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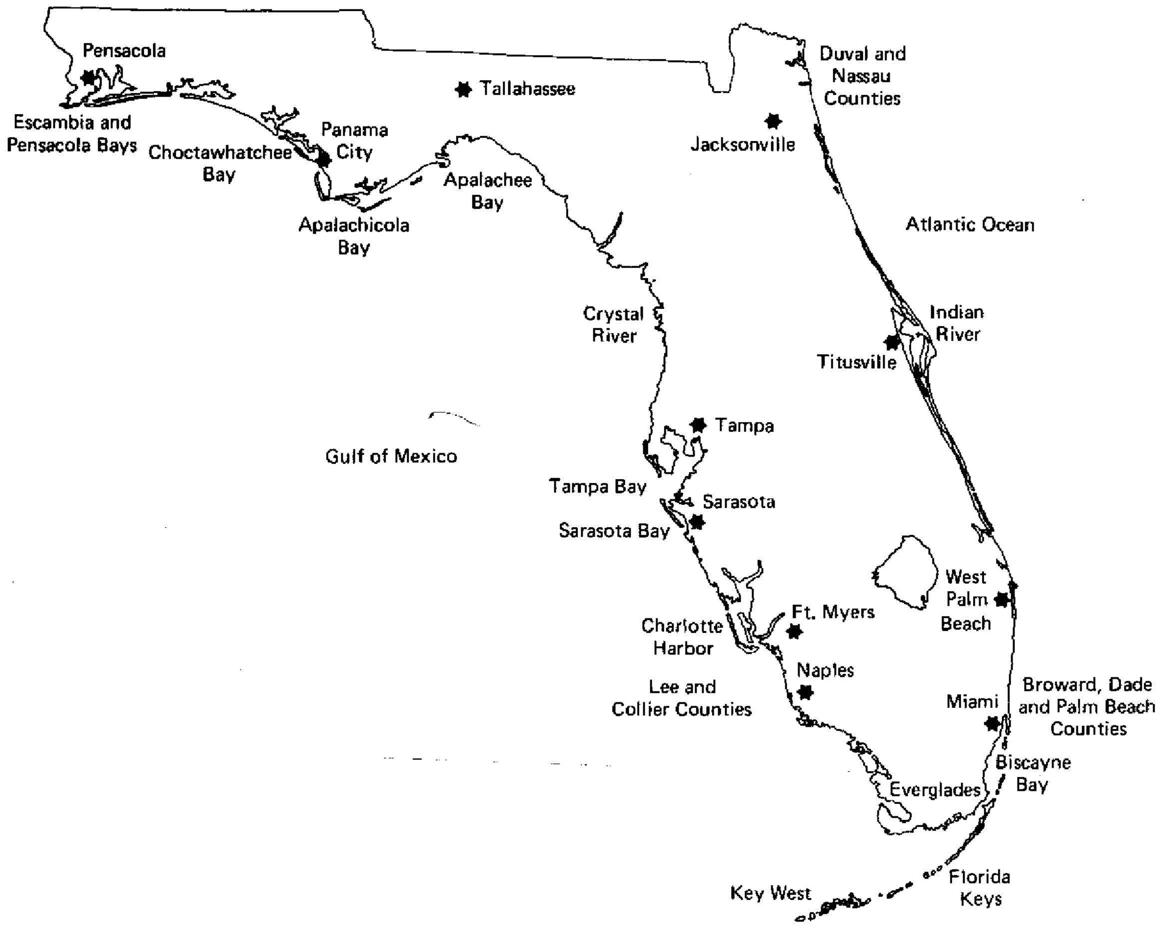
CONTAMINANTS IN FLORIDA'S COASTAL ZONE



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FLORIDA SEA GRANT COLLEGE PROGRAM July 1984

CONTAMINANTS IN FLORIDA'S COASTAL ZONE: A REVIEW OF PRESENT KNOWLEDGE AND PROPOSED RESEARCH STRATEGIES

A Summary of a Workshop
Held April 5-6, 1984
in Gainesville, Florida
and
a Literature Review

Jointly sponsored by:

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by

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INTRODUCTION

Concern for the presence of chemical contaminants in the environment has been evident for several years. This concern recently extended to the State of Florida in the form of increasing awareness of groundwater contamination from agricultural and industrial chemicals. However, Florida's coastal zone waters have not received the same level of interest as have its fresh water resources. Since Floridians use groundwater predominantly for drinking water, it is clear why these waters have received more attention. However, Florida's coastal water environment is the home of many fish and shellfish species that are the center of considerable commercial and sport fishing activities while many coastal lands are among the most valuable in the State. The quality of coastal waters certainly affects the value of the fisheries and also the value of coastal properties.

For the purposes of legal definition, the coastal zone of Florida includes the entire state, due to its low land elevation, high water table, extensive shoreline and many rivers. However, of most interest here is the seaward boundary, which extends three nautical miles into the Atlantic Ocean and three marine leagues into the Gulf of Mexico (Guy, 1983). It is this aquatic area that is the focus of this report.

Many factors can affect the quality of Florida's coastal waters (this includes the water itself, fish, shellfish and other biota, and sediments). Among these are the transport of contaminants from rivers to their coastal estuaries, the movement of pesticides from target areas to coastal waters, the direct discharge of effluents to coastal waters, and dredging of coastal channels and ports and the release of petroleum hydrocarbons from drilling activities, tankers, and urban runoff.

The distribution and fate of these contaminants have been studied by various individuals and groups, generally on a project by project basis, depending on the source of funds and other resources available to the researcher(s). A variety of state agencies have responsibilities for various facets of the coastal zone but no one Florida agency has overall authority for the coastal zone itself. The agency activities are coordinated but not controlled by an Interagency Management Committee. It appears that the issues of special focus have involved obtaining federal grants for disaster preparedness, hazard mitigation, dredging programs, fisheries management, and aquatic preserves (Belsky and Gaster, 1984). Yet, unless any of the existing program interests specifically involve contaminants, the central issue of coastal contamination generally is left to each agency's diverse regulatory programs. Thus, while the federal government's National Oceanic and Atmospheric Administration (NOAA) is making a concerted effort to assess the status of contamination in the nation's coastal waters as a whole, no similar organized effort is apparent at the state level.

Given the current interest in contaminants in Florida's fresh waters, the Florida Sea Grant Program was approached with the proposal to assess the status of contaminants in Florida's coastal waters. The proposal was funded for a six-month period from January 1 through June 30, 1984. Though this was not a significant amount of time, it was felt that a reasonable start could be made toward identifying the major contamination-related issues involving the coastal zone and then establishing a series of recommendations that would address any problems that were identified.

This project had two main objectives. The first was to hold a Workshop which would serve as an open forum to discuss coastal contamination issues based on the knowledge of the attendees and then to provide a series of recommendations that would serve as a basis for future activity. The second objective was to perform a literature review to compile as many references as possible that relate to coastal contamination in Florida and to summarize the literature in an overview fashion. The information gathered while meeting these two objectives was to be combined and incorporated into a final project report.

This document represents the combination of the Workshop Proceedings and the literature review.

THE WORKSHOP

One of the project objectives was to hold a Workshop with the following goals: to review pertinent background information on contaminants in Florida's coastal zone; to obtain input from leaders in the scientific, regulatory, commercial and environmental oranizations in Florida, the southeastern US, and the nation; to identify key issues affecting contamination of the coastal zone; and to develop recommendations to address these issues.

Approximately 200 individuals were invited to attend the Workshop which was held on the University of Florida campus in Gainesville, Florida, on April 5-6, 1984. A number of the invitees were able to attend and participate and their names appear in Appendix A. At the outset, the Workshop was designed to be informal to stimulate discussion and interaction. Interest groups (workgroups) were formed under the major themes of Policy, Biology and Ecosystems, and Chemistry. Attendees were encouraged to participate in one of the interest groups during the first day and then to join another workgroup for the second day. This approach was intended to foster an interdisciplinary exchange of ideas. The Workshop Agenda appears in Appendix B.

The Workshop was convened and attendees were welcomed by the Dean of the University of Florida College of Engineering (Dr. Wayne Chen) who stressed various state-of-the-art advances that are being made as a result of engineering research in Florida. He emphasized that much of the progress involved improved productivity in manufacturing processes as well as new materials designed to be used in medical applications. Dr. James Cato, Director of the Florida Sea Grant Program, outlined Sea Grant's role in studying Florida's marine resources and the various programs that involve research and advisory services. He reviewed the budgetary situation and discussed a variety of Sea Grant projects that have related to the goals of the Workshop.

The general organization of the Workshop was discussed by Dr. Joseph J. Delfino, the principal investigator for this project. Key points that were made involved funding patterns for basic and applied research in recent federal budgets, and a conceptual design of the desired outcome of the Workshop discussions. Attendees were provided with a set of topics which could form the basis of workgroup discussions. In summary, the Workshop attendees were encouraged to think freely and widely to develop a set of issues and recommendations that might lead to new research initiatives in the future.

After the welcoming remarks, overviews of the problems of coastal contamination were provided by six invited speakers. Summaries of their overview presentations appear in the next section. Upon conclusion of those presentations, the workgroup concept was explained and attendees were allowed to select the workgroup of their choice. These workgroups reviewed information appropriate to their major interests and then established an agenda of main issues that would be discussed in detail. A preliminary set of recommendations emerged at the beginning of the second day of the Workshop. These recommendations were refined after attendees joined different workgroups and brought other insights to the topic areas. At the conclusion of the second day, a revised set of recommendations was discussed, initially within each workgroup, and then by the entire group of Workshop attendees. A summary of the issues discussed and the recommendations provided by each workgroup appears in this report following the overview presentations.

The Workshop approach to the topic of contamination in Florida's coastal zone was reasonably successful in its attempt to define issues and develop recommendations. The ultimate test of the success of this effort, though, will be the implementation of the recommendations. The Workshop attendees, individually, do not have the authority to mandate that the recommendations be implemented. Rather, the dissemination of this report by Florida Sea Grant to all Florida agencies with interests and responsibilities for coastal zone matters may serve as a stimulus for those agencies, separately, or as part of the Interagency Management Committee, to address the issues and to consider the merits of the recommendations. If this follow-up activity occurs, then the time and effort involved in the Workshop will have been worthwhile.

The next sections of this report represent summaries of the activities of the Workshop. Included are edited notes taken during the overview presentations as well as annotated transcriptions of the workgroup discussions.

OVERVIEW PRESENTATIONS

As a prelude to the Workgroup discussions, five speakers delivered overview presentations to the assembled group of Workshop attendees. The speakers and topics were selected to provide the audience with a range of perspectives and experiences to set the tone and provide a framework for the discussions to follow. The text that follows represents a summary of the presentations, excerpts from materials which the speakers provided or authored, and certain selected references added by the project staff to incorporate some related and pertinent material.

GULF OF MEXICO STRATEGIC ASSESSMENT PROJECT

Speaker: C. John Klein, Strategic Assessment Branch, Office of Oceanography and Marine Services, National Oceanic and Atmospheric Administration, Rockville, Maryland 20852

The Strategic Assessment Branch in NOAA has the mission to conduct assessments of multiple ocean resource uses for the United States and to determine marine resource development strategies. The goal is to derive maximum benefits while insuring minimum environmental damage and conflicts among uses.

This goal is approached by the Strategic Assessment Branch (SAB) through evaluations of existing and projected ocean resource demands by integrating levels of use, resource availability, pollution discharges, possible environmental impacts, and use conflicts. The SAB has developed and maintained computerized inventories of coastal and marine resources, and has focused on the major estuaries of the United States coastal zone. Strategic assessment regions have been established according to geographical areas and include the east coast (northeast and southeast), Gulf of Mexico, west coast and Alaskan coastlines. The assessment performed along the Gulf of Mexico coastline was presented at the Workshop.

The Gulf of Mexico project was initiated in October 1980. The entire Gulf of Mexico is under study, including both the coastal and deeper waters of the United States and Mexico (NOAA, 1983a). The U.S. study area incorporates all coastal counties, all areas defined by individual coastal states as their "coastal zone," and the area of the coastal plain defined by the 100-meter contour on land.

The data being gathered will be used to identify areas which should receive further, more detailed study. These studies will emphasize special ecological conditions, the interrelationship of water quality with development and pollution control strategies, and possible spatial relationships between existing water quality and special biologically important areas (e.g., spawning and nursery areas).

The Gulf of Mexico is a substantial "semi-closed" sea with a surface area of about 0.62 million square miles. The major salt water input is from the Caribbean Sea with its outflow through the Straits of Florida to the Atlantic Ocean. The Mississippi River dominates the freshwater influence on the Gulf and it has an average discharge at its mouth of over 640,000 cubic feet per sec. The Mississippi River has been estimated to be the major source of organic and inorganic pollutants entering the Gulf since it drains over 1.25 million square miles of the United States, where uncounted sources of industrial, municipal and agricultural pollutants originate.

Several hundred estuaries exist along the Gulf Coast, spread over 15 thousand miles of shoreline. The Gulf of Mexico is a vital source of U.S. commercial fisheries production, including both fishes and invertebrates. Besides this important biological function, the Gulf is also a critical resource for oil and gas. Not only are significant quantities of these resources extracted from beneath the waters of the Gulf but also tanker traffic, pipelines and petrochemical refining are features of Gulf Coast activity.

It is obvious that there are many potential sources of contamination and the Gulf's biological resources must be carefully assessed to develop a baseline against which future observations can be measured.

The baseline data will be incorporated into a master Gulf of Mexico Data Base and a series of more than 100 maps will be provided in the form of a Gulf of Mexico Data Atlas. Among the categories to be included in the data base are the physical environment (bathymetry, reefs, seasonal currents, temperatures, winds, etc.), living environments (wetlands, grasses, algae), biological species (40 fishes, 15 invertebrates, mammals, reptiles), economic activities (onshore population, refineries, wastewater treatment plants, offshore oil and gas activities, spills, pollutant discharges, etc.) and jurisdictions (political boundaries, protected areas, etc.).

A number of key studies were necessary to provide input to the data base and maps including the following. Life history data for various marine species in the Gulf of Mexico were gathered, based on the commercial or recreational importance, threatened or endangered status, or their particular ecological significance. The data were gathered primarily from existing information rather than newly designed studies.

A National Ocean Coastal County Pollution Discharge Inventory was compiled for several pollutant categories (BOD, nitrogen, phosphorus, fecal coliforms, petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals). Sources inventoried included industrial, commercial, municipal as well as agricultural and other non-point categories.

A third project estimated both operational and accidental discharges of oil from ships in the Gulf of Mexico. This information was integrated with data from known oil seeps in the Gulf, blow-outs, and spills.

In addition to the compilation of the data bases and generation of the maps in the Atlas, various analyses will be completed. A qualitative or descriptive analysis will review species life histories and provide an understanding of spatial relationships, habitats, etc. A number of grid cells have been established in the Gulf to aid in the analyses. These analyses can be used for predictive efforts related to oil and gas leases, deepwater ports, oil spill contingency plans and identifying areas of needed data and additional research priorities.

On the quantitative level, a pollutant trajectory analysis and predicted water quality status will be made. A model is being developed to compute concentrations of various pollutants in the Gulf, based on pollutant discharge estimates from both onshore and offshore sources. The model will assume steady state conditions and be applied for winter and summer season conditions.

Finally, a synthesis of the qualitative and quantitative analyses will be attempted to estimate the possible risks faced by the biological resources of the Gulf to current and possible future activities. This synthesis will overlay the life history information with the pollutant discharge and transport data and will try to identify potential problem areas.

Of additional interest will be a focused effort on the Gulf Coast estuaries as part of a national estuarine data base development (NOAA, 1983b). NOAA will seek to determine which estuaries are seriously stressed, identify resource use conflicts, assess the role of individual estuaries on the distribution of marine species, predict impacts from policies on waste management, economic development and resource uses and finally, to locate information gaps and identify new areas of research. Given the perceived central role of estuaries in the life history of many marine species in Florida's waters, the results of the estuarine study will be eagerly awaited.

Examples of the Florida Gulf Coast estuaries to be included in the data base development include: Big Lostmans Bay and River; Charlotte Harbor and Peace and Myakka Rivers; Sarasota Bay; Tampa, Old Tampa, Hillsborough Bays; Suwannee Sound and River; Apalachicola Bay and River, and East Bay; and Pensacola, East and Escambia Bays.

OIL POLLUTION STUDIES IN THE EASTERN GULF OF MEXICO AND WEST FLORIDA COASTAL WATERS

Speaker: Edward S. Van Vleet, Department of Marine Science,
University of South Florida, St. Petersburg, Florida 33701

Perhaps the most visible contaminant insult to the coastal and marine environment comes from petroleum hydrocarbons, especially the higher molecular weight components commonly referred to as pelagic tar. Grim reminders of oil spills, drilling platform blowouts, tanker accidents and intentional dumps of bilge wastes appear as widespread surface slicks, shell and sand encrusted tar balls on beaches and, at the extreme, oil fouled birds and marine life.

In recent years, concerns have arisen along the Gulf of Mexico coastline over the increased incidents involving oil spills. Of recent note were the IXTOC-1 drilling blowout in the Bay of Campeche and the collision and subsequent spillage of major amounts of oil from a tanker near Galveston, Texas (Van Vleet et al., 1981 and 1983a). The State of Florida has a strong interest in the integrity of its Gulf coast shoreline, its beaches and marine life. In response to the petroleum hydrocarbon incidents, the State contracted with the Department of Marine Sciences at the University of South Florida (USF) in St. Petersburg to investigate the status of the oil pollution problem and the potential threat to Florida's coastal waters.

Various groups, including federal and state agencies, contract consulting organizations along with the USF participated in a large program to develop physical and chemical data to assess the magnitude of the problem. Physical oceanographic studies looked intensively at the general circulation in the Gulf of Mexico and identified large scale circulation patterns in the western regions of the Gulf. These studies also detailed the so-called Loop Current which enters the Gulf from the south through the Yucatan Straits and subsequently exits through the

Straits of Florida where it joins the Gulf Stream in the North Atlantic Ocean.

Transect cruises were established from Florida's west coast into the Gulf of Mexico's eastern area, including one transect designed to intercept the Loop Current. Remote sensing data from a NOAA satellite supplemented shipboard data as a means of locating the Loop Current. Neuston nets were used to sample pelagic tar and were deployed to collect both surface and mid-water floating and suspended tar. Specialized analytical approaches were used to recover the tar and to prepare samples for laboratory analyses (Van Vleet et al., 1981 and 1983a).

Pelagic tar found in the eastern Gulf of Mexico was found to be associated with the Loop Current while relatively little pelagic tar was found on the west Florida continental shelf. It seems that the distribution of pelagic tar in the eastern Gulf is very patchy. However, since petroleum can "weather" or fractionate into different molecular weight components depending on exposure time, a variety of tests were applied to try to assess the origin and fate of the material retrieved during the net tows.

From the Florida perspective, it appeared that the west Florida continental shelf area that was sampled during the USF study was relatively unspoiled in terms of floating tar contamination. The USF group cautioned, though, that localized oil and tar related problems could, and would, most likely occur in bays as a result of runoff, boating activities and spills. In the open waters, pelagic tar observations are skewed by meterologic events, where seasonal high winds and heavy seas mix surface tar materials to deeper waters, effectively leading to lower concentrations in retrieved samples.

The USF group observed that while no significant quantities of the IXTOC-1 oil have impacted Florida's coastal areas, there seems to be a background of pelagic tar materials similar to the IXTOC-1 residues which are present in the Gulf and are supplemented with higher amounts of oil from other sources. While these other sources have not yet been confirmed, possibilities include drainage from the Mississippi River, natural seepage, and the more plausible explanation related to tanker and shipping activities. The latter's accidental and intentional discharges of oil contribute to the pelagic tar burden of the eastern Gulf of Mexico. Also awaiting further work and confirmation is the contribution of pelagic tar material from the Caribbean Sea via the Yucatan Channel, since this source would also contribute to the pelagic tar levels in the Loop Current.

Petroleum hydrocarbon inputs to Florida's coastal waters and bays can originate from sources far less spectacular than well drilling blowouts or tanker accidents. Of particular interest and concern are oil pollutant sources such as urban runoff which is related to automotive use of petroleum, and also treatment plant discharges. The Tampa Bay area was the site of a study aimed at assessing the significance and impact of these types of inputs (Van Vleet and Reinhardt, 1983).

A number of sampling stations were established in the greater Tampa Bay area, including sites in Tampa Bay proper as well as in Old Tampa Bay and Hillsborough Bay. Effluents, runoff waters, sediments and biota were collected and analyzed for hydrocarbons.

The literature had indicated that wastewater treatment plants can be responsible for large fractions of the total hydrocarbon loading to coastal areas and it appears that most of this material is combined with particulate matter and is deposited on the sediments. Thus, benthic organisms and their predators could be at risk if the loading was substantially higher than the natural processes which would ultimately degrade the contaminants.

However, the study found that wastewater treatment plant effluents contributed very little, if any, of total hydrocarbons to the Tampa Bay area waters. Even the raw wastewater influent to the treatment plants contained very low levels of hydrocarbons when compared to data from treatment plants elsewhere in the

United States. One explanation was the possible degradation of the hydrocarbons within the municipal sewer systems, while the materials were enroute to the treatment plant. Higher temperatures could have stimulted microbial degradation of the hydrocarbons, leading to a more efficient and effective removal of the material. Even waters collected from storm sewer drains contained relatively low concentrations of hydrocarbons.

Hydrocarbon levels in sediments in the study area were variable but could not be ascribed to any specific source. The benthic organisms sampled and analyzed showed only a small amount of petroleum hydrocarbon bodyburden present although geographic areas seemed to influence the hydrocarbon levels in different individuals of the same species. Proximity to wastewater treatment plants had no apparent influence on the hydrocarbon concentrations in benthic organism tissues.

