas (Olinger et al., 1975; Young, 1981). The low assimilative capacity of these bays identified by Olinger et al. (1975) is, in part, caused by poor circulation, which allows for a buildup of organic bottom sediments. Young (1981) confirmed that this condition still exists, referring to the condition as a "noxious sludge layer." It is apparent that all components of the Pensacola Bay system have abundant concentrations of TOC in the sediments. Olinger et al. (1975) discussed this phenomenon in some detail, noting that TOC was "high" throughout the system (roughly 4 to 5 mg/L, on average), as compared to the 2 mg/l recognized by the National Academy of Sciences (1972) as the upper limit or point above which TOC could become problematic. It is easy, therefore, to understand how Blackwater and East bays, which have inherent poor circulation, could act as sinks for organic sediment. It is therefore important to develop and then maintain a high level of point and NPS pollution control in the basins of these bays.

Relative to Pensacola and Escambia bays, the Blackwater/East Bay component is in significantly better condition with regard to nitrogen and phosphorus aspects of water quality. Data from Olinger et al. (1975) indicate that East Bay, Blackwater Bay, Pensacola Bay and Choctawhatchee Bay had mean TN concentrations of 0.274 mg/L, 0.276 mg/L and 0.256 mg/L, respectively. Escambia Bay, with a mean TN of 0.392 mg/L, is highest due to continual high nitrogen input and abundant sediment nitrogen sources. Pensacola Bay, by virtue of its greater tidal exchange and proximity to the Gulf of Mexico, is on a par with the other bays. It is noteworthy that the bays (with the exception of Escambia Bay) are well below the NAS Water Quality Criteria (1978) for nitrogen of 0.360 mg/L. More recent studies by Young (1981) indicate nitrogen (total organic {kjeldahl - TKN} nitrogen) values up to 1.15 mg/L (ranging between < 0.05 and 1.15 mg/L with a mean of 0.38 mg/L) in Blackwater Bay and up to 0.34 mg/L (ranging between < 0.03 and 0.34 mg/L with a mean of 0.21 mg/L) in East Bay.

In comparing early circulation patterns (Olinger et al., 1975) and eliminating recycling as a possibility, one simplistic interpretation to these newer data would be that the Blackwater/East Bay component is also functioning as a nutrient and organic carbon sink due to the overloading of these compounds relative to the insufficient circulation of these systems. Olinger et al. (1975) helped illustrate this and further confirmed the presence of this enriched strata in the surface sediments of the bays.

Biochemical oxygen demand (BOD) is sometimes used as a rough indicator to help understand the relationship between the variations observed in DO in waterbodies. Olinger et al. (1975) conducted only limited BOD tests in the Blackwater/East Bay component and concluded that, in general, it was quite low in Escambia Bay and concluded that BOD was not the controlling factor in the observed monthly variations in DO in that bay. Young (1981) conducted some limited BOD tests in Blackwater/East Bay and found BOD values ranging from 0.3 to 2.5 mg/L, with an average of 1.1 mg/L, a value lower than that for Escambia Bay. East Bay exhibited BOD values of 0.5 - 2.3 mg/L, again lower than the Olinger et al. values for Escambia Bay. It is reasonable, therefore, to conclude that BOD was not a significant contributor to the DO variability in these bays in 1974-78 and in the 1980-81 data from DEP.

Based on the literature cited in this review, it may be concluded that the Pensacola Bay system is only in fair condition relative to water quality. Nitrogen is readily available from the sediment in the western bays and is most likely available in the eastern bays, although they have received less study. Escambia Bay receives abundant nitrogen and carbon inputs. Phosphorus appears to be limiting in all the bays. DO becomes problematic in the deeper waters during the warm summer months in all the bays, but heavy metals are not an evident problem. Point sources are significant pollutant inputs to the entire system, especially the industrial sources. Efforts to upgrade the quality of all these sources appear warranted, as future development and its associated increases in nonpoint pollutant discharges will expand their influences on water quality in the system.

<u>Santa Rosa Sound</u>

Santa Rosa Sound is a lagoon between Santa Rosa Island and the mainland which connects Pensacola Bay with Choctawhatchee Bay in the east. The sound receives relatively little direct freshwater inflow and has an annual mean salinity of 24 ppt (Hand et al., 1996; FDEP, 1993). Hand et al. (1996) assesses water quality in Santa Rosa Sound as good, but notes that it is threatened by NPS runoff from development, as well as ditching and two WWTPs. Effluent originating from golf courses, including some irrigated with treated wastewater, also create adverse biological effects (Lewis, 1997).

Bayous

There are numerous bayous along the shoreline of the Pensacola Bay system. They vary in size, some of the larger ones being Bayou Grande, Bayou Texar, Bayou Chico, Mulatto Bayou, Catfish Basin, Big and Little Sabine bays, Indian Bayou, Hoffman Bayou, Woodland Bayou, Gilmore Bayou, Thompson's Bayou, Tom King Bayou, and Trout Bayou. Along with the upper reaches of the bays, seagrass beds, and the Pensacola Bay pass, these bayous were, and in some cases remain, centers of biological productivity within the estuarine system. They are sources of nutrients and detritus which enhance primary productivity and thereby provide food for herbivores and detritivores. All bayous have been impacted to some extent by human activities. Three of the more heavily impacted bayous are Bayou Chico, Bayou Texar, and Mulatto Bayou. A discussion of historical and current conditions in each of these water bodies is found below.

Stormwater runoff tends to concentrate within bayou waters and thus tends to concentrate related adverse impacts. There are additional factors which cause the bayous to be particularly susceptible to inputs of pollutants. Because bayous have a much smaller surface area and are much narrower than the open bay, the small fetch limits the size of waves which can be generated. This decreases the amount of mixing and promotes stratification and low DO levels. Some bayous have restricted inlets, which also tends to decrease mixing of upper and lower layers (caused by thermal and density gradients). Because of the decreased mixing and the resulting stratification, oxygen is not transported from the upper layer to the lower layer, and, therefore, this lower layer often exhibits anoxia (depletion of dissolved oxygen), particularly when there are inputs of oxygen demanding pollutants. In an undisturbed bayou, this decreased wave energy and physical movement of water is conducive to the growth of extensive marsh vegetation, which provides the necessary food and protection for juvenile fish and the tremendous biological productivity of this ecosystem. The bayous of the Pensacola Bay system are in various stages of degradation, Bayou Chico probably having the dubious distinction of being the most severely impacted.

Bayou Chico

Prior to 1971, there were at least eight industrial and domestic waste sources discharging to Bayou Chico. Since 1971, all but one, the Warrington Domestic Wastewater Facility, have ceased direct discharges to the bayou. The other domestic facilities were Moreno Courts Sub-Division, Penn Haven Sanitation Company, and Corry Field (U.S. Navy). Newport Division, Tenneco Chemicals, Inc. (now Reichhold Chemicals, Inc.) produced Naval Stores products using various solvents, including a blend of naptha-toluene extraction solvents. The Armstrong Cork Company produced fire resistant acoustical ceiling tile. The Ashland Chemical Company produced synthetic resins from petrochemicals. American Creosote was also located nearby and contributed phenolic compounds and possibly other chemicals via a ditch to Bayou Chico. Weis-Fricker was engaged in the business of importing mahogany. The extent of chemical use and discharge by these industries has not been thoroughly assessed. Glassen et al. (1977) reported that "these discharges inhibited biological activity to a great extent. According to local people, one could moor a boat in Bayou Chico and in a week or two the boat's bottom would be free of barnacles. Piles also seemed to last `forever' as boring organisms were not a problem." There were also significant nonpoint source inputs from ship repair facilities, oil terminals, scrap metal junkyards and residential areas. For instance, the Pensacola Shipbuilding Company opened in 1917 on Bayou Chico and by 1918 employed 1,500 workers in the shipyard. During World War II, the Pensacola Shipyard and Engineering Company employed as many as 7,000 workers at a time on Bayou Chico (McGovern, 1976).

One industry which impacted the water quality of Bayou Chico was the Newport Turpentine and Resin Company, which has been in operation since 1916 under various ownerships and was purchased by Reichhold Chemicals, Inc. in 1973. The facility has manufactured wood-based chemical products, and since 1916 has subjected tree stumps to various extraction procedures. The facility had twelve unlined impoundments for both process water and stormwater. Approximately

150,000 gallons per day of industrial wastewater was routed to the unlined impoundments. Stormwater runoff from the plant site was also routed to the impoundments after being processed (in recent years) through an oil/water separator. During heavy rains, stormwater runoff, which could not be accommodated by the basins, was discharged from the oil/water separator directly to Bayou Chico. Major chemicals recently in use include phenols, toluene and ethylbenzene. A consent order was executed on June 15, 1984, by the Florida Department of Environmental Protection (DEP) to effect clean-up of contaminated ground water and cease discharge of industrial wastewater and stormwater (from process areas) to Bayou Chico.

In response to the problems which were caused by the multitude of point and nonpoint sources discharging to Bayou Chico, the Florida State Board of Health conducted water quality surveys of the bayou in April and May of 1969. The U.S. Army Corps of Engineers evaluated sediments in 1971 and 1974 and water quality in September and January of 1972. A draft report (U.S. Army Corps of Engineers, 1977) describes sediments and water quality within the bayou.

A major DEP funded restoration study was conducted by Glassen et al. (1977) and evaluated land uses in the watershed, sources of pollutants, the hydrography of the bayou, sediment grain size, sediment thickness distribution, sediment quality (including metals, nutrients, oils, greases and hydrocarbons), heterotrophic activity, and an analysis of the alternative courses of action. Glassen et al. (1977) found the sediments in the bayou to be heavily polluted with oils, greases, chlorinated hydrocarbons and 5-ring aromatics, particularly in the main part of the bayou. "Parking lot" type hydrocarbons and extremely high levels of nutrients were found to be entering at the bayou's upper reaches. The 5-ring aromatics found in the main body of the bayou are often highly toxic, carcinogenic, and resistant to microbial degradation and were determined to be from industrial sources rather than from sewage or stormwater runoff from residential areas. Extremely high nutrient levels were found in the upper arms of the bayou, probably from a combination of sewage effluent, lawn fertilizers and urban stormwater runoff. Glassen et al. (1977) concluded in their evaluation of alternatives that elimination of nutrient inputs from stormwater, sewage treatment plants, and lawn fertilizers (and pesticides) was the only feasible restoration alternative. They also suggested that widening the inlet might improve flushing and water quality (if nutrient inputs were eliminated).

Brinson and Keltner (1981) conducted an extensive assessment of urban stormwater runoff and associated pollutants entering Bayou Chico. The work included an evaluation of the meteorology, soils characteristics, hydrographs for ten storm events and a water quality characterization, including information on physical, inorganic, organic, bacterial, and metal constituents in the water column and their effects upon the bayou's organisms. Brinson and Keltner's (1981) characterization of stormwater entering Bayou Chico was incorporated into a report which also evaluated the effects of removal of a limited quantity of contaminated sediments on water quality and benthos. Approximately 7,600 cubic meters of unconsolidated sediments were removed from the northeast arm of Bayou Chico by dredging (it should be noted that this area was determined by Glassen et al. (1977) to be not as severely impacted by industrial pollutants as was the main body of the bayou). Extreme precautionary measures were employed during the study, in conjunction with the removal of the contaminated sediments. In spite of the precautionary measures, the authors determined that "water samples for the remaining parameters which were monitored during sediment removal activities (i.e., turbidity, TOC, chromium, cobalt, iron, lead, manganese, mercury, zinc, oils and greases, phenolic compounds, pesticides, and PCBs) failed to meet state standards for Class III Waters or to show a reduction of the substance (sic) in the return water. Data were insufficient to determine the long-term effects of sediment removal on benthos; however, total and fecal coliform levels in the water column continued to exceed state water quality standards following removal of contaminated sediments. Stormwater entering the bayou failed to meet state water quality standards for turbidity, suspended solids, DO, BOD, nutrients, total and fecal coliforms, copper, lead, mercury, zinc, oils and greases, and phenols. Removal of contaminated sediments by the means used in this study was determined to provide limited, if any, long-term benefits to water quality because of numerous pollutants reentering the bayou in the return water and via stormwater outfalls." (Brinson and Keltner, 1981).

More recently, the University of West Florida's Institute of Coastal and Estuarine Research (ICER) has studied the sedimentology, sediment and water column chemistry, and biology of Bayou Chico. These studies have been coordinated with simultaneous studies of sediments and stormwater by the NWFWMD under SWIM. Currently, the U.S. EPA is completing an Ecosystem Criteria Research Program which has included an extensive set of monitoring data for this system.

