Florida



Oceans and Coastal Resources Council

Annual Science Research Plan

FY 2006-2007

February 1, 2006

COUNCIL COMPOSITION

Ex officio (non-voting) members:

- **Colleen Castille (co-chair**) – Secretary, Dept. of Environmental Protection (DEP).
- **Ken Haddad (co-chair)** – Executive Director, Fish and Wildlife Conservation Commission (FWC).
- **Sherman Wilhelm** – Director of Aquaculture, Dept. of Agriculture and Consumer Services (DACS).

Voting members:

Appointed by DEP

- **Karl Havens**, Ph.D. – Chair of the Department of Fisheries and Aquatic Sciences, University of Florida.
- **Thomas N. Lee**, Ph.D. – Research Professor of Meteorology and Physical Oceanography at the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami.
- **John C. Ogden**, Ph.D. – Director of the Florida Institute of Oceanography and Professor of Biology, University of South Florida.
- **Lisa Robbins**, Ph.D. – Chief Scientist, United States Geological Survey Center for Coastal and Watershed Studies.
- **Thomas D. Waite**, Ph.D. – Dean of the College of Engineering, Florida Institute of Technology.

Appointed by FWC

- **James Cato**, Ph.D. – Director, Florida Sea Grant.
- **Billy Causey** – Superintendent, Florida Keys National Marine Sanctuary.
- **R. Grant Gilmore**, Ph.D. – Senior Scientist, Estuarine, Coastal and Ocean Science, Inc., (ECOS).
- **Jerome Lorenz**, Ph.D. – Research Director, National Audubon Society's Tavernier Science Center.
- **Shirley Pomponi**, Ph.D. – President and Chief Executive Officer, Harbor Branch Oceanographic Institution.

Appointed by DACS

- **Jane Davis** – Aquarium Curator, The Living Seas at Walt Disney World's Epcot®.
- **Ernest Estevez**, Ph.D. – Director, Mote Marine Laboratory's Center for Coastal Ecology.
- **Rob Kramer** – President, International Game Fish Association.
- **Jerry Sansom** – Executive Director, Organized Fishermen of Florida.
- **Jody Thomas** – Director, The Nature Conservatory's South Florida Region.

Council staff

- **Steven H. Wolfe** – Council Liaison, DEP Office of Coastal and Aquatic Managed Areas (CAMA).
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TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

1. Introduction

The Oceans and Coastal Resources Act, §161.70, et seq., Florida Statutes, created the Florida Oceans and Coastal Resources Council and charged it with—among other things—coordinating coastal and marine research in Florida, identifying research gaps and creating an annual Research Plan, and recommending new management strategies that enhance management efforts for our coastal and marine resources.

To identify research gaps, the Council collected prioritized lists of management needs from the primary state agencies with coastal and oceans management responsibilities. The Council compared the needs to available research to identify where research funding was needed. A common theme throughout the lists was the need to understand and predict environmental change on an ecosystem level.

Developing a system to monitor and predict ecosystem change due to environmental perturbations, whether from human or natural causes, will help Florida's resource managers balance the needs for sustainable use and preservation.

2. Research Recommendations

The Council organized the Management Needs into the categories of research needed to address them. These Research Categories are:

A: Habitat Mapping and Characterization
B: Ecosystem Monitoring and Assessment
C: Modeling Systems
D: Understanding Effects From Climate Change
E: Watershed and Freshwater Flow
F: Water Quality
G: Harmful Algal Blooms (HABs)
H: Public Health Issues
I: Living Marine Resources
J: Habitat Restoration
K: Non-native Invasive Species
L: Aquaculture
M: Measuring Coastal Economies and Assessing Human Impacts on Resources

The Council identified Research Focus Areas within each Category. These describe broad areas around which to organize research. Within the Focus Areas, more specific Research Components describe research to address a specific goal aimed at the Management Needs. Budgets were created for the Research Components, but these will generally require multiple individual research projects to accomplish. The Council recommends the appropriate agencies, with Council input, establish committees of scientists and agency managers to detail the research projects and select researchers to fund.

The research listed here was selected by the Council as the most important of the complete set identified as needed. Each year, research results should be assessed for their success in achieving goals and funding mechanisms adjusted when necessary to improve results.

The budget for a Research Component is intended to fund the individual projects required by that Component. The budgets do not account for the administrative costs associated with implementation. The Council strongly recommends that an amount proportional to overall funding should be provided to the agency overseeing the research program to enable proper management, oversight, external review, and feedback mechanisms for the research program.

Additionally, the Council encourages the agency or agencies charged with implementing the Research Components to use existing mechanisms, or develop new mechanisms as appropriate, to fund innovative collaborative work between the private sector and Florida universities and research institutions in order to maximize the expertise of each and effectively link research with education of the next generation of scientists.

3. Integrated Data Management and Dissemination

In addition to specific research topics, managers of coastal resources in Florida stressed the need to deal more effectively with the data and communication portion of the research/management circle.

The need for and benefits from improvements in this area cannot be overemphasized. The Council believes improved collection, handling, sharing, and interpretation of research and monitoring data is a critical first step towards improving the State's resource management. The steps proposed below should begin as soon as possible.

To ensure continued support for this necessary part of the management/research circle, the Council encourages that an appropriate percentage of research funding be targeted to support the costs of providing a strong integrated data management and dissemination program.