Summarizing, it appeared that enhanced microbial metabolism in the subtropical environment typified by the Tampa Bay area resulted in significant degradation of hydrocarbons, either as part of wastewater treatment plant operations or natural processes operating in receiving waters.

STRATEGY OF POLLUTANT ASSESSMENT IN COASTAL WATERS: THE MISSISSIPPI SOUND STUDY

Speakers: Julia S. Lytle and Thomas F. Lytle, Gulf Coast Research Laboratory, Ocean Springs, Mississippi 39564

Mississippi Sound is a narrow body of water extending along the Mississippi coast from Lake Borgne to Mobile Bay. Though historically a valuable fishery nursery area, the Sound has also become the site of industrial complexes that now dominate the economy of South Mississippi. Since the impact of industrial and municipal pollutants on the coastal estuaries of Mississippi was virtually unknown, the Mississippi-Alabama Sea Grant Program funded a four year study, begun in 1979, to describe pollutant distribution, investigate pollutant transport processes and to develop land use guidelines.

Sampling and analysis efforts were devoted primarily to sediments collected throughout Mississippi Sound. The sediments were the focal point of the study since they preserve an integrated record of past pollution events and because the most serious pollutants (organics, metals) tend to accumulate in the sediments soon after they are discharged into the water (Lytle and Lytle, 1982). Surface sediment samples (37) and sediment cores (45) were collected over a three year period. Sediment sampling was concentrated in the Pascagoula River and Biloxi Bay where residential and commercial development is most intense.

The predominance of organic wastes in industrial effluents emptying into Mississippi Sound waters directed the analysis program to concentrate on organic pollutants. Sediment cores (10 foot sections) were sectioned and all core segments, as well as surface sediment grab samples, were analyzed for hydrocarbons, total organic carbon (TOC), total Kjeldahl nitrogen (TKN), phenols and grain size. Geological descriptions were recorded to allow correlation between chemical and geological characteristics in the cores.

The TOC values showed high pollution levels in the eastern portion of the Sound, particularly in the Escatawpa River where TOC was found to be 20 to 40 times greater than background values, and were as high as 25% of the sediment weight. The TKN values showed maxima of only a few tenths of one percent in areas of the Sound near fish processing plants and other likely contributors of nitrogenous wastes. Phenols were observed at highest levels in the eastern Sound near industrial sources, but the values at most of the sampling sites were less than one part per million (ppm).

Hydrocarbons were the most significant of the pollutants found in the sediments of Mississippi Sound. Concentrations found in Bayou Casotte and other regions in the eastern Sound were as high as 13 mg/g and were in the range of 100 to 1,000 times the background values found elsewhere in the general area. Given the complexity of the organics, gas chromatography had to be coupled with mass spectrometry in many instances to insure unequivocal identification of compounds. Analyses revealed three principal sources of pollutant hydrocarbons in these sediments: petroleum associated with an oil refinery, fuel oil and sewage. Land runoff apparently also contributed some of the pollutants. Of particular concern was the presence of significant levels of polynuclear aromatic hydrocarbons in many of the sediment samples.

The movement of pollutants in the general study area was investigated in detail using chemical tracers. One effort involved the use of paper mill waste products to trace the movement of organic pollutants generated at several sites near a paper mill on the Escatawpa River (Lytle and Lytle, 1982). Lignin compounds normally present in sediments of these coastal estuaries result from terrestrial plant residues that contain approximately equal amounts of vanillyl- and syringyl-lignins. If ratios are found that favor the vanillyl-lignin, the input of paper mill wastes is indicated.

Results of this study showed that the only sediments which were significantly enriched in the vanillyl-lignins were those in the immedite vicinity of the paper mill. As one moves from the mill area on the Escatawpa River to the East Pascagoula River, and then into the Sound, the ratios of the two major lignin classes indicate predominantly a terrestrial or natural origin of these materials. Thus, the research effort confirmed that organic pollutants in this area are transported only very short distances from their source. The sediment organic distribution data provide a description which indicates highly localized areas of contamination existing within the rivers and bays of the Mississippi Sound region while there are much larger areas that have relatively little pollution from hydrocarbons.

The distribution of the organic contaminants also appears directly related to the clay content in the sediments. Almost without exception, significant levels of pollutants that were found in the different sediment samples from Mississippi Sound were accompanied by an enriched clay content in the sediments (Lytle and Lytle, 1983). Those areas of the Sound that had relatively high sand and low clay contents generally showed low pollutant levels. Using distributional studies and comparing the patterns of enriched organic levels with clay contents, the western area of Mississippi Sound appears to be the major accumulation site of most of the pollutant residues that are transported into the Sound.

Given the distribution of the pollutants in the sediments, a logical question arose as to the significance of these pollutants, particularly with respect to toxicity. Thus, three-phase toxicity bioassay studies were performed using surface sediment samples. The organisms that were exposed to various sediment-water mixtures were mysid shrimp, sheepshead minnows and amphipods. The object of these studies was to determine what type of sediment-water disturbance might result in toxicity to the organisms tested. Significant mortalities from bioassay exposures were found with sediments from some regions of the Sound. These toxicities, combined with determinations of sediment settling rates, leachability of contaminants, vulnerability of the biological community structure and the probability of sediment disturbance were given numerical ratings and combined into an "environmental stress index."

Environmental stress indices were graphically displayed by sediment sample location in the Sound and areas of concern were identified. A few locations were shown to be "trouble-spots" based on the cumulative weight of the factors that are considered for the index. The environmental stress index can be used by regulatory agency personnel and land use planners to direct development of the land in a way that is most environmentally compatible. After seeing its usefulness in Mississippi Sound, the environmental stress index has the potential for application in other coastal areas of the U.S. where a sufficient data base exists.

COASTAL ZONE MANAGEMENT: UPDATE AND PROJECTS

Speaker: Chris L. Beditz, Office of Coastal Management, Florida Department of Environmental Regulation, Tallahassee, Florida 32301

In 1972 Congress passed the Coastal Zone Management Act in response to the intense pressures on the coastal areas of the United States. The Act was substantially amended in 1976 and again in 1980. It is again up for review by Congress in 1985. The Act and its amendments affirm a national interest in the protection and careful development of the coastal zone by providing assistance and encouragement to coastal states to develop and implement management programs for their coastal areas.

During this past decade the State of Florida also recognized the need for resource management, particularly within the coastal zone. The state Legislature created the Coastal Coordinating Council in 1970, which began development of a coastal management program. In 1975 the Legislature abolished this Council and transferred its duties and functions to the Department of Natural Resources. Legislation in 1977 transferred the program to the Department of Environmental Regulation (DER), where it is presently located.

In 1978, the Legislature renewed its commitment to coastal zone management with passage of the Florida Coastal Management Act and, following federal approval of Florida's coastal management program, the state received grants under the Federal Coastal Zone Management Act for program development. This act specifically directed Florida's coastal zone management program be structured around the coodination and implementation of existing statutes. To accomplish this goal, Governor Graham and the Cabinet formed the Interagency Management Committee (IMC) in 1980.

The Interagency Management Committee is comprised of the chief executives of the ten state agencies with coastal management responsibilities. The IMC is the key element to an effective coastal management program in Florida. Because the program is based on existing laws and regulations, which are administered by numerous state agencies, coordination between and among these state agencies is essential to the success of the program. Due to the diversity and complexity of coastal zone issues, they cannot be addressed by any single agency; the IMC provides the organization and guidance needed to prevent a fragmented approach to coastal zone management.

Florida's Coastal Management Program is built around ten primary issues which provide a focus for the future direction of the program. The ten issues are identified within three broad areas: resource protection, coastal development, and coastal storms. Examples of projects supported by DER through federal implementation funds which address coastal issues are discussed below.

Suwannee River Water Management District. Funding has been provided to the District to supplement monitoring programs aimed at determining ambient water quality and defining significant degradation for the Suwannee River. The research should improve the regulatory capabilities by determining the cause and extent of water quality problems and establishing a baseline for pollutant discharge regulations.

Florida State University. Using the existing data base that has been compiled over the last ten years, the University is analyzing the impact of dredging in Apalachicola Bay on key water quality factors and biological parameters. The results of this analysis may result in specific rules regarding dredging in the bay.

Manatee County Utilities Department. This study involves establishing a comprehensive data base to analyze the water release practices at the Lake Manatee Reservoir. The results of the study will enhance both an upstream consumptive use study and a wasteload allocation study being conducted downstream.

Palm Beach Area Planning Board. Funding was provided to conduct a comparative water quality baseline study of Lake Worth to determine the changing conditions of the lake over the past ten years. The data may identify possible "cause and effect" relationships which can provide a basis for the development of an environmental management program for Lake Worth.

Northwest Florida Water Management District. This study involves an ongoing effort to develop a managemment program for Choctawhatchee Bay. The scope of this study includes an inventory and assessment of seagrass and oyster beds, a fish population inventory, collection of groundwater quality and inflow data, and the assessment of sediment contributions to the Bay.

One of the major projects dealing with water quality is referred to by DER as "the Ports project." In 1981, the Florida Legislature passed a law which contained two major provisions affecting coastal management. The law gave DER the authority to develop separate water quality criteria and standards for the eleven deepwater ports, and it directed the department to establish a permit system for issuing 25 year maintenance dredging permits. Under this same legislation, a state funded spoil site acquisition and improvement program is to be established.

To address the legislative objectives, DER conducted a phased project at several deepwater ports to implement two major areas of the law: (1) to assess water quality, sediments and other conditions in the ports and navigational systems; the analysis of this information is expected to lead to rule changes, improvements in regulatory criteria, and long-term maintenance dredging permits; (2) to evaluate disposal sites proposed by the ports, and the ability of each site to meet regulatory requirements; this involves assessing the compatibility of sites in terms of long-term dredging and disposal permits.

Specific project requirements were contracted to outside organizations. These included acquisition of water quality and sediment information; assistance in translating the data results into rules and draft permits; and determining the engineering feasibility of disposal sites.

Initially, the project examined the need for developing separate water quality standards for ports; it was assumed that the ports were more polluted and required different standards. However, after extensive water quality tests, it was determined that the existing water quality standards were being maintained and changes in standards were not necessary. The sediment analyses did indicate that the quality of sediment to be dredged is of utmost importance in understanding potential water quality impacts from maintenance dredging operations. Thus, standards for sediment quality had to be developed, since none existed at the time.

During these investigations a need was identified for establishing a permit process which recognizes that port maintenance dredging is an ongoing operational necessity. Regulations in existence prior to these studies treated maintenance dredging in a manner similar to new construction "dredge and fill" projects. The final rule which was adopted approaches the regulation of deepwater port maintenance dredging through an operational type permit rather than a construction type permit.

The new rule, adopted in February, 1984, also fulfills several other needs. It allows for consideration of port-specific circumstances and conditions without sacrificing environmental protection. It incorporates all major applicable provisions of existing rules into one easily understood format. Finally, the rule addresses the issue of providing reasonable assurance that state water quality standards will not be violated by establishing a two phase permitting process. Phase I begins on the basis of existing data and the proposed actions which are provided by the applicant. During this phase, testing and other investigations are carried out to confirm assumptions and the effectiveness of prescribed management practices. This phase also provides for the development of a long-term, port-wide dredged material management plan. Confirmation and completion of these activities allow for entry into Phase II and continuation of the permit for up to 25 years.

The success of these somewhat radical departures from traditional permitting approaches depends upon how vigorously eligible applicants apply the long-term solutions. Presently, though, the Florida Coastal Management Program is struggling for funding. The Office of Coastal Management is hopeful to receive general revenue funding from the 1984 Florida legislative session. The office is also in the process of submitting a grant proposal to the National Oceanic and Atmospheric Administration for additional program implementation funding. The coastal management program plays a critical role in ensuring that sound environmental information is transferred into responsive regulations and environmental management systems. Continued funding and joint efforts from all programs at the state level are necessary to solve Florida's complex coastal problems.

TRACE METAL CHEMISTRY IN MARINE WATERS

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The concentration and fate of metals in the coastal marine environment has received considerable study near many industrialized areas but somewhat less effort has been devoted to the topic in Florida.

One of the main considerations in studying trace metals in sea water is analytical methodology. For example, there has been much interest in the concentration of lead in the oceans during this century. By examining the historical record, one finds that the reported concentration of lead has changed during the past 50 years from about 8,000 ng/L to somewhere between 1-10 ng/L. Why has this occurred? Principally, the change in the data has been due to improvements in analytical methodology. Also, as the years have progressed, more care has been taken in avoiding contamination, both in the field sampling process and in laboratory operations. The observed problem with the lead data probably exists for most of the trace metals of interest to marine chemists but the lead issue has received the most notoriety.

The improvement in analytical methodology now allows identification of potentially toxic trace metals at very low levels. Accordingly, these concentrations have to be considered in terms of possible effects on the biota. The studies to be discussed here focus on nearshore areas since anthropogenic influences are generally greater in coastal areas with the result that metals are typically found at higher concentrations in these areas compared with open waters in the oceans.

One trace metal that has received attention in the Indian River Lagoon area is copper. While copper is a necessary micronutrient that is needed by all life forms, it can also be toxic, like most elements, at high concentrations. Interest in copper as a contaminant arose due to its use as an ingredient in anti-fouling paints and inputs of copper from this source in relatively restricted bays and harbors along the Indian River Lagoon were hypothesized to be a potential environmental problem (Trefry et al., 1983).

The anti-fouling paints which contain copper are applied to the hulls of boats to prevent attachment and growth of organisms. The copper is formulated to leach into the water at a rate fast enough to prevent the organisms from becoming attached to the hull but not so fast as to deplete the copper content too rapidly. Due to this leaching, enriched copper levels have been reported in various harbors in the United States. Because of such reports, harbor areas along the Indian River Lagoon in Florida were studied to determine the extent of copper contamination. The presence of large marinas and boat-repair facilities was taken as a good indicator that an area might have copper concentrations above normal background levels.

Eau Gallie Harbor was selected as a principal study site. Samples of water, suspended matter, sediment and barnacles were taken from a number of locations. Copper concentrations in water ranged from 0.4 to 5.6 µg/L with the highest readings found in the immediate area of several boat marinas. Similarly, high copper levels were found in suspended matter in harbor areas (ca. 100 µg/g of suspended matter) whereas less impacted areas showed copper concentrations averaging only about 30 µg/g. These numbers were supported by performing laboratory leachng experiments in aquaria whereby leaching rates were established for copper in marine paint that was applied to wood test panels.

The sediments in the harbor also reflected the pattern of enriched copper. Copper concentrations approaching 200 µg/g were found in the central part of the Eau Gallie Harbor. These levels were three to four times greater than typical copper distributions elsewhere.

To determine the impact of the copper on the biota, barnacle (<u>Balanus</u> <u>eburneus</u>) soft tissue was analyzed. Compared to open

Indian River Lagoon barnacles, those from the Eau Gallie Harbor were enriched in copper by about a factor of four. These findings corroborate those found in the water and suspended matter, as discussed above.

Besides the barnacle, the commercially harvested blue crab (Callinectes sapidus) was studied for copper content. A working hypothesis sugggested that the mobile and transient blue crab could take up copper when it moved into a polluted area such as Eau Gallie Harbor. Despite the inability to make definitive statistical inferences, it was clear from the data that crabs collected from Eau Gallie Harbor had about 70% higher copper concentrations in their claw tissues than those collected from the open Indian River Lagoon. Gonad tissue also showed sizeable differences, with the copper levels about 2.5 times greater in the Harbor crabs compared with the Indian River Lagoon population.

The data for the distribution of copper in the study area showed that only a small amount of the copper present in the Harbor is transported and deposited in the Lagoon proper. Alternatively, whatever copper that is transported out of the Harbor is likely mixed and diluted rapidly. A mass balance for copper in the Harbor was developed to account for as much of the copper as possible. In sum, it appeared that about 75% of the total copper entering the Harbor is retained there while only about 25% is exported to the Indian River Lagoon. The major sink for copper in the Harbor is the sediments.

Overall, the copper status of the Indian River Lagoon indicates a slight enrichment of the copper in the water (0.4 to 0.8 μg/L) compared to the open ocean (0.1 μg/L) but these differences do not reflect any serious contamination. Elevated copper levels in clams (Mercenaria mercenaria) collected from the Port Canaveral Turning Basin were higher than usual for this species, indicating a localized source of copper at that location.

Besides copper, the barnacle indicator organism showed that zinc could also be enriched in the biota (Barber and Trefry, 1981). Sources of zinc in Eau Gallie Harbor appeared related to boating activity, e.g., the use of galvanized metals, sacrificial anodes and other zinc-containing materials.

In summary, it appears that trace metal problems in coastal areas of Florida, or at least those showing behavior such as copper in the Indian River Lagoon, are focused in restricted circulation areas such as harbors and marinas. Other metals might similarly be expected to concentrate in harbor sediments and thence to accumulate in the biota. Efforts will be necessary to carefully plan the siting of marinas and the discharge of effluents into harbors and bays to avoid significant accumulations of metals in locations similar to the Eau Gallie Harbor as discussed here.

An extension of the barnacle and clam studies in the Indian River Lagoon system could take a form such as a statewide "Operation Oyster." Patterned after the highly successful international "Mussel Watch" (Farrington et al., 1983), an "Operation Oyster" program could be implemented to develop a historical record of contaminant accumulation in a variety of depositional zones along Florida's coastline. The "Mussel Watch" program provided very useful data for many locations, especially in the State of California (Martin et al., 1982) and related efforts involving fish have been successful in the Great Lakes region (Sullivan et al., 1983). So there is every reason to believe that such an activity would benefit resource management and environmental protection programs in Florida.

POLICY WORKGROUP

Introduction

The policy workgroup addressed the problem of chemical contamination in Florida's coastal zone by discussing general chemical pollution problems and the political, social and economic context surrounding decisions on how to control such pollution. This was a different approach than the chemistry and biology workgroups which discussed contaminant problems in somewhat specific detail.

Martin H. Belsky, chairman of the workgroup, began the discussion with an overview of a paper he recently completed, titled "Environmental Law and Policy in the 80's." Belsky noted that, since 1980, a number of legal and policy changes have occurred in the way we deal with pollution and in the demands on the scientific community to show the causes and effects of such pollution. Three specific areas were highlighted: the requirement of cost-benefit analysis, the need for risk assessment, and delegation of responsibility to the states under "New Federalism."

Issues

Cost-Benefit Analysis

Cost-benefit analysis is a procedure used to evaluate the costs associated with a regulation or activity as compared to the benefits that will be gained from such rule or action. According to Executive Order 12291, promulgated in 1981, a strict cost-benefit analysis will now be applied to each new regulation. This stricter review could produce a decrease in environmental protection by requiring a detailed justification of the costs of a rule to business as compared to only the potential benefits of such a rule to the environment. The cost-benefit analysis is a frustrating exercise for many scientists, who believe they cannot put the value of controlling contaminants in dollar terms. However, scientists must now recognize the need to quantify the benefits and costs accurately.

The problem inherent in the cost-benefit analysis procedure is determining the economic value of an aesthetic benefit or of clean air or water. How does an economist place a market value on a wetland? How does the economist quantify injuries to an ecosystem? Traditionally, the scientist has avoided the cost-benefit analysis by claiming that it is not his responsibility to determine the economic value of an ecological resource. If this attitude is maintained now, with the existence of Executive Order 12291, this would mean that environmental controls would not be established as the costs of protection, easily quantifiable by economists, would always outweigh the benefits, which only scientists can estimate. To protect the environment from impacts resulting from an improper analysis, the scientists must take an active role in this determination.

The group discussion then focused on the inaccuracy of the cost-benefit analysis procedure. Questions were raised as to the types and amounts of evidence required to assess costs related to risks, the methods that should be used in this evaluation, and the additional burden this placed on both the scientist and regulatory agencies. One final issue surrounding the cost-benefit procedure is predicting the long-term costs and benefits associated with an activity. These long-term assessments are especially difficult to forecast because of the unknown response an ecosystem will exhibit to an impact. The group decided this could only be determined on a case-by-case basis, and would require extensive, long-term monitoring data to determine the extent of the impacts.

The workgroup's conclusions were that regulations should not rely on cost-benefit analyses since scientists are not comfortable with this type of analysis; that practical problems are involved when performing the analysis, thereby reducing it to a "guesstimate"; and that a procedure should be established to accurately quantify ecological and aesthetic values. Regulators must be sensitive to the inherent bias of a cost-benefit analysis in favor of easily quantified economic values when compared to the more troublesome estimations of softer environmental benefits.

Risk Assessment

Risk assessment is an evaluation of the types and levels of risk associated with a particular activity or the release of a chemical contaminant. The methods which are used to determine levels of risk are somewhat related to the cost-benefit analysis procedure, and share many of the same problems when scientists are asked to quantify risk levels. If risk must be at a certain level to allow controls on activities or pollutants, how do we assess those risks, and is this a political or scientific problem?

The federal government's new Executive Order 12291 provides that "adequate information" must be included to justify a protective rule to control pollution. Although this is a vague statement, the intent is to preclude environmental controls until hard information on damage is shown. Thus, with acid rain in the United States, the federal government has refused to require controls on pollutants that could be causing such acidity, claiming that adequate information does not exist to show that the risk of harm has been demonstrated. Hard proof is required before protection will be mandated.

Another major issue related to risk assessment is the difference between short term versus long term risk. Long term risk may not yet be able to be calculated as to a particular contaminant, yet must be addressed. A chemical contaminant that does not present a risk through a short-term evaluation may pose a substantial threat when examined from the long-term perspective. Long-term risks are more difficult to quantify because of the amount of time and level of detail involved, and the need for continued financial support to conduct the study. The workgroup summarized this issue by stating that the problems related to chemical contamination need to be studied on a continuing, long-term basis to fully assess the types and levels of risk. Regulatory controls need not wait until all the evidence is available.

<u>"The New Federalism"</u>

"The New Federalism" is a popular phrase used to describe the attitude of the present federal administration in dealing with pollution issues; previous federal responsibilities are to be turned over to the state. Pursuant to this policy, the present administration has given the responsibilities for contaminant controls to each individual state to study, manage, and enforce, yet without providing the necessary funding.