Bayou Texar

Bayou Texar and its influent stream, Carpenters Creek, are located within the urbanized area of the City of Pensacola and, along with other areas within the Pensacola Bay system watershed, have a history of periodic fish kills, bacterial contamination and poor water quality. These problems received increased attention during the period of the late 1960s and early 1970s concurrent with a general national environmental awareness and because of the numerous fish kills which occurred in Bayou Texar. A number of studies (Moshiri et al., 1972; Moshiri, et al., 1974, Moshiri, et al., 1976; Hannah, 1972; Hannah et al., 1973; Moshiri, 1978; Moshiri and Crumpton, 1978; Moshiri et al., 1978; Moshiri et al., 1979; Moshiri et al., 1980; Moshiri et al., 1981) examined the relationships between various aspects of microorganisms and sediment-water nutrient exchange, primary productivity and a nitrogen-phosphorus budget for the bayou.

The local governments, through the Intergovernmental Program Office in Pensacola, commissioned a restoration study for Bayou Texar (Henningson et al., 1975) which provided baseline data and an overview of water quality and pollution problems based on generally accepted problems which were affecting the bayou. Sediment deposits resulting from uncontrolled development and the resulting increased stormwater discharges, erosion, defective septic tanks, and inadequate sewage systems were identified as the primary cause of the problems in the bayou. It was also noted that tidal exchange between the bayou and the bay was being hampered by the constricted mouth of the bayou in the vicinity of the L&N Railroad trestle. Unlike previous studies, this study formulated a series of recommendations intended to improve or correct the named problems. These recommendations ranged from the elimination of septic tanks, sewer line renovations and sewage treatment plant expansion to land use controls and dredging of the bayou.

A study conducted by the University of West Florida (Hood and Moshiri, 1978) included recommendations aimed at resolving some of the problems associated with the Bayou Texar. In an agreement with the Lake Restoration Division of DEP, this two-part study involved delineating the extent of coliform and fecal streptococci in the water column and sediment of the bayou; and analyzing sediment samples provided by the NWFWMD for salt content and heavy metals. Both aspects involved forming recommendations which would alleviate problems, if and where they existed. The information developed, along with the data gathered in prior investigations, was employed in assessing the environmental impact dredging would have on the bayou (Hood and Moshiri, 1978).

Additional subsequent studies by the Northwest Florida Water Management District (1978) and Moshiri (1981) reviewed and evaluated the previous recommendations and other practices designed to help improve the Bayou Texar and Carpenters Creek System. These studies evaluated the sediment types and magnitudes in both Carpenters Creek and the bayou and assessed the hydraulics of the creek. Increased stormwater discharge and urbanization were noted, as in previous studies, as the primary causes of the problems of the bayou. As a result, selective dredging of sediments deposited near major stormwater outfalls and construction of sewage pump stations in the basin were accomplished. Unfortunately, because of continuing basin development, the benefits of the dredging were soon negated by continued sediment discharges and untreated stormwater runoff into the creek and bayou.

Raney (1980), utilizing computer models, evaluated the possibility of increasing tidal exchange by modifying the bayou mouth and concluded that, due to the small tidal magnitudes in the area, this proposal would not be effective. He suggested that stormwater runoff control and improved land use practices were more desirable courses of action.

An extensive assessment of Bayou Texar conducted by the UWF ICER began in 1988 and is ongoing. This study focused on the geomorphologic, hydrographic, hydrologic, physical-chemical, and biological factors that have helped characterize the overall environmental status of the bayou. As a result of data provided by this study, recommendations have already been made for the construction of a jetty and limited restorative dredging (Stone and Morgan, 1989; Morgan and Stone, 1989). Other recommendations, aimed toward the reduction of nutrient and pollutant inputs into the bayou, are being prepared. Additionally, evaluations of sedimentation, bathymetric trends and water level fluctuations are being compiled.

Since the late 1970s and early 1980s, there have been attempts at land use control, stormwater detention and diversion and sewage improvements. These efforts have met with varying degrees of success. Water quality, although intermittently improved, generally remains poor, and fish kills, although reduced in frequency and magnitude, still occur. Both of these conditions underscore the need for these ongoing efforts to evaluate the problem of stormwater discharge and sediment and nutrient loading and the role of the sediment already in the bayou. The purpose of such evaluations has been to formulate effective restoration strategies and procedures based on site-specific data and begin to restore the Carpenters Creek/Bayou Texar to an acceptable condition.

Mulatto Bayou

Mulatto Bayou is a moderately sized bayou on the eastern shore of Escambia Bay which has had a long history of poor water quality and fish kills. The waters of Mulatto Bayou have been affected by residential development and canal dredging. Olinger et al. (1975) and Adams (1972) reported that a total of 19 fish kills occurred in the Mulat-Mulatto Bayou complex during the period 1970 through 1974. This was second only to Escambia Bay in the total number of fish kills occurring in the Escambia Bay System during this period. Since the mid-1970s, very little information has been obtained for Mulatto Bayou.

Other Bayous

Most of the other bayous have not been extensively evaluated for water quality or habitat problems or for control of pollution sources. Adams (1972) compared phytoplankton primary productivity and related parameters in Mulatto Bayou and Catfish Basin, two ecologically similar estuarine bayous. Mulatto Bayou has been subjected to many anthropogenic disturbances, while Catfish Basin remains a relatively pristine habitat. Other bayous also warrant special attention and exceptional protection from current and future inputs of pollution due to the role they play in the biological health of the system. Much of this can hopefully be accomplished through increased efforts in stormwater management and improved land use controls.

Biological Resources

Northwest Florida, because of its geographical setting and geological and hydrological history, has a diverse array of habitats which support a variety of vegetative communities and a vast assortment of animal species. Bottomland hardwood forests predominate in the river floodplains, and pines mixed with a variety of other tree species and shrubs prevail in the uplands. Wetlands dominate the coastal fringe of the system and large portions of the river floodplains. Dune vegetation and salt marshes are common and important habitats of the barrier island, beaches, and spits that border the coastline. Seagrasses, oyster reefs, unvegetated soft bottoms, and benthic algae communities provide habitat diversity within the estuarine system. The following information was adapted primarily from Stith et al. (1984) and Wolfe et al. (1988).

Habitat and Flora

The Pensacola Bay watershed supports a diverse array of native vegetative habitats, including pine, beech-magnolia, scrub oak, and bottomland hardwood forests; beach dune areas; bogs; titi and bay swamps; blackwater streams; brackish and salt tidal marshes; intertidal flats; oyster reefs; and seagrass beds.

Most native pine forests in the region have been cut for timber; cleared for agriculture; developed as residential, commercial, or industrial property; or intensively managed for silviculture. As a result, the uplands are now a mosaic of natural regeneration forests (mainly pine), pine plantations, agricultural lands, and developed areas. The regeneration forests typically contain native pines mixed with other types of vegetation. Pine plantations consist of slash pine (*Pinus elliottii*), sand pine (*P. clausa*), or loblolly pine (*P. taeda*) planted in rows. Residential areas often contain numerous shade trees and shrubs, including several aforementioned species as well as live oak *(Quercus virginiana*) and laurel oak (*Q. hemisphaerica*), a variety of native and exotic species, and mowed lawn grasses. Commercially and industrially developed lands may be covered with large buildings, facilities, and paved areas and may contain landscapes of trees, shrubs, and/or grasses.

Native sandhill pine forests typically would have a longleaf pine (*P. palustris*) overstory, with turkey oak (*Q. laevis*) as the most common midstory (or overstory when pines are absent), and wiregrass (*Aristida stricta*) as the ground cover. A native pine community found within floodplains, termed pine flatwoods, is composed of longleaf pine, slash pine (*P. elliottii*), or pond pine (*P. serotina*) as the overstory and a mixture of species such as saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), gallberry (*Ilex coriacea*), runner oak (*Q. pumila*), fetterbush (*Lyonia lucida*), and wiregrass as the understory. Beech-magnolia forests have gradually replaced many fire-perpetuated longleaf pine ecosystems and are located in areas downslope from where fires occurred in the pine woods and upslope from areas of permanently wet soils. Predominant trees are the American beech (*Fagus grandifolia*) and southern magnolia (*Magnolia grandiflora*). Other vegetation identified includes dogwood (Cornus florida), American holly (*Ilex opaca*), laurel oak (*Q. laurifolia*), sparkleberry (*Vaccinium arboreum*), witch hazel (*Hamamelis virginiana*), ferns (*Polystichum acrostichoides*, *Thelypteris spp*., etc.), and red bay (*Persea borbonia*).

River floodplains are characterized by several trees and shrubs such as bald cypress (*Taxodium distichum*); water, ogeechee, and swamp tupelo (*Nyssa spp*.); black willow (*Salix nigra*); swamp titi (*Cyrilla racemiflora*); black titi (*Cliftonia monophylla*); overcup oak (*Q. lyrata*), Red maple (*Acer rubrum*); sweetgum (*Liquidambar styraciflua*); several vines such as laurelleaf greenbrair (*Smilax laurifolia*), poison ivy (*Rhus radicans*), and cross vine (*Bigonia capreolata*); and ground cover species such as small chain fern (*Woodwardia areolata*), lizard tail (*Saururus cernuus*), and spider lily (*Hymenocallis occidentalis*). These areas can be found along the alluvial streams and rivers (Escambia River) and are characterized by broad floodplains that are saturated for several months of the year and substantially dry for the remaining months.

Marsh habitats are located near the mouths of the rivers and along the brackish water shorelines immediately downstream from the floodplain forests. Characteristic plants include needlerush (*Juncus roemerianus*), sawgrass (*Cladium jamaicense*), cattails (*Typha spp*.), giant reed (*Phragmites communis*), arrowhead (*Sagittaria lancifolia*), saltmarsh cordgrass (*Spartina alterniflora*), saltmeadow cord grass (*Spartina patens*), giant cutgrass (*Zizaniopsis miliancea*), pickerel weed (*Pontederia cordata*), and softstem bulrush (*Scirpus validus*). These marsh systems contain a network of meandering, interconnecting river distributaries and tidal streams. Flooding and dewatering occur in response to the various interactions between tides, river flows, wind, barometric pressure, and rainfall.

Beach and dune systems are generally restricted to high energy shorelines and are found primarily on Santa Rosa island, a barrier island located at the pass of Pensacola Bay. Plants such as sea oats (*Uniola paniculata*), sea rocket (*Cakile lanceolata*), dune elder (*Iva imbricata*), and sea purslane (*Sesuvium portulacastrum*) establish on the seaward side of constantly shifting dunes. These species are highly tolerant of salt spray and intense heat, and are critical to the growth and stabilization of dune systems. On the backsides of these dunes, Spanish bayonet (*Yucca aloifolia*), myrtle oak (*Q. myrtifolia*), greenbriar (*Smilax auriculata*), and saw palmetto are characteristic. The vegetation growing on the relic dune systems located further inland consist of sand-live oak (*Q. virginiana geminata*), Chapmans oak (*Q. chapmanii*), and fetterbush, with a ground cover of reindeer moss (*Cladonia rangifera*) and other lichens.

Scrub oak communities may be found behind coastal dune lines or further inland where conditions are sandy, hot, and dry. The harsh conditions of the coastal areas cause the vegetation to be gnarled and stunted as an adaptation to the environmental stress. Many of the plants in these areas are frequently quite old, and their success has been essential to the stabilization of the dune system. Other scrub oak communities are not exposed to such intense situations, but may consist of vegetation smaller in stature than normal conditions would allow. Scrub oak areas are dominated by a mixture of sand pine (*P. clausa*) and slash pine along with sand-live oak and southern magnolia. Understory consists of nettles (*Cnidoscolus stimulosus*), jointweed (*Polygonella polygama*), fetterbush, poison oak (*Toxicodendron querciflora*), yaupon (*Ilex vomitoria*), and royal fern (*Osmunda regalis*). Open areas are usually occupied by lichens, St. Johns wort (*Hypericum spp*.), and stunted sea oats.

Bay swamps are identified in four phases: (1) sweetbay phase, where sweetbay magnolia (*M. virginiana*) is predominant with a few slash pine, swamp bay (*Persea borbonia*), and loblolly bay (*Gordonia lasianthus*); (2) slash pine phase, with sweetbay present but slash pine predominant; (3) mixed swamp phase, with predominance shared by sweetbay, blackgum, cypress, sweetgum, red maple, water oak (*Q. nigra*), and diamond-leaf oak (*Q. laurifolia*); and (4) Atlantic white cedar phase, with Atlantic white cedar (*Chamaecyparis thyoides*) as the conspicuous member of the community. The understory of bay swamps tends to be patchy and dense, consisting of switch cane (*Arundinaria gigantea*), wax myrtle, swamp titi, sweet pepperbush (*Clethra alnifolia*), and black titi (*Cliftonia monophylla*). Other common species include wild azalea (*Rhododendron canescens*), muscadine (*Vitis rotundifolia*), myrtle leaf holly (Ilex myrtifolia), odorless wax myrtle (*Myrica inodora*), and odorless yellow jessamine (*Gelsemium rankinii*).