Data Focus Area 1: Enable more effective use of present and future data by establishing data-exchange (metadata) standards and requiring their adoption by appropriate state entities.

***Recommended 1st-year action*:** Establish a working panel by July 1, 2006, to solicit input from stakeholders (state and local agencies, water management districts, private research institutes, and non-governmental organizations (NGOs)) and charged with developing a statewide strategy by June 30, 2007, to develop data-exchange (metadata) standards for use by all state agencies. To the extent possible, coordinate with Gulf of Mexico Alliance and federal efforts.

Data Focus Area 2: Establish means for comprehensive management of assessment, monitoring, real-time, and historical data, including support of researchers, storage and archiving of data, and easy access to data.

Recommended 1st-year actions:

1) DEP, FWC, and DACS, in consultation with this Council and collaborating with the Water Management Districts and other stakeholders in Florida's coastal and oceans data, will identify specific shared baseline information needs and collaborate on the design of a system that will store, manage, and maintain this data. Funding requirements to implement this proposal will be provided to this Council for inclusion in the FY2007-2008 Annual Research Plan.

2) Undertake a pilot project to identify key historical data for rescue and restoration and develop methods to achieve restoration in a cost-effective manner. Have state and local agencies identify existing databases that are candidates for conversion and compile information describing data contained therein.

Data Focus Area 3: Establish programs to support effective collection of data.

Recommended 1st-year action: Establish a working panel to recommend the best means for providing strong statistical support to researchers during both the design and analysis phases of their research and to ensure that support is incorporated into the state's research programs. They will provide this information to the Oceans Council for possible inclusion in the FY 2007-2008 Annual Research Plan.

Data Focus Area 4: Establish programs to support effective use of data.

Recommended 1st-year action: Establish working panel to recommend best means for providing strong data-interpretation support to researchers and to ensure that support is incorporated into the state's research programs.

4. What This Report Does and Does Not Do

The short time-frame for this first report has necessitated a somewhat abbreviated Research Plan. The Council has extracted this more-targeted Annual Research Plan, to be annually submitted to the Legislature.

Management Needs

Available time prevented collection of a comprehensive, prioritized set of all state Management Needs. This year's Research Plan was limited to the main state agencies with coastal and oceans responsibilities.

Research Review

The Council began collecting a Research Review that describes past and present coastal and oceans research. The present "working draft" of the Research Review contains results from an initial call for information. This collection continues and will become available on the Council's website.

Ongoing Research Efforts

The Act seeks better coordination of coastal and oceans research. The Council realizes, however, that in the time available this year, it was not able to acquire the desired all-encompassing understanding of this

research. The Council stresses that this year's Research Plan is not generally intended to replace ongoing state-funded research efforts and partnerships. These research recommendations are based on identified research gaps and are intended to supplement that research already underway.

5. Research Priority

The Council offers the following list in order of importance. It is also expected to provide guidance on state research priorities to state and federal programs. Note that the integrated data management recommendation is not incorporated in this list. Budget estimates for the Research Components in the list will be generated by Council staff and added as an appendix. The Council will review the estimates and submit a final table.

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
1	*Establish real-time interdisciplinary observing systems in areas that currently have no or minimal observing. [B. Monitoring; RC3.2]*
2	*Identify and evaluate new technologies—including but not limited to sensors (LIDAR, sonar, passive acoustics, infrared), telemetry (radio, satellite, telephone) and bio-chemical analyses (elemental isotopic, genetic)—for their potential to measure biological activity continuously at a level similar to that presently used to monitor water quality, hydrology, and climate. These technologies and/or techniques should be compatible and simultaneously deployed with Integrated Oceanographic Observation Systems (IOOS) that are located in coastal waters around the United States. [F. Water Quality; RC 18.4]*
3	*Establish continuous, long-term monitoring of salinity and dissolved-oxygen conditions in the estuaries to support development of modeling tools, assess the impact of sea-level rise, and assist in resource management (for instance, commercial and sport fisheries). [B. Monitoring; RC 3.7]*
4	*Using a historical approach, estimate the effect of the loss of coastal mangrove and seagrass habitat on the species that depend upon them. [E. Freshwater Flow; RC 14.3]*
5	*Develop, install, and implement new and improved biological monitoring instrumentation and protocols that will make biological observations match the geographic scale of physical oceanography measurements. Examples are tracking migratory species, developing methods for interdisciplinary observations of nutrients, chlorophyll, algal blooms, and fisheries and other aquatic resources to link physical-chemical conditions to biological effects. [B. Monitoring; RC 3.5]*
6	*Establish an interdisciplinary remote sensing capacity for Florida's coastal and offshore waters. [B. Monitoring; RC 3.4]*
7	*Produce present-day highest-resolution bathymetric maps, identifying physical geologic setting (sediment/rock) and submarine aquatic vegetation with the goal of mapping the entire State's waters by 2015. [A. Mapping; RC 2.1]*
8	*Use existing technology, including satellite remote sensing, to better link red tide research and monitoring to physical oceanography in order to better predict red tide size, trajectory, and intensity and potential impacts and to provide an early warning system. [B. Monitoring; RC 5.5]*
9	*Develop an integrated statewide water budget, considering watersheds outside of Florida as necessary, that accounts for inputs, storages, transfers, and losses of atmospheric, surface, and ground waters to identify the extent of inflow change to the state's coastal waters. [E. Freshwater Flow; RC 11.3]*
10	*Develop new methods for the assessment of fishery populations that include acoustical and genetic methods. [I. Living Marine Resources; RC 28.1]*
11	*Identify and prioritize specific coastal areas around the State for bathymetric mapping - with the goal of mapping the entire State's coast by 2010. [A. Mapping; RC 1.1]*
12*	*Develop coastal, estuarine, riverine, and lagoonal models to be nested with adjacent shelf models to improve understanding of land-sea linkages. [C. Modeling; RC 6.3]*
12*	*Conduct monitoring, assessment, and modeling evaluations of the impacts of fishing on ecosystems. These studies will include impacts of various gear uses; removal of both predator and prey species, sex, size population-dynamic relationships; loss of keystone species; and other trophic-level interactions. [I. Living Marine Resources; RC 28.2]*