The workgroup members felt that without the much needed federal funds and guidance, the effectiveness of many of the environmental protection programs will be diminished substantially. The group members stated that without an overall federal authority, the standards enforced at the state level would vary from state to state. Due to many of the state's desires for continued growth and industrial development, a level of competition could exist among the states in deciding who would permit the most pollution, and thus attract the most development.

As a result of the increased state responsibility for implementation of a previously federally managed program, the workgroup members felt that changes would occur at the state, regional and local levels in program management and authority. While most members stated that the additional responsibilities would severely constrain the effectiveness of many state departments, others saw this new division of responsibility as an opportunity for the state government to improve on the federal standards and implement specific state goals.

Role of Local Government

The role that local government plays in the enforcement of state standards is an important factor in the effectiveness of the environmental protection programs. The workgroups members felt that local governments should be required to enforce the minimum state standards and still have the option of adopting stricter standards if they desired.

The workgroup stressed that many problems are not limited to a particular locality. Since nature does not respect political boundaries, growth management, quality of life, and chemical contamination, problems need to be studied and resolved on a regional basis. This idea led to the recommendation to establish regional water quality standards.

Wasteload Allocation Process

The topic of wasteload allocation was a particularly sensitive one in the policy workgroup as well as with the biology workgroup. The theory behind wasteload allocation is that one determines the assimilative capacity of a water body, and then uses any available capacity for disposal of wastewater effluent. Scientists are concerned that the information gathered from a study of wasteload allocation is not adequate to assess the total impacts from the effluent. Long-term impacts cannot be adequately addressed, as such a study is based on the quality of the water body at one particular point in time which does not include predictions of future pollutant inputs. Many members feared that the wasteload allocation process could be used as a "license to pollute." One Workshop attendee calls this process one which supports "economic and ecologically allowable levels of contaminants." The workgroup members felt that the basic research involved in the wasteload allocation process was inadequate, and that wasteload allocation studies should be conducted by an independent agency, one that is not intimately involved with issuance of the permit. Additionally, the members felt that the standards being developed for the level of "acceptable pollution" should be done from a scientific viewpoint, as opposed to a personal viewpoint.

Recommendations

1. Regional water quality districts should be established.

The regional water quality districts would be similar in nature to the existing Florida water management districts, but the boundaries would be hydrologic and not political in nature. The purpose of the districts would be to regulate the quality of all freshwater and saltwater within the hydrologic boundaries. Additionally, the water quality districts would have stronger regulatory and enforcement abilities than the existing water management districts. A board of directors, appointed by the Governor and subject to approval by the Cabinet, was the recommended mechanism for leadership and direction for each of the districts. It was pointed out that the recent requirement to co-locate DER districts with the water management districts was a first step in moving towards this idea.

2. User's fees should be charged to reflect environmental costs; a portion of these fees should be used to fund basic research.

User's fees should be established for each generator who produces a waste or creates a negative impact on the environment. Members of the workgroup felt that a portion of this money should be placed in a separate account to fund basic research to address pollution and waste problems in all areas in the state. It was stated that this extra fee charged to the generator would ultimately be passed on to the consumer; however, this is a real cost of doing business and should be recognized as part of the customer's price. In addition to establishing user's fees, the enforcement efforts in Florida should be accelerated and a portion of the money obtained from increased fines and penalties could also be applied to fund basic research.

3. <u>Research should be conducted independently of the regulators.</u>

The group members stated that the regulatory agencies should not be involved in conducting much of the research. Private laboratories and universities, and the state universities, should be responsible for conducting the research needed to understand the problems affecting Florida's coastal zone. Results from the research conducted should be readily available on a statewide basis. The existing tie of research to regulation is one of the reasons that there is insufficient basic research. Currently, an enormous amount of data exists on certain topics, but the data are site specific. The question of whether the data were still applicable to other situations was addressed by the suggestion of using an integrated modeling approach to solve these problems.

4. <u>Scientists should be involved in the development of public policy</u>.

The role of the scientist in the development of public policy is not clearly defined and the group members did not agree as to the level of involvement the scientist should have in establishing such policy. The underlying premise is that scientists should only be involved in science and the decisions should be left to the politicians; however, this attitude has not been healthy for the environment, nor is it realistic. There was a consensus among the workgroup members that scientists should be involved in the decision-making process to a certain extent. This goal would be accomplished by more scientists attending public meetings, distributing pertinent research information to affected individuals, and providing input to the policy-makers.

5. <u>Scientists should establish a list of areas in Florida to be preserved</u>.

The workgroup members recommended development by a group of scientists of an inventory of sensitive coastal areas in Florida to be purchased for protection. The list should be developed strictly on the scientific value of the site and not related to political and social influences. This list would then be reviewed by the Governor and Cabinet to determine which areas should be purchased for preservation. The group members felt the state should have powers of eminent domain for the purposes of environmental protection. Although the State of Florida currently has a list of those sensitive areas that should be purchased, the group members felt these lists were developed almost solely from the political process and that more of a scientific basis for such decisions is necessary.

The group members expanded this idea of preservation areas by further recommending that other areas in the State be divided into two general development patterns. One area would be designed so some development would be permitted, but with site specific stipulations and restrictions; the other development pattern would be a type of "full development district" where all types of development would be permitted, provided there were no significant impacts to the environment outside of the boundaries of this somewhat unrestricted development district.

6. <u>Growth management strategies should be based on availability of resources</u>.

Growth management strategies should be based on scientific facts and the effect of growth on the availability of natural resources. As such, the scientist should be involved with this decision-making process. This workgroup discussed the idea of "spaceship earth" as it relates to the carrying capacity of the environment.

7. Marine education should be included in the basic curriculum in Florida schools.

The concern for the citizens of Florida to understand the processes and the environment unique to this state resulted in the recommendation to include marine education in the basic curriculum in Florida's schools.

8. Policy and regulations are needed to address the problem of waste disposal from the increasing number of houseboats in Florida.

As the land along the coastal zone becomes more valuable, there will be an increasing number of houseboats to satisfy people's desires to live close to the water. Currently, these houseboats are not regulated for waste disposal. The Blue Ribbon Marine Advisory Committee, which prepared regulations governing marinas built on state-owned lands, should study this problem and develop regulations.

9. Regulations are needed to address the small quantity waste generation in Florida.

Since Florida is not a highly industrialized state, most of the pollution problems do not stem from the large industrial corporations. The source of many problems in this state is from the small quantity waste generator, such as individual dry cleaning operations or the wastes produced from individual households. The regulations developed to address this problem must be designed to be easily enforceable on a statewide scale and easily understood by the general population.

BIOLOGY AND ECOSYSTEMS WORKGROUP

Introduction

This workgroup approached the problem of chemical contamination in Florida's coastal zone on the basis of biological and ecological considerations. The outcome of this approach reflected the participation of a diverse group of attendees.

The workgroup, chaired by Paul Cardeilhac, agreed that contamination of the coastal zone consists of highly variable concentrations of several constituents such as pesticides, inorganics (especially metals), petroleum hydrocarbons, industrial organics, radioactivity, nutrients and the general release of contaminants during harbor and channel dredging activities.

An attempt to prioritize the major contaminants in terms of perceived importance was unsuccessful. Constraints included the extensiveness of the Florida coastline and the diversity of the aquatic ecosystems. Highlighting this problem is the inescapable fact that as long as Florida's population continues to grow on the coast, there will be increased environmental impacts related to human activities.

Another result related to the diversity of the aquatic habitats along the Florida coastline and the diffuse nature of the various contaminants, was that the workgroup found it difficult to designate special areas as "highly stressed" compared to others. There was a general consensus that most of the major ports and developed embayments along the coast were suffering from urbanization effects (urban runoff, transportation activities, dredging, petroleum leaks and spills, etc.).

Additional areas were perceived to be increasingly affected by the illusive nature of non-point source pollution, including construction and development activities. Present almost everywhere are the problems of sewage discharges, marine transportation activity, seafood processing wastes, altered fresh water flows, etc. Many of these topics are mentioned in the literature review section which appears later in this report.

Issues

Insufficient Biological Data

There appear to be insufficient and inconclusive data available to provide a strong technical basis on which to implement comprehensive management plans that deal with contaminants in Florida's coastal zone. The workgroup suggested that good studies have been performed in certain areas but, with very few exceptions (e.g., Apalachicola Bay), they have been of a limited duration to allow useful trends or impacts to be fully assessed. The nature of the funding or the original study objectives are two likely reasons for this situation. The net result of this historical problem is the absence of thorough biological and ecological surveys of Florida's coastal zone.

Targeted Monitoring

In many cases, it appears that monitoring has been performed mostly for the sake of monitoring itself, either out of general interest or in response to a regulatory requirement. However, without the proper biological or ecological guidelines, the time and expense devoted to monitoring often leads to the generation of data which have limited use. Typically, monitoring is expected to provide an answer, but perhaps to a question that hasn't yet been asked or to provide clues to solving a problem that hasn't yet been identified.

The workgroup saw a need for monitoring to be directed or "targeted" to answer specific questions, such as: What is the carrying capacity of a body of water?; What is an appropriate waste-load allocation for a given water, based on biological and ecological conditions?; or, to determine the importance of certain phenomena such as sediment-water interactions and biomagnification of contaminants.

It is clear that there will apparently always be a need for monitoring since so many regulatory actions require monitoring as a condition of permit applications, permit operations, and general program needs. However, it is also apparent that all state and federal agencies should try to coordinate their monitoring responsibilities, perhaps resulting in a much more efficient accumulation of environmental data.

Toxicological Effects

From the available record, it appears that the vast majority of the chemical contaminant data that are available do not address the toxicological significance of the concentrations reported. In most cases, the biological significance of the chemical data is unknown in terms of any given species present in the aquatic system from which the data were obtained. Very few aquatic toxicological bioassay studies seem to have been performed, especially with reference to species found in Florida's coastal waters. A major problem area that was identified concerns the need for a strong connecting link between observed chemical data and coincident biological responses.

Another issue in this category, perhaps also of equal interest in the chemistry area, concerns the specific form of the contaminant that is present. Many chemicals elicit vastly different toxicological effects depending on the form taken in a given aquatic system. For metals, this relates to the oxidation state of the element; for other contaminants, e.g., organics, this refers to the status of the organic as a soluble constituent or as a molecule adsorbed onto a suspended particle (e.g., clay). Whenever possible, the form of the chemical should be specified to allow a better toxicological assessment to be made. This is one topical area that requires biologists and ecologists to work closely with chemists in coordinated studies.

Finally, possible toxicological factors related to chemical contaminants have varying importance depending on the life stage of the organisms present. Thus, when biological monitoring surveys are performed, as much as possible, life stages should be identified and stated for the record. This will allow a better estimation to be made of the possible toxicological significance of a chemical found in the system, assuming that some type of toxicological response study had already been performed. If no specific toxicological data are available, the presence of biological life history data coupled with the chemical contaminant information will at least provide some type of boundary condition that can be applied to other locations at some other time.

Biological Control

One of the reasons this Workshop was held relates to the extensive use of chemicals in Florida for some type of biological control activity. Regardless of the initial point of application of a chemical (i.e. pesticide), there is always the possibility of it moving from the target area to another, unintended aquatic system. Herbicide usage for terrestrial and aquatic weed control and aerial spraying of pesticides for mosquito control are only two such examples. The workgroup supported the concept that biological control methods should be applied more often, where applicable, and chemical control methods used sparingly, only in those situations where no biological method is currently available. This appears to be one area where a significant amount of additional research might be warranted.

Pollution Indicator Organism Concept

There was considerable discussion aimed at the concept and possible implementation of a pollutant indicator organism program. Topics such as appropriate criteria for indicator organisms and the possibility of groupings of indicator organisms received much attention. At some point it became clear that there was probably no one organism that could fulfill all of the conceptual demands that might be placed on it to yield meaningful information as an "indicator" organism. However, certain criteria emerged which appear to be applicable should an agency decide to adopt an indicator organism. The criteria include: (a) a cosmopolitan (state-wide) distribution; (b) a sessile or residential lifestyle; (c) a demonstrated sensitivity to contamination; and (d) an economic value, i.e., sport or commercial importance. After the discussion, the attendees seemed to agree that few, if any , Florida organisms could meet all of the crtieria, especially one which requires a cosmopolitan distribution. This impediment is troublesome since there are so many different habitats along the coastline of Florida that somewhere, sometime, any given organism will not be present due to an unsuitable habitat.

The next obvious approach is to identify organisms in various geographical locales that could act as regional indicator organisms. Also, another approach might incorporate a suite of organisms in a given area to act as a group indicator. Other possibilities no doubt exist, but the workgroup did appear interested in having some effort made on a state-wide basis to apply this concept. If some form of this idea could take hold and be applied in certain selected areas, its usefulness as a predictor or assessor of pollution impact on the biota could be tested.

Impact of Hydrocarbons

Perhaps one of the most ubiquitous contaminants in Florida's coastal zone is the class of organic compounds identified as hydrocarbons, or more specifically, those hydrocarbons derived from petroleum-related sources. While severe petroleum hydrocarbon problems seem to be restricted to localized areas such as harbors and marinas, there is a low level presence of hydrocarbon materials in many coastal areas of the state.

However, not all hydrocarbons have the same impact on various components of the biological community present in any one location. There was considerable discussion concerning the most significant constituents of the petroleum hydrocarbons that seriously impact on the most sensitive biota in a given area. Petroleum hydrocarbons, once they enter the aquatic environment, can fractionate into various forms, including volatile, soluble and insoluble components. Coupled with the targeted biological surveys mentioned earlier, there is a clear need to provide some type of assessment of the most biologically sensitive areas in a given region so these might receive the initial efforts for preservation and decontamination following some type of incident involving the release of petroleum hydrocarbons.

Stressed Areas

One of the initial goals of the workgroup was to provide a prioritized listing of the most severely stressed areas in Florida's coastal zone in terms of biological and ecological functions. As mentioned in the introductory comments to this section, however, this desired outcome was not achieved. Part of the problem involved the lack of a clear definition as to what actually was meant by contamination and stress. Some attendees suggested using known stressed areas in other places as models, e.g., Mississippi Sound, Long Island Sound, Chesapeake Bay and Delaware Bay. There has been a substantial amount of work done in those locations and, as a result, a relatively good understanding of the chemical-biological interactions now exists. By spending time studying those case histories, predictive information could be gained and applied to selected Florida coastal environments. Once a good understanding is gained as to what is meant by a stressed environment, this knowledge, coupled with detailed data from case histories elsewhere, might lead to an assessment and ranking of possible biologically stressed areas in Florida.

Recommendations

1. Fundamental biological data are needed.

The fundamental biological and ecological data necessary to define and evaluate the community structure and diversity of coastal Florida ecosystems should be obtained as time and resources allow. These data will allow an assessment of the impact of future contamination while also providing a current status report on the ecosystems in the presence of contaminants now known to be present. The data should be obtained by utilizing a targeted monitoring approach.

2. Correlations of biological effects with contaminant concentrations must be performed.

For areas with known contamination, correlations of physiological, reproductive and behavioral changes in the biological community should be matched with the levels of contamination found. This would provide a correlative data base for future predictive use.

3. Pollution indicator organisms should be selected.

Additional study and research is needed to develop and expand the concept of pollution indicator organisms for Florida's coastal ecosystems. A decision should be made soon as to the ultimate value of this approach for state agency programs.

4. Toxicological effects must be better quantified.

The toxic or potentially toxic forms of contaminants found in Florida's coastal waters should be studied under controlled conditions to determine the current level of risk associated with their presence in ecosystems that have well characterized biological populations. The possibility of synergistic effects should be explored where sufficient data exist. The fate of the toxic forms should be studied to determine if a given contaminant has a residence time that is of concern to the biota in a given environment.

5. Coastal eutrophication problems should be assessed and controlled, especialy in restricted circulation areas.

The impacts of continued coastal development, with special reference to urban and non-point source runoff, need to be assessed. Of particular concern are those areas of restricted circulation and heavy loadings (e.g., Indian River and parts of Tampa Bay). The impact of accelerated coastal eutrophication needs to be predicted to allow proper management strategies to be developed.

6. Biologicaly stressed areas should be identified and remediation plans developed as soon as possible.

Upon completion of additional targeted monitoring, and expansion of the biological and ecosystem data base for Florida's coastal zone, an initial assessment of biologically stressed areas should be performed. This could be done in the context of assessments made for similar coastal and embayent locations in other states. Evaluative statements should be based on a combination of the Florida data with observations made in those other environments. If stressed areas are ultimately designated, preliminary remedial plans should be developed, along with plans for management strategies designed to prevent future deterioration. These actions are underway now in certain Florida areas (e.g., Tampa Bay) and should be expanded to the extent that state and federal matching funds allow.

7. Biological control methods should be used in place of chemical control whenever practical.

Research should be stimulated and supported to provide suitable alternatives to chemical control of undesirable plant and animal species in or near aquatic systems. This effort is underway for terrestrial applications, e.g. release of sterile fruit flys in citrus areas where extensive use of chemical pesticides has been the practice in the past. Extension of the principles and practices of biological control to the aquatic system is highly desirable.

8. <u>A Coastal Marine Advisory Committee should be established by state agencies having coastal zone responsibilities</u>.

A group of estuarine and coastal marine biologists, ecologists and chemists should be selected and appointed (perhaps on a staggered three year term basis) to a committee charged with the responsibility of providing research advice to appropriate agencies. This group should not duplicate nor replace the duties of the agency personnel. Rather, they could provide research insight to the agency staff based on their experience, thereby adding another dimension to the planning processes that occur. This Committee might also act as a focal point for Florida's marine science community by providing information and suggestions for preparing proposals to address important state research needs and to offer ideas for likely sources of financial support.

CHEMISTRY WORKGROUP

Introduction

The discussions in the chemistry workgroup covered a wide range of topics. At the outset, the workgroup chairman, H. Anson Moye, had attendees provide brief statements of their research interests and review some of their findings for projects that involved chemical contaminants in the coastal zone. It was interesting that one of the dominant themes throughout the discussions was analytical methodology. Many attendees found it informative to discuss the techniques used in different laboratories since results obtained in studies of chemical contaminants are significantly affected by the analytical method chosen.

Among the research projects highlighted by the workgroup participants are the following items. These are listed in random order to reflect the diverse interests of the group and do not necessarily represent topics that were eventually selected for inclusion in the set of "issues" that are identified and discussed in the next section of this report.

Research is being performed on the transport and degradation of herbicides such as diuron and ethion and their possible chemical and biochemical break-down products; the vitality and senescence of seagrass communities and the possible role of contaminants, acting individually or synergistically, is being investigated; the chemical and biochemical factors involved in the occurrence of the red tide is an active research area, with the possibility of seeding of organisms from offshore sites being studied; the role of upwelling in the distribution and fate of contaminants is being appreciated more fully and is being assessed; and the use of chemicals for control of insects and nuisance aquatic plants continues to be explored, with concern shown for non-target organisms, especially when aerial spray methods result in drift from the target area into sensitive biological regions.

Studies of the radium-226 radioisotope in the Tampa Bay region are being performed, with a view toward assessing the potential contributions of radium from groundwater sources and phosphate mining activities since this is a potentially vital topic which has only begun to be addressed; hydrocarbon inputs to coastal waters from urban runoff and other sources is a popular research area; the search for, and use of, chemical tracers to follow the distribution of pollution sources has received increasing interest, currently manifested by the use of coprostanol to mark the transit of sewage discharges into coastal waters; techniques to separate natural from anthropogenic sources of organic compounds continue to be researched; the impact of dredging in canals, harbors and coastal areas seems to be a continung area of interest; remote sensing of pollutants from aircraft and space satellites, while seemingly an exotic approach to pollution studies, holds much promise for detecting and tracing certain water quality parameters, such as algae and turbidity; and finally, the entire question of wastewater discharges into the coastal zone from municipal and industrial (especially seafood processing plants) continues to be actively addressed.

Following the presentations of individual research interests, the workgroup spent a considerable amount of time trying to itemize and prioritize the major chemical contaminants found or likely to be found in Florida's coastal waters. As was the situation in the biology and ecosystems workgroup, this approach did not prove satisfactory. A major impediment to this process was the lack of a suitably comprehensive data base from which to draw the desired list of contaminants. Furthermore, the wide variety of environmental settings along Florida's coast provides such a diverse set of contaminant conditions that it was difficult and essentially impossible to generalize at the state-wide level.

However, the lack of an overall list of contaminants of concern did not detract from this workgroup's efforts. The attendees gained an understanding of a number of interesting studies that have been performed, or which are currently in progress, with the result that ideas for future research were stimulated. The specific topics appear as itemized issues in the following section. Also, the workgroup spent some of its most productive time in joint session with the biology and ecosystems workgroup. Since a main concern over chemical contaminants relates to interactions with the biota, the biological perspectives explored during these joint sessions were very valuable. This indicates a need for a continuing dialog between the chemists and biologists.

Some of the concerns voiced during this workgroup's sessions were essentially the same as those which initially led to the convening of the Workshop. There has been a considerable amount of work performed in Florida by various groups and some of it has been published in the accessible literature. There has been even more work performed which has not seen wide distribution of results. Thus, Florida's coastal marine scientists have not had full access to all of the information that has been generated.

This Workshop was one step in the process designed to alleviate the situation. Besides the Sea Grant Program, the Florida Department of Environmental Regulation (FDER, in press) and the National Oceanic and Atmospheric Administration (NOAA, 1984) are currently involved in accumulating records of past and present work involving Florida's coastal zone. Within the next year, there should be a considerable improvement in the amount and quality of information available to assist research efforts in the area of contaminants, their effects, and eventual fate in the coastal zone of Florida.