Titi swamps come in five varieties, three of which have a pine overstory: (1) a titi phase with no other overstory, (2) a pond pine phase, (3) a slash pine phase, (4) a pond pine-slash pine phase, and (5) a holly phase with neither a pine nor titi overstory, but with myrtle-leaf holly as the dominant shrub. One or both titi species, black titi and swamp titi, may be found in these areas. Titi swamps often border on pine areas and may form the border between bay swamps and pine communities.

Shrub bogs and herb bogs are distinguished by their distinct vegetation characteristics and great biological diversity. Shrub bog are usually found downslope from herb bogs and support dense evergreen shrubs (usually titi). These areas form a very distinctive transition from the dry soil uplands or moist soil herb bogs to the stream or pond forests. Predominant vegetation among the shrub areas are the black and swamp titi. Also fetterbush, dahoon holly (*Ilex cassine*), sweet pepperbush, and large gallberry are present. Herb bogs (or seepage bogs) have moist soil most of the year which is usually covered with Sphagnum moss (*Sphagnum spp*.). Vegetation consists of insectivorous plants including sundews (*Drosera spp*.), pitcher plants (*Sarracenia spp*.), butterworts (*Pinguicula spp*.), and bladderworts (*Utricularia spp*.). Vegetative species such as Sphagnum moss, hat-pins (*Eriocaulon spp*.), floating orchid (*Habenaria spp*.), beaked rushes (*Rhynchospora spp*.), and savannah grass (*Panicum spp*.) are characteristic of highly acidic soils.

There are many blackwater streams distributed throughout the Pensacola Bay system watershed. Some of the major ones are Shoal River and Trammel Creek. These streams are highly acidic, sluggish, and originate in herb and shrub bogs. A gradient increase of these streams would accelerate turbulence; increase DO, pH, and alkalinity; reduce carbon dioxide and bottom organics; and cause a conversion from a blackwater stream to a sand-bottomed stream. Thus, the only difference between these two types of streams is a function of velocity.

Intertidal flats are the unvegetated bottom portions of estuaries, bays, lagoons, and river mouths that lie between the high and low tide marks. Usually composed of sandy and muddy sediments, intertidal flats appear barren and unproductive due to the absence of macrophytes such as marsh grass or seagrass. However, benthic microalgae are abundant and productive in these areas. Because this algae is consumed directly by benthic invertebrates, the intertidal flats are substantially important to the productivity of an estuarine system.

Communities of submerged vegetation are found throughout nearshore waters where bottom conditions and light penetration provide suitable habitat. Fragile in nature, aquatic plant communities are easily disrupted by human activities such as dredging and fisheries trawling. Although these communities make up a relatively small percentage of the total submerged lands, their high primary productivity and protective cover enhance their significance to marine species. Three species of true seagrasses can be observed within the salt waters of the system and two species of grasses can be found in the brackish water areas. They are turtle-grass (*Thalassia testudinum*), manatee-grass (*Syringodum filiforme*), shoal grass (*Halodule wrightii*), tape-grass (*Vallisneria americana*), and widgeon grass (*Ruppia maritima*), respectively.

Fauna

The river systems of the Pensacola Bay system, including associated tributaries and wetlands, support diverse populations of fish and wildlife. Following sampling during the 1980s, for example, Bass (1990) reported 71 species of fish from the Escambia river, of which 46 were described as native North American freshwater species, with the remainder representing marine, euryhaline, and diadromous groups. Common species sampled included warmouth (*Lepomis gulosus*), largemouth bass (*Micropterus salmoides*), channel catfish (*Ichthyomyzon punctatus*), spot (*Leiostomus xanthurus*), striped mullet (*Mugil cephalus*), and spotfin mojarra (*Eucinostomus argenteus*). Bass (1990) concluded that the fish assemblages in the river appear stable, persistent, and condusive to monitoring to discern anthropogenic impacts.

Biological sampling was conducted in the Blackwater River between 1976-1977 (Bass and Hitt, 1977). Upper river biomass was considered relatively low. Characteristic fish species of this area include spotted bass (*Micropterus punctulatus*), sailfin shiner (*Pteronotuopis hypselopterus*), and blacktail redhorse (*Moxostoma poecilurum*). The lower river was assessed as supporting higher biomass. Characteristic fish include chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), warmouth (*Lepomis gulosus*), and bluegill (*Lepomis macrochirus*), and redear sunfish (*Lepomis microlophus*). Estuarine species, such as spot (*Leiostomus xanthurus*), striped mullet (*Mugil cephalus*), and Atlantic croaker (*Micropogon undulatus*) are well represented in the lower river. The Blackwater River system supports the endangered backmouth shiner *(Notropis melanostomus*).

Fish species identified by Eglin AFB (1993) from the Yellow and Shoal rivers include speckled madtom (*Noturus leptacanthus*), redbreast sunfish (*Lepomis auritus*), chain pickerel (*Esox niger*), warmouth (*Lepomis gulosus*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*).

The riverine and associated wetland environment also supports an array of reptiles, amphibians, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. With the exception of the crocodilians, of which only the American alligator (*Alligator mississippiensis*) occurs in the area, the reptiles and amphibians are comprised of several taxonomic families. Some specific species found in the area are the spotted newt (*Notophthalmus viridescens*), Alabama waterdog (*Necturus alabamensis*), lesser siren (*Siren intermedia*), bullfrog (*Rana catesbeiana*), bird-voiced tree frog (*Hyla avivoca*), alligator snapping turtle

(*Macroclemys temminckii*), Suwannee cooter (*Pseudemys concinna suwanniesis*), diamondback terrapin (*Malaclemys terrapin*), eastern coral snake (*Micrurus fulvius*), cottonmouth (*Agkistrodon piscivorus*), and rat snake (*Elaphe spiloides*).

Mammals found within the area are taxonomically classified into nine major groups: marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. Some are nocturnal, while others are diurnal. Some are carnivorous, while others are herbivorous, and still others are omnivorous. A few species are believed to migrate or are highly mobile, but most of the mammals can be considered permanent residents. Mammals found in the area include raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), white-tailed deer (*Odocoileus virginianus*), feral hog (*Sus scrofa*), bottlenose dolphin (*Tursiops truncatus*), beaver (*Castor canadensis*), gray squirrel (*Sciurus carolinensis*), eastern mole (*Scalopus aquaticus*), opossum (*Didelphis virginiana*), and nine-banded armadillo (*Dasypus novemcinctus*).

More than 200 species of fish and shellfish have been reported in the estuarine waters of the Pensacola Bay system. Four anadromous fish are known to inhabit the river systems: Gulf sturgeon *(A. oxyrhynchus desotoi*), Alabama shad (*Alosa alabamae*), skipjack herring (*Alosa chrysochloris*), and striped bass (*Morone saxatilis*). Largemouth bass (*Micropterus salmoides*) and redear sunfish (*Lepomis microlophus*), which are tolerant of low salinities, often invade the streams and embayments in the river delta marshes. Other species native to the area include spot (*Leiostomus xanthurus*), bay anchovy (*Anchoa mitchilli*), Atlantic croaker (*Micropogonias undulatus*), spotted seatrout (*Cynoscion nebulosus*), longnose gar (*Lepisosteus osseus*), Gulf menhaden (*Brevoortia patronus*), channel catfish (*Ichthyomyzon punctatus*), striped mullet (*Mugil cephalus*), American eel (*Anguilla rostrata*), chain pickerel (*Esox niger*), golden shiner (*Notemigonus crysoleucas*), coastal shiner (*N. petersoni*), silver perch (*Bairdiella chrysura*), clown goby (*Microgobius gulosus*), darter goby (*Gobionellus boleosoma*), blue crab (*Callinectes sapidus*), ghost crab (*Ocypode quadrata*), American oyster (*Crassotrea virginica*), and Penaeid shrimp (*Penaeus spp*.).

More than 250 species of birds have been reported as migratory or permanent residents within the area, several of which breed there as well. These birds can be grouped generally as (1) species that occur year-round, both nesting and overwintering, (2) species that nest during the warm season and overwinter to the south, (3) species that overwinter and nest further north, and (4) species that pass through during spring migrations to more northern nesting sites and/or during fall migrations to overwintering areas. Different populations of the same species sometimes exhibit more than one type of migratory behavior. Some of the upland birds found in the area include wild turkey (*Meleagris gallopavo*), crow (*Corvus brachyrhpnchos*), bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), red-shouldered hawk (*Buteo lineatus*), red-headed woodpecker (*Melanerpes erythrocephalus*), purple martin (*Progne subis*), and eastern bluebird (*Sialia sialis*). Shorebirds include species such as osprey (*Pandion haliaetus*), great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), piping plover (*Charadrius melodus*), stilt (*Himantopus mexicanus*), sandpiper (*Calidris spp*.), gulls (*Lanius spp*.), brown and white pelicans (*Pelecanus spp*.), American oystercatcher (*Haematopus palliatus*), and terns (*Sterna spp*.). Birds of the area eat a great variety of foods, are also food to many predators, and exhibit a diversity of nesting behaviors.

The Fishery — Finfish, Shrimp, and Shellfish

In contrast to other less apparent aspects of the Escambia Bay System, such as benthic macroinvertebrates, commercial and recreational fisheries receive considerable public attention. These fisheries have direct economic and seafood production importance, but are also important for their recreation, tourism, and indirect economic benefits. The fisheries of the system have experienced significant declines and catastrophes, including numerous fish kills and mass oyster mortalities. Some events have been documented scientifically (e.g., Little and Quick, 1976), while others have received primarily only media attention.

Documented landings are compiled by the Florida Marine Research Institute (FMRI) and National Marine Fisheries Service (NMFS). Such data, however, are not reliable indicators of system productivity or even the harvest from any specific estuary, as they are reported by port of offload and not catch site. Portions of the landings reported in Escambia and Santa Rosa counties, for example, are harvested from other estuaries and from the Gulf of Mexico. Additionally, variations are often caused by economic factors. For example, the relative cost of fuel and reported yields elsewhere in the Gulf combine at times to reduce fishing pressure in the PBS. Other conditions, such as the influx of pollutants and bacteria as the result of storms, may force closure of shellfish beds, lowering the total harvest without respect to size of the resource.

As of January 31, 1996, the Pensacola Bay System has been classified separately for winter and spring/fall for shellfish harvesting (Thompson, 1996). Pensacola Bay is generally prohibited throughout the year, as are Escambia and Blackwater bays north of I-10 and Escribano Point, respectively, and East Bay Bayou. During the spring and fall, most of Escambia Bay is classified as conditionally approved, with the exception of a portion of the northwest bay, which is restricted. East Bay is conditionally approved during the spring and fall. During the winter, most of Escambia Bay is conditionally restricted, except for limited areas along the eastern bay which are conditionally approved. Most of East Bay is conditionally approved during the winter, except the northwestern portion, which is conditionally restricted. Santa Rosa Sound is not classified or monitored for shellfish harvesting. In general, the PBS oyster industry appears marginal and subject to wide swings in production. It is also noteworthy that scallop populations have historically survived in the Pensacola Bay system, and substantial harvests were reported in the late-1960s. Bay scallops, however, are dependent upon seagrasses. They are currently virtually nonexistent in most of the system, except in limited areas where relatively stable seagrass communities survive.

According to Berrigan (personal communication, 1989), shrimp harvests since 1983 have been generally stable in Escambia Bay (average of 567,000 pounds/year) and variable in East Bay and Santa Rosa Sound (average of 8,700 pounds/year). This is in contrast to 1972, when the industry collapsed and no shrimp were harvested in Escambia Bay. This collapse roughly coincided with the discovery of Polychlorinated biphenyls (PCBs) contamination in the sediments, shrimp, and finfish (Duke et al, 1970). Although it is unknown whether PCBs have had a direct effect, it is plausible that an array of such environmental stresses as PCB contamination, loss of seagrasses, disruptions in the salinity regime, and low dissolved oxygen may have all played a role in shrimp mortality.

Threatened and Endangered Species

Many species of flora and fauna are state, federally, or internationally listed as endangered, threatened, or of special concern. A variety of factors, such as species' population status, problems, opportunities, and needs influence the selection process for a species to be listed. The Endangered Species Act of 1973, as amended, authorized the federal listing of certain species as endangered or threatened. The Florida Endangered Species Act of 1977 resulted in the State of Florida listing of endangered, threatened, and species of special concern. The U.S. Fish and Wildlife Service, Florida Game and Fresh Water Fish Commission, Florida Department of Environmental Protection, and Florida Department of Agriculture and Consumer Services share threatened and endangered species responsibilities. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement among the United States and nearly 40 other nations. Its primary function is to regulate international trade in the species it protects.

Table 7 identifies species found within the Pensacola Bay system that are federally- or state-listed as threatened, endangered, or species of special concern.