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
14	*Evaluate the long-term stability of coastal wetlands (marshes, mangroves, seagrasses) in relation to sea-level rise and episodic disturbances (i.e., hurricanes). [C. Climate Change; RC 9.5]*
15	*Assess effectiveness of Marine Protected Areas and Marine Reserves and other types of protected areas to enhance the surrounding ecosystem, for instance through "spillover" effect. [I. Living Marine Resources; RC 27.2]*
16	*Determine the market and non-market values for all sectors of the Florida ocean and coastal economy using a consistent methodology and available data bases that can be repeated periodically to track the performance of each sector dependent on the coast and ocean. Make the information available to the legislature and the public on the web. [M. Coastal Economics; RC 35.1]*
17	*Integrate HAB monitoring with data collection in the Ocean Observing System to allow examination of empirical relationships between HAB occurrence, spatial extent and intensity with physical-chemical data and provide an improved understanding of factors controlling HABs. [B. Monitoring; RC 5.4]*
18	*Create maps to link previously mapped areas on the coast (identified through the State Coastal Inventory) seamlessly to existing offshore data where possible. This will show where gaps exist and identify datasets that are not compatible [A. Mapping; RC 1.2]*
19	*Establish and enhance hydrological, chemical, and biological monitoring and assessment, including stationary and mobile systems such as shipboard surveys with accompanying modeling of the systems being monitored, to support agency programs to preserve and manage Florida's natural resources. [B. Monitoring; RC3.6]*
20	*Assess the effect that human waste management, and septic tank use in particular, has on nutrient loading and water quality in nearshore habitats. [F. Water Quality; RC 17.1]*
21	*Identify quantitative relationships between nutrient concentrations in coastal waters and impairment of flora and fauna, so that agencies can use this information to establish scientifically-sound targets (such as nutrient criteria) for nutrient concentrations and loads. [F. Water Quality; RC 15.7]*
22	*Assess the impacts of non-point source pollution, particularly storm-water runoff from urban areas, and determine the most effective means of abatement. [F. Water Quality; RC 16.1]*
23	*Perform bathymetric and benthic-habitat mapping of important Florida tidal rivers and estuaries by 2010. These are to be used to determine essential environmental conditions needed for living marine resources and to provide data for modeling the environmental impacts of management decisions regarding water use. [A. Mapping; RC 2.3]*
24	*Develop and field-test biotic indicators (species, species groups, habitats, communities) as criteria and targets for statewide use in determining whether watershed and stream management practices are protecting natural estuaries and marine ecosystems, and restoring impaired ones. [E. Freshwater Flow; RC 13.1]*
25	*Work with fishers to identify fishery spawning aggregation sites around the state, and then validate and characterize these areas. [I. Living Marine Resources; RC28.5]*
26	*Determine the relationship of the timing, quantity, and distribution of major river outflows and submarine groundwater discharges to the distribution and abundance patterns of coastal marine organisms. [E. Freshwater Flow; RC 14.1]*
27	*Develop and demonstrate recirculating marine aquaculture technology for marine sport fish stock enhancement and restoration. [K. Aquaculture; RC34.1]*
28	*Quantify the impacts of HABs on commercial and recreational fisheries, coastal tourism, contact recreation, and other human activities integral to the economy of Florida's coastal areas. [G. Harmful Algal Blooms; RC 23.3]*
29*	*Determine the locations and sizes, dominant physico-chemical features, living resources, and unique ecological functions of all oligohaline and tidal-fresh waters in Florida. [E. Freshwater Flow; RC 13.2]*
29*	*Conduct studies linking key fish spawning areas to larval distribution and adult population-distributions on the Florida shelf, for example Riley's Hump in the Tortugas Ecological Reserve. [I. Living Marine Resources; RC 27.1]*
29*	*Determine the economic impacts of long term trends in beach loss, including:* *a) Determine the economic and environmental costs and benefits of continued beach-renourishment projects, including determining the economic feasibility, extent, availability, quantity and quality of offshore sands suitable for beach renourishment. Link to water quality studies of this issue in the Water Quality section.* *b) Determine the effect of continued beach-renourishment projects on turtle, seabird, and adjacent coral and fish populations and on other organisms dependent on beach ecosystems for food, shelter, and reproduction. Include subsequent economic impact as well. [M. Coastal Economics; RC 36.6]*