Issues

Chemical Contaminants in Florida's Coastal Zone

The most dominant issue addressed by this workgroup concerned the need for, and current lack of, a thorough list of chemical contaminants and the concentrations that have been found in Florida's coastal waters. In the absence of this type of comprehensive list, a prioritized ranking of the most significant chemical contaminants is not possible. Yet, this type of information was perceived to be critical to an overall understanding of the status of contamination in the coastal zone.

In addition to a master list of contaminants, the areal distribution of the chemicals was also seen to be important, and this too is presently unavailable. Some progress is being made in this area, though, as was discussed by C. John Klein in his overview presentation. The NOAA strategic assessment of the Gulf of Mexico will provide information on the distribution of selected contaminants in Florida's west coast waters. Naturally, the degree of detail will depend on the extent of information in the data bases being searched by the NOAA group. However, it is expected that many chemical contaminants will not appear in the NOAA output since information concerning their distribution simply hasn't been gathered at this time nor has it been made available in an easily retrievable form.

There was a general perception that different data bases exist at the state and federal level with varying amounts of data stored, but these bases have not been merged and compiled in a uniform and accessible manner. The ability to plan future research in the area of chemical contaminants in Florida's coastal zone rests to a certain degree on the ability of scientists to gain easy access to the data. The identity, concentration levels, and geographical distribution of chemical contaminants was seen by this workgroup as one of its most significant issues, yet not one that can be easily resolved.

Besides the problems discussed above, another critical aspect of the contamination issue involves the significance of the chemicals in terms of human health and the health of the ecosystem in which they are found. If chemicals are found to accumulate in organisms, and these organisms are then consumed by humans, it is clear that some estimate of their toxicological importance is necessary. Furthermore, besides human toxicity, the significance of the chemicals to the ecosystem itself is important since a sensitivity of one or more species to a given chemical may substantialy affect the structure of the ecosystem, interrupt predator-prey relationships, alter reproductive behavior, and impose physiological stress. The consensus was that only sketchy information is presently available regarding this issue.

Sources of Chemical Contaminants

Once sufficient information is gathered about the status of chemical contamination in Florida's coastal waters, the issue then becomes one of source reconciliation. It is important to understand where contaminants originate once it is known that they are present. After the contaminants' identity and concentration are established, their sources must be identified and ultimately controlled. Identifying contaminant sources is a major effort and is a high priority issue for state and federal regulatory agencies. However, given the potential number of sources, and the resources available to the agencies, it is clear that it will take some time to thoroughly evaluate all potential sources of contamination. Afer the identification process is completed, the matter of control must be addressed. This will move the issue into the economic and political arena.

Contaminant sources fall into two broad categories, natural and anthropogenic (man-made). It is possible that natural materials can be considered contaminants if they are present in a given body of water in excess concentrations, e.g., excessive phosphate concentrations can result in eutrophication while low levels are desirable and even necessary for a healthy ecosystem. Metals are naturally present in the environment as part of the geological regime of an area. However, when they are present at substantialy higher concentrations, they can affect the biota in some potentially negative ways. Decisions have to be made as to which contaminants must be controlled and in what order of priority. Emphasis on contaminant control will have to be made in terms of the extent of the observed or predicted impact. Problems that have a local impact may get less emphasis than those having regional or state-wide significance.

Indicator Contaminants

The biology and ecosystems workgroup struggled with the concept of indicator organisms. In much the same fashion, the chemists tried to address the feasibility of establishing indicator contaminants to provide summary information that would lead to further results and decision making. However, selection of an indicator contaminant is as difficult to achieve as is the selection of an indicator organism. Each effluent, receiving water and surrounding environment has its own chemical signature and it is very difficult to select, a priori, an indicator contaminant that might be used to determine the extent of contamination present. There has been some interest in using a chemical tracer, for example, to aid in assessing the extent of sewage contamination present. Historically, indicator bacteria (coliforms) had been used but there are certain deficiencies in that approach. The selection of coprostanol, a chemical whose environmental presence is generally restricted to sewage, has been successfully applied in determining the fate of sewage effluents. Extending this approach to other situations appears to be a valuable exercise. Continued use of generalized indicators such as biochemical or chemical oxygen demand (BOD, COD) or total organic carbon (TOC) has to be made cautiously since much specific detail might be lost.

Behavior of Contaminants in Aquatic Systems

The fate of chemicals that are introduced into an aquatic system is an area of intense interest. Depending on a chemical's properties, it may undergo various transformations, some of which would tend to remove it from causing further environmental damage. Other types of transformations (e.g., biomethytlation of mercury), can create new environmental problems which might be even more serious than the ones which existed before the transformations occurred.

It must be understood, though, that there are many transformations that can occur which are protective in the sense that a chemical contaminant might be rapidly removed from the water column and then safely stored in the sediments. The processes of precipitation and adsorption onto particles are examples. Of course, if the sediments become resuspended through wave action or dredging, then the chemicals may be released back into the water column, thereby negating the effect of the original protective mechanism. Sediments, therefore, can play an important role in the overall behavior of contaminants in coastal waters.

The mere presence of a chemical in moderately high concentration is not necessarily a critical problem unless the specific form happens to be highly toxic or of a nature that makes it likely to be bioaccumulated. Trace metals exist in various oxidation states, not all of which have the same toxicity. Organic compounds have different structural configurations (e.g., isomers) which have varying degrees of toxicity. It is thus very important to obtain as much information about a chemical contaminant as possible to allow for a proper assessment of its environmental significance.

Analytical Methodology

In studying chemical contaminants in various aquatic matrices, appropriate analytical methods must be employed. In many cases, these involve state-of-the-art techniques. In other situations, more traditional methods might be appropriate since they are more reliable and are subject to fewer operational difficulties. It is important for the analyst to carefully select methods to fit the circumstances. It is useful to have analytical methods described as clearly as possible in published reports so the reader will understand how samples were treated and analyzed. In many cases, the data interpretation will be highly dependent on the method employed.

Identifying unknown contaminants is a continuing challenge. Analytical techniques need to be developed to insure that contaminants are detected at concentrations that could be environmentally significant. In most circumstances this means that very small concentrations need to be detected and accurately assayed. This should also include metabolic products of pollutants which are not often addressed. Metabolic products might be important in a given situation and the ability to assess their significance might rest on the availability of a method that can detect it at environmental or physiological concentrations.

Research Integration at the Ecosystem Level

Many studies of environmental contamination have been performed with special emphasis placed on the contaminant itself and not necessarily on other constituents present in the ecosystem where it is found. Thus, interpretation is restricted to only the chemical, while little else can be stated about the chemical's role in its immediate environment. Thus it is important that studies of chemical contaminants should be part of broader programs rather than simply being analytical studies of several samples taken from a given environment. Chemists and biologists need to interact and design studies that will yield maximal results for the efforts expended. Naturally, for these types of integrated studies to succeed, sufficient information must also be known or gathered to adequately assess the status of the various components of the ecosystem. As discussed in the biology and ecosystems workgroup, there are still significant data needs in this area remaining to be acquired.

Recommendations

1. Establish a comprehensive list of chemical contaminants, including their spatial and temporal distribution in Florida's coastal zone.

The need for this information was made abundantly clear during the Workshop. Despite the existence of data bases maintained by state and federal agencies, the manner in which the data are available simply does not promote easy access and retrieval of the needed information. This will be a substantial effort which should be made by appropriate Florida state agencies assuming they agree with the immediacy of this recommendation. The effort should be performed by data base specialists with input from marine scientists. The initial list should be short and consist of those contaminants for which scientists know abundant data are available. Then the list can be expanded, perhaps to include the USEPA's priority pollutants. Once this has been done, then all other contaminants for which data can be found should be added to the list. Everyone agreed that this task will be time consuming and expensive but the continued growth of the state requires that the current status of contaminants be known so future observations can be compared with a comprehensive baseline data set. Unless such a baseline is establshed, long term trend analyses will be difficult or impossible to perform.

2. Assess the significance and impact of contaminants in the coastal marine environment from physical, chemical, toxicological and ecological perspectives.

Once a suitable list of contaminants has been compiled, the chemicals on the list should be screened to determine if they are environmentally significant. This could initially be done through literature reviews but at some point, new experimental work would have to be initiated. Many of the contaminants that are likely to appear on an accumulated list likely will not have been thoroughly studied for their toxicological and ecological behavior. The use of structure-activity principles should be encouraged along with the completion of risk assessments. In conjunction with recommendations made by the policy workgroup during this Workshop, risk assessments are a valuable way to translate technical findings into information that can be used by policy groups.

3. <u>Identify and select contaminant classes for additional research</u>.

Based on the accumulated list of contaminants, certain classes of contaminants are likely to appear more predominant than others (e.g., petroleum hydrocarbons, pesticides, metals). Given the sources that will be available to pursue additional contaminant work, the selection of specific compounds to represent classes should be attempted. Where possible, tracer compounds should be identified, such as coprostanol as a model constituent in sewage. Performing research on the basis of a model or tracer compound might be the most efficient way of obtaining valuable environmental fate data within reasonable budgetary constraints. Naturally, if the process outlined in recommendation No. 2 above results in the identification of a vitally important individual compound (on the basis of toxicity or persistence), then that compound should be selected for further study, regardless of whether it could also represent a class of compounds from the master contaminant list. It would be desirable to perform environmental fate studies in conjunction with information found on biologically stressed areas in Florida (see recommendation No. 6 in the biology and ecosystems workgroup section) so that the effort would integrate the chemical data within the context of a stressed ecosystem. Inclusion of the biotic component would allow estimations of food chain bioaccumulation, acute and chronic toxicity and the impact of the contaminant(s) on trophic structure to be made.

4. <u>The role of sediments in the coastal zone as a sink for contaminants should be assessed</u>.

The workgroup discussions focused on the importance of sediments as a sink for many contaminants. Since the sediments represent at least a temporary storage location (resuspension due to waves, dredging, etc. can reintroduce contaminants into the water column), they represent a logical environmental component to study in detail. This was clearly demonstrated in the research project performed in Mississippi Sound as reported by the Lytles in their overview presentation that was summarized earlier in this report.

5. <u>Design field studies to be transferable to other sites</u>.

Once a decision is made to perform additional contaminant research in a given area, preferably in an identified biologically stressed area, the experimental design should be established in a way to make it easily applied to other areas. This template approach will insure the inclusion of various components in a study design that were found useful in previous studies and will also provide a framework to build on when modifications become necessary.

6. <u>Adopt appropriate analytical methodology for chemical studies</u>.

Chemists should judiciously select from standardized methods and state-of-the-art techniques to best approach a given analytical problem. Reliance solely on either one of these categories for philosophical reasons is not advisable since there are good attributes to both the traditional standardized methods as well as newly developed techniques. With respect to chemical studies in the coastal zone, selection of methods that can be used by many different organizations which have a common set of instrumentation available would be preferable to using an instrument which may not be generally available to others. Obviously, there will be exceptions to this, especially when very expensive instruments are involved. Adherence to a quality assurance program is strongly recommended to guarantee the integrity of the data. Participation in quality control check programs is urged for those doing many routine analyses. Chemists may want to develop a roster of instruments currently available in laboratories where coastal and marine studies are performed and perhaps indicate their availability on a time sharing basis for those who do not have local access to a particular instrument. A good example of this is the gas chromatograph/mass spectrometer which is generally beyond the budget of most laboratories but is available in some state university departments.

7. Identify chemical "hot spots" in Florida's coastal zone.

In conjunction with recommendation No. 6 from the biology and ecosystem workgroup, areas having unusually high concentrations of contaminants should be identified. These may or may not coincide with areas determined to be biologically stressed, although it might be anticipated that the two categories could overlap in many situations. Efforts should be made to identify sources and institute proper controls to reduce and eventually eliminate movement of contaminants into the coastal zone.

8. Encourage development of scientific preserves for long term studies.

Since Florida is experiencing rapid growth which is predicted to continue for the remainder of the century, the establishment of selected preserves along the coast line should be encouraged. The state is active in purchasing land to be set aside for various public uses, and an extension of this approach to include areas of unique scientific value should be considered. In those locations where significant contamination already exists, provision should be made to perform long term studies to determine the ultimate fate of the contaminants and the rate of recovery experienced by the ecosystem involved. Accumulation of this type of information will be very useful should similar contamination occur elsewhere. Then, a good technical basis will be available to allow predictions of the rate of recovery to be made.

9. <u>Funds should be made available by the State of Florida to stimulate research aimed at understanding and solving problems in the coastal zone</u>.

Current funding mechanisms to study contamination of the coastal zone are inconsistent and do not allow the develoment of a coordinated approach to developing a comprehensive data base. Projects appear to be funded on a case by case basis which is not unusual since most activities performed in the environmental arena have tended to be reactionary rather than anticipatory. Since Florida is oriented towards water, and its growth so strongly focused in coastal areas, it should be obvious that the state legislature, through appropriate state agencies, should increase state support for coastal zone research. A modest start could involve provision for an annual appropriation to be applied by Florida Sea Grant for matching NOAA grant funds. Having state funds available for this purpose would allow marine scientists the opportunity to propose contaminant research projects which would ordinarily remain unfunded due to the lack of matching funds. These funds could be directed to FDER or FDNR with the provision that they be used for matching NOAA/Sea Grant funds for projects which relate to the needs of these agencies for coastal contamination problems. Coastal municipalities and industries could assist in funding coastal zone contaminant research since their activities contribute to the problems. A larger funding base will allow research to emphasize fundamental processes rather than examining one problem at a time.

THE LITERATURE REVIEW

Introduction and Approach

The literature review was developed by utilizing a variety of bibliographic sources. The various sources are outlined here.

The first source used was the Dialog Information Service. This computerized literature review service accessed various databases according to a search statement prepared by a reference librarian. The search statement was designed to find references relating to various Florida geographical locations (e.g., Tampa Bay, Indian River, Biscayne Bay, etc.) and activities that result in some form of pollution (effluent discharge, dredging, etc.). The vast majority of the references found by this approach were retrieved from the Water Resources Abstracts database while relatively few references were located in the Enviroline database.

Another source of reference material was the University of Florida Library in Gainesville, Florida. The Government Documents Section provided various state and federal agency reports, including those prepared by the Florida Departments of Environmental Regulation and Natural Resources, the US Army Corps of Engineers and Environmental Protection Agency. Some additional references were located in the Coastal and Engineering Archives.

A valuable source of information was located in the form of an inventory of non-federally funded on-going or recently completed marine pollution research activities in the South Atlantic and Gulf of Mexico regions. This information was provided by National Environmental Satellite Data and Information Service (NESDIS) personnel at the National Oceanic and Atmospheric Administration (NOAA) facility in Miami, Florida. The inventory will be part of a larger report designed to aid the National Marine Pollution Program Office (NOAA) in developing a comprehensive five-year Federal Plan for Ocean Pollution Research, Development and Monitoring. The Federal Plan must identify and prioritize national needs and problems related to marine pollution and it is important that the magnitude and scope of non-federally funded research be known.

The information collected by the NESDIS personnel was obtained through personal and telephone interviews with state and local government agencies, academic institutions and private research organizations. The information provided in the inventory document included a general description of each project; the name of the contact person and organization performing the research; the time frame for the project; an analysis of the project activity (e.g. 50% research, 50% monitoring) and pollutants involved (e.g. 25% nutrients, 75% metals); the pollution source (e.g. 100% marine waste disposals); and the focus within a geographical area (e.g. 100% estuarine in Tampa Bay). The document is an update of a similar report published in 1980 and this current publication, to be entitled Inventory of Non-Federally Funded Research, Development and Monitoring Activities - Southeast Region is scheduled to be published and distributed sometime this year.

Additional information provided by the NOAA office in Miami was a computerized search of environmental data and references available through the National Environmental Data Referral Service (NEDRS). This search consisted of data and report citations, many of which are available in published form but also included some information which is currently unpublished. The search was performed using the BRS Database (Latham, New York). Included in each citation are the organization and individual contact names and addresses, the data available and information as to the method of accessing the data.

Bibliographies of publications available through various organizations was another source of reference material. The most significant bibliography located was the Bibliography of Water Resource Investigations. This document, prepared by the

Bureau of Water Analysis in the Florida Department of Environmental Regulation (FDER, in press), is a result of a requirement of the 1983 Florida Water Quality Assurance Act. The bibliography is stored on the FAMULUS system at the Northeast Regional Data Center located on the University of Florida Campus and will be updated annually. The document currently contains over 5,900 references relating to all aspects of water resources in the State of Florida, including both fresh water and salt water. A keyword search procedure can be used to retrieve references for specific topics.

Unfortunately, a draft copy of this document was not available until the final stages of preparation of this Sea Grant report and thus it was not possible to cross-check the listings and incorporate additional references from the FDER report into this document. However, since the FDER document will be readily available throughout the state after its formal publication, there was really no need to duplicate its information in this report. Obviously, there will be a certain amount of overlap since similar databases were addressed.

Several other bibliographies were useful in providing references; these include a listing of holdings at the National Marine Fisheries Service Panama City Laboratory (NMFS, 1982); a summary of reports published by the FDNR (1983b); a summary of reports published by Florida Sea Grant (1983); a listing of publications available through the Strategic Assessment Branch of NOAA (NOAA, 1983c); and several bibliographies published by the USEPA Gulf Breeze Laboratory in Florida. The Gulf Breeze Laboratory published a general bibliography of its in-house and extramural research projects performed from 1970 to 1982 (USEPA, 1983). Also, topic-specific bibliographies have been prepared which include abstracts of research conducted by the Gulf Breeze Laboratory. These topics include PCBs, microbial ecology and the EPA Drilling Fluid Hazard Assessment Research Program reports.

Very useful sources of information were the reprints and technical reports provided by the Workshop participants. Many reports provided by these individuals represented documents that haven't been formally published in the technical literature and thus were not retrieved by the approaches discussed above. These materials contained valuable information and the citations are incorpoated in this report where appropriate.

The following literature review is organized by geographical area in the State of Florida. Each geographical area is introduced with a short narrative followed by a tabular listing of the literature citations that were retrieved for that particular area. There were 18 geographical categories covered in this way. Each tabular listing of citations has a set of abbreviations which provide information on the contents of the reference according to a set of major topics that were established. The topics and their abbreviations appear as a Legend for Tables which precedes the narrative for Duval and Nassau Counties. An overview of the geographical areas is displayed in Figure 1, which gives the design for the geographical areas which were partitioned to most easily handle the literature references that were found.

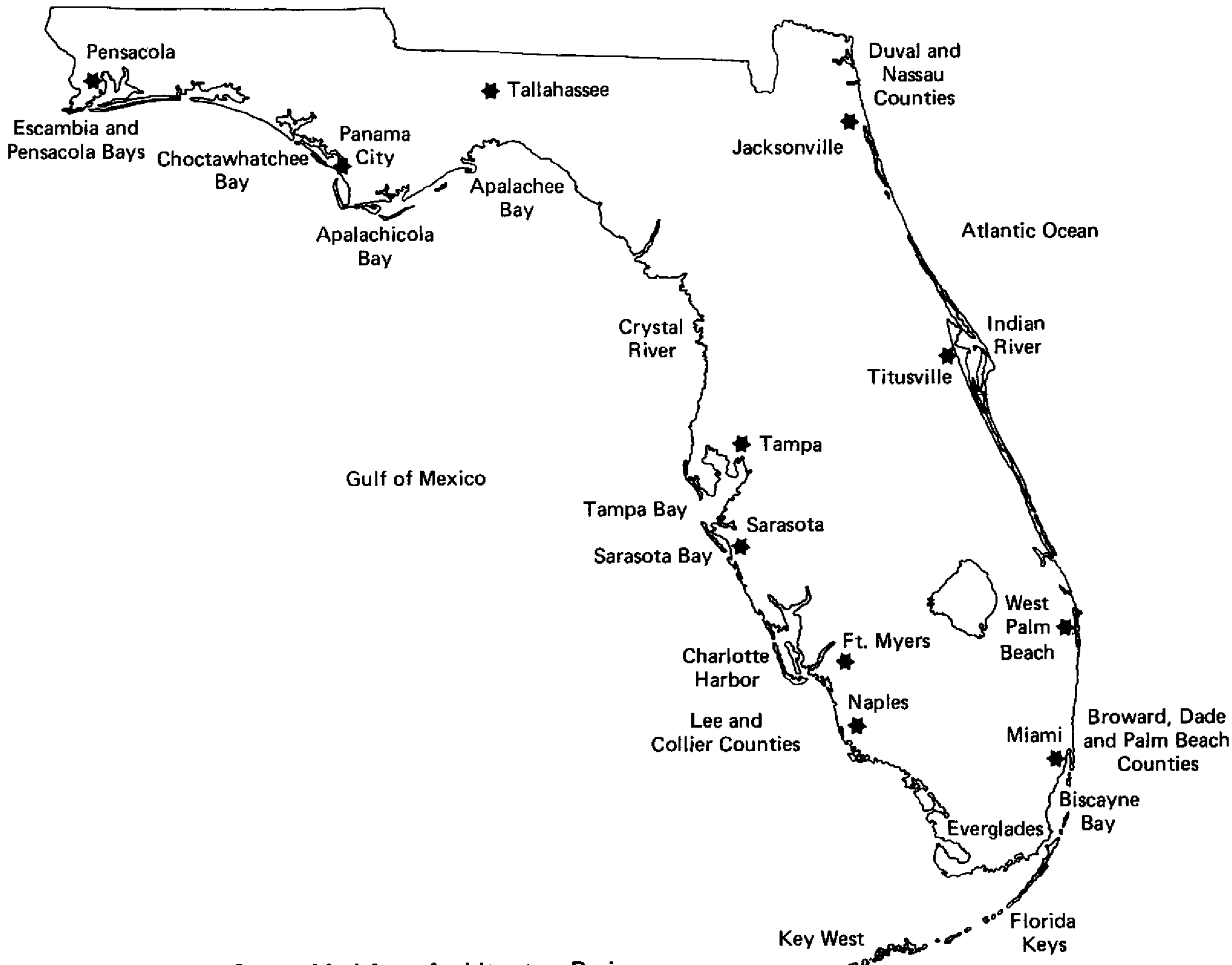

Figure 1. Geographical Areas for Literature Review

Legend for Tables

AmelR	Amelia River
AqTox	Aquatic toxicology
BgCy	Big Cypress Swamp
Dev	Development activities
Dredg	Dredging, channel improvement
Eco	Ecology, Ecosystems
EIS	Environmental Impact Statement
Est	Estuary
Evgl	Everglades
GW	Groundwater resources
HC	Hydrocarbons
Hg	Mercury
IndOr	Indicator organisms
Keys	Florida Keys
Mar	Marinas
Met	Metals
Mod	Modeling
OCS	Outer Continental Shelf, oil and gas leasing
Oil	Oil spills
Org	Organic compounds
PCB	Polychlorinated biphenyls
Pest	Pesticides
Phys	Physical oceanography, hydrology
PlMgt	Planning and management
PME	Pulp mill effluent
Port	Ports and harbors
Rad	Radioactivity, radioisotopes
RedT	Red Tide
Reefs	Reefs, Coral reefs
SaltWI	Salt water intrusion
SeaGr	Sea Grass
SfcW	Surface water resources
SoFl	South Florida

StAnd	St. Andrews Bay
StJR	St. Johns River
Therm	Thermal discharges
WLA	Wasteload allocation
WQ	Water Quality
WwEff	Wastewater effluents, treatment plants

Duval and Nassau Counties

The major water body located in Duval County is the St. Johns River which creates a large estuary when it reaches the coast in the Jacksonville, Florida, area. The St. Marys and Nassau Rivers are the significant water bodies located in Nassau County.