Table 7. Occurrences of Listed Species in the Pensacola Bay System Watershed

Scientific Name	Common Name	Federal Status	State Status
FISH			
Acipenser oxyrhynchus desotoi	Gulf sturgeon	T	SSC
Crystallaria asprella	Crystal darter		T
Etheostoma histrio	Harlequin darter		SSC
Fundulus jenkinsi	Saltmarsh topminnow		SSC
Pteronotropis welaka	Bluenose shiner		SSC
Notropis melanostomus	Blackmouth shiner		E
AMPHIBIANS			
Hyla andersonii	Pine barrens treefrog		SSC
Rana capito	Gopher frog		SSC
Rana okaloosae	Florida bog frog		SSC
REPTILES			
Alligator mississippiensis	American alligator	T	SSC
Caretta caretta	Loggerhead	T	T
Chelonia mydas	Green turtle	E	E
Dermochelys coriacea	Leatherback turtle	E	E
Drymarchon corais couperi	Eastern indigo snake	T	T
Gopherus polyphemus	Gopher tortoise		SSC
Lepidochelys kempi	Atlantic ridley	E	E
Macroclemys temminckii	Alligator snapping turtle		SSC
Pituophis melanoleucus mugitus	Florida pine snake		SSC
BIRDS			
Charadrius alexandrinus	Snowy plover		T
Charadrius melodus	Piping plover	T	T
Cistothorus palustris marianae	Marian's marsh wren		SSC
Egretta caerulea	Little blue heron		SSC
Egretta thula	Snowy egret		SSC
Egretta tricolor	Tricolored heron		SSC
Eudocimus albus	White ibis		SSC
Falco peregrinus	Peregrine falcon		E
Falco sparverius paulus	Southeastern American kestrel		T
Haematopus palliatus	American oystercatcher		SSC
Mycteria americana	Wood stork	E	E
Pandion haliaetus	Osprey		SSC
Pelecanus occidentalis	Brown pelican		SSC
Picoides borealis	Red cockaded woodpecker	E	T
Rynchops niger	Black skimmer		SSC
Sterna antillarum	Least tern		T
MAMMALS			
Myotis grisescens	Gray Bat	E	E
Peromyscus polionotus trissyllepsis	Perdido Key beach mouse	E	E
Tamias striatus	Eastern chipmunk		SSC
Trichechus manatus	West Indian manatee	E	E
Ursus americanus floridanus	Florida black bear		T

Table 7. Occurrences of Listed Species in the Pensacola Bay System Watershed (continued)

Scientific Name	Common Name	Federal Status	State Status
MOLLUSKS			
Anodonta suborbiculata	Flat Floater	T	
Fusconaia escambia	Narrow Pigtoe	T	
Fusconaia rotulata	Round Ebonyshell	E	
Lampsilis ornata	Southern Pocketbook	T	
Pleurobema strodeanum	Fuzzy Pigtoe	T	
Villosa choctawensis	Choctaw Bean	T	
PLANTS			
Chrysopsis cruiseana	Cruise's golden aster		E
Drosera intermedia	Spoon-eaved sundew		T
Epigaea repens	Trailing arbutus		E
Hexastylis arifolia	Heartleaf		T
Illicium floridanum	Florida anise		T
Kalmia latifolia	Mountain laurel		T
Lilium catesbaei	Southern red lily		T
Lilium iridollae	Panhandle lily		E
Macranthera flammea	Hummingbird flower		E
Pinguicula planifolia	Chapman's butterwort		T
Platanthera integra	Yellow fringeless orchid		E
Polygonella macrophylla	Large-leaved jointweed		T
Rhododendron austrinum	Orange azalea		E
Sarracenia leucophylla	White-top pitcher-plant		E
Sarracenia rubra	Sweet pitcher-plant		T
Stewartia malacodendron	Silky camellia		E
Xyris scabrifolia	Harper's yellow-eyed grass		T
Calamovilfa curtissii	Curtiss' sandgrass		T
Conradina glabra	Apalachicola rosemary	E	E
Asclepias viridula	Southern milkweed		T
Gentiana pennelliana	Wiregrass gentian		E
Hymenocallis henryae	Panhandle spiderlily		E
Hypericum lissophloeus	Smooth-barked St. John's-wort		E
Magnolia acuminata	Cucumber magnolia		E
Magnolia ashei	Ashe's magnolia		E
Magnolia pyramidata	Pyramid magnolia		E
Matelea alabamensis	Alabama anglepod		E
Panicum abscissum	Cutthroat grass		E
Medeola virginiana	Indian cucumber-root		E
Lindera subcoriacea	Bog spicebush		E
Linum westii	West's flax		E
Litsea aestivalis	Pondspice		E
Rhexia parviflora	A meadowbeauty		E
Xyris longisepala	Karst pond xyris		E
Cladonia perforata	Perforate reindeer lichen	E	E
Pellaea atropurpurea	Purple cliff brake		E
Pinguicula ionantha	Voilet-flowered butterwort	T	E
Thalictrum cooleyi	Cooley's meadowrue	E	E
Verbesina chapmanii	Chapman's crownbeard		T
Xanthorhiza simplicissima	Yellow-root		E

Table 7. Occurrences of Listed Species in the Pensacola Bay System Watershed (continued)

Federal/ and State Legal Status

Federal (U.S. Fish and Wildlife Service - USFWS)

E = Listed as Endangered Species in the List of Endangered and Threatened Wildlife and Plants under the provisions of the Endangered Species Act. Defined as any species which is in danger of extinction throughout all or a significant portion of its range.

T = Listed as Threatened Species. Defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

State

Animals (Florida Game and Fresh Water Fish Commission - FGFWFC)

E = Listed as Endangered Species by the FGFWFC. Defined as a species, subspecies, or isolated population which is so rare or depleted in number or so restricted in range of habitat due to any man-made or natural factors that it is in immediate danger of extinction or extirpation from the state, or which may attain such a status within the immediate future.

T = Listed as Threatened Species by the FGFWFC. Defined as a species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is declining in area at a rapid rate and as a consequence is destined or very likely to become an endangered species within the foreseeable future.

SSC = Listed as Species of Special Concern by the FGFWFC. Defined as a species, subspecies, or isolated population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.

Plants (Florida Department of Agriculture and Consumer Services - FDACS)

E = Listed as Endangered Plants in a Preservation of Native Flora of Florida Act. Defined as species of plants native to the state that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue, and includes all species determined to be endangered or threatened pursuant to the Federal Endangered Species Act of 1973, as amended.

T = Listed as Threatened Plants in the Preservation of Native Flora of Florida Act. Defined as species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in such number as to cause them to be endangered.

Sources: Wood, 1996; Cox et al, 1994; Deyrup, 1994.

Exotic Species

Noted species of exotic plants within the area are mimosa (*Albizia julibrissin*), Chinese tallow (*Sapium sebiferum*), oleander (*Nerium oleander*), chinaberry (*Melia azedarach*), cogongrass (*Imperata cylindrica*), Bermuda grass (*Cynodon dactylon*) and common privet (*Ligustrum silense*). Other exotic species inhabit isolated developed locations but are apparently not spreading significantly or posing a threat to native plants. Exotic animals identified in the Florida Panhandle include Norway rats (*Rattus norvegicus*), house mice (*Mus musculus*), starlings (*Sturnus vulgaris*), wild pigs (*Sus scrofa*), and black rats (*Rattus rattus*). Nine-banded armadillos (*Dasypus novemcinctus*), coyotes (*Canis latrans*), and cattle egrets (*Bubulus ibis*) are species which have naturally migrated to the area in the recent past.

Biological Indicators of Ecological Health

Tidal Marshes and Emergent Macrophytes

Hopkins (1973) indicated that 14.4 percent of the Escambia County shoreline and 31.2 percent of the Santa Rosa County shoreline support tidal marsh communities. The remnant marsh communities are valuable as resources for food and cover, shoreline stabilization, and primary productivity (Stith et al., 1984). Additionally, emergent vegetation provides a source of organic detritus, which is an important part of the estuarine food web. This is an especially important nutrient complement between riverine flood-driven pulses that nourish the estuary and those nutrients already cycling within the system.

Most marsh habitat in the Pensacola Bay system occurs in lower portions of the river floodplains and tidal creeks (Stith et al., 1984). Such marshes may be divided into two habitat types—fresh-to-slightly brackish and saline. In higher salinity areas, dominant species of vegetation include black needlerush (Juncus roemerianus) and saltmarsh cordgrass (Spartina alterniflora). Giant reed (*Phragmites australis*), bulrush (*Scirpus* sp.) and big cordgrass (*Spartina cynosuroides*) may also be present, and species such as saltmeadow cordgrass (*S. patens*) are present in higher elevations. In areas more dominated by freshwater inflow, more typically freshwater species such as sawgrass (*Cladium jamaicense*), pickerelweed (*Pontederia lanceolata*), bulrush (*Scirpis validus*), cattail (*Typha spp.*), and duck potato (*Sagittaria lancifolia*) may predominate. Vegetation is frequently segregated into zones, with vegetation changes reflecting changes in elevation and salinity.

Regulation, acquisition, and other public programs, as well as increased public awareness of and recent research into the functions and values of wetlands, have helped protect marshes and other wetlands. Federal and state regulations offer limited protection from dredging, filling, and other encroachments. Local ordinances and improved wetland delineation techniques and guidelines also have potentially improved wetland protection. Land acquisition programs have also played an important role in providing long-term protection for sensitive wetlands. The Save Our Rivers, Preservation 2000, CARL, and other acquisition initiatives have protected substantial areas of coastal and riverine wetlands. For example, over 44,000 acres along the Yellow and Escambia rivers and Garcon Point have been acquired through the these programs. For such reasons, wetlands within the Pensacola Bay system watershed may be protected better now than they have been in past decades. Recently, however, increased development pressures have become focused on wetlands and other low-lying areas. In Escambia County, for example, developers appear to be running out of more suitable lands, and are turning to low-lying areas to take advantage of an increasing demand for new houses (Hu, 1997).

Submerged Vegetation

A great deal has been written concerning the loss of seagrasses in the Pensacola Bay system (Hopkins, 1973; Rogers and Bisterfield, 1975; Olinger et al., 1975; Stith et al., 1984; Reidenauer and Shambaugh, 1986). The system contains three species of true seagrasses: *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), and *Halodule wrightii* (shoal grass), and two brackish-water species: *Vallisneria americana* (tape grass) and *Ruppia maritima* (widgeon grass). The earliest documented assertion of seagrass bed loss was in a 1955 report to the Florida Board of Conservation by Murdock (Hopkins, 1973) after an industrial plant went on-line and began discharging under permit into the Escambia River. Hopkins noted that the Murdock report clearly linked the loss of marine grasses in Escambia Bay with industrial discharges in the drainage basin. These problems were compounded by the location of several other chemical production facilities on the east shore of Escambia Bay.

The best documentation of the loss of submerged vegetation in Pensacola Bay was by Rogers and Bisterfield (1975), who utilized 23 years of aerial photography, a ground truth network, and supplemental aerial photography to investigate the recession and disappearance of most of the grassbeds in the system. As indicated by this study, in 1949 extensive grassbeds existed along all shores of Escambia Bay. By 1974, all but one small patch of *V. americana* along the upper western shore of the bay had disappeared. In Pensacola and East Bay, small beds that existed (at least in 1951) near the north side of the bay Bridge were eliminated, most likely as a result of dredging and filling in and near the port of Pensacola. The south shore of the bay west of the bay bridge was not historically mapped, but loss of 14 miles of a continuous grassbed on the east side is documented. From 1949 to 1966, half was lost, and additional species alteration occurred (*H. wrightii* replaced *T. testudinum*). Subsequent losses continued until 1974, at which time virtually all the *T. testudinum* had been eliminated. Olinger et al. (1975) noted that, according to bay-front residents, *V. americana* was becoming increasingly abundant in 1974 and 1975. Near Laura Point, only a small bed of *V. americana* was noted, but growth was apparent around each patch.

In 1974, the Escambia Bay Recovery Study Team and others transplanted plugs of *H. wrightii* to four sites on the east and west sides of Escambia Bay, below the I-10 bridge (Olinger et al., 1975). Observation by DEP employees in 1985 indicated that some growth of *H. wrightii* in eastern Escambia Bay near Indian Bayou had been observed. More recently, DEP and the University of West Florida have initiated an effort to propagate *R. maritima* under laboratory conditions, and transfer planting units to selected sites. Over 30 such transplant sites in the Pensacola Bay system have thus far been established, some in conjunction with artificial reefs (Kirschenfeld, 1997).

Blackwater Bay has a lower salinity than the other bays and therefore has grassbeds composed primarily of *V. americana* and *R. maritima*. Historical records show that the beds changed little from 1950 to 1974 (Rogers and Bisterfield, 1975). Epiphytic algae growth was observed on *V. americana* beds in the shoal area between the Yellow and Broad rivers, which possibly indicated excessive nutrients in the water.