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
32	*Coordinate methods of sampling and analysis among the multiple State, Federal, and local agencies and universities and research institutions that monitor and research HABs in Florida. [B. Monitoring; RC 5.1]*
33	*Determine coastal construction and design practices related to reducing shoreline erosion. Determine the social, economic, and environmental consequences of increasing rates of beach erosion, coastal armoring, and beach renourishment. [M. Coastal Economics; RC37.3]*
34	*Develop and implement rapid monitoring and assessment tools and procedures for identifying microbial pathogens in rivers, coastal waters, sediments (including beaches), and seafood. [H. Public Health; RC 24.1]*
35	*Compare the environmental risk to water quality of septic systems to that of centralized sewage systems to area waters, particularly on islands. [F. Water Quality; RC 17.3]*
36*	*Assess the effects of nutrients from ocean outfalls on coastal habitats. [F. Water Quality; RC 17.2]*
36*	*Determine the hydrologic conditions that result in HAB development, using a combination of observations and modeling. Enhance the collection of data on the size, duration, intensity of blooms. [G. Harmful Algal Blooms; RC 20.2]*
38	*Determine influence of watershed nutrients resulting from land-use practices on HAB formation and collapse. [G. Harmful Algal Blooms; RC 20.3]*
39	*Evaluate the potential benefits and risks of offshore aquaculture in Florida. [K. Aquaculture; RC33.4]*
40	*Determine the economic value of coastal ecosystems and habitat when left to function as a natural system. [M. Coastal Economics; RC35.2]*
41*	*Building on existing initial efforts (DEP, FWC, WMDs, CERP), hold statewide workshops to identify initial habitats for which to develop bioassessment methods. Discuss possible pilot projects in different regions that pose different expectations. [F. Water Quality; RC 18.1]*
41*	*Determine which geospatial habitat conditions support an increase in fish recruitment as a result of marine reserves. This research should consider the size and location in relation to biotic and abiotic conditions. [I. Living Marine Resources; RC29.3]*
43	*Demonstrate economically feasible production and marketing of a high-value marine fish species that can be farmed in a land-based recirculating production system. [K. Aquaculture; RC33.1]*
44	*Determine the social and economic costs and benefits that derive from public and private conversion of coastal and waterway access points to non-water dependent uses. Determine incentives to retain water-dependent and water-related facilities that serve public needs and reflect public values in order to maintain public access to public coastal waters. Produce annual reports stating the length of Florida's sandy beaches that are publicly accessible. [M. Coastal Economics; RC36.1]*
45	*Determine factors resulting in macro-algal blooms. [G. Harmful Algal Blooms; RC 23.2]*
46	*Create coastal ocean environmental indices in support of fisheries research and spatial management of the fisheries. Monitoring of habitat conditions on a daily basis will be important to understanding linkages of the environment to marine resources. [I. Living Marine Resources; RC28.6]*
47	*Determine the role of the shoreline in reducing wave and flood damage, including ways to implement shoreline protection measures that do not damage the coastal and offshore natural environment. Develop a scientific basis for determining erosion and coastal setback zones. [M. Coastal Economics; RC37.4]*
48	*Develop methods for determining sources of nutrients so agencies can improve source regulation. [F. Water Quality; RC 15.1]*
49	*Define potential impacts of offshore oil and gas development of Florida's coastline with an emphasis on effects on fish, wildlife and their habitats. [F. Water Quality; RC 16.5]*
50	*Use existing water quality monitoring programs to collect samples for algal identification and toxin analysis concurrent with nutrient and other water-quality samples. [B. Monitoring; RC 5.2]*
51	*Determine the relationship, if any, of the increased frequency of coral diseases and elevated seasonal seawater temperatures to better target management activities that may focus on other possible causes. [D. Climate Change; RC 9.2]*

* - Tied in rank

II. INTRODUCTION

Florida is the only continental state largely surrounded by coastal seas and oceans. The quality of life of its people and much of their livelihood are directly connected to the condition of these waters and their tributaries. Florida's weather and climate are strongly modified by the warm waters flowing from the Caribbean and along all of the State's coasts through the offshore boundary currents, as part of the Gulf Stream current system. Florida is also undergoing explosive growth and development that is concentrated in the coastal zone, where multiple interests intersect and informed management is critical. Loss of habitat to support fish and wildlife, degradation of water quality, increasing harmful algal blooms, storm impacts, and the decline of fisheries and ecologically and economically important marine ecosystems, such as coral reef communities, clearly demonstrate the need for sound governance of State and connecting waters.

Managers of coastal and marine resources face the challenge of balancing conservation and development objectives in the context of the uncertainty of our knowledge of natural systems and the political and social pressures of human systems. In order to make the wise decisions necessary to achieve this balance, decisions on commercial or recreational use of these resources must be coupled with an increasingly comprehensive understanding of the marine environment and of the socio-economic factors that influence use of that environment. In this complex undertaking, research is not limited to seeking understanding of nature and its interactions. Here it plays a critical role in finding answers to pressing questions that managers and public policy makers have in their efforts to achieve a balance between sustainable use and conservation of Florida's natural resources.

To achieve this goal of informed decision-making and stewardship requires accurate assessment, continuous monitoring, and real-time ability to predict changes to the physical, chemical, biological, geological, and socioeconomic components of our marine ecosystems. It also requires a fully-integrated data handling system to allow all resource managers and other interested parties to easily use present and future data in making their decisions.

A. The Oceans and Coastal Resources Council

The Oceans and Coastal Resources Act, § 161.70, et seq., Florida Statutes, created the Florida Oceans and Coastal Resources Council and charged it with—among other things—coordinating coastal and marine research in Florida, identifying research gaps and creating an annual Research Plan, and recommending new management strategies that enhance management efforts for our coastal and marine resources.