The research activities performed in these counties have focused primarily on contamination in the St. Johns River. Examples of studies include: mercury distribution in the St. Johns estuary; the impact of the Port of Jacksonville on water quality; and wasteload allocation and water quality studies in the St. Johns River.

The transport, fate and geochemical interactions of heavy metals in the St. Johns estuary is controlled by processes such as adsorption-desorption reactions, and flocculation and sedimentation which occur at the river-estuary and salt marsh-sediment boundaries (Skidaway Institute of Oceanography, 1974). More specifically, the transfer of mercury through the estuary to the Atlantic Ocean is controlled by mixing of estuarine waters, loss in plant detritus and migration of estuarine organisms to offshore areas (Windom, 1973). Recent research in this area consists of an assessment of mercury and hydrocarbon contamination in the St. John's River conducted by Jacksonville University (1983) and continued trace metal monitoring performed by Duval County (in progress-1).

The Port of Jacksonville study conducted by the Florida DER in 1983 determined that mercury was the only contaminant to exceed state water quality standards. It appears that organics, pesticides and PCBs are not obvious problems in the Port based on the low levels observed in the sediments. However, cadmium, mercury, silver and nitrogen could create water quality problems during maintenance dredging (FDER, 1983a). A current research project being performed by the Duval County Planning Department is assessing the impact of port tributaries and streams. Water quality monitoring has been conducted and projections will be made concerning future land uses (Duval County, 1984).

A study conducted on the residual levels of 2,4-D in water and blue crabs from the St. Johns River demonstrated that the levels were well below the 0.1 mg/L tolerance level (Joyce and Sikka, 1977). However, recent water quality studies indicated that the St. Johns River and associated bottom sediments in Duval County are contaminated with PCBs (Duval County, 1983).

Wasteload allocation studies performed in the St. Johns River Basin consist of six separate studies of the Pottsburg, Cedar, Ortega, McGirts, Withlacoochee and Arlington East Rivers. Each of these rivers was degraded during the 1950's through 1970's. These studies will attempt to determine the level of recovery that has been experienced in each river (FDER, in progress-1).

A comprehensive water quality monitoring effort conducted in 1967 by the Federal Water Pollution Control Administration indicated that the St. Marys and Amelia River estuaries had poor water quality. Untreated waste discharges from industrial and municipal sources caused the dissolved oxygen in the Amelia River to be depleted to a mean value of 2 mg/L (Gallager, 1971). Currently, two paper mills and a small sewage treatment plant continue to discharge into the Amelia River. The Florida DER conducted a wasteload allocation for the Amelia River to determine the assimilative capacity of the river and reallocate the wasteload sources (FDER, 1983b).

General water quality monitoring studies currently being performed for these two counties include: routine monitoring of Ft. George Island to establish an extensive data base for use in permitting and land use decisions (Duval County, in progress-2); biological and chemical monitoring of the Nassau River Basin to establish a regional baseline and check the efficacy of the USGS estuarine model (SJRWMD, in progress); an interbasin diversion study of the St. Johns River to evaluate the effects of diverting freshwater from the river into tidal lagoons during periods of high flow (SJRWMD, 1984); and an assessment of PCB contamination in fish in the St. Johns River (Duval County, 1983).

Two recent studies which addressed man's impact are the Outer Continental Shelf (OCS) Onshore Facility Siting Study for northeast Florida and a power plant mitigation and coal barge facility study for Palatka.

The purpose of the OCS siting study was to evaluate the onshore impacts of offshore oil development. The study included the area from the Georgia border to St. Augustine. Projections were made regarding the type of onshore facilities that would be located in the region and the environmental and economic impacts from this development (NEFRPC, 1983a).

The power plant mitigation study is a comparison of the pre- and post-construction impact statements prepared for the Seminole Electric Power Plant in Palatka. The study focused on site suggestions for auxiliary facilities and transportation problems, including possible coal barge traffic in the St. Johns River estuary (NEFRPC, 1983b).

In summary, the research and monitoring activities performed in Duval and Nassau Counties have primarily focused on water quality in the St. Johns River with additional interest aimed at the St. Marys and Amelia Rivers. The impact of effluents on dissolved oxygen in the rivers and the presence and fate of contaminants such as metals (especially mercury) and organics (especially PCBs) are major concerns. The citations retrieved during this review for the Duval and Nassau County area appear in Table 1.

Table 1. Literature Citations: Duval and Nassau Counties

Anderson, W. (1972)	SfcW
Atlantis Scientific (1976a)	StJR, WQ
Duval County (1983)	StJR, PCB
Duval County (1984)	StJR, PlMgt
Duval County (in progress-1)	Met
Duval County (in progress-2)	WQ
Florida Dept. of Environ. Reg. (1983a)	Port
Florida Dept. of Environ. Reg. (1983b)	AmelR, WLA
Florida Dept. of Environ. Reg. (in progress-1)	StJR, WLA
Gallager, T.P. (1971)	AmelR, WQ
Jacksonville University (1983)	StJR, HC
Jacksonville University (in progress)	StJR, Hq
Joyce, J.C. and Sikka, H.C. (1977)	StJR, Pest
Pyatt, E.E. (1964)	StJR, Mod
NEFRPC (1983a)	StJR, OCS
NEFRPC (1983b)	PlMgt
Skidaway Institute of Oceanography (1974)	Met, Est
SJRWMD (1984)	StJR, WQ
SJRWMD (in progress)	WQ
Windom, H.L. (1973)	Hg, Est

The Indian River

The Indian River System extends from Ponce de Leon inlet in Volusia County to the St. Lucie Inlet in Martin County. Included in this coastal riverine-lagoon system are the Mosquito Lagoon, the Banana River, the Indian River, their tributary streams and the inlets connecting the system to the Atlantic Ocean. The land areas adjacent to this system include Volusia, Brevard, Indian River, St. Lucie and Martin Counties. Other significant waters in the Indian River area are Lake Okeechobee, the St. Lucie Drainage Canal and the upper St. Johns River.

The majority of the research conducted on the Indian River System has been involved with water quality monitoring, particularly for pesticides and metals and their effects on indicator organisms. Inputs of copper from anti-fouling paints have posed an envronmental stress on biota in some of the embayments and harbors in the Indian River system. Above normal copper concentrations were consistently observed in the water column, sediments, crabs and barnacles in Eau Gallie Harbor. Outside of this area, copper levels appear to be in more normal ranges. Overall, copper shows a slightly enriched concentration in the Indian River Lagoon (0.4-0.8 ug/L) compared to the open ocean (0.1 ug/L) but these values do not reflect any serious contamination (Trefry et al., 1983).

Several studies have addressed the issue of bioaccumulation of metals in indicator organisms. Barnacles located in Eau Gallie Harbor and the Indian River Lagoon were enriched in copper and zinc (Barber and Trefry, 1981). In 1980, approximately 100 large red drum died in the Indian River and in Mosquito Lagoon. Based on analyses of stomach contents, this episode appears to have been triggered by ingestion of copper, zinc and arsenic, perhaps as a result of the dietary preference of the red drum for blue crabs (Cardeilhac et al., 1981). The dynamics of copper chemistry in a shoal grass community near Link Port were studied by French and Montgomery (1983). Their findings indicated that the initial uptake of copper is by the leaves, following which copper is translocated to the roots. Another study of metals is being performed by Brevard County (in progress-3) wherein the metal content of clam tissue is being monitored.

Investigations of chlorinated pesticides and PCBs in water and sediment samples were made near sewage and power plant outfalls, freshwater tributaries and agricultural canals along the Indian River. Chlorinated pesticide residues and PCBs were not detected in surface water samples and were essentially at or below the detection limit (<0.1 ppm) in the sediments (Wang, 1983). A study was performed to assess the impact of trichloroethylene-contaminated groundwater as it was discharged to a relief canal which flows to the Indian River (Wang and Lenahan, 1983).

General baseline water quality studies performed in Brevard County include a survey of Syke's Creek (Brevard County, 1983); a survey to detect changes in benthic macro-invertebrate communities (Brevard County, in progress-1); and a long-term ambient water quality monitoring program (Brevard County, in progress-2). The Florida DER is currently conducting a baseline water quality study to ascertain seasonal variations in the Indian River from Sebastian Inlet to Port St. Lucie to anticipate potential impacts from development on the adjacent barrier island (FDER, in progress-2). The Florida DER is also conducting an intensive survey of the Loxahatchee River Basin to provide necessary baseline data (FDER, in progress-3).

A three year environmental baseline study was conducted in the coastal waters offshore from the St. Lucie nuclear power plant (Gallagher, 1977). The information obtained in this study was utilized to prepare final EISs for Units 1 and 2 of the nuclear plant (USAEC, 1973, 1974). Due to the ecological and economic importance of the Indian River lagoon system, a steering committee composed of representatives of several Florida universities and research organizations was formed to promote the wise use and optimum productivity of the system. A Symposium was held to summarize research conducted in the area since this had not been done previously (Montgomery and Smith, 1983).

It is clear from this narrative and the listing provided in Table 2 that the Indian River Lagoon system has been and will likely continue to be the site of interesting and important research. The proximity of several universities and research organizations insures that research activity will continue.

Table 2. Literature Citations: The Indian River

Barber, S. and Trefry, J.H. (1981)	IndOr, Met
Brevard County (1983)	WQ
Brevard County (in progress-1)	Eco
Brevard County (in progress-2)	WQ
Brevard County (in progress-3)	IndOr, Met
Cardeilhac, P.T. et al. (1981)	IndOr, Met
Florida Dept. of Environ. Reg. (1980)	WQ, Dev
Florida Dept.of Environ.Reg. (in progress-2)	WQ, Dev
Florida Dept.of Environ.Reg. (in progress-3)	WQ
French, T.D. and Montgomery, J.R. (1983)	IndOr, Met
Gallagher, R.M. (1977)	WQ, Eco
Kouadio, I. et al. (1984)	WQ, Met
Montgomery, J.R. and Smith, N.P. (1983)	Est, WQ, Eco, Met
SFWMD (in progress)	WQ, Mod
Trefry, J.H. et al. (1983)	WQ, Met, IndOr
US Atomic Energy Comm. (1973)	EIS, Rad, Therm
US Atomic Energy Comm. (1974)	EIS, Rad, Therm
Venuto, C.J. and Trefry, J.H. (1983)	IndOr, Met
Wang, T.C. (1983)	PCB, Org, Est
Wang, T.C. and Lenahan, R.A. (1983)	Org, SfcW, Est
Wang, T.C. et al. (1979)	PCB, Pest, Est
Wang, T.C. et al. (1980)	PCB, Pest, Est

Broward, Dade and Palm Beach Counties

Broward, Dade and Palm Beach Counties are located on the southeast coast of Florida. All three counties are intensely developed along their coastlines. The Everglades are located directly adjacent to this area.

The Intracoastal Waterway, Lake Okeechobee, Lake Worth and the Loxahatchee River are major water bodies in these counties. Additionally, a series of drainage canals that are used for irrigation run from Lake Okeechobee, across the Everglades, to Florida's east coast. It should be noted, however, that this oveview does not include research conducted on Biscayne Bay which is addressed in the following section.

The research performed in these counties has focused on the impacts of urban development, such as stormwater runoff and the disposal of wastewater effluents, and also general water resources and baseline water quality monitoring projects. Since significant portions of these counties were developed by dredging and filling, thereby creating an intricate network of finger canals, many of the studies have tracked the movement of contaminants through the canal network to Biscayne Bay or to the Atlantic Ocean.

A study conducted by Dade County identified positive drainage systems (pipes directly connecting land areas with surface waters) that were discharging into canals and also into Biscayne Bay. Pollutant loading rates were calculated for all of the positive drainage systems identified (Dade County, 1981). Another study relating to stormwater runoff was conducted by Dade County in conjunction with the US Geological Survey, where they discovered that the shallow strata of the Biscayne Aquifer were attenuating pollutants found in stormwater (e.g., lead, zinc and nutrients). This stormwater runoff is a prime source of recharge to the Biscayne Aquifer, which is the major drinking water supply for southeast Florida (Lefkoff, 1982).

Additional research concerning the water resources of these three counties has addressed the problems of saltwater intrusion (Land, 1972); overpumping of the Biscayne Aquifer (Land et al., 1973); contamination of the aquifer (Klein and Hull, 1978); and the effects of bottom sediments on infiltration from the Miami Canal to the Biscayne Aquifer (Miller, 1978).

Several studies were conducted in the early 1970's to assess the use of ocean outfalls for marine waste disposal. These included an Environmental Impact Statement which considered the results of the Palm Beach County sewage improvement program (USEPA, 1972a) and individual studies to predict the extent of pollution from a marine sewage outfall located adjacent to Palm Beach County (Hoffman, 1971). Presently, the Florida DER is monitoring the effects of a sewage treatment discharge on water quality in the Intracoastal Waterway and Port Everglades Harbor (FDER, in progress-4, in progress-5).

More specific contaminant studies were conducted on the chemistry of copper and chlorine introduced into marine systems during energy production (University of Miami, 1980); levels of PCBs and PCB degrading bacteria in estuarine and marine environments (Sayler et al., 1978); and the degradation of ethion in irrigation canal waters (Dierberg and Pfeuffer, 1983).

Studies which have discussed the impact of human activity in the South Florida environment include an analysis of growth management issues as they affect the Intracoastal Waterway (Marsh, 1974); an identification of the major pollution sources and problems in Broward County (Davis, 1972); an analysis of the impacts associated with the Outer Continental Shelf Oil and Gas Development (SFRPC, 1983); and an Environmental Impact Statement which discussed the impacts of deepening the Port Everglades harbor (USACOE, 1972). An environmental monitoring study of coral reef communities was performed pre-, during and post-dredging operations in Port Everglades. This study involved water quality analyses (pesticides, PCBs, metals), multiple assessments of reef "health," continuous water current measurements and sediment transport analyses (Continental Shelf Associates, 1980).

Studies associated with circulation patterns and hydrology included a multi-year observation of the littoral environment and beach profiles (Dewall and Richter, 1977); an analysis of the first documented red tide outbreak on the east coast in 1972 (Murphy et al., 1975); and the development of an improved system to measure surface currents (Richardson, 1974). Recently, the University of Florida's Coastal and Oceanographic Engineering Department has investigated sediment erosion and deposition problems at Jupiter Inlet (University of Florida, 1984).

The intense development of the South Florida area encompassed by Broward, Dade and Palm Beach Counties is manifested by the number of citations retrieved during this literature review (Table 3). Emphasis has been placed on port and harbor development and the impacts of dredging, the distribution and fate of contaminants, and physical oceanographic studies of currents and circulation patterns. Since these three counties represent some of the most rapidly growing areas in Florida, it is likely that a considerable amount of research activity will occur there in the future.

Table 3. Literature Citations: Broward, Dade and Palm Beach Counties

Continental Shelf Associates (1979)	WQ, Eco
Continental Shelf Associates (1980)	WQ, Eco, Port
Dade County (1981)	WQ, SfcW
Davis, N.S. (1972)	PlMgt
Dewall, A.E. and Richter, J.J. (1977)	Phys
Dierberg, F.E. and Pfeuffer, R.J. (1983)	Pest, SfcW
Florida Dept.of Environ.Reg. (in progress-4)	WQ, WwEff
Florida Dept.of Environ.Reg. (in progress-5)	WQ, WwEff
Hoffman, H.A. (1971)	WwEff
Hopkins, D.R. (1975)	PlMgt, WwEff
Judge, R.M. (1980)	WQ
Judge, R.M. (1982a)	WQ
Judge, R.M. (1982b)	WQ
Judge, R.M. (1982c)	WwEff
Klein, H. and Hull, J.E. (1978)	GW
Land, L.F. (1972)	SfcW, GW, SaltWI
Land, L.F. et al. (1973)	Gw, SaltWI
Lee, T.N. and McGuire, J.B. (1973)	PlMgt, WwEff
Lekhoff, L.J. (1982)	GW, WQ
Marsh, G.A. (1974)	SfcW, WQ, Eco
Miller, W.L. (1978)	SfcW, Gw
Murphy, E.B. et al. (1975)	RedT
Podgor, J.E. (1982)	PlMge
Richardson, W.S. (1974)	Phys
Sayler, G.S. et al. (1978)	PCB
Sherwood, C.B. et al. (1973)	SfcW, GW
SFRPC (1983)	OCS
University of Florida (1984)	Phys
University of Miami (1980)	WQ, Eco, Reefs
US Army Corps of Engrs. (1972)	EIS, Port, Dredg
US Environ. Protect. Agency (1972a)	EIS, WwEff
Waller, B.G. et al. (1976)	SfcW, WQ

Biscayne Bay

Biscayne Bay is a large, shallow, subtropical lagoon located along the southeast coast of Florida. The Bay covers approximately 573 sq.km. and is almost entirely contained within Dade County. Biscayne Bay plays an important role in the local economy by providing aesthetics and extensive recreational and commercial activities. The Bay contains within its boundaries the largest port in Florida and the Biscayne National Park (Corcoran et al., 1983). Important waterways that drain into Biscayne Bay include the Miami River, the Little River, Black Creek/Goulds Canal and Military Canal.

Research conducted in Biscayne Bay has focused on the impacts resulting from the intensive urban development in Dade County. Since the Bay contains a large seagrass community, many of the studies were oriented towards impacts on this unique ecosystem. The Turkey Point nuclear power plant has been the site of numerous studies concerning effects of the thermal effluent on the Bay. There is some evidence that the thermal effluent was initially detrimental to the aquatic animals in the area of the plant (Nugent, 1970). Thorhaug et al. (1976, 1978) studied the effects of the thermal effluent on the seagrass communities in Biscayne Bay. Temperatures of one to two degrees above ambient produced minimal impact but increases on the order of five degrees centigrade in the summer caused denudation of the *Thalassia* community.

Besides the thermal effects studies, research has been performed to establish existing background levels of radioactivity in the water and sediments of Biscayne Bay prior to the operation of the Turkey Point nuclear power plant (Johnson and Pemble, 1974; Johnson and Eakins, 1974). There are doubtless many additional studies that have been performed in connection with the potential ecological, thermal and radiological impacts of the Turkey Point plant but these studies were not retrieved by the process used during this review. Additional information about these unpublished studies assumedly is available from the operators of the Turkey Point nuclear power plant.

Water quality studies conducted in Biscayne Bay have included monthly monitoring of the Bay (Alleman, 1982); the relationship between marinas and water quality (Continental Shelf Associates, 1983a); numerous studies of the water quality impacts of sewage outfalls in the area (Table 4); and research concerning the distribution and transport of metals in the water and sediments of Card Sound (Gilio and Segar, 1976; Segar and Pellenbarg, 1973).

As a result of planned explorations for offshore oil and the predicted increased activity in the Port of Miami related to the movement of oil, the potential for major problems involving oil spills increased substantially. As a result, an intensive study of the hydrocarbon status in the waters, sediments, fish and shellfish of Biscayne Bay was performed (Corcoran et al., 1983). The resulting data provide a reference point for the future. Additionally, an "oil spill sensitivity analysis" and supporting handbook were produced to assist in response to any oil spills that may occur in the Bay (SFRPC, 1981a, 1981b).

Other monitoring activities relating to human impact on Biscayne Bay included investigations of the revegetation of seagrass beds that were previously destroyed due to dredging and construction work (Dade County, 1983a; Thorhaug and Hixon, 1975).

Finally, management objectives for the Bay have been established. Among the recommendations resulting from a symposium held to stimulate future action are: regulation and control of boat discharges into the Bay; development of county rules that are more restrictive than federal rules; strict enforcement of regulations on the runoff of fertilizers and pesticides; and better maintenance of the Bay to enhance sport and commercial fishing activities (McKenry, 1976).

A listing of all retrieved citations concerning Biscayne Bay appears in Table 4. The listing indicates that research emphasis in the Bay has been oriented toward the nuclear power plant and its potential impacts, the effects of urbanization, especially wastewater discharges and possible problems related to future development of oil and natural gas resources.