Although historical data are available documenting extensive losses of seagrasses in Pensacola Bay, recent (after 1975) data are scarce. *Thalassia testudinum* and *H. wrightii* are apparently nearly absent from Pensacola and Escambia bays—only *V. americana* and *R. maritima*, persistent brackish-water species, are surviving in limited areas of Escambia Bay. These species are also apparently doing well in portions of Blackwater Bay, and *H. wrightii*, *T. testudinum*, *S. filiforme*, and *R. maritima* communities are surviving in portions of Santa Rosa Sound (NWFWMD, 1988; DER, 1988; Kirschenfeld, 1997).

Benthic Macroinvertebrates

Prior to 1975, there were apparently no published studies of benthic fauna within Escambia Bay. A purpose of the Olinger et al. (1975) study was to examine such fauna and major benthic habitats. Benthic habitats identified include the following:

1. sand shelf;
2. transition zone;
3. mud plain;
4. oyster beds;
5. grassbeds;
6. sewage treatment plant outfalls;
7. industrial plant outfalls; and

8. deep mud (in deep portions of the bay).

Subsequent to the Olinger et al. (1975) study, Cooley (1978) published a comprehensive inventory of the estuarine fauna in the vicinity of Pensacola. This study represents the best faunal reference on the system, but it includes little interpretive content or data interpretation. It also does not provide an extensive discussion of habitats.

The EPA Recovery Study (Olinger et al., 1975), representing the most comprehensive and far-ranging study on the Pensacola Bay system, indicated that improvements in environmentally damaged estuaries can occur and that useful information can be obtained from older data. Based on the results of this study, it was concluded that oyster bed habitats had the highest species diversity and biomass within Escambia Bay. Grassbeds were found to be the second most diverse and productive. Similar results were observed in East Bay. At industrial discharge stations, the species types were dominated by polychaete worms, as opposed to mollusks and crustaceans. Benthic faunal assemblages near wastewater plant discharge stations were found to be similar to those in other similar sediment types, suggesting that the domestic wastewater discharges were not a dominant factor on the benthic macroinvertebrates. The deep water mud sediment habitat in Escambia, East and Pensacola bays had similar benthic assemblages, although the Pensacola Bay habitat contained two high salinity species that were absent in the other two bays.

Olinger et al. (1975) concluded, based on limited studies during the period of October 1973 to September 1974, that the diversity values obtained indicated that the macroinvertebrates of Escambia Bay appeared to be normally distributed throughout the bay. In comparison to Hillsboro Bay, Tampa Bay and Galveston Bay, however, the diversity in Escambia Bay was lower during the critical summer period.

The DEP Northwest District Biological and Physiochemical Assessment of Pensacola Bay (DER, 1988) indicated that relatively high productivity and diversity were found in the relatively clean, vegetated littoral zone, a condition which was reduced when the organically-enriched mud plain habitat was examined. This study further concluded that despite stresses being imposed on it from various point and nonpoint sources, Pensacola Bay was apparently "holding its own," since the benthic community exceeded expectations with respect to numbers of species and diversity at most locations in the bay. Collard (1989) in his review of the EPA Recovery Study (Olinger et al., 1975), indicated, based on the biological data from the study, that the Pensacola Estuarine System may be considered "typical" and, compared to other estuaries of its type and morphology, was "unremarkable" during the period sampled. He noted that, according to Ross and Jones (1979), benthic faunal diversity in Escambia Bay at U.S. Highway 90 was relatively low, possibly due to salinity variation, and that thermal effluents and pollutants such as PCBs may have impacted estuarine fauna. In contrast, the fauna in lower Escambia Bay near Garcon Point exhibited no significant changes, although it was reportedly an unstable community due to extreme environmental variation and variable levels of industry discharge-related stress. In the middle of Blackwater Bay, Ross and Jones (1979), indicated that the Shannon-Weaver Diversity Index (H') was fair, with low species diversity being associated with salinity variation, siltation, river discharge, and possibly effluent from the Milton sewage treatment plant.

Collard (1989) suggests, based on his study of the benthic macroinvertebrates in the Pensacola estuarine system, that biological conditions are highly variable. He further indicates that environmental degradation will probably persist without sustained and substantial efforts to reduce and mitigate anthropogenic impacts. He concludes that it is inappropriate to label the Pensacola estuarine system as "typical," "disturbed," or "polluted," because, although one or more of these descriptors may be accurate, the system has not been investigated thoroughly or accurately enough to allow confident characterization.

Collard (1989) and other assessments of benthic macroinvertebrates suggest that while indices, natural versus artificial substrates analyses, analyses of species composition, etc. are useful in achieving an overall understanding of the system, interpretation and application of their results may vary depending on assessment of a wide array of natural and anthropogenic variables. Nevertheless, it appears that the Pensacola Bay system—considering its history and the magnitude of the overall environmental impact—exhibits at least a stable benthic macroinvertebrate population, with variations apparently associated with point source pollution, loss of seagrass habitat, sediment contamination, and salinity. Interpretation, comparison, and application of specific research results would be useful; however, a valid methodology for doing so must be carefully developed.

Freshwater Mussels

Species diversity and numbers of individuals of freshwater mussels have declined precipitously in recent decades (Williams et al, 1992). It has been estimated, for example, that over 50% of the nation's mussels are extinct or imperiled (Master, 1990; cited in Williams et al., 1992). The decline in freshwater mussel populations has been associated primarily with anthropogenic activities. Habitat destruction, dredging activities, dams, and channelization alter the natural flow of these rivers and restrict the habitat of mussels as well as host species.

Specific impacts detrimental to the sustainability of freshwater mussels range from direct habitat destruction, such as dredging, channelization, and impoundments, to habitat degradation caused by sedimentation, contaminants, and poor water quality. Commercial harvest may also affect populations in some areas. Currently no major dams exist within the river systems of the SWIM planning area. Species populations within these systems are predominantly affected by the increased silt load from nonpoint source pollution in Alabama and Florida. Agricultural practices, pesticide use, deforestation, and destruction of riparian zones all occur within this water system and may also impact mussels and fish which act as hosts for juvenile mussels (Williams et al.,1992).

Monitoring of mussel population levels can indicate habitat quality problems if population levels continue to fall. Stable or increasing populations, on the other hand, may be indicative of stable or improving conditions. According to Deyrup (1994), the Escambia and Yellow rivers currently hold six species classified as threatened or endangered (see Table 8).

Table 8. Threatened and Endagered Mussels of Rivers of the Pensacola Bay System

Common Name	Scientific Name	Status (federal)	River(s)
Choctaw Bean	*Villosa choctawensis*	Threatened	Escambia, Yellow
Fuzzy Pigtoe	*Pleurobema strodeanum*	Threatened	Escambia
Southern Pocketbook	*Lampsilis ornata*	Threatened	Escambia
Narrow Pigtoe	*Fusconaia escambia*	Threatened	Escambia, Yellow
Flat Floater	*Anodonta suborbiculata*	Threatened	Escambia
Round Ebonyshell	*Fusconaia rotulata*	Endangered	Escambia

Source: Deyrup, 1994

Stream Condition Index

The Florida Department of Environmental Protection has developed criteria for monitoring resident biota of wadeable streams, refining methods described by the EPA (Plafkin et al., 1989) for conditions specific to Florida. This methodology aggregates metrics of bottom-dwelling macroinvertebrates into a Stream Condition Index (SCI), for use as an indicator of watershed health and impairment identification (Barbour et al., 1996). The resident biota of streams effectively function as "continual natural monitors" of both cumulative and episodic pollution and habitat alteration impacts (Barbour et al., 1996). Thus, the SCI may be used to assess the impacts of nonpoint source pollution, as well as other impacts, on the biological integrity of these streams.

Aquatic macroinvertebrates found in fresh water include insects, mollusks, flatworms, crustaceans, and annelids (Dissmeyer, 1994). Benthic aquatic insects in particular have been the subject of systematic monitoring. The sensitivity of such species to alterations in habitat and water quality make them potentially more effective indicators of stream impairment than chemical measurement (Dissmeyer,1994).

The framework for implementation of the Florida SCI includes the characterization of reference conditions, with which comparisons may be made. Additionally, rapid bioassessment, or "Biorecon," methods have been developed to provide assessments of conditions using fewer samples and with less intensive laboratory analysis requirements than SCI. At the time of this writing, the Department has conducted bioassessment surveys of thirty-one streams in the Pensacola Bay system watershed. Of these, 15 were assessed as "impaired," 11 were considered "healthy," and three were considered suspect (Butts, 1997).

Socio-Demographics

Escambia County is one of the more populous counties in the State, with an estimated population of 282,742 in 1995 (BEBR, 1996). The county's population has been projected to increase to 300,100 by 2000 and 350,000 by 2020 (BEBR, 1995). The City of Pensacola is the only large incorporated population center in the county. The city, which lies on the western shore of Pensacola Bay, had an estimated 60,373 residents in 1995. The majority of the county's population resides in unincorporated areas, largely in the southern part of the county.

The economy of Escambia County is strongly influenced by the military, tourism, government, and manufacturing. Major chemical manufacturing interests near the northern end of Escambia Bay also contribute significantly to the local economy. Military-related employment is close to 25 percent of the county work force. The principal military facility in the area is Naval Air Station (NAS) Pensacola. Statistics from 1987 indicated 502 farms were located in Escambia County, consisting of 65,426 acres. Seventy percent of this was estimated to be in row-crops.

Santa Rosa County had an estimated 96,091 residents in 1995 (BEBR, 1996). The county's population has been projected to increase to 111,700 by 2000 and 161,900 by 2020 (BEBR, 1995). Santa Rosa County has two substantial incorporated population centers: Milton, at the northern end of Blackwater Bay, had an estimated 7,511 residents in 1995, while Gulf Breeze, at the southern end of Pensacola Bay, had an estimated 5,922 residents.

The economic base of Santa Rosa County is strongly influenced by retirement, tourism, the military, government, and manufacturing. Military bases which provide employment for Santa Rosa County residents include Whiting Field, near Milton; NAS Pensacola; and the Eglin Air Force Base (AFB) reservation and Hurlburt Field, which are spread across Santa Rosa, Okaloosa, and Walton counties. Manufacturing facilities along the northeast shore of Escambia Bay are also of economic importance. In 1987, there were 435 farms in the county, with over 81,000 acres. Seventy percent of the farm acreage was in crops, while forests accounted for 20 percent of these farms. Pastures accounted for ten percent of the farmland.

Okaloosa County had an estimated 1995 population of 162,707 (BEBR, 1996). The county's population has been projected to reach 177,200 by 2000 and 232,600 by 2020 (BEBR, 1995). Most of the population is concentrated in the southern portion of the county and is outside of the Pensacola Bay system watershed. Crestview, with a 1990 population of 9,886, is the only incorporated Okaloosa County municipality of substantial size located within the Pensacola Bay system watershed. Within Okaloosa County's portion of the watershed, the economic base is primarily agriculture. In the county as a whole, however, services, trade, the military, tourism, and manufacturing dominate. Eglin AFB encompasses a significant portion of the southern part of the county and contains substantial undeveloped land. Blackwater River State Forest occupies a major portion of northern Okaloosa county.

The total population of Walton County was estimated to be 33,415 in 1995 (BEBR, 1996). The population is projected to grow to 36,500 by 2000 and 48,800 by 2020 (BEBR, 1995). Only the northern portion of Walton County is within the Pensacola Bay system watershed area, and no incorporated areas are located within this area. The major economic base for this portion of Walton County is agriculture.

Land Use

The Florida portion of the Pensacola Bay system watershed includes the mainland surrounding Escambia, Pensacola, Blackwater and East bays in Escambia and Santa Rosa counties (Figure 1). This watershed also includes several bayous, the Gulf Breeze peninsula, and Santa Rosa Island. Land uses within the Pensacola Bay system watershed include urban development, recreation, conservation, agriculture, and silviculture.

The pattern of development and land use differs significantly in the eastern and western portions of the basin. The western portion is predominantly urban, while the eastern portion is primarily low-density, rural, and undeveloped. The majority of the Pensacola urban area is located within the basin, primarily northwest of Pensacola and Escambia bays. This area includes the City of Pensacola (24 square miles) and the unincorporated communities of Pleasant Grove, Warrington, Brent, Brownsville, Pace, and Floridatown. The Pensacola urban area exhibits intensive industrial, commercial and residential development. The extensive industrial and manufacturing facilities in the area have a profound effect on the system. Industrial land use and warehousing are located predominantly along the waterfront and along railroad lines. The Port of Pensacola and chemical manufacturing complexes located along Bayou Chico are the major industrial land uses within the city (City of Pensacola Comprehensive Plan, 1981). The Port is used by commercial, recreational, and military vessels. The Port’s substantial repair and maintenance facilities are oriented primarily to commercial trade.

Commercial land uses within Escambia County occur primarily as strip commercial development along major arterials. Two regional malls are located in the northeastern portion of the Pensacola urban area. The Pensacola Central Business District (CBD) is located near the waterfront on Pensacola Bay. The CBD includes the Pensacola Historic District, an area of restored historic homes, and buildings used primarily as offices and shops.