To help identify the research gaps, Florida's primary state agencies with coastal and oceans management responsibilities submitted to the Council prioritized lists of their significant management needs (www.dep.state.fl.us/oceanscouncil). The Council attempted to compare the needs to previous and current research collected as part of a Research Review to identify where research funding might be warranted. A common theme throughout the lists received was the need to understand and predict environmental change to water quality, habitat, and biological communities on an ecosystem level. Developing a system to monitor and predict ecosystem change due to environmental perturbations will provide new insights and a higher level of understanding of natural versus human-induced effects and help guide future uses and remediation/restoration activities.

B. What is an Ecosystem?

An ecosystem is a dynamic, complex association of plants, animals, microbes, and the chemical, physical, and social conditions that surround them. Humans both depend on and impact marine ecosystems. All living and non-living components within an ecosystem are directly or indirectly connected. Ocean currents, lunar tides, climate, and water chemistry all influence the survival, reproduction, and feeding of the aquatic organisms dependent on a specific ecosystem.

Ecosystems come in many sizes and the boundaries are not sharply defined. Even something as apparently constrained as a tidal pool is affected by rainwater and periodic inputs of new water from the adjacent ocean and land. Most marine species use multiple habitats within their ecosystem. Many larval or juvenile stages settle from the plankton into temporary "nursery" habitats, then take up adult life in other habitats. Migratory species annually and predictably move over great distances, even whole oceans. Marine ecosystems of the State of Florida are connected by the strong oceanic flows surrounding the state, requiring a comprehensive, collaborative, statewide view of coastal management.

C. What is Ecosystem-Based Management?

The Oceans and Coastal Resources Act cites the report of the U.S. Commission on Ocean Policy while specifying the need for Florida's resource management to continue transition to "an ecosystem-based management approach."

Ecosystem-based management is an adaptive and integrated approach to management that considers the entire ecosystem—the organisms (including humans), their interactions, and the chemical, physical, and social environment that surrounds and sustains them. The goal of ecosystem-based management is to maintain a healthy, productive and resilient ecosystem so that it can sustainably provide the services human beings want and need today as well as for future generations. Ecosystem-based management differs from traditional approaches that usually focus on a single species, area, activity or concern; it considers the cumulative impacts of all of these.

Coastal and ocean ecosystems are vitally important to coastal states and they are at risk. Over half of the U.S. population lives along the coast, and more than $200 billion in economic activity was associated with the ocean in 2000. Despite their economic significance, U.S. oceans, like those around the world, are changing in unprecedented ways.

Combinations of factors, many resulting from human activities, are affecting the marine ecosystems of Florida and the world. Major disturbances to the ocean are: (1) the direct and indirect effects of fishing, (2) land-based sources of pollution, (3) loss of habitat, and (4) changing climate. These disturbances can threaten the ability of ocean ecosystems to provide the benefits that people require from them. Traditional marine-resources management approaches consider each activity or threat in isolation. Coordinated, integrated management is rare. The ecosystem-based approach addresses these concerns by considering the cumulative impacts from all sources. It looks at interactions and takes into account ecosystem knowledge and uncertainties while trying to balance the diverse human objectives.

Florida's Ocean Strategies (1999), the report of the U.S. Commission on Ocean Policy (2004), and the U.S. Ocean Action Plan (2004) describe the ecosystem approach as the cornerstone of a new vision for healthy, productive, resilient marine systems that provide stable fisheries, abundant wildlife, clean beaches, vibrant coastal communities, and healthy seafood for all Americans.

Management that emphasizes the protection of ecosystem structure, function, and key processes is much more likely to ensure the long-term delivery of these important services. From a governance perspective,

implementation of an ecosystem-based approach will enable more coordinated and sustainable management of activities that affect the oceans. Ecosystem-based management should reduce duplication and conflicts, and in the long run be more cost-effective. A delay in full transition to management based on an ecosystem approach will result in continued conflicts over resources, degradation of ocean ecosystems, disruption of fisheries, loss of recreational opportunities, health risks to humans and wildlife, and loss of biodiversity.

Full implementation of ecosystem-based management involves all ~~of~~ the general categories of research that the Florida Ocean and Coastal Resources Council has identified in this report, including comprehensive mapping of the distribution of habitats and resources, the dynamics of currents linking areas around the state, key areas such as spawning aggregations and migration routes, and existing human impacts on the coastal ocean.

D. Integrated Data Management

Data is only useful if it can be placed in the hands of those needing the information. In many cases, the data is most useful if it is first translated from the raw numbers into more-easily understood forms. At present, sharing of data is very difficult, even among and often within state agencies. Experience indicates that this is a situation not likely to be resolved solely through voluntary efforts.

One of the critical recommendations contained in this Research Plan is for the Legislature to undertake steps to create a standard for data sharing, require all state agencies to use those standards, and encourage others to follow suit. The full recommendation is contained in the *Integrated Data Management and Dissemination* section of this report.

E. What This Report Does and Does Not Do

Council members have worked diligently toward developing a comprehensive Research Plan for the Legislature to consider. The short time-frame for this first report (four months from the first meeting of the Council) has necessitated for this year a somewhat abbreviated Research Plan from what is envisioned to become the norm.