Table 4. Literature Citations: Biscayne Bay

Alleman, R. (1982)	WQ
Austin, C.B. (1971)	PlMgt
Continental Shelf Associates (1983a)	Wq, Eco
Corcoran, E. et al. (1983)	HC
Dade County (1983a)	Eco
Dade County (1983b)	Phys
Dade County (1984a)	SeaGr
Dade County (undated)	PlMgt
D'Amato, R. (1973)	WwEff
Gilio, J. and Segar, D. (1976)	Met, SeaGr, Eco
Johnson, T.S. and Pemble, T.D. (1974)	Rad, WQ
Johnson, W. and Eakins, J. (1974)	Rad, Eco
McKenry, C.E.B. (1976)	PlMgt
McNulty, J.K. (1961, 1970)	WWeff, Eco
Nugent, R.S. (1970)	Therm, Eco
Prager, J.C. et al. (1973)	Therm
Prestamo, F.J. and Greenan, C.G. (1976)	PlMgt
Roessler, M.A. and Beardsley, G.L. (1975)	PlMgt
Schneider, J.J. (1969)	Phys
Segar, D.A. and Pellenbarg, R.E. (1973)	Met, Est
Singletary, R.L. (1971)	Therm
SFRPC (1981a; 1981b)	Oil, HC, Eco
Targett, N.M. and Mitsui, A. (1979)	AqTox
Thorhaug, A. (1976)	Therm, SeaGr, Est
Thorhaug, A. and Hixon, R. (1975)	Dredg, SeaGr
Thorhaug, A. et al. (1973)	Therm,Phys,Eco,Est
Thorhaug, A. et al. (1976)	Dev, Eco
Thorhaug, A. et al. (1978)	Therm, SeaGr, Est
University of Miami (1981)	Met, IndOr
University of Miami (in progress-1)	Oil, IndOr
Waite, T.D. (1976)	WQ, Dev
Warzeski, R.I. (1976)	SfcW, Phys
Wilson, S.A. (1975)	PlMgt

The Everglades and Florida Keys

The southern coastline of Florida is dominated by two major features, the Everglades and the Florida Keys. The publications dealing with this region have focused on certain issues, specifically the biogeochemical cycling of metals (particularly mercury) and general water quality monitoring as related to development activities.

The biogeochemical aspects of mercury cycling were studied during the 1970's by R.C. Harriss and his associates at Florida State University. Andren and Harriss (1973) found that methylmercury (a toxic form of mercury found in aquatic systems) constituted a very small percentage of the total mercury present (less than 0.1 percent) in sediment samples from the Everglades. The complexing capacity of organic matter in Everglades sediments was studied by Lindberg and Harriss (1974a). Their data indicated that mercury could be significantly complexed by organic matter but that increasing salinity levels tended to diminish this complexation phenomenon. Additional studies involving mercury, particularly its involvement with mangrove vegetative organic matter in the Everglades were performed by Trip and Harriss (1976).

The role of land development in the Big Cypress Swamp area on metals in canals within the Everglades was investigated by Horvath et al. (1972) and Horvath (1973). The metals studied were manganese, iron, cobalt, copper, zinc, cadmium and lead. Chokoloskee Bay was found to have metal concentrations enriched two to five times greater than control areas due to land drainage and development activities.

Water quality studies have been oriented toward assessing the impact of land development activities and the effect of construction (e.g., the new Florida Keys bridges) on the ecologically important seagrass communities. Continental Shelf Associates (1981a) performed a two-year study of seagrass revegetation that was necessary to restore communities affected by the replacement of 37 bridges in the Florida Keys. In addition to the survival and spread of the replanted seagrass, various water quality parameters (e.g., nutrients, carbon, metals) were recorded.

Schomer and Drew (1982) described a substantial effort that was aimed at providing an ecological analysis of the region extending from the Everglades to the Florida Keys, and which also included Florida Bay. They developed a conceptual model of the region and delineated four major ecological zones. The zones vary in climate, hydrology, substrate and water chemistry, all of which factors affect ecological communities that inhabit any one particular zone. The study provided an excellent overview of the communities that have adapted to the environmental conditions prevalent in the different zones.

From the listing of articles in Table 5, it is clear that the Everglades and Florida Keys have seen a reasonable amount of research activity during the past 25 years. As the population of south Florida continues to grow, it is expected that additional development pressure will be applied to the Everglades and Florida Keys region. These historical studies provide a good baseline which can be used to measure the impact of future development.

Table 5. Literature Citations: The Everglades and Florida Keys

Andren, A.W. and Harris, R.C. (1973)	Evgl, Hg
Carter, M. et al. (1973)	BgCy, Eco
CH2M Hill (1984)	WQ, SeaGr
Continental Shelf Associates (1981a)	Keys, SeaGr
Crowder, J.P. (1974)	BgCy, Dev
Dade County (1984b)	SeaGr
Florida Dept. of Administration (1973)	BgCy
Florida Dept. of Environ. Reg. (1984a)	Keys
Horvath, G.J. (1973)	BgCy, Met
Horvath, G.J. et al. (1972)	Evgl, Met
Jaap, W.C. and Wheaton, J. (1975)	Reefs
Lindberg, S.E. and Harriss, R.C. (1974)	Evgl, Hg
McPherson, B.F. (1970)	Evgl, WQ
Reark, J.B. (1960, 1961)	Evgl, Eco
Requejo, A.G. et al. (1979)	Evgl, Org
Research Planning Institute (1981)	SoFl, Oil
Rio Palenque Research Corp. (in progress)	Keys, WQ
Schomer, N.S. and Drew, R. (1982)	Evgl, Keys, Eco
Thompson, J.H. and Bright, T.J. (1980)	Keys, AqTox
Tripp, M. and Harriss, R.C. (1976)	Evgl, Hg
University of Miami (in progress-2)	Reefs, WQ
US Fish and Wildlife Service (1983)	Keys, SeaGr

Collier and Lee Counties

Collier and Lee Counties, located on the southwest Florida coast, have an extensive barrier island system, resulting in numerous embayments and passes. Unlike many other areas in Florida, attempts have been made to preserve parts of this unique coastal environment.

The J.N. "Ding" Darling National Wildlife Refuge is located on Sanibel Island; the Rookery Bay Sanctuary, a 5,000 acre preserve owned by the National Audubon Society is located in Collier County; the Corkscrew Swamp and the Big Cypress National Preserve are located in both Collier and Lee Counties; and Estero Bay has been designated as an aquatic preserve by the FDNR. Part of Charlotte Harbor is located in Lee County but it is covered separately in the next section of this report.

The major surface water draining this area is the Caloosahatchee River which has been the site of studies performed by the USGS to determine the magnitude and extent of salt water intrusion upstream of Fort Myers (Boggess, 1970a). During periods of low flow, salt water from the tidally influenced portions of the River moves upstream as much as five miles during boat lockages through the W.P. Franklin Dam east of Fort Myers (Boggess, 1970b).

The Rookery Bay area has been the focus of comprehensive environmental and water quality monitoring studies, resulting in a land use plan which called for an extensive preservation area and a buffer zone to maintain the integrity of the estuarine system (Veri et al., 1973; Wycoff and Pine, 1975). A baseline water quality monitoring study conducted since 1980 in Rookery Bay will be useful for establishing the characteristics of a nearly pristine estuary. The data gathered from this study will be used as a basis for comparison for other, more developed estuaries in the same region of the state (FDNR, in progress-1).

Marco Island, south of Naples, Florida, is the site of a large scale planned development where environmental and water quality studies were used to evaluate the density and design of the development plan (Weinstein et al., 1977; Tabb et al., 1977). A feature of the Marco Island Development Plan is the proposed restoration of freshwater inflow to fringe estuarine wetlands that were impacted by previous dredging and construction (Larsen, 1981).

An ongoing water quality study is being performed in Naples Bay to determine changes that occur in the Bay as a result of land use and sewage disposal practices in the drainage basin (Conservancy, in progress). Since 1982, the study has determined the pollutant loadings to the Bay from various land use categories during storm events.

A pesticide monitoring study of the chemical fenthion (Baytex) was performed by the USEPA at Sanibel Island (USEPA, 1976). A thermally generated fog containing the pesticide was aerially applied in Lee County to control mosquitos. The objectives of the study were to confirm insecticide drift and its persistence in the atmosphere; to determine if biological uptake occurred; and to determine the magnitude of thermal oxidation of the pesticide and the amount of pesticide impacting ground and surface waters.

Additional references retrieved for Collier and Lee Counties appear in Table 6. The research performed in these counties has focused on baseline environmental and water quality studies, providing a data base from which future impacts of development can be measured.

Table 6. Literature Citations: Collier and Lee Counties

Boggess, D.H. (1970a, 1970b)	SaltWI
Boggess, D.H. et al. (1977)	SaltWI
Clark, J. (1974)	WQ, Est, PlMgt
Conservancy (1982)	SfcW, WQ
Conservancy (in progress)	WQ
Florida Dept.of Nat. Resources(in progress-1)	WQ
Larsen, P. (1981)	Dev, Est
McCoy, J. (1972)	SfcW, GW, SaltWI
Smith, A.C. and Taylor, R.L. (1972)	IndOr
Tabb, D. et al. (1977)	Eco, Dev
US Environ. Protect. Agency (1976)	AqTox, Pest,IndOr
US Environ. Protect. Agency (1979)	WQ, Eco, Dev
Veri, A.R. et al. (1973)	PlMgt
Weinstein, M.P. et al. (1977)	WQ, Eco, Est
Wycoff, R.L. and Pyne, R.D.G. (1975)	PlMgt

Charlotte Harbor

Charlotte Harbor is a major embayment located on the southwest coast of Florida. Its two main tributaries are the Peace and Myakka Rivers. Historically, the immediate environs of the Harbor were not heavily developed but this is starting to change, perhaps due to the same influences that are stimulating the rapid growth of the Ft. Meyers-Naples area to the south.

Relatively few literature citations were retrieved for this geographical area (Table 7), perhaps due to the lack of significant development in the past. However, the studies that have appeared indicate a concern for potential impacts related to present and future growth in the region. Research has focused on three areas: the impact of land development on water quality; the distribution of hydrocarbons in the sediments; and water quality problems related to the influx of nutrients and other constituents from tributaries.

The impact of shoreline development on aquatic preserves in Charlotte Harbor is being monitored to determine if leases and permits conform with the standards that have been adopted to protect areas that are set aside as preserves (FDNR, in progress-2). Extensive monitoring of water quality in the Harbor is being performed to construct a data base which will be used to assess the impact of increased land development. Included in the monitoring studies are metals, pesticides, radionuclides and physical hydrodynamic data (FDER, in progress-6).

The nature and distribution of hydrocarbons in the sediments of Charlotte Harbor have been surveyed, again to provide background information to be used in the event that some future contamination incident may occur in the area (FDER, 1983a; Van Vleet et al., 1983b). Petrogenic, pyrogenic and biogenic hydrocarbons were assayed in sediment samples collected from over 40 sites in the Harbor. The areas which showed above normal hydrocarbon concentrations coincided with marina, land development and industrial activities. The studies seem to indicate that in subtropical estuaries such as Charlotte Harbor, some type of steady-state situation is established between the rate of influx of hydrocarbons and their rate of degradation by bacteria present in the sediments.

Water quality studies in Charlotte Harbor have emphasized the influx of nutrients, particularly phosphates, from the drainage basin. The major source of phosphate is the Peace River where phosphate levels are influenced by mining activities upstream. The impact of the phosphate discharges was studied by Harriss et al. (1972) who found that the phosphate waste discharges, in combination with domestic wastes, were causing eutrophic conditions to occur in certain areas of the Harbor. Fraser and Wilcox (1981) noted seasonal pulses in nutrients transported by tributaries into the Harbor and found that the wet summer season provided the highest loading of phosphate and nitrate compared to other seasons. Planktonic productivity responded directly to the nutrient pulses. The highest productivity occurs near the tributary mouths and then decreases towards the mouth of the Harbor. The algal populations appeared similar to those found in other Florida estuaries with diatoms being the dominant forms present.

The interrelationships among various chemical parameters (e.g., chelating agents such as organic acids; trace metals such as iron and molybdenum; and orthophosphate) and the physical factors of rainfall and Peace River mean discharge were studied by Kim and Martin (1974). Their research was performed as part of an overall effort to understand the controlling factors involved in outbreaks of red tide organisms in Charlotte Harbor. An index developed on the basis of iron concentrations was found to be useful for predicting the likely appearance of red tide organisms.

Table 7. Literature Citations: Charlotte Harbor

Barnett, B.S. et al. (1980)	IndOr, Eco, Dev
Florida Dept.of Environ.Reg. (in progress-6)	WQ, Est, Mod
Florida Dept. of Nat. Resources (1983a)	HC, Eco
Florida Dept.of Nat.Resources(in progress-2)	Dev, Eco
Fraser, T.H. and Wilcox, W.H. (1981)	WQ, Eco, Phys
Harriss, R.C. et al. (1972)	WwEff, WQ, Eco
Kim, Y.S. and Martin, D.F. (1974)	WQ,SfcW,Met,RedT
Sutcliffe, H. (1975)	GW, SaltWI
Van Vleet, E.S. et al. (1983b)	HC, Est

Sarasota Bay

Compared with Tampa Bay, and even Charlotte Harbor, Sarasota Bay is a much smaller body of water. Yet, Sarasota Bay, located on the southwest coast of Florida, south of Tampa Bay, is similarly experiencing many of the growth-related problems that are occurring elsewhere in this region. The Bay is classified as an estuary and connects with the Gulf of Mexico through three main passes. The Bay is confluent with Tampa Bay through Anna Maria Sound to the north and its waters are influenced by the Manatee River and the waters of the Gulf. Three freshwater streams are tributary to Sarasota Bay (Tiffany, 1980).

Sarasota Bay does not possess any significant water flow-through characteristics, with the result that net tidal transport through the system is minimal. The impact of this physical setting is that any pollutants entering the Bay will have relatively long residence times prior to eventually being flushed out into the Gulf of Mexico.

As might be expected based on the scenario described above, the research that has been performed in Sarasota Bay has emphasized water quality, with particular emphasis on those factors which are closely related to pollutant discharges along the coast line. There is not an extensive bibliography available for Sarasota Bay (Table 8), but it appears that continued growth in the area, accompanied by the release of additional pollutants to the Bay, will stimulte additional work in the future.

The physical circulation properties of Little Sarasota Bay were studied by Camp, Dresser and McKee (1982) who were given the task of developing a hydrodynamic model which would be used to predict the impact of future alterations that occurred in the Bay area and its inlet system. Tidal cycles, bathymetry and currents were measured. The influence of stormwater runoff and land development activities on water quality in the vicinity of the Philippi Creek tributary was addressed as part of an overall "208" plan performed for the area (SWFRPC, 1977). The impact of wastewater effluents discharged to saltwater was addressed as part of a wasteload allocation (WLA) study in which extensive chemical, biological and hydrodynamic data were gathered. A model for Big Sarasota Bay was also developed as part of the overall WLA study (Sarasota County, 1983).

Perhaps the single most comprehensive report relating to water quality in Sarasota Bay was a compilation of a series of studies aimed at assessing the environmental status of the Bay (Tiffany, 1980). The purpose of the report was to provide baseline information on water quality, including data on metals, sediments, seagrasses and other selected components of the marine flora and fauna communities. Turbidity was suggested as being responsible for a decline in the seagrass community, while biological diversity indices indicated that Sarasota Bay is a moderately stressed ecosystem. Of particular interest was the finding of relatively high zinc concentrations in organisms collected from the Bay. While values for other metals seemed to be in the normal background range, the zinc data definitely indicated an anthropogenic influence on the biota (Dickinson and Tiffany, 1980).

Recently, the results of a multi-year monitoring effort performed in coastal Manatee County, including several stations sampled in North Sarasota Bay, were reported (Larkin and Tiffany, 1984). A variety of water quality parameters have been followed on a monthly basis since 1969. Included among these were nutrients, turbidity and dissolved oxygen. This data base will be valuable for assessing the impact of future growth and development on water quality in Sarasota Bay.

While the total amount of information found for Sarasota Bay was not substantial, it appears that there is a sufficient foundation available upon which to build the structure of future research activity. Since the area is experiencing continued growth, it is expected that additional reports will appear in the literature in the coming years.

Table 8. Literature Citations: Sarasota Bay

Camp, Dresser and McKee (1982)	Phys, Mod
Dickinson, K.D. and Tiffany, W.J. (1980)	Met, Eco
Larkin, T.B. and Tiffany, W.J. (1984)	WQ
Sarasota County (1983)	WQ, WLA, Mod, WwEff
Smith, N.P. (1982)	Phys
SWFRPC (1977)	WQ, SfcW, Dev
Tiffany, W.J. (1980)	WQ, Met, Eco

Tampa Bay

Tampa Bay is one of the largest estuaries in the world with a surface area of approximately 400 square miles (TBRPC, 1983). It can be subdivided into a number of distinct water bodies including Old Tampa Bay, Hillsborough Bay, Middle and Lower Tampa Bay and Terra Ceia Bay. Major surface waters that flow into the Bay include the Alafia, Hillsborough, Manatee and Palm Rivers and Booker, Bullfrog and Sweetwater Creeks.

Tampa Bay and its contiguous water bodies have been the site of numerous studies as evidenced by the extensive listing provided in Table 9. A wide range of research has been performed but only some of the water quality studies have had sufficient continuity to provide the level of detail necessary for establishing long-term trends and management strategies.

The long-term water quality monitoring studies include the efforts of Hillsborough County to follow water quality trends starting back in 1972. Approximately 80 sampling stations, located on a county-wide basis, are monitored monthly for a variety of parameters (Hillsborough County, in progress). The results of data collected in 1981 indicate the areas with the poorest water quality include Hillsborough Bay, McKay Bay and portions of Old Tampa Bay (Wilkins, 1982). Since 1973, St. Petersburg has conducted a water quality monitoring program at 13 stations in Tampa Bay and Boca Ciega Bay (St. Petersburg City, in progress). Additional baseline data include a water quality study conducted in 1972 for a three-month period (Goodwin et al., 1975). Continental Shelf Associates (1983b) performed a wasteload allocation study, including an analysis of the seagrass community in Tampa Bay.

The City of Tampa has participated in the National Urban Runoff Program for the purpose of developing sufficient knowledge to control water pollution from urban stormwater runoff (Tampa City, 1983a, 1983b). The first two phases of this study consist of analyzing water quality and quantity. The final phase is the development of a stormwater management plan to address the issues identified in the first two phases. The lower Hillsborough River was the first area studied. Rice (1984) reported that the Hillsborough River investigation involved a combined biological and chemical characterization approach to study the relationship between stormwater runoff and pollution problems in the receiving water body.

Other water quality studies have been concerned with the operations of the Ports of Tampa and Manatee, both located in Tampa Bay. The Port Authority conducts routine water quality and sediment monitoring to provide a data base for permit applications (Tampa Port Authority, in progress). Low levels of dissolved oxygen appear to be a chronic water quality problem for the Port of Tampa (FDER, 1983a). Oxygen depletion, combined with the release of nitrogen from the sediments during maintenance dredging represent potential water quality problems. Mercury and silver levels in the sediments could cause water quality problems during dredging operations if they were released into the water column in Port Manatee. However, there was no indication of problems with organic compounds in the sediments.

Studies relating to dredging and its impact on water quality in Tampa Bay include the work of Lewis (1976) who identified that dredging and filling activities resulted in a greater than 40% loss of the original marine wetlands bordering Tampa Bay; a digital simulation model to determine the effects of dredging on circulation, water quality and biota (Coker et al., 1973); and studies on the benthic environment as it is affected by dredging (Taylor, 1971, 1973).

The presence of sedimentary fluorite in Tampa Bay was studied by Taft and Martin (1974). Samples collected from a discharge canal near a phosphate processing plant indicated that the fluoride concentrations were as much as 40 times greater than those found in normal sea water.

The distribution of hydrocarbons in Tampa Bay, the lower Hillsborough River and Charlotte Harbor was assayed by Pierce et al. (1984). They identified oil pollution from specific land and water use activities and provided baseline information for oil contamination in those bodies of water. Van Vleet and Reinhardt (1983) investigated the inputs and fates of hydrocarbons in Tampa Bay. Their data indicated that the Bay was relatively pristine in terms of hydrocarbon levels in the sediments. Since these findings were not anticipated, they hypothesized that elevated annual temperatures in the Bay, compared with those found in more northern environments, resulted in increased microbial metabolic degradation rates.

A series of hydrographic observations in Tampa Bay and the Gulf of Mexico, including extensive collections of water quality data over a several year period, were conducted by Saloman and Taylor (1971a, 1971b, 1972) and Saloman (1973, 1974). Their work provides an excellent historical baseline for future reference purposes.

Studies concerning the outbreak of red tide, a phenomenon that affects Tampa Bay and major portions of the west coast of Florida were reported by Steidinger and Ingle (1972) and Blogoslawski et al. (1975). A 3.5 month red tide occurred in the summer of 1971 in Tampa Bay. Several conclusions were offered, based on observations made during this outbreak. These include: pollution does not necessarily trigger a Florida red tide; <u>Gymnodinium Breve</u> (now known taxonomically as <u>Ptychodiscus brevis</u>) blooms almost annually and may bloom from a resident cyst population; and the major red tides can be predicted by monitoring programs. Recent publications dealing with the red tide phenomenon are listed in FDNR (1983b).

Numerous planning and management studies have been prepared on the Tampa Bay system. A significant document is the 208 Areawide Water Quality Management Plan (TBRPC, 1978) which identified point and non-point sources of pollutants entering the Bay and developed general management objectives to address problem areas. An updated management plan for the Bay was recently completed (TBRPC, 1983). The Tampa Bay Area Scientific Symposium held in 1982 summarized essentially all available scientific information and data relevant to Tampa Bay. A major conclusion from the Symposium was that scientists and managers must take a comprehensive view when making decisions affecting the Bay (Simon, et al., in press).

It appears from this discussion of the extensive work performed on Tampa Bay that there is an adequate understanding of the problems facing the Bay but that proposed solutions and their implementation take time to put into practice. Continued emphasis on water quality studies will provide the data needed in the future to determine if the Bay's water quality has responded favorably to the various remedial actions that have been, or will soon be taken.