In 1990, Escambia and Santa Rosa counties contained an estimated 145,061 dwelling units, with approximately 77 percent of these located in Escambia County (BEBR, 1995). The majority of the housing units are single-family, year round occupancy. Residential growth is particularly rapid in the unincorporated urban fringe areas of the county. An increasing amount of seasonal residential development is occurring in Escambia and Santa Rosa counties, primarily on Santa Rosa Island and Perdido Key.

Naval Air Station Pensacola borders Pensacola Bay, northwest of Santa Rosa Island. Additional active and inactive U.S. Naval Reservations are located within the Pensacola urban area to the west of Escambia and Pensacola bays. Beyond the urban area, in the western and northern portions of the Pensacola Bay system basin, the predominant land use is forestry. Agricultural production is limited and consists primarily of row crops.

Limited agricultural activity occurs north of Escambia and East bays. Eglin Air Force Base occupies over 470,000 acres within Santa Rosa, Okaloosa, and Walton counties and has constrained urban expansion within the eastern Pensacola Bay system basin. The Blackwater River State Forest and Wildlife Management Area, located in northeast Santa Rosa and northwest Okaloosa counties, is managed for conservation and recreational purposes and further constrains development.

The Gulf Breeze peninsula is urbanizing rapidly and includes the City of Gulf Breeze, which is the largest urban area in the eastern portion of the Pensacola Bay system basin. A portion of the peninsula, the Naval Live Oaks Reservation, is managed by the U.S. Department of the Interior as part of the Gulf Islands National Seashore. Intensive residential and commercial development is occurring on Santa Rosa Island and along the U.S. Highway 98 corridor. The national seashore, which is managed for conservation and recreation uses, constrains urban sprawl on the western end of the island. Fort Pickens State Park at the western end of the National Seashore offers camping and picnicking facilities. The Florida DEP manages the Fort Pickens Aquatic Preserve, which includes approximately 34,000 acres of submerged and periodically inundated land.

In Okaloosa and Walton counties as well as most of the rest of the watershed, the major land uses are silviculture and agriculture. Crestview is the only incorporated area of substantial size in either county within the Pensacola Bay watershed. The primary land uses in Crestview are residential and commercial.

Forestry and agriculture are the primary land uses within Alabama's portion of the watershed (Littlepage, 1997). All of the Alabama counties within the watershed have been assessed as consisting of at least 25 percent prime farmland, with portions categorized as more than 75 percent prime farmland (Alabama Water Improvement Commission, 1979). Primary agricultural uses in the area include row crops (corn, peanuts, and soybeans) and livestock production. Within Alabama, the basin also includes some conservation lands, notably including the 84,000 acre Conecuh National Forest, which is adjacent to Florida's Blackwater State Forest to the south. The Alabama Water Improvement Commission (1979) concluded that the Perdido-Escambia Basin had severe sediment problems associated with agriculture, especially cropland, gully, and roadbank erosion.

Historical Setting

The Pensacola Bay system watershed has a rich and unique human history, and virtually all of the significant events affecting it have had a direct or indirect effect on the character of the riverine and estuarine resource. Below is a very general and brief chronology describing the historical setting of the area. Table 9 lists some of the major scenic and historic sites in the watershed area.

10,000 B.C. Archaeological records have yielded evidence of human occupation. The Paleo-Indians were the first residents of northwest Florida.

A.D. 1500s The earliest historic reference to the Pensacola area is found in documents of sixteenth-century Spanish exploration and colonization. These early Spanish records refer to Pensacola Bay as Bahia de Achuse.

1529 The Spanish mariner Maldonado anchored in Bahia de Achuse while waiting for Hernando de Soto's inland exploratory expedition.

1559 The Spanish established a temporary settlement at Bahia de Achuse under the command of Tristan de Luna. The Luna expedition's mission was to establish another inland settlement at the aboriginal town of Coosa and to secure an inland route between the Santa Maria settlement at Pensacola and the Atlantic Coast Spanish settlement of Santa Elena. The Luna colonization attempt failed due to the loss of ships and supplies as the result of a hurricane in 1561.

1677-1693 Records from this time document wars between Indians in the Pensacola area. Pensacola Indians attacked Apalachee Indians in 1677. In 1668, the Jordan expedition encountered Pensacola Indians and learned of an ongoing war with the Mobile Indians. In 1686, the Carlos de Siguenza expedition visited Pensacola Bay and discovered that Pensacola Indians had been driven inland by raiding Mobile Indians.

1698 Beginning of continuous settlement in Pensacola called Santa Maria de Galve (First Pensacola). The Spanish established Fort San Carlos de Austria at the site of the present Naval Air Station in Pensacola. The fort withstood several attacks by British-supported Creek Indians before falling in 1719.

1723 The Spanish regained control of Fort San Carlos de Austria through a treaty, and established the Presidio of Punta de Siguenza (Second Pensacola) on Santa Rosa Island. In 1752, the Presidio of Punta de Siguenza was destroyed by a hurricane.

1757 Fort San Miguel was constructed near present day Pensacola in anticipation of attacks from British-supported Tallapoosa Indians. King Ferdinand VI named the settlement near San Miguel, Penzacola (Third Pensacola). After Tallapoosa raids of local Indian settlements in 1771, the natives were relocated to the fort.

1763 Treaty of Peace concluded the Seven Years War, and awarded Florida to Great Britain. The British gained control of Fort San Miguel. Pensacola experienced rapid growth under British control. Numerous residential, government, and commercial structures were erected by colonists. Creek Indians moved to the area, and trade with natives became an important part of the local economy. Spanish fortifications were improved, and Fort George was constructed north of Pensacola to provide protection from possible Spanish attacks.

1781 Spanish troops under Governor Bernardo Galvez regained control of Pensacola. The Spanish constructed Fort San Carlos de Barrancas on the present Naval Air Station site to protect the harbor. Indian trade continued to be an important commercial activity, and the local population continued to grow. Immigrants from the Canary Islands and Europe moved to the area. Brickyards, sawmills, and cattle ranches were established.

1784 The first commercial treaty between the Spanish government and Indians was signed. The Treaty of Pensacola established Spain's control over Indian trade.

1800 William Augustus Bowles declared war on Spain and attempted to establish a separate state for Seminole and Creek Indians called Muskogee.

1814 American troops commanded by Andrew Jackson attacked Pensacola, where Indians were seeking refuge, and defeated the Spanish.

1818 General Andrew Jackson again occupied Pensacola as part of an expedition to secure the American frontier from Indian attacks. Governor Masot was forced to surrender Spanish forts in Pensacola until the Spanish could ensure control of the Indians.

1819 The Spanish under Governor Jose Callava reoccupied Pensacola, and American rule ended. By the second period of Spanish control, Milton had become a major trading post. Milton was situated at the junction of two major Indian trading trails and in an area with abundant supplies of longleaf pine, one of the first major exports of west Florida.

1821 The Adams-Onis Treaty was ratified, and Florida became an American territory. Pensacola was the temporary capital, and a military post was established at the head of the bay. The Navy yard began operation in the 1830s and, forts Barrancas (1844), Pickens (1834), and MacRee (1840) were constructed. During this period bricks and lumber were important area products. An industrial complex was developed, and sandstone was quarried to provide construction materials.

1861 Union troops held Fort Pickens at the beginning of the Civil War. When Confederate troops occupying Fort Barrancas were transferred to other areas, the Union Army moved into Pensacola and established Fort McClellan near the site of the former British Fort George.

1865 The Victorian America period began after the Civil War, and area expansion began. Railroads provided transportation for a growing timber industry.

1870-1880 The area economy grew rapidly during this time period. The timber trade flourished, turpentine became a valuable forest product, and commercial fishing was added to the local economy.

1917 Relocation of the Navy's small air establishment from Annapolis, Maryland to Pensacola prior to World War I began a major military growth trend in the area. Pensacola became known as the "cradle of Naval aviation," and government became the area's predominant industry.

1976 Gulf Islands National Seashore National Park opened and attracted tourists to its incomparable beaches. The Naval Aviation Museum also opened and contributed to the marked increase in tourist visits.

Table 9. Major Scenic and Historic Sites

NAME	*LOCATION*
Bagdad Mills	Milton
Blackwater River State Forest	North Santa Rosa County
Blackwater River State Park	Central Santa Rosa County
First European Settlement in U.S.	Pensacola
Fort George Historic Site	Pensacola
Fort Pickens, Gulf Islands Nat. Seashore	Santa Rosa Island
Fort San Carlos de Barrancas	Pensacola Naval Air Station
Naval Live Oaks Reservation	Gulf Islands National Seashore
Pensacola Lighthouse	Pensacola Naval Air Station
Pre-Columbia Indian Site	Fort Walton Beach
Saint Mary's Episcopal Church	Milton
Seville Square Historic Site	Pensacola
The Buccaneer Schooner	Municipal Wharf, Pensacola
U.S. Naval Aviation Museum	Pensacola Naval Air Station
West Florida Museum of History	Pensacola
Source: Escambia County OEDP Committee, 1976	

REFERENCES

Adams, J.K. 1972. "A Comparative Study of Phytoplankton Primary Productivity and Related Parameters in Two Northwest Florida Estuarine Bayous." M.S. Thesis, University of West Florida, Pensacola, Florida, 14 pp.

Adler, Robert W. 1996. "Model Watershed Protection." National Wetlands Newsletter (July-August 1996): 7-12.

Alabama Water Improvement Commission. 1979. Agriculture Runoff Management Plan. Montgomery, Alabama.

Appleton, Elaine. 1995. "A Cross-Media Approach to Saving the Chesapeake Bay." Environmental Science and Technology 29, 12: 550-555.

Barbour, M.T., J. Gerritsen, and J.S. White. 1996. Development of the Stream Condition Index (SCI) for Florida. Tallahassee: Florida Department of Environmental Protection.

Barnett, Ernie, Jim Lewis, Jim Marx, and David Trimble, ed. 1995. Ecosystem Management Implementation Strategy. Tallahassee: Florida Department of Environmental Protection.

Bartel, Ronald L., Nicholas D. R. Wooten, and Walter C. Hunner. 1994. "Stormwater Monitoring Program for the City of Pensacola NDES Part II Application." Northwest Florida Water Management District Technical File Report 94-5.

Bass, D. Gray, Jr. 1990. "Stability and Persistence of Fish Assemblages in the Escambia River, Florida." Rivers 1,4 (October 1990): 296-306.

Bass, Jr., D. Gray and Vinard Hitt. 1977. Ecology of the Backwater River System, Florida. Northwest Streams Research Project, Florida Game and Fresh Water Fish Commission.

Bay Area Resource Council. 1988. Environment of the Pensacola Bay System. Pensacola, FL, 28 pp.

Brinson, S.T., and J.M. Keltner Jr. 1981. Water Quality and Biological Assessment of Bayou Chico, Florida, a Two-Part Study. Florida Department of Environmental Regulation.

Bureau of Economic and Business Research. 1995. 1995 Florida Statistical Abstract. 29th Edition. Gainesville: University Presses of Florida.

Bureau of Economic and Business Research. 1996. Florida Estimates of Population, 1995. Gainesville: University Presses of Florida.

Butts, Glenn, and Donald Ray. 1986. An Investigation of Upper Escambia Bay During Drought Conditions July-August 1986. Pensacola: Florida Department of Environmental Protection, Northwest District.

Butts, Glenn, Florida Department of Environmental Protection. 1997. Personal communication, June 12.

Collard, S.B. 1989. "Benthic Macroinvertebrate Species Indicator List." STAR Grant Final Rep., Florida Inst. Government/Florida Dept. Environ. Regul., 850 pp.

Collard, S.B. 1991a. The Pensacola Bay System: Biological Trends and Current Status. Water Resources Special Report 91-3. Havana: Northwest Florida Water Management District.

Collard, S.B. 1991b. Management Options for the Pensacola Bay System: The Potential Value of Seagrass Transplanting and Oyster Bed Refurbishment Programs. Water Resources Special Report 91-4. Havana: Northwest Florida Water Management District.

Cooley, N.R. 1978. "An Inventory of the Estuarine Fauna in the Vicinity of Pensacola, Florida." Florida Mar. Res. Publ. 31:1-119.

Cox, J., R. Kautz, M. MacLaughlin, and T. Gilber. 1994. Closing the Gaps in Florida's Wildlife Habitat Conservation System. Tallahassee: Florida Game and Fresh Water Fish Commission.

DeBusk, Bill, University of West Florida. 1997. Personal communication, June 6.

Deyrup, Mark, and Richard Franz, ed.. 1994. Rare and Endangered Biota of Florida: Volume IV. Invertebrates. Gainesville: University Press of Florida.

Dissmeyer, George E. 1994. Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards. Atlanta: USDA Forest Service.

Duke, T.W., J.I. Lowe, and A.J. Wilson. 1970. A Polychlorinated Biphenyl (Aroclor 1254) in the Water, Sediment, and Biota of Escambia Bay, Florida. Bulletin of Environmental Contamination and Toxicology, 5, 2.