One of the challenges of creating a means to coordinate statewide research is the need to arrive at a "big picture" for how to improve the connections among research, management needs, and available funding. At the same time, we need to provide for appropriate feedback mechanisms that assess how well the effort is working so that adaptive changes can be made to establish a constantly-improving mechanism that is responsive to those who fund and use the research results.

This 'big picture" requires a plan with short-term and long-term goals, mechanisms to track progress toward those goals, and management aspects not appropriate in a document like this one that is meant to describe the research for support in the next year's budget. As a result, the Council has extracted this more-targeted Annual Research Plan, to be annually updated and submitted to the Legislature.

Management Needs

Available time prevented collection of a single comprehensive, prioritized set of the state agencies' Management Needs. The list used to guide this Research Plan was limited to the main state agencies with coastal and oceans responsibilities and who responded to the request for a prioritized list of their agencies Needs. These lists are available on the Council's website. While the scope of the resulting combined list is broad, it almost certainly does not include all of the Management Needs of all state and

local agencies. This collection effort will be expanded in the coming year to better incorporate the full spectrum of Management Needs of Florida's state and local governments.

Also during the coming years, universities, research laboratories, and non-governmental organizations will be be invited to submit lists of Florida's management needs. This does not mean that these groups will be submitting their own needs, but will be invited to submit their perspective on the needs the agencies should consider in managing the state's coastal and marine resources. The broad range of perspective outside the state agencies can lead to increased recognition of critical problems and potentially-innovative solutions.

Research Review

In the time provided, the Council began to build a Research Review, intended to become a continually-updated, online database that describes the who, what, when, where, and why of past and present coastal and oceans research. The Research Review will not contain research results themselves, but the supporting information about the research.

The present "working draft" of the Research Review contains results from the initial call for information from the various private, state, and some federal research entities in Florida. After creation of a user-friendly interface is completed, this will be available on the Council's website. This collection of information continues, now focusing on researchers who did not respond during the first short-turnaround request, older research not requested during the initial call, and additional federal agencies. While the short time period available to develop the research plan prevented a comprehensive comparison, it is the intent of the Council to prepare a more complete Research Review prior to the awarding of specific contracts for new research.

Ongoing Research Efforts

The Oceans and Coastal Resources Act seeks better coordination of coastal and oceans research. In response, the Council strived to include in its considerations all ongoing research in Florida. The Council realizes, however, that in the time available it was not able to acquire the all-encompassing understanding of this research that is desirable. ***As a result, the Council stresses that recommendations in this year's Research Plan are not generally intended to replace ongoing research efforts and partnerships that are funded by the state.*** These research recommendations contained herein are based on identified research gaps and are intended to supplement that research already underway.

III. RESEARCH TO ADDRESS MANAGEMENT NEEDS

Introduction

The Council organized the previously-discussed list of state-agency Management Needs based upon the types of research necessary to address them. The set of Research Categories arrived at was used to help organize the Research Plan.

Because a single Management Need might require several different types of research and a single piece of research might help address several Management Needs, the Council identified Research Focus Areas within each Research Category. These describe fairly broad research areas around which to organize a research effort. Within the Focus Areas, more specific Research Components were created with the intent to describe research to address a specific goal aimed at one or more of the Management Needs. Budgets were created for the Research Components, but it is envisioned that it will generally require multiple individual research projects to accomplish the goal contained in a Research Component.

The Research Components contained in this document identify research and information gathering that is either needed to address high-priority state Management Needs or forms an initial step required before the research to directly address those Needs can be undertaken. The research listed here is that the Council selected as the most important from the complete set of research they identified during this effort. Each year, research results should be assessed for their success in achieving goals and funding mechanisms adjusted when necessary to improve results.

The budgets for the individual Research Components are intended to fund the individual Research Projects that make up that Component. The budgets do not account for the administrative costs associated with implementation. The Council strongly recommends that an amount proportional to overall funding should be to provided to the agency overseeing the research program to enable proper management, oversight, external review, and feedback mechanisms for the research program.

Additionally, the Council encourages the agency or agencies charged with implementing the Research Components to utilize existing mechanisms, or develop new mechanisms as appropriate, to fund innovative collaborative work between the private sector and Florida universities and research institutions in order to maximize the expertise of each and effectively link research with education of the next generation of scientists.

The following Research Focus areas and Research Components are the most important of the total research identified by the Council. As a result, to maintain their overall relationship, the original numbering is retained resulting in discontinuous numbering of this list.

The "3 Ms"

In studying the state's management needs and the research required to address them, the Council realized that three of the proposed Research Categories could be viewed as tools to provide necessary information to support much of the research in the other categories, as well as to directly support management decisions. These "tool" research categories—Mapping, Monitoring, and Modeling—became known as the "3Ms". Improved science-based ecosystem management of Florida's coastal and offshore marine resources depends on establishing this coordinated, integrated foundation.

Mapping provides the basic information of "what" and "where." Without this accurate information readily available, tasks like directing development to minimize environmental impacts and identifying habitats and areas that need preservation are difficult and prone to error.

Monitoring provides information on the status and functioning of key ecosystem components and identifies trends that portend trouble, thereby allowing problems to be addressed or prevented. It helps measure restoration progress and assists regulators in making permitting decisions. Monitoring also provides data necessary to build and verify useful models.

Modeling helps scientists understand how ecosystem components function and provides managers with means to predict effects of management actions or natural occurrences (like storms) on the ecosystem. Modeling can also help managers optimize management actions by permitting them to better predict the outcomes of alternate management tactics.