Table 9. Literature Citations: The Tampa Bay Area

Ankerberg, C.W. (1983)	Eco, IndOr, WwEff
Blogoslawski, W.J. et al. (1975)	RedT, AqTox
Coker, A.E. et al. (1973)	WQ, Phys, Eco
Collins, L.A. and Finucane, J.H. (1974)	WQ
Continental Shelf Associates (1983b)	WQ, SeaGr, WLA
Continental Shelf Associates (1984)	WQ, WLA
Fanning, K.A. and Bell, L.M. (1982)	WQ
Florida Dept. of Environ. Reg. (1983a)	Port
Goodwin, C.R. et al. (1975)	WQ, Mod
Hillsborough County (1974)	Dev, Est
Hillsborough County (in progress)	WQ
Hutchinson, C.B. and Stewart, J.W. (1978)	GW, WQ
Lewis, R.R. (1976)	WQ
Olson, K.S. and Reynolds, J. (1984)	Met, Eco
Pierce, R.S. et al. (1984)	Oil, HC
Rice, S. (1984)	SfcW, Eco, AqTox
Saloman,C.H. and Taylor,J.L.(1971a,1971b,1972)	WQ
Saloman, C.H. (1973, 1974)	WQ
Simon, J.L. (1974)	WQ
Simon, J.L. et al. (in press)	WQ
Smolenyak, K.J. et al. (1980)	Dev, SfcW, Mod
Steidinger, K.. and Ingle, R.M. (1972)	RedT
Stiles, C.D. and Blake, N.J. (1976)	Eco, Therm
St. Petersburg City (in progress)	WQ
Studt, J.F. and Blake, N.J. (1976)	Eco, Therm, AqTox
Taft, W.H. and Martin, D.F. (1974)	WQ,WwEff
Tampa City (1983a, 1983b)	WQ
TBRPC (1971)	Dev, PlMgt
TBRPC (1978)	WQ, PlMgt
TBRPC (1982)	Dev
TBRPC (1983)	PlMgt
TBRPC (in progress-1)	PlMgt
TBRPC (in progress-2)	Dredg

Tampa Port Authority (1983)	Port
Tampa Port Authority (in progress)	WQ, Port
Taylor, J.L. et al. (1971)	Eco, WwEff, Dredg
Taylor, J.L. et al. (1973)	SeaGr, Dredg
Van Vleet, E.S. and Reinhardt, S.P. (1983)	Oil, HC, WwEff
Wilkins, R.G. (1981)	WQ

Crystal River

The main focus of research activity in the Crystal River area on the west central coast of Florida has been the potential impacts of thermal and radiological discharges from a power plant facility. The facility produces electricity using both coal-fired and nuclear powered generators.

There were relatively few literature citations retrieved for this area by the procedure employed during this project (Table 10). However, since power plants, and nuclear facilities in particular, have substantial monitoring obligations as conditions of their operating permits, it is assumed that there have been many monitoring reports prepared by contractors for the operators of the power plant facility. These reports are not always widely available although they must certainly contain considerable environmental monitoring data. The reports are usually reviewed by state and federal regulatory agencies.

A long-term radiological monitoring program has been performed by the University of Florida (Bolch, 1973; Bolch et al., 1970) wherein the environs of the nuclear power plant have been sampled on a regular basis for radioisotopes that might have been released from the plant. The literature does not show evidence for any measurable accumulation of radioactivity in the vicinity of the plant.

Thermal effects studies, as they have often been called, were conducted in the area of the power plant. Previously, there was considerable concern for the possible deleterious environmental impact of waste heat released through cooling water systems. Physical dispersion models have been constructed (Carder et al., 1976) and biological studies have been performed (Grimes, 1971; Grimes and Mountain, 1971). One study found that salinity was a more significant factor in the distribution of invertebrates than was the temperature of the water (Lyons et al., 1971).

Recently, a rather ambitious project was completed which addressed the issue of the protection of manatees which inhabit the Crystal River area during certain periods of the year (Packard, 1983). Given the endangered status of manatees, studies such as this add greatly to our understanding of the ecology of these marine mammals.

Table 10. Literature Citations: Crystal River

Bolch, W.E. (1973)	Rad, Eco,SeaGr
Bolch, W.E. et al. (1970)	Rad, Eco, WQ
Carder, K.L. et al. (1976)	Mod, Therm, Phys
Grimes, C.B. (1971)	Therm, Eco, Met, WQ
Grimes, C.B. and Mountain, J. (1971)	Therm, Eco, WQ
Lyons, W.G. et al. (1971)	Therm, Eco, WQ
Mountain, J.A. (1972)	Therm, Eco, WQ, Met
Packard, J.M. (1983)	PlMgt, Eco

Apalachee Bay

Apalachee Bay is an embayment located between Wakulla and Taylor Counties in north Florida. The Aucilla, Fenholloway and Ecofina Rivers drain into its waters. The proximity of Apalachee Bay to Tallahassee apparently has been a stimulus to scientists from Florida State University who performed the research which has been reported for this area.

The studies conducted on Apalachee Bay have emphasized the impact of pulp mill effluents on the biota of the bay. A seven-year study of epibenthic macroinvertebrates compared an unpolluted area in the Ecofina River with a polluted area in the Fenholloway River. This study, performed by Dugan and Livingston (1982), indicated that areas of acute pollution had extremely low biomass and showed characteristic macrophyte species. Comparisons of the constancy of species composition over the study period as well as changes in species rankings following a pollution abatement program in the Fenholloway River showed that there was enhanced species persistence in the unpolluted area.

In conjunction with the above report, it was postulated that selective removal of dominant species by bleached kraft mill effluents allowed recruitment of various anomalous species in areas of chronic impact. This contributed to unusual patterns of community structure as compared with published data from other pollution stressed aquatic systems (Zimmerman and Livingston, 1979). In another study, Heck (1976) investigated community structure and seagrass meadows and found that several commonly used indicators of pollution stress were ineffective in differentiating contaminated areas from control areas.

While Apalachee Bay has not received the same extensive study that other areas in the state have seen, the studies which were identified in the literature review indicate that a relatively intensive effort has been performed to assess the impact of pulp mill effluents on the biota.

Table 11. Literature Citations: Apalachee Bay

Dugan, P.J. and Livingston, R.J. (1982)	IndOr, PME
Heck (1976)	IndOr, PME
Zimmerman, M.S. and Livingston, R.J. (1979)	IndOr, PME

Apalachicola Bay

Apalachicola Bay, located in northwest Florida, is the estuarine terminus of the Apalachicola, Chattahoochee and Flint River system. The Apalachicola River has the largest annual discharge of Florida's rivers and is the only Florida drainage system having its origin at the base of the Appalachian Mountains. The Apalachicola Bay system is composed of six major subdivisions: the Apalachicola River delta, East Bay, Apalachicola Bay, St. Vincent Sound, St. George Sound and Alligator Harbor. Apalachicola Bay is the center of a significnt oyster fishery of great economic value. Thus, it is critical that the factors affecting water quality in the Bay be understood and that the water quality be maintained at a level high enough to sustain the oyster fishery.

The Apalachicola Bay system appears to be the most comprehensively studied water body in Florida. Continuous water quality monitoring has been performed there since 1972. Extensive interdisciplinary research activities have been conducted as evidenced by the listings provided in Table 12. Scientists from Florida State University have provided the main thrust of the research on the Bay, particularly through the influence of R.J. Livingston. The recently published Resource Atlas of the Apalachicola Estuary provides a comprehensive data base which translates a significant collection of technical material into an easily readable form (Livingston, 1983a). That publication contains a master bibliography of essentialy all of the technical research that has been performed on the Bay. Accordingly, anyone interested in that bibliography should consult Livingston (1983a). Because Livingston's document is so thorough, we will highlight only a portion of the studies here.

The majority of the studies conducted on Apalachicola Bay have been concerned with water quality monitoring and baseline environmental studies. A long-term network of monitoring studies has been established and is still maintained, with the principal aim of protecting the oyster fishery from pollutant sources (Livingston, 1983c, in progress). The effects of forestry operations and management practices in the drainage basin on the water quality of the Bay have been studied (Hydroscience, 1977; Livingston, 1978). Nearly 80% of the land in the Apalachicola Basin is used for forestry and agriculture. The economy of Franklin County is thus apparently dependent on both terrestrial and marine harvesting. It is interesting to note that Franklin County has supported some of the research performed on the Bay.

Other water quality monitoring studies have included a Lower Chipola River Basin Assessment (FDER, 1984b) which investigated the effects of heavy metal pollution on the lower part of the Chipola River and Apalachicola Bay; and water quality and sediment analyses of Old Pass Lagoon (Florida State University, 1984).

Studies concerning the effects of dredging on the water quality of Apalachicola Bay have been conducted for several years (USACOE, 1975, 1976, 1980; Livingston, 1984). Baseline environmental studies include the early work of Ingle and Dawson (1953) and an environmental impact assessment performed by the US Dept. of Commerce (1979). Several modeling activities have been completed, including a hydrodynamic/water quality model (University of Florida, 1981); the verification of an estuarine model for the Bay (Graham et al., 1978); the use of enhanced LANDSAT images for calibrating a real time water quality model (Hill and Graham, 1980); and the implications of temporal variations in the system as they relate to biological sampling strategies (Livingston, 1977a).

Considerable effort has been expended on studies of the effects of pollutants on the biota in the Bay. Livingston et al. (1976) determined the relationship of laboratory avoidance reactions of estuarine organisms to the field reactions of the organisms toward stormwater runoff and pulp mill effluent. The field reactions of blue crabs and pinfish to these pollutant sources were monitored in both Apalachicola and Apalachee Bays.

A four-year study of the organochlorine residues (DDT series, PCBs, mirex) was centered on epibenthic organisms in Apalachicola Bay. Livingston et al. (1978) attributed the decline in these residues over time to decreased upland usage and a major flushing of the river basin in 1973. A change in the dominant species and overall species diversity during the study period was also noted. Efforts aimed at discovering the cause of oyster depletion several years ago were performed by Menzel et al. (1958, 1966).

Numerous planning and management reports have been compiled which utilized the extensive data base that has developed from all of the water quality studies. A conference on the Apalachicola drainage system, held in 1976, provided an excellent summary of work available at the time (Livingston and Joyce, 1976). Another conference was held in 1982 to follow up the earlier one, this time addressing the Bay from the perspective of the oyster industry (Andree, 1982).

In 1972, the Apalachicola National Estuarine Sanctuary was created, apparently becoming one of the largest of its kind in the counry. The FDNR (1982) prepared a management plan for the Sanctuary. Many other management programs have addressed the problems of protecting a valuable economic, ecologic and aesthetic resource (Livingston, 1975, 1983; Livingston et al., 1975; Whitfield and Beaumariage, 1977).

In summary, the research on Apalachicola Bay has addressed a wide range of problems. The interdisciplinary approach used has provided excellent information, allowing the management of the Bay's aquatic resources to be based on sound scientific principles. The Apalachicola Bay research record is an excellent model after which similar programs in related environmental settings should be patterned.

Table 12. Literature Citations: Apalachicola Bay

Andree, S. (1982)	IndOr
Florida Dept. of Environ. Reg. (1984b)	WQ, Met
Florida Dept. of Nat. Resources (1982)	PlMgt
Florida State University (1984)	WQ,Met, Org
Graham, D.S. et al. (1978)	Mod, Phys
Hill, J.J. and Graham, D.S. (1980)	Mod, Est
Hydroscience (1977)	WQ, Eco
Ingle, R.M. and Dawson, C.E. (1953)	WQ, Eco
Laughlin, R.A. et al. (1978)	IndOr, SfcW
Livingston, R.J. (1975)	PlMgt, Eco
Livingston, R.J. (1976)	Eco, IndOr, Est
Livingston, R.J. (1977a)	Eco, IndOr, Est
Livingston, R.J. (1977b)	Est
Livingston, R.J. (1978)	WQ, Eco
Livingston, R.J. (1983a)	Eco,WQ,PlMgt,IndOr
Livingston, R.J. (1983b)	PlMgt
Livingston, R.J. (1983c)	WwEff, Mar, Dev
Livingston, R.J. (1984)	Dredg,Eco
Livingston, R.J. (in progress)	WQ, IndOr
Livingston, R.J. and Joyce, E.A. (1976)	PlMgt, WQ
Livingston, R.J. and Thompson, N.P. (1975)	PlMgt, IndOr
Livingston, R.J. et al. (1975)	Eco, PlMgt
Livingston, R.J. et al. (1976)	IndOr, SfcW, PME
Livingston, R.J. et al. (1978)	Pest, IndOr, WQ
McFarlane, R.B. (1980)	Eco, WQ
Menzel, R.W. et al. (1958)	IndOr
Menzel, R.W. et al. (1966)	Eco, WQ
US Army Corps of Engrs. (1975)	Dredg, Eco
US Army Corps of Engrs. (1976)	EIS
US Army Corps of Engrs. (1980)	Dredg
US Dept. of Commerce et al. (1979)	EIS
University of Florida (1978, 1981)	Mod, SQ, SfcW
Whitfield,W.K. and Beaumariage,D.S. (1977)	PlMgt, IndOr

Panama City

Panama City is located on St. Andrew Bay in northwestern Florida. The St. Andrew Bay system is composed of North, East and West Bay and Grand Lagoon. Drainage from the Choctawhatchee and East Rivers flows into the West Bay area. Relatively limited research has been performed in this area based on the few citations found during this review (Table 13).

Two environmental impact statements were prepared by the USACOE (1971a, 1971b) to determine the impacts of channel deepening and enlargement projects in St. Andrew Bay and Grand Lagoon. Grand Lagoon, an arm of St. Andrew Bay opposite from Panama City, serves as the operating base for commercial and recreational fishing vessels. Channel enlargement would prevent loss of the existing channel and accommodate more recreational vessels while deepening of the channel in St. Andrew Bay would improve flushing of the waters which contain nutrients from wastewater discharges. The projects were designed to meet the future navigational and recreational needs of the Panama City area.

The Department of the Air Force (1972) prepared an environmental impact statement for construction of a secondary wastewater treatment plant at Tyndall AFB which is located on Santa Rosa Island between East Bay and the Gulf of Mexico. The EIS quantified the impacts resulting from the construction and operation of a secondary wastewater treatment plant. The treated effluent is discharged into St. Andrew Bay.

A special study to determine the effects of pulp mill and sewage effluents on the water quality of St. Andrew Bay was recently performed (FDER, 1984c). A baseline environmental study, including aquatic toxicological experiments, was performed near a US Navy research platform offshore from Panama City (Potomac Research Inc., 1978). The project included short-term bioassays, community studies and invertebrate identifications.

Bay County, adjacent to the study area, had its groundwater resources cataloged by the USGS (Foster, 1972). An atlas was prepared which included information such as the depth of the Floridan Aquifer, the types of rock penetrated, levels of dissolved minerals in the water and the location of good quality water. Groundwater adjacent to the Gulf and the Bay system is not potable, having chloride concentrations about 1,000 mg/L.

Since research activity in the Panama City area has not been extensive, the focus to date has been on water quality issues related to effluent discharges.

Table 13. Literature Citations: Panama City

Dept. of the Air Force (1972)	WwEff, EIS
Florida Dept. of Environ. Reg. (1984c)	StAnd, WwEff, PME
Foster, J.B. (1972)	GW, SaltWI
Lo, K.-M. et al. (1976)	WQ, Phys, Mod
Potomac Research Incorp. (1978)	Eco, AqTox
US Army Corps of Engrs. (1971a)	StAnd, EIS, Dredg
US Army Corps of Engrs. (1971b)	StAnd, EIS, Dredg

Choctawhatchee Bay

Choctawhatchee Bay, located in northwest Florida, is a hypopycnal lagoon that is connected to the Gulf of Mexico via East Pass. East Pass Lagoon (Destin Harbor) opens into Choctawhatchee Bay just north of East Pass. The Choctawhatchee River drains into the eastern portion of the Bay which itself is separated from the Gulf of Mexico by Santa Rosa Island.

Sonu and Wright (1975) investigated the interaction among tides, water density, longshore currents and wave and wind patterns associated with East Pass inlet. The land breeze and instability at the boundary between the nearshore effluent pool and the undiluted offshore water are two important factors that affect dispersion in the area.

A two-phase project involving East Pass Lagoon was conducted to determine existing water quality, to evaluate the land and water uses and to identify water quality impacts based on future land use projections. East Pass Lagoon is subject to minimal flushing, resulting in stagnant areas in the eastern area where almost anoxic conditions prevail. A land use/water quality model was established for the lagoon. The results indicated that the area draining US Highway 98 has a much greater impact on water quality compared with any other sources investigated. Also, the model predicted that impacts associated with runoff from upland development in the Destin area would have a greater potential to adversely affect water quality in the lagoon than boating activities (Florida State University, 1982).

The NWFWMD (1984) is studying the water and sediments in Choctawhatchee Bay to determine the cause of a major fish kill that occurred in 1982. A number of water quality parameters are being analyzed. Cooper and Livingston (in progress) are assessing water quality in the East Pass Lagoon.

Research in this area has been limited as seen from the relative paucity of references available (Table 14). However, a good water quality data base is being gathered and this should prove useful in efforts to guide future land use activities in the region.

Table 14. Literature Citations: Choctawhatchee Bay

Cooper,W.T. and Livingston,R.J.(in progress)	WQ, Org
Florida State University (1981)	WQ, Eco, Phys
Florida State University (1982)	WQ,PlMgt,Dev,Mod
NWFWMD (1984)	WQ, IndOr, HC
Sonu, C.J. and Wright, L.D. (1975)	Mod, Phys

Escambia and Pensacola Bays

Escambia and Pensacola Bays are located in the extreme northwestern section of Florida's panhandle. The port city of Pensacola is located on Pensacola Bay. The Yellow, Blackwater and Escambia Rivers drain into the greater Escambia-Pensacola Bay area.

A variety of studies have been performed in this region (Table 15). The focus of the research has been primarily water quality and pesticide monitoring. The water quality, including nutrient levels of the Escambia River was compared with the water quality of other rivers and streams in northwest Florida (USEPA, 1972b). The study showed that the quality of most of the streams was comparable, although significant differences existed when the data were converted to actual loading rates when considering flow data.

Moshiri et al. (1972, 1978) investigated the extent of nitrogen and phosphorus inputs and their effects on algal productivity in Bayou Texar. The nitrogen and phosphorus concenrations decreased toward the south in the bayou, apparently being related to carbon fixation rates.

The isolation of bacteria capable of degrading nitriloacetate was attempted by Bourquin and Przybyszewski (1976, 1977) but apparently without much success. Earlier, the FWPCA (1970) and Hall (1972) studied wastewater discharges into Escambia and Pensacola Bays. Inadequately treated pulp mill effluent was identified as a major source of low dissolved oxygen concentrations, foam and increased sludge deposits. Atlantis Scientific (1976b) attempted to assess the anticipated environmental impacts of the theoretical achievement of the requirements of PL92-500 which was passed in 1972. The study characterized historical and existing water quality in the area and projected future water quality on the assumption of specific levels of wastewater treatment being attained.

The concentrations of chlorinated organic compounds (DDT, PCBs) have received interest in the Escambia Bay area. Duke et al. (1970) found Aroclor 1254 in the water, sediment and biota. The maximum concentration of the PCB found in shrimp collected from Escambia Bay was 2.5 ppm. The significance of the PCB content in the shrimp was assessed by performing controlled laboratory experiments (Nimmo et al., 1971). Hansen and Wilson (1970) monitored pesticide residues from fish collected in an estuary near Pensacola and compared them with residues in fish exposed to DDT in the laboratory. The fish collected from the estuary rarely had more than 0.1 ppm of the DDT. Spanish mackeral showed an average PCB concentration of less than 1 ppm based on studies reported by Gadbois and Maney (1983) for fish collected from East Bay in 1979 and 1981.

Escambia and East Bays have experienced severe vegetation losses since 1949. A comparison of aerial photos from 1949 and 1974 indicated that all of the seagrass beds were gone except for one bed in East Bay. The loss of seagrass was ascribed to the synergistic effects of sewage and industrial effluents, dredging and filling, beachfront alterations and changing watershed characteristics (Rogers and Bisterfeld, 1975).

The Florida DER studied water quality in the Port of Pensacola as part of the broader deepwater ports study (FDER, 1983a). The data indicate that metal levels in the water column were low except for mercury which exceeded Florida standards at the port berthing area, although no adequate explanation was available for this finding. Concentrations of organics in the water were all low. The sediments did not have serious concentrations of metals although cadmium and silver appeared elevated above normal values. It was estimated that dredging might cause water quality problems due to enriched oxygen demanding materials and nutrients in the bottom sediments. Elutriate tests confirmed the potential for the sediments to release nutrients.

The research in these Bays has focused on the impact of effluent discharges, perhaps reflecting activities in an active port environment. Concern for the presence of chlorinated organics and their toxicity has been evident, likely related to the existence of the USEPA laboratory at Gulf Breeze and its very active research program.

Table 15. Literature Citations: Escambia and Pensacola Bays

Ahearn, D.G. et al. (1977)	Eco, WQ, Org
Atlantis Scientific (1976b)	WQ, Eco, WwEff
Bourquin, A.W. and Przybyszewski, V.A.(1976)	WQ
Bourquin, A.W. and Przybyszewski, V.A.(1977)	WQ, Eco
Cantelmo, F.R. and Rao, K.R. (1978)	Org, Eco, AqTox
Cantelmo, F.R. et al. (1979)	WQ,Eco, AqTox
Duke, T.W. et al. (1970)	PCB
FWPCA (1970)	WwEff, PME, WQ
Florida Dept. of Environ. Reg. (1983a)	Port
Gadbois, D.F. and Maney, R.S. (1983)	PCB, IndOr
Hall, J.S. (1972)	WwEff, WQ
Hansen, D.J. and Wilson, A.J. (1970)	Pest, AqTox
Moshiri, G.A. et al. (1972, 1978)	WQ, Eco
Moshiri, G.A. et al. (1980)	WQ
Nimmo, D.R. et al. (1971)	PCB, AqTox, IndOr
Rogers, R.G. and Bisterfeld, F.T. (1975)	SeaGr, WwEff, Dredg
Tagatz, M.E. et al. (1974)	Pest, AqTox, Est
US Environ. Protect. Agency (1971)	Phys, WQ, IndOr
US Environ. Protect. Agency (1972b)	WQ
Vashon, R.D. and Schwab, B.S. (1982)	WQ, Org

Gulf of Mexico

In addition to the research reports discussed under the various geographical areas that are located on Florida's west coast, a number of references were identified that did not specifically fall into any one of those areas. As a result, they were grouped together under the heading of "Gulf of Mexico" since the reports were generally oriented to this body of water.