Edwards, N.C. 1976. "A Study of the Circulation and Stratification of Escambia Bay, Florida During the Period of Low Freshwater Inflow." M.S. Thesis, Florida State University, Tallahassee, FL, 192 pp.

Edwards, Patrice, Florida Department of Environmental Protection. 1997. Personal communication, August 12.

Eglin Air Force Base. 1993. Natural Resources Management Plan: 1993-1997. Eglin AFB: 646 ABW.

Elder, J.F. and PV. Dresler. 1983. "Creosote Discharge of the Nearshore Estuarine Environment in Pensacola Bay, Florida: Preliminary Assessment of Effects," in Movement and Fate of Creosote Waste In Ground Water. Water-Supply Paper 2285, U.S. Geological Survey.

Ellis, E.E. 1969. Some Basic Dynamics of the Pensacola Estuary. Florida Air and Water Pollution Control Committee.

Escambia County Overall Economic Development Committee. 1976. Overall Economic Development Program: Escambia County, Florida.

Escambia/Santa Rosa Coast Resource Planning and Management Committee. 1985. Escambia/Santa Rosa Coast Resource Management Plan.

Fernald, Edward A., and Donald J. Patton, eds. 1984. Water Resources Atlas of Florida. Tallahassee: Florida State University.

Florida Department of Agriculture and Consumer Services, Division of Forestry. 1996. "Draft Forest Resource Management Plan for the Blackwater River State Forest, Okaloosa/Santa Rosa Counties."

Florida Department of Environmental Protection. 1993. Fisheries-Independent Monitoring Program: 1993 Annual Data Summary Report. St. Petersburg: Florida Marine Research Institute

Florida Department of Environmental Protection. 1994. Florida Coastal Sediment Contaminants Atlas: Technical Volume. Tallahassee: Florida Department of Environmental Protection.

Florida Department of Environmental Protection. 1995. Northwest District FDEP Ecosystem Management. Pensacola: Florida Department of Environmental Protection.

Florida Department of Environmental Protection. 1996. Pensacola Bay Ecosystem Management Plan: Environmental Indicator System. Pensacola: Florida Department of Environmental Protection.

Florida Department of Environmental Regulation. 1984. “Final Report, Deepwater Ports Maintenance Dredging Study. Volume I.”

Florida Department of Environmental Regulation. 1988. “A Special Monitoring Project Basin Survey, Biological and Physiochemical Assessment of Pensacola Bay 1987-1988.” Northwest District, Biology Section, 67 pp.

Florida Department of Natural Resources. 1976. Florida Regional Coastal Zone Environmental Quality Assessment: Region 1. Tallahassee: Florida Dept. Natural. Resources.

Florida Department of Natural Resources. 1991. Yellow River Marsh: Aquatic Preserves Management Plan. Tallahassee: Florida Department of Natural Resources.

Florida Natural Areas Inventory. 1990. Memorandum-Updated Special Plants List, Special Vertebrate List, and Rank Explanation Sheet.

Florida Resources and Environmental Analysis Center (FREAC) of Science and Public Affairs. 1989. Florida Rivers Assessment - First Year Report (second review draft). Tallahassee: Florida State University with Florida Department of Natural Resources and U.S. National Park Service.

Galtsoff, P.S. (ed.). 1954. “Gulf of Mexico, Its Origin, Waters and Marine Life.” U.S. Fish Wildl. Ser., Fish. Bull. 64.

George, S.M. 1988. “The Sedimentology and Mineralogy of the Pensacola Bay System.” M.S. Thesis, University of Southern Mississippi.

Glassen, R.C, J.E. Armstrong, J.A. Calder, R.W.G. Carter, P.A. La Rock, J.O. Pilotte, and J.W. Winchester. 1977. Bayou Chico Restoration Study. Tallahassee: Florida State University, Florida Resources and Environmental Analysis Center.

Greening, Holly. 1995. “Resource-Based Watershed Management in Tampa Bay.” Tampa Bay National Estuary Program.

Guo, George Z., and Thomas Pratt. 1993. Stormwater Assessment of the Palafox Watershed. Water Resources Special Report 93-8. Havana: Northwest Florida Water Management District.

Hand, Joe, Jana Col, and Linda Lord. 1996. 1996 Florida Water Quality Assessment, 305(b) Technical Appendix. Tallahassee: Florida Department of Environmental Protection.

Hannah, R.P. 1972. "Primary Productivity and Certain Limiting Factors in a Bayou Estuary." M.S. Thesis. Pensacola: University of West Florida.

Hannah, R.P., A.T. Simmons, and G.A. Moshiri. 1973. "Nutrient-Productivity Relationships in a Bayou Estuary." J. Water Pollut. Control Fed. 45(12):2508-2520.

Henningson, Durham, and Richardson. 1975. Water Quality Management Plan for Escambia and Santa Rosa Counties. Pensacola: West Florida Regional Planning Council.

Hood, M.A., and G.A. Moshiri. 1978. "Environmental Assessment of Potential Restoration Programs for Bayou Texar, Pensacola, Florida." University of West Florida (Unpublished Report).

Hopkins, T.S. 1969. The Escambia River and Escambia Bay During Summer 1969: A Report in Two Parts. U.S. Bureau Comm. Fish, Contract No. 14-17-002-177.

Hopkins, T.S. 1973. Marine Ecology in Escarosa. Florida Department of Natural Resources, Coastal Coordinating Council.

Horvath, G.J. 1968. "The Sedimentology of the Pensacola Bay System, Pensacola, Florida." M.S. Thesis, Florida State University, Tallahassee, Florida.

Hu, Winnie. 1997. "Development Soaring in Low-Lying Areas." Pensacola News Journal, January 30, p. 5A.

Hudson, Thomas J., and David R. Wiggins. 1996. Comprehensive Shellfish Harvesting Area Survey of Pensacola Bay System Escambia and Santa Rosa Counties, Florida. Tallahassee: Florida Department of Environmental Protection.

Hunner, Walter C., Felton B. Ard, and James Edmonds. 1994. Preliminary Nonpoint Source Loading Rate Analysis of the Pensacola Bay System. Water Resources Special Report 92-2. Havana: Northwest Florida Water Management District.

Hutchinson, G.E. 1957. A Treatise on Limnology, Vol. 1. Geography, Physics and, Chemistry. New York: John Wiley & Sons, Inc.

Isphording, W.C., F.D. Imsand, and G.C. Flowers. 1987. "Storm-related Rejuvenation of a Northern Gulf of Mexico Estuary." Transactions-Gulf Coast Association of Geological Societies. 37: 357-370.

Isphording, W.C., F.D. Imsand, and G.C. Flowers. 1989. Physical Characteristics and Aging of Gulf Coast Estuaries, Transactions-Gulf Coast Association of Geological Societies, 39: 387-401.

Ketchen, G.H. and R.C. Staley. 1979. "A Hydrographic Survey of Pensacola Bay." Tallahassee: Florida State University, Department of Oceanography.

Kirschenfeld, J. Taylor. 1997. Personal communication, February 3.

Jones, W.K., J.H. Cason, and R. Bjorklund. 1992. A Literature-Based Review of the Physical, Sedimentary, and Water Quality Aspects of the Pensacola Bay System. Northwest Florida Water Management District Water Resources Special Report 92-5 (revision of Water Resources Special Report 90-3). Havana: Northwest Florida Water Management District.

Lewis, Michael A. 1997. Presentation at the Choctawhatchee River and Bay Technical Symposium, May 30.

Little, E.J. and J.A. Quick. 1976. Ecology, Resource Rehabilitation, and Fungal Parasitology of Commercial Oysters, *Crassostrea virginica* (Gmelin), in Pensacola Estuary, Florida. Tallahassee: Florida Dep. Nat. Resour., Mar. Res. Lab., 21, 89 pp.

Little, Keith J., Caleb Curren, and Lee McKenzie. 1988. "A Preliminary Archaeological Survey of the Blackwater Drainage, Santa Rosa County, Florida." Institute of West Florida Archaeology, University of West Florida, Report Number 19.

Littlepage, John, Alabama Office of Water Resources. 1997. Personal communication, May 16.

Livingston, Eric, Ellen McCarron, Michael Scheinkman, and Sue Sullivan. 1988. Florida Nonpoint Assessment: Volumes One and Two. Tallahassee: Florida Department of Environmental Regulation.

Livingston, Eric, Florida Department of Environmental Protection. 1997. Personal communication, June 5.

Livingstone, D.A. 1963. "Chapter G. Chemical Composition of Rivers and Lakes." Data of Geochemistry, Sixth Edition, Geological Survey Professional Paper 440-G.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Tallahassee: Florida Department of Environmental Protection.

Marmer, H.A. 1954. "Tides and Sea Level in the Gulf of Mexico," in Gulf of Mexico: Its Origin, Waters, and Marine Life. U.S. Fish and Wildlife Service, Fisheries Bulletin 81.

Marsh, O.T. 1966. "Geology of Escambia and Santa Rosa Counties, Western Florida Panhandle." Florida Geological Survey Bulletin 46.

Martens, J. 1931. "Beaches of Florida." Florida Geological Survey, 21-22 Annual Reports, pp. 67-119.

Martin, Bob, U.S. Environmental Protection Agency. 1997. Personal communication, May 13.

McAfee, R.O. 1984. Pensacola Bay Water Quality Monitoring Program Review and Assessment, June 30, 1983 to July 1, 1984. Pensacola: Escambia County Utilities Authority.

McGovern, James R. 1972. Volume I, Colonial Pensacola. Pensacola, Florida.

McGovern, James R. 1976. The Emergence of a City in the Modern South: Pensacola 1900-1945. E.O. Painter Printing Company.

McNulty, J.K., W.N. Lindall, Jr., and E.A. Anthony. 1972. "Cooperative Gulf of Mexico Estuarine Inventory and Study, Florida: Phase 1 Area Description." NOAA, Natl. Mar. Fish. Serv., Tech. Rep. CIRC-368, 126 pp.

Morang, Andrew. 1992. A Study of Geologic and Hydraulic Processes at East Pass, Destin, Florida: Volume I. Technical Report CERC-92-5. Vicksburg, U.S. Army Corps of Engineers, Waterways Experiment Station.

Morgan, J.P., and G.W. Stone. 1989. "Recommendations for the Dredging at the Mouth of Bayou Texar, Pensacola, Escambia County, Florida." Pensacola: University of West Florida.

Moshiri, G.A., R.P. Hannah, and G.C. Landry. 1972. "Determination of a Nitrogen-phosphorus Budget for Bayou Texar, Pensacola, Florida." University of Florida Water Resources Research Center Res. Ctr. Publ. No. 17.

Moshiri, G.A. et al. 1974. "Determination of a Nitrogen-Phosphorus Budget for Bayou Texar, Pensacola, Florida." University of Florida Water Resources Research Center Res. Ctr. Publ. 29, 86 pp.

Moshiri, G.A. 1976. "Interrelationships Between Certain Microorganisms and Some Aspects of Sediment-water Nutrient Exchange in Two Bayou Estuaries." Phases I and II. University of Florida Water Resources Research Center Res. Ctr. Publ. No. 37, 45 pp.

Moshiri, G.A. 1978. "Certain Mechanisms Affecting Water Column-to-Sediment Phosphate Exchange in a Bayou Estuary. " J. Water Pollut. Control Fed. 50(2):392-394.

Moshiri, G.A., W.G. Crumpton, and D.A. Blaylock. 1978. "Algal Metabolites and Fish Kills in a Bayou Estuary: An Alternative Explanation to the Low Dissolved Oxygen Controversy." J. Water Pollut. Control Fed. 50(8):2043-2046.

Moshiri, G.A., and W.G. Crumpton. 1978. "Some Aspects of Redox Trends in the Bottom Muds of a Mesotropic Bayou Estuary." Hydrobiologia 57(2):155-158.

Moshiri, G.A. et al. 1978. "Water-Column and Benthic Invertebrate and Plant Associations as Affected by the Physico-Chemical Aspects in a Mesotrophic Bayou Estuary, Pensacola, Florida." Gainesville: University of Florida, Water Resources Research Center. Res. Ctr. Publ. 41.

Moshiri, G.A., W.G. Crumpton, and N.G. Aumen. 1979. Dissolved Glucose in a Bayou Estuary, Possible Sources and Utilization by Bacteria. Hydrobiologia 62 (1): 71-74.

Moshiri, G.A., N.G. Aumen, and W.G. Swann, III. 1980. "Water Quality Studies in Santa Rosa Sound, Pensacola, Florida." Gulf Breeze: U.S. Environmental Protection Agency, Environmental Research Lab.

Moshiri, G.A. 1981. "Study of Selected Water Quality Parameters in Bayou Texar." Final Report on Contract No. DACW01-80-0252, University of West Florida.