The 3Ms will provide prediction capabilities that, in combination with hypothesis-driven, cause-and-effect research, form the foundation for good resource management in Florida.

Research Category A: Habitat Mapping and Characterization

Introduction

Coastal and nearshore habitat and resources on the Florida coast and shelf are shaped by geological, hydrological, and biological processes interacting on a variety of scales from 100s of kilometers (for instance, groundwater flow and climate change) to millimeters (like microbial communities and small benthic invertebrates). A comprehensive understanding of the ecosystems making up these areas depends upon reliable baseline data in order to ultimately support wise management of resources and habitats.

One of the significant gaps in baseline data describing the Florida coastal and marine areas are maps describing bathymetry, substrate, habitat, and biological and natural resources. These maps are critical for managers to understand the environment, its change through time, and the impacts of natural and human-induced changes to the environment. Much of Florida's coastal ocean was dry land in the last ice age and both geological and physical features reflect this.

Florida has hundreds of square miles of coastline and submerged marine areas. Because of the enormity of the area, the mapping of these in their entirety must likely be a phased approach, including the acquisition of a variety of data that will be used in defining Essential Fish Habitat and wetland, mangrove, seagrass, hard bottom, and coral habitats, etc. These data in turn will be used as the baseline to conduct sustained observations of how the biological communities are affected by their environment and to develop user-friendly biophysical models for research and management applications, such as fishery management and habitat restoration.

This research would provide the geological characterization and physical attributes that are necessary for conducting biological resource assessments of the benthic habitats. Studies of beach erosion, coastal processes, and nearshore sand transport would provide the scientific underpinning for examining health issues related to fluctuations in bacteria on sand and possible purging of the marine water and sediment systems by storms.

Research Focus Area 1: Creation of high-resolution bathymetric/topographic coastal maps

In their lists of Management Needs, resource managers recognized the critical need to understand coastal habitat vulnerability and the need for reliable scientific information on which to base decisions about what, how, where, and if to restore coastal and nearshore habitats.

The geology of Florida coasts, both in terms of substrate and low lying, karstic landscape, is a critical factor in shaping the ecosystem. In addition, catastrophic events such as hurricanes and storms can affect beaches and interact with local geology. Understanding such events is key to understanding current shoreline form and long-term processes such as supply of sand and sediment to beaches and wetlands. These mechanisms pose significant risk to human development and restoration projects.

High-resolution coastal elevation and nearshore bathymetric data are critically needed to provide a baseline from which to assess beach and coastal erosion, understand the impacts of existing land uses on the coast, and assess loss of habitat such as coastal wetlands and nearshore seagrasses. While coastal elevation data are presently being collected by a few agencies at different resolutions along different parts of the coast, an inventory of these data will be critical to our understanding of the remaining gaps that need to be collected and the coordination of the agencies in future collection.

Complicating the collection, traditional technology is not adequate in the very shallow, broad areas nearshore to provide the information needed for fisheries habitat characterization. These data must be collected using specialized equipment and this has prevented mapping large portions of beaches, wetlands, estuaries, and the subtidal coast. However, for existing data, a seamless bathymetric/topographic map can be created as a baseline in characterizing habitat.

All Research Components in this Focus Area should be coordinated with other agencies performing mapping (for instance, USGS and NOAA) and refer to habitat maps of FWC where appropriate to help identify gaps.

The projects listed will provide agencies with much needed base-line data to evaluate short-term and long-term trends on the coast, including coastal erosion and habitat change and for evaluating the success of restoration efforts.

Research Components

RC 1.1: Identify and prioritize specific coastal areas around the State for bathymetric mapping - with the goal of mapping the entire State's coastline by 2010. [Priority 11 of 51]

RC 1.2: Create maps to link previously mapped areas on the coast (identified through the State Coastal Inventory) seamlessly to existing offshore data where possible. This will show where gaps exist and identify datasets that are not compatible. [Priority 18 of 51]

Research Focus Area 2: Mapping Marine Habitats

Nearshore and offshore Florida coasts are historically rich and productive ecosystems supporting abundant populations of fish and wildlife. At the present, declines in key populations of species of fish are of considerable concern for resource managers and public alike. Marine living resources are associated with specific habitat, yet the high-resolution characterization of much of these habitats is

lacking, thus impeding understanding of the fundamentals necessary to manage the living resources. Habitat is created in large part by geologic and hydrologic processes which together determine the nature of living communities. For example, sandy sediment supports a biological community distinct from hardbottom or mud. Identifying areas of specific sediment cover versus hardbottom will also allow determination of extent, availability, quantity, and quality of offshore sands that may or may not be suitable as a resource for beach renourishment.

Habitat characterization is needed to provide resource managers parameters to evaluate health of an ecosystem and resilience to anthropogenic effects. For example, seagrass beds provide important habitat to both fish and birds and are an important source of primary production in the nearshore coastal and estuarine region of Florida. Seagrasses, however, are threatened by anthropogenic activities which cause increased turbidity levels, shading, and physical disturbance of the bottom. Managers recognize that this habitat is critical for healthy marine waters, however, not enough information is known about their distribution.

The first step in habitat mapping is to provide a map of the seafloor composition (sand, silt, muddy sand, sand, rock, etc.) and those organisms who themselves form habitat (seagrasses, corals, etc). There are technologies available for mapping shallow-water habitats and small areas of deep water, but improved methods are needed for cost-effectively mapping large deep-water areas.