By far the largest number of reports for a given topic in the Gulf of Mexico involves petroleum hydrocarbons and oil spills. This is consistent with the significant amount of crude oil production that is occurring in the Gulf as well as the increased leasing and exploration activity that has been experienced in recent years. Also, the impact of the IXTOC-1 blowout and tanker spills have created anxiety among coastal states for the fate of the marine resources in their coastal zones and the aesthetic quality of their beaches.

Research has been performed in conjunction with OCS leasing (Alexander et al., 1977; Continental Shelf Associates, 1981b, 1982, 1983c, 1984b) and concern for coastal zone impacts (Jones, 1974). The distribution of hydrocarbons in areas of the Gulf has been assessed by Lytle and Lytle (1976) as well as Lissauer and Welsh (1975) and Sackett (1974). The impact of hydrocarbons on fisheries resources was addressed by Austin (1970). The distribution of crude oil residues was studied in an extensive project by the Florida Institute of Oceanography (1982, 1983). This group is also studying the use of satellite data for tracking the movement of hydrocarbons in the Gulf.

Another topic that has been widely addressed in the Gulf of Mexico is the red tide phenomenon. This has been mentioned earlier in connection with the Tampa Bay area and is also covered in the Florida (no specific area) section which follows shortly. Among the notable reports that were retrieved was the study by Abbott (1975) who compared the Florida-Gulf organisms with those identified in red tides in California waters. The response of red tide organisms to municipal waste materials was studied by Doig and Martin (1974) while Moon et al. (1980) reported on compounds in marine sediments that were cytolytic toward the red tide organism. The ecology of a lesser known red tide organism that was implicated in a fish kill was noted by Williams and Ingle (1972).

Finally, a topic which has not received much notoriety as yet in Florida coastal zone research is the occurrence and distribution of radioactive substances. There appears to be a combination of natural and human activity involved, with the radioisotopes originating from natural geochemical discharges to coastal waters and also through mining activities wherein radioactive material is released during recovery of economically useful minerals. Papers by Fanning et al. (1982a) and Mo (1971) relate to this issue.

The emphasis on petroleum hydrocarbon and red tide studies has dominated the literature found for the Gulf of Mexico. With the availability of the NOAA (1983a, 1983b) studies, a considerable improvement in our understanding of contaminant issues in the Gulf has occurred. As petroleum related activities increase in future years, we can expect to see continued research emphasis placed on this topic, particularly in terms of the interaction of the petroleum hydrocarbon residues with biota, especially fish and shellfish.

Table 16. Literature Citations: Gulf of Mexico

Abbott, B.C. (1975)	RedT
Alexander, J.E. et al. (1977)	WQ, OCS, HC
Austin, H.W. (1970)	IndOr, OCS
Continental Shelf Associates (1981b)	IndOr, OCS, Phys
Continental Shelf Associates (1982, 1983c, 1984b)	OCS, Eco, Phys, WQ
Doig, M.T. and Martin, D.F. (1974)	RedT, WwEff
Fanning, K.A. et al. (1982a)	Rad
Fanning, K.A. et al. (1982b)	WQ, Phys
Florida Institute of Oceanography (1982)	Oil, HC, OCS
Florida Institute of Oceanography (1983)	Oil, HC, OCS
Florida Institute of Oceanography (in progress)	Oil, HC, Phys
Gearing, P. et al. (1976)	HC
Jones, J.I. (1974)	HC
Lissauer, I.M. and Welsh, J.P. (1975)	Oil, Phys, Mod, Port
Lytle,T.F. and Lytle, J.S. (1976)	HC
Mo, M.T. (1971)	Rad
Moon, R.E. et al. (1980)	RedT
NOAA (1983a)	PlMgt, Eco, WQ, HC
NOAA (1983c)	PlMgt, WQ, Phys, OCS
Rice, S. et al. (1982)	Eco, Dredg, Phys
Sackett, W.M. (1974)	HC, OCS
Stelzenmuller, W.B. (1965)	Phys, Est
US Dept. of the Interior (1973)	EIS, OCS
US Dept. of the Interior (1984a)	PlMgt, Oil, Eco, Mod
US Dept. of the Interior (1984b)	PlMgt, Oil, WQ, Phys
Van Vleet, E.S. et al. (1981)	Oil, HC
Van Vleet, E.S. et al. (1983a)	Oil, HC
Williams, J. and Ingle, R.M. (1972)	RedT

Atlantic Ocean

Very few literature citations were retrieved for the Atlantic Ocean in the vicinity of Florida. Obviously, one might expect that a considerable amount of research has been performed in these waters but the manner in which our literature review was performed necessarily restricted the retrievals to those reports which appeared to have some connection with the coastal zone. Thus, open water studies were not considered in this review. The reports listed in Table 17 are provided here simply to report their existence in the event someone might be interested in their contents. Reports of research performed in Florida's Atlantic coastal waters appear in this report under the coastal geographic section to which they most logically belong.

The most significant of the reports listed in Table 17 is the Final EIS for an OCS sale (USDOI, 1983). The EIS describes the physical, biological and socio-economic environments that would potentially be impacted by this sale. A detailed list of impacts that would occur to each resource as a result of the proposed sale is identified. The EIS contains a list of alternatives to the sale with a summary of the environmental consequence for each alternative.

The Eastern U.S. Coastal and Ocean Zones Data Atlas (Ray et al., 1983) is a data base used to identify areas of the East Coast which are least suitable for major energy development and to identify those areas that should be further analyzed for special protection status because of their ecological importance.

Basta et al. (1983) prepared a framework to comprehensively assess the potential effects on living marine resources of increased use of the ocean for waste disposal. Sludge production for the years 1980 and 2000 were calculated for 163 coastal counties. A number of potential locations for dumpsites were evaluated based on transportation costs, biological impacts and economic characteristics of each dumpsite.

A study by Manheim et al. (1970) surveyed the continental margin of the Atlantic Coast from Cape Code to the Florida Keys to determine the concentration and circulation pattern of suspended particles. The survey concluded that particles which escape estuaries or are discharged from rivers into the Continental Shelf region travel along the shore rather than move seaward. The particles were predominantly amorphous organic matter.

The few studies discussed in this section appear to relate to human activities as they affect marine resources.

Table 17. Literature Citations: Atlantic Ocean

Basta, D.J. et al. (1983)	PlMgt, WQ, WwEff
Manheim, F.T. et al. (1970)	WQ, Keys, Phys
Ray, G. et al. (1983)	WQ, PlMgt, Eco, OCS
US Department of the Interior (1983)	EIS, OCS

Florida (no specific area)

During the literature review, a significant number of papers and reports were retrieved which were not easily assigned to one of the geographic areas that have been discussed to this point. Accordingly, these references have been collected and placed in this broad category that has been titled simply "Florida (no specific area)." The references included in this section are listed in Table 18.

As might be expected, the main categories into which the references fall reflect those that have been discussed often within each of the geographical areas preceding this section. There are citations dealing with coastal development and its impact on nearby waters; the impacts of oil spills and tar balls; issues related to Florida's coastal management programs; studies involving trace metals; agency monitoring reports for metals and organics; general reports on the red tide; and literature reviews and summaries of organizational publications that relate to coastal issues. Each of these will be briefly discussed below.

The impact of urban development and its role in altering hydrologic cycles and introducing pollutants into storm water was reviewed by Alverson and Wilcox (1977). The continued conversion of coastal wetlands into developed areas and the activities of coastal canal construction and their ecological impact were criticized in two reports (Anonymous, 1972; BSFW, undated). The severe impacts on organisms in these altered areas are detailed.

The Florida Coastal Management Program (CMP), its attempts to develop into a meaningful governmental activity, and the voices of its critics have all appeared in the literature. There are some 10 state agencies involved in coastal activities in Florida, with the result that an Interagency Management Committee (IMC) was formed to coordinate their activities. An analysis of the origins and actions of the Florida CMP was provided by Welch (1976) while a more critical assessment was prepared by McCann (1978) who concluded that the Florida CMP would be ineffective.

A thoroughly researched critique of the CMP was presented by Guy (1983) who analyzed the development of coastal legislation in Florida and who subsequently concluded that the state would have to develop or clarify certain basic policy decisions prior to the program becoming as effective as possible. Comparisons between Florida's CMP and coastal programs from other states were made. A recent conference held on Sanibel Island discussed the status and future directions of policy towards Florida's coasts. Belsky and Gaster (1984) summarized this conference and their report is an excellent transcription of the presentations and discussions that occurred at the conference.

Research on the distribution and environmental fate of trace metals has been a popular topic. Metals in sediments were addressed by Pilotte et al. (1978) while the conversion of tin in coastal waters were reported by Byrd and Andreae (1982). The interaction of mercury with estuarine plant detritus was the subject of a paper by Lindberg and Harriss (1974b).

Considerably more data on metals was provided in reports provided by Florida agencies. The FDHRS (in progress) is investigating metals in shellfish while a substantial number of analytical results have been developed by the FDER under individually authored reports (Bricker et al., 1982, 1983; Pan et al., 1981, 1982; Stephens et al., 1981, 1983). These reports contain data from FDER monitoring stations and special investigations. Data on organic chemicals and metals are included in these reports. Specific "hot spots" are identified when concentrations for elements or compounds exceed normal background concentrations or exceed state standards.

The Florida red tide is famous throughout the world, in part because of the amount of research that has been focused on it and also because of the ecological and economic damage that is created when a red tide outbreak occurs. An extended red tide occurred in 1971 and its impacts were reviewed by Habas and Gilbert (1974). Earlier work on the red tide was summarized by Hutton (1956) while current research activity has originated primarily through scientists at the FDNR Marine Laboratory (Roberts et al., 1977; Steidinger, 1975; Steidinger and Joyce, 1973) and the University of South Florida (Ingle and Martin, 1971). Additional red tide references were listed earlier in Tables 9 and 16 in the Tampa Bay and Gulf of Mexico sections, although it should be noted that these are not complete listings of red tide research in Florida.

Compilations of research and monitoring activity have finally begun to appear in print. The FDNR Marine Laboratory published a summary of its many reports (FDNR, 1983b); likewise, the Florida Sea Grant Program has distributed a listing of its research publications (FSG, 1983). Throughout this report, numerous references have been made to the NOAA (1984) inventory of non-federally funded research projects. A complete description of this document was provided in the introduction to the literature review. Recently, the most comprehensive report retrieved was the 1984 Bibliography of Water Resource Investigations (FDER, in press). Several other bibliographies were useful in obtaining references on research conducted in Florida. A discussion of these was also provided in the introduction to the literature review.

In summary, the Florida (no specific area) section is a general overview of the topics and issues that were discussed within each geographical section earlier. Of particular interest is the finding that Florida agencies have realized the importance of gathering past work into accessible references and the efforts of the FDER, in particular, stand out as a significant contribution in the area of water resources information for the State of Florida.

Table 18. Literature Citations: Florida (no specific area)

Alverson, K.A. and Wilcox,W.H. (1977)	PlMgt,WQ
Anderson, W.D. (1970)	Therm, WQ
Anonymous (1972)	Eco, Dev, Dredg, WQ
Anonymous (1974a)	Oil, WQ, PlMgt
Anonymous (1974b)	WwEff, Oil, WQ
Baker, P. (1977)	Est, SfcW, PlMgt
Belsky, M.H. and Gaster, C. (1984)	PlMt, Est, Dev
Bricker, B. et al. (1983)	Met, Org, Pest
Bricker, J.L. et al. (1982)	Met, Org
BSFW (undated)	IndOr, Eco, Dev, Dredg
Byrd, J.T. and Andreae, M.O. (1982)	Met, Est
Colton, J.B. et al. (1974)	Org, WQ
Cordes, C. et al. (1980)	Oil, Phys
Dawes, C.J. and McIntosh, R.P. (1981)	Eco, Org, Est
FWPCA (1968)	Est, WQ
Florida Attorney General (1973)	WQ, WwEff, Oi
Florida Dept. of Administration (1975)	PlMgt, Eco, WQ
Florida Dept. of Community Affairs (1984)	PlMgt, OCS
Florida Dept. of Environ. Reg. (in press)	WQ, GW, SfcW, Est
Florida Dept. of Health Rehab. Svcs. (in progress)	IndOr, Met
Florida Dept. of Nat. Resources (1983b)	IndOr, WQ, Eco, RedT
Florida Sea Grant Program (1983)	IndOr, Mar, Dev, Port
Guy, W.E. (1983)	PlMgt, Est
Habas, E.J. and Gilbert,C.K. (1974)	RedT
Hagan, J.E. (1972)	Est, WQ, Therm
Hansen, W.G. et al. (1977)	HC, WQ
Henderson, G.E. (1978)	IndOr, PlMgt
Hutton, R.F. (1956)	RedT
Ingle, R.M. and Martin, D.F. (1971)	RedT
Jaynes, G. (1981)	GW, SaltWI
Klein, H. (1971)	GW, WQ
Leahy, T.M. (1979)	Mar

Lewis, R.R. (1975)	SeaGr, Eco
Lindberg, S.E. and Harriss, R.C. (1974b)	Hg, Est, Eco
Maloney, F.E. and O'Donnell, A.J. (1978)	Dev, PlMgt
Martens, C.S. and Harriss, R.C. (1976)	WQ
Martin, D.F. et al. (1971)	Org, Met, WQ
McCann, C. (1978)	PlMgt, Est
McCarthy, J.C. et al. (1974)	WQ
Miller, J.C. (1977)	GW, SaltWI, WQ
Miller, W.L. (1975)	WQ, Est, SoFl
NOAA (1976)	Mar, Dev, Eco
NOAA (1983b)	Est, Mod
NOAA (1984)	WQ, HC, Eco, PlMgt
Odum, W.E. et al. (1982)	Eco, SoFl
Pan, Y.H. et al. (1981)	Met, Org
Pan, Y.H. et al. (1982)	Met, Org
Pascale, C.A. (1974)	GW, SaltWI, SfcW
Pilotte, J.O. et al. (1978)	Met, Est
Roberts, B.S. et al. (1979)	RedT, AqTox
Ryan, J.O. et al. (1984)	Dredg, Port
Saner, W.A. and Curtis, M. (1974)	Oil, Phys
Savannah Lab. and Environ. Svcs. (in progress)	Port, Met, HC, WQ
Scholl,J.E. et al. (1980)	WQ, SfcW
Seaburn, G.E. et al. (1979)	Est, Mod, WLA
Smiley, D.M. (1976)	Dev, Est
Steidinger, K.A. (1975)	RedT
Steidinger, K.A. and Joyce, E.A. (1973)	RedT
Stephens, T.L. et al. (1981)	Met, Org
Stephens, T.L. et al. (1983)	Met, Org
SRWMD (in progress)	WQ, Mod, SfcW
Swan, D.S. (1970)	Oil
University of Florida (1970)	WQ, GW, Est
University of Miami (1976)	OCS, IndOr
University of South Florida (in progress)	WQ, Phys, Mod

Welch, D. (1976)	PlMgt, Dev
Yokel, B.J. (1976)	Est,WQ

SUMMARY AND CONCLUSIONS

The objectives of this project were two-fold: to hold a Workshop to discuss research issues and priorities with representatives from Florida's scientific, regulatory and private organizations; and to conduct a literature review for research related to the topic of contaminants in Florida's coastal zone. Both of these objectives were met and the results of the efforts expended in meeting them appear in this report.

The Workshop held on April 5-6, 1984, provided the opportunity for participants with various backgrounds and interests to interact and discuss topics of common concern. There were a number of problems shared by the three workgroups as they struggled with contamination problems in Florida's coastal waters. Each workgroup was finally able to define a set of issues that merited discussion and then developed a series of recommendations that represented actions that each group felt were necessary to resolve problems that were identified. While there were various individual reactions to the usefulness of the Workshop, it seemed that most attendees were able to extract information that was helpful to them in their work and also to have felt that they provided useful input for the discussions and recommendations.

The literature review effort was informative but necessarily incomplete given the relatively short amount of time available during the project. There were some difficult aspects, particularly involving the so-called "gray literature," or those documents and reports that are not peer reviewed and not published through normal scientific channels in journals, books, etc. Examples of this type of literature include monitoring studies performed by agencies; research conducted by consulting groups and industries; and reports of various types issued by researchers in the universities. Many of these documents do not appear in any bibliographic retrieval system and were obtained only through informal channels or from second or third parties.

Clearly, there is a need to improve on this type of information dissemination and retrieval. The FDER compilation of the computerized Bibliography of Water Resource Investigations is an excellent start in alleviating this problem.

The computerized database search performed through the Dialog System did not provide as much information as we had expected. Despite the preparation of well designed search statements and an excellent retrieval protocol performed by the reference librarian, we found many older references and relatively few recent ones, with policy issues predominating over technical issues. This indicates that exclusive reliance on computerized database searches is not wise although such an approach does provide some useful information.

During the literature review, it became evident that certain areas of Florida have received much more intense study than others. Considerable effort has been expended, for example, in Tampa Bay, Biscayne Bay and the St. Johns River; an excellent series of studies was completed in Apalachicola Bay. Yet, developing areas in southwest Florida have not seen significant research activity although population pressures now building will most certainly create new contamination problems. The relatively pristine Rookery Bay area merits additional effort now to provide unique baseline information that will be valuable in future years.

There are many recommendations offered at the end of each of the three workgroup summaries in the Workshop section of this report and the reader is encouraged to review these in depth. However, from that set, we highlight here some of the recommendations that merit immediate attention and action. These include:

* the need for coordinated, multi- and inter-disciplinary research;

* the need for a comprehensive list of chemical contaminants in Florida's coastal zone;

* the need for developing scientific preserves for long-term research programs;

* the need for scientists to become actively involved in policy development and the concurrent need for policy makers to insure that scientists are consulted on scientific issues;

* the need for a coastal marine research advisory committee; and

* the need for consistent and continuing research support through reliable funding sources to address the issue of contamination in Florida's coastal zone.

In conclusion, we can say the following about the status of contaminants in Florida's coastal zone:

* the rapidly increasing population of Florida will add more contaminants to the coastal zone through an increase in point and non-point sources since most development is occurring in coastal areas;

* based on available data, contaminants reflect activities typical of a more agriculturally oriented rather than industrially oriented state;

* oil drilling and transportation activities in the Gulf of Mexico have caused some coastal contamination but have the potential of creating serious problems in the event of a major accident;

* most seafood species seem generally free from gross chemical contamination in those areas where data are available;

* ports, harbors and marinas have varying contaminant loadings in general proportion to their level of activity, with some isolated pockets of more serious contamination existing;

* the overall status of coastal contamination in Florida cannot be quantitatively stated since a comprehensive database presently does not exist; and

* the State of Florida needs to adopt a more serious and direct approach to contaminant identification, quantitation and control in the coastal zone.

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APPENDIX A

CHEMICAL CONTAMINATION IN FLORIDA'S COASTAL ZONE

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APPENDIX B

CHEMICAL CONTAMINATION IN FLORIDA'S COASTAL ZONE

April 5-6, 1984
J.W. Reitz Union: Rooms 361-363
University of Florida Campus

Thursday, April 5

9:30 - 10:00 Late Registration

10:00 - 10:30 University Welcome and Opening Remarks

Dean Wayne Chen, College of Engineering
Dr. James Cato, Florida Sea Grant
Dr. Joseph J. Delfino, Environmental Engineering Sciences Department

10:30 - 12:00 Overview Presentations

"Gulf of Mexico Strategic Assessment Project"
Mr. C. John Klein, NOAA: Ocean Assessment Division; Rockville, MD.

"Oil Pollution Studies in the Eastern Gulf of Mexico and West Florida Coastal Waters"
Dr. Edward S. Van Vleet, University of South Florida; St. Petersburg, FL.

"Strategy of Pollutant Assessment in Coastal Waters"
Dr. Thomas F. Lytle and Dr. Julia S. Lytle, Gulf Coast Research Laboraory; Ocean Springs, MS.

"Coastal Zone Management: Update and Projects"
Ms. Chris Beditz, Office of Coastal Management, DER; Tallahassee, FL.

"Metal Chemistry in the Marine Environment"
Dr. John F. Trefry, Florida Institute of Technology; Melbourne, FL.

12:00 - 12:30	Work Groups: Identification and Charge
	<u>Work Group Topics</u>
	Chemistry work group: Chaired by Dr. H. Anson Moye, Room 361
	Biology/Ecosystem work group: Chaired by Dr. Paul Cardeilhac, Room 362
	Policy work group: Chaired by Professor Martin Belsky, Room 363
12:30 - 1:30	Lunch Break
1:30 - 3:15	Work Group Meetings
3:15 - 3:30	Break
3:30 - 5:00	Work Group Meetings

Friday, April 6

8:30 - 9:15	Work Groups: Summarize Thursday's Discussions
9:15 - 10:15	Work Group Reports
10:15 - 10:30	Break
10:30 - 12:30	Mixed Work Groups: Interdisciplinary Exchange
12:30 - 1:30	Lunch Break
1:30 - 2:30	Mixed Work Group Meetings: Summary Discussions
2:30 - 3:00	Mixed Work Group Reports
3:00 - 3:15	Workshop Summary