Moy, Larry D., and Lisa A. Levin. 1991. "Are *Spartina* Marshes a Replaceable Resource? A Functional Approach to Evaluation of Marsh Creation Efforts." Estuaries 14, 1: 1-16.

Murdock, J.F. 1955. "An Evaluation of Pollution Conditions in the Lower Escambia River." Report No. 55-28 to Florida Board of Conservation by the Marine Laboratory, University of Miami, 7pp.

Musgrove, R.H., J.T. Barraclough, and R.G. Graham. 1965. "Water Resources of Escambia and Santa Rosa Counties, Florida." Tallahassee: Florida Geological Survey, Report of Investigations No. 40.

National Commission on Water Quality. 1976. "E.I.S., Water Quality Analysis, Escambia River and Bay." Tallahassee: Atlantic Scientific.

National Ocean Service. 1987. National Estuarine Inventory, Data Atlas, Volume 2. National Oceanic and Atmospheric Administration.

Nordlie, Frank G. 1990. "Rivers and Springs," in Ecosystems of Florida, Ronald L. Myers and John J. Ewel, eds. Orlando: University of Central Florida Press.

Northwest Florida Water Management District. 1978. "Evaluation of the Sedimentation and Hydraulic Characteristics of Bayou Texar and Carpenters Creek, Escambia County, Florida." Report to Office of Water Resource and Restoration, Division of Environmental Program, FDER.

Northwest Florida Water Management District. 1988. "Stormwater Evaluation for the Restoration of Bayou Texar." Water Resources Special Report 88-3.

Northwest Florida Water Management District. 1988. Surface Water Improvement and Management Program, Pensacola Bay System. Program Development Series 89-2 and Technical Appendix.

Northwest Florida Water Management District. 1990. "Pensacola Bay System Circulation Project Description." Florida Coastal Management Grant Application.

Northwest Florida Water Management District. 1993. Review of the Pensacola Bay System Nonpoint Source 208 Plan Methodologies. Northwest Florida Water Management District Program Development Series 93.2. Havana: Northwest Florida Water Management District.

Northwest Florida Water Management District. 1994. District Water Management Plan. Program Development Series 96-2. Havana: Northwest Florida Water Management District.

Office of Program Policy Analysis and Government Accountability. 1995. Review of the Implementation of the Surface Water Improvement and Management Program. Report No. 95-20. December 21, 1995. Tallahassee: OPPAGA.

Olinger, L.W., R.G. Rogers, P.L. Force, T.L. Todd, B.L. Mullings, F.T. Bisterfeld, and L.A. Wise II. 1975. Environmental and Recovery Studies of Escambia Bay and the Pensacola Bay System, Florida. Washington: U.S. Environmental Protection Agency.

Paulic, Mary, Joe Hand, and Linda Lord. 1996. Florida Water Quality Assessment, 1996 305 (b) Main Report. Florida Department of Environmental Protection, Tallahassee, 318 pp.

Pensacola Chamber of Commerce. 1927. "Industrial and Economic Survey of Pensacola, Florida."

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/440/4-89-001. Washington: U.S. EPA.

Pratt, Thomas R., Patricia G. Weiland, James H. Cason, Janet M. Starnes-Smith, W. Kenneth Jones, Duncan J. Cairns, and Lytha P. Simoneaux. 1990. The Pensacola Bay System Surface Water Improvement and Management Plan: A Comprehensive Plan for the Restoration and Preservation of the Pensacola Bay System. Program Development Series 91-2. Havana: Northwest Florida Water Management District.

Pratt, Thomas R., Paul F. McGinty, George Z. Guo, P.E., Walter C. Hunner, and Eric F. Songer. 1993. Stormwater Assessment of the Bayou Chico Watershed, Escambia County, Florida. Northwest Florida Water Management District Water Resources Special Report 93-7. Havana: Northwest Florida Water Management District.

Raney, D.C. 1980. "Study of Methodology for Evaluating Water-Quality Problems at Bayou Texar, Florida." University of Alabama, Bureau of Engineering Research, Report Number 263-112, 155 pp.

Reidenauer, J. and C. Shambaugh. 1986. "An Analysis of Estuarine Degradations Within the Pensacola Bay System and Their Relationship to Land Management Practices." Florida Department of Community Affairs, Draft, 132 pp.

Roaza, H. P. and Pratt, T. R. 1992. "Analysis of the Suitability of Existing STORET Data for Loading Rate Calculations in the Pensacola Bay System." Northwest Florida Water Management District Technical File Report 92-1.

Rogers, R. (Coordinator). 1988. "Draft EIS for Designation of a New Ocean Dredged Material Disposal Site, Pensacola, Florida." Atlanta: U.S. Environmental Protection Agency, Region IV.

Rogers, R.G., and F.T. Bisterfield. 1975. "Loss of Submerged Vegetation in the Pensacola Bay System, 1949-1974." In Proceedings of the Second Annual Conference on Restoration of Coastal Vegetation in Florida. R.R. Lewis (ed.), pp. 35-51.

Ross, L.T. and D.A. Jones (eds.). 1979. "Biological Aspects of Water Quality in Florida, Part 1: Escambia-Perdido, Choctawhatchee, Apalachicola, Aucilla-Ochlockonee-St. Marks, and Suwannee Drainage Basins." Florida Department of Environmental Regulation, Tech. Ser. 4(3).

Science Applications International Corporation. 1986. "Remote Sediment Profile Study of Pensacola Bay, Florida." No. SAIC-86/7500.99, Newport: Scientific Applications International Corporation.

Shuba, P.J. 1981. Pensacola Bay Nutrient Monitoring Study, 15 July 1981 to 13 October 1981. Research report submitted to Pensacola Public Utilities Department, Project Number A010.

Seal, T.L., F.D. Calder, G.M. Sloane, S.J. Schropp, and H.L. Windom. 1994. Florida Coastal Sediment Contaminants Atlas: A Summary of Coastal Sediment Quality Surveys. Tallahassee: Florida Department of Environmental Protection.

Smith, Jim, Florida Department of Environmental Protection. 1997. Personal communication, June 5.

Snowden, Cynthia and Duncan J. Cairns. 1993. Surface Water Improvement and Management Program Priority List for the Northwest Florida Water Management District. Havana: Northwest Florida Water Management District.

Stith, L., J. Barkuloo, and M.S. Brim. 1984. Fish and Wildlife Resource Inventory for Escambia Navigation Project Escambia and Santa Rosa Counties, Florida. Panama City: U.S. Fish and Wildlife Service.

Stone, G.W., and J.P. Morgan. 1989. "Recommendations for Extension of the Jetty at the Mouth of Bayou Texar, Pensacola, Escambia County, Florida." University of West Florida (Unpublished Report), 11 pp.

Stone, G. W. Morgan, J. P., Moshiri, G.A., and S. Elawad. 1990. "Physical, Biological and Environmental Studies of Bayou Texar Escambia County, Florida (Volume V of V. Rep-02: 12-32-90)." Pensacola: University of West Florida.

Stone, G. W. Morgan, J. P., Moshiri, G.A., and S. Elawad. 1990. “Conclusions and Recommendation for Environmental Quality Improvement in Bayou Texar (Project Report, 1988-1990).” Pensacola: University of West Florida.

Stone, G. W., White, D., Morgan, J. P., and Moshiri, G.A. 1991. “Sedimentation Rates and Macroinvertebrate Distribution in Bayou Texar Escambia County, Florida.” Pensacola:University of West Florida (Rep-02: 09-30-91).

Stone, G.W., and J.P. Morgan. 1991. “Heavy Metal Concentrations in Subsurface Sediments Bayou Chico, Pensacola, Florida (Rep-05: 12-02-91).” Pensacola: University of West Florida.

Stone, G.W., and J.P. Morgan. 1992. “Recent Sediment Flux and Bathymetric Changes in the Entrance Channel to Bayou Texar: Escambia County, Florida (Rep-02: 06-29-92).” Pensacola: University of West Florida.

Stone, G.W., and J.P. Morgan. 1993. “Sedimentation Rates and Geochemistry of Subsurface Sediments 12th. Avenue, Bayou Texar Pensacola, Florida (Rep-02: 09-15-93).” Pensacola: University of West Florida.

Summers, J.K., T.T. Polgar, J.A. Tar, K.A. Rose, D.G. Heimbuch, J. McCurley, R.A. Cummins, G.F. Johnson, D.T. Yetman, and G.T. DiNardo. 1985. “Reconstruction of Long-term Time Series for Commercial Fisheries Abundance and Estuarine Pollution Loadings.” Estuaries. 8(2A):114-124.

The Nature Conservancy, 1995. “Research Report: Eglin Air Force Base, Florida 1995.” A Compilation of Inventory, Monitoring and Research Conducted in Support of Ecosystem Management.

Thompson, R.L., Florida Department of Environmental Protection. 1996. Memorandum of January 30.

Twachtmann, Dale, Florida Department of Environmental Protection. 1990. Letter of April 30.

U.S. Army Corps of Engineers. 1977. “Draft Report on Water Pollution in Bayou Chico.” Mobile: Mobile District.

U.S. Army Corps of Engineers. 1980. Water Resources Study: Escambia-Yellow Rivers Basins. Mobile: Mobile District.

U.S. Department of Agriculture. 1996. Http://www.nhq.nrcs.usda.gov/OPA/FB96OPA/OviewFB.html.

U.S. Department of the Interior. 1970. “Effects of Pollution on Water Quality: Escambia River and Bay, Florida.” Athens: Federal Water Pollution Control Administration, Southeast Water Laboratory, Technical Services Program.

U.S. Department of the Interior. 1988. “Statement for Management, Gulf Islands National Seashore.”

U.S. Department of the Navy. 1986. “Draft Environmental Impact Statement: U.S. Navy Gulf Coast Strategic Homeporting, Appendix IV. “ Pensacola, Florida. Southern Div., Naval Facilities Eng. Command, Charleston, South Carolina.

U.S. Environmental Protection Agency. 1971. “Circulation and Benthic Characterization Studies Escambia Bay, Florida.” Athens: Federal Water Pollution Control Administration.

U.S. Environmental Protection Agency. 1972. Proceedings of the Conference - Pollution of the Interstate Waters of the Escambia River Basin (Alabama - Florida) and the Interstate Portions of the Escambia Basin within the State of Florida; Third Session, Jan. 24-26. Gulf Breeze: U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1983. "Chesapeake Bay Program: Findings and Recommendations."

U.S. Environmental Protection Agency. **Ongoing**. Tiger Point Golf Course Impacts Assessment. Gulf Breeze Project Office.

U.S. Geological Survey, U.S. Department of the Interior Minerals Management Service, and U.S. Environmental Protection Agency. **Ongoing**. Northeastern Gulf of Mexico Coastal and Marine Ecosystem Program: Coastal Characterization.

U.S. Public Health Service. 1962. "Proceedings of the Conference on the Interstate Pollution of the Conecuh - Escambia River." USDHEW, Pensacola, Florida.

White, D.W., Stone, G. W., Morgan, J. P., and Moshiri, G. A. 1993. "Relationship of Benthic Invertebrates to Sedimentation Within the Vicinity of Two Stormwater Outfalls in Bayou Texar Escambia County, Florida (Rep-01: 03-05-93)." Pensacola: University of West Florida.

Wiley, Debi, Patricia Weiland, and Duncan J. Cairns. 1990. Point Source Assessment of the Pensacola Bay System. Water Resources Special Report 90-5. Havana: Northwest Florida Water Management District.

Williams, J.D., M.L. Warren, K.S. Cummings, J.L. Harris, and R.J. Neves. 1992. "Conservation Status of Freshwater Mussels of the United States and Canada." Fisheries 18, 9.

Windsor, J.G., Jr. 1985. "Nationwide Review of Oxygen Depletion and Eutrophication in Estuarine and Coastal Waters: Florida Region." Department of Oceanography and Ocean Engineering. Florida Institute of Technology.

Wolfe, Steven H., Jeffrey A. Reidenauer, and D. Bruce Means. 1988. An Ecological Characterization of the Florida Panhandle. Washington: U.S. Fish and Wildlife Svc. Biological Report 88 (12), and Minerals Management Svc. OCS Study/MMS 88-0063.

Wood, Don A. 1996. Florida's Endangered Species, Threatened Species, and Species of Special Concern. Tallahassee: Florida Game and Fresh Water Fish Commission, Division of Wildlife.

Wood, Kimberly and Ronald L. Bartel, 1994. "Bayou Chico Sediment and Water Quality Data Report, Escambia County, Florida." Technical File Report 94-3.

Young, W.T. 1981. "A Biological and Water Quality Survey of Blackwater, Yellow, and Shoal Rivers and Tributaries, and East Bay Estuaries." Tallahassee: Florida Department of Environmental Regulation.

Young, W.T. 1985. "Pensacola Mainstreet Sewage Treatment Plant Discharge Impact Assessment Survey." Pensacola: Florida Department of Environmental Regulation.