All Research Components in this Focus Area should be coordinated with other agencies performing mapping (for instance, USGS and NOAA) and refer to habitat maps of FWC where appropriate to help identify gaps. They must also be coordinated with the coastline-mapping efforts of Research Focus Area 1 above.

These data are also crucial when modeling sediment processes and transport of pollutants. Habitat mapping will provide baseline data from which Management can compare changes over time. These data can also be fed into integrated models which can predict change in a habitat once critical parameters change.

Research Components

RC 2.1: Produce present-day highest-resolution bathymetric maps, identifying physical geologic setting (sediment/rock) and submarine aquatic vegetation with the goal of mapping the entire State's waters by 2015. [Priority 7 of 51]

RC 2.3: Perform bathymetric and benthic-habitat mapping of important Florida tidal rivers and estuaries by 2010. These are to be used to determine essential environmental conditions needed for living marine resources and to provide data for modeling the environmental impacts of management decisions regarding water use. [Priority 23 of 51]

Research Category B: Ecosystem Monitoring and Assessment

Introduction

Florida is unique in that it is surrounded by oceanic boundary currents. The Loop Current in the eastern Gulf of Mexico continues as the Florida Current in the Straits of Florida and along the east coast. These

offshore boundary currents directly affect the adjacent coastal environments by driving water circulation patterns, generating upwelling that can stimulate red tide blooms, provide the pathway for recruitment of fish and invertebrate larvae, and directly connecting Florida's waters with those of the Caribbean and the entire southeast U. S. coast.

Science-based management of Florida's coastal and offshore marine resources requires a systematic, interdisciplinary monitoring and assessment approach that integrates physical, chemical, and biological processes, including statewide discharges of surface and ground waters to the coasts. Monitoring and assessment is the collection and analysis of long-term data and results of controlled experiments conducted to establish cause-effect relationships.

Ecosystem monitoring and assessment includes periodic, continuous, and real-time data collection at fixed stations and by mobile sampling equipment and crews, each at scales sufficient to address management questions. Present needs requires greatly improved integration of methods for sampling physical and chemical constituents and the biological communities to provide the necessary ecosystem information that supports good management decisions.

Monitoring can be conducted for many purposes. These can be divided broadly into two categories, the collection of data to inform one about status and trends of a system, and the collection of data in an attempt to understand the functioning of the system, typically through data analysis, modeling, and scientific interpretation. Data from status-and-trends monitoring can also be used in the model development and verification. Research to develop methods for monitoring and research which depends on monitoring data for modeling or other purposes will be addressed here. Monitoring to provide raw information for management needs (for instance, to determine whether minimum water quality criteria are being met) will not be addressed here, though these efforts can also provide data for modeling.

Research Focus Area 3: Integrated Observation and Prediction System for Florida's Coastal Marine Ecosystems.

Fulfilling Florida's need to observe and predict environmental change and the ecosystem response of its coastal waters will require two components. The first is the creation of a sustained interdisciplinary observing system that spans all three of Florida's shelf regions: the West Florida Shelf (WFS), South Florida Shelf (SFS), and East Florida Shelf (EFS) from the outer shelf to the coastal estuaries and rivers. This will require a mix of remote sensing, shipboard and small-boat surveys, and in-situ stations for continuous monitoring of water quality and status of marine resources. This system must be fully integrated with regional and international integrated ocean observing systems (IOOS) in Florida waters, and will require Florida to fund additional ocean observing stations to provide Florida-specific information. These facilities will also support improved shipping and port operations. Research and development of biological observation methods for use at these stations will also be required to provide the necessary information to link the ocean currents and chemistry to the coastal biology and resources.

The second necessary component is the establishment of data/modeling center(s) for data quality control and dissemination, model development, and web-based posting of user-friendly data and model results to accommodate science-based decisions by management agencies. These will be addressed in the *Integrated Data Management and Dissemination* section of this report.

The monitoring component of the ecosystem prediction system will be presented here (in Focus Area 3) and the modeling component will be presented below in Category C: Modeling Systems (Focus Area 7).

Research Components

To establish and maintain an integrated state-wide, observation-based, predictive system of coastal marine ecosystem monitoring, it will be necessary to:

RC 3.2: Establish real-time interdisciplinary observing systems in areas that currently have no or minimal observing. [Priority 1 of 51]

Review of ongoing observation programs using fixed moorings in state coastal waters shows no or sparse observations from regions along the east Florida coast, the Dry Tortugas, the northwest Florida coast, and also within several major estuaries. Real-time moored monitoring stations need to be established in these regions to make continuous observations of physical, chemical, and biological constituents and to improve ecosystem forecasts for the highly-connected coastal shelf environments.

RC 3.4: Establish an interdisciplinary remote sensing capacity for Florida's coastal and offshore waters. [Priority 6 of 51]

This capacity is needed to improve spatial and temporal coverage of presently-available satellite data, improve reliability of methods for shallow coastal waters, and develop new methods for remote monitoring of HAB and other planktonic species and sea grass distributions. New methods are needed to improve user access and provide user-friendly tools for data manipulation of satellite information. These satellite data products are necessary to help assimilate data into predictive models and are the only means available for simultaneous coverage of large coastal and offshore regions.

RC 3.5: Develop, install, and implement new and improved biological monitoring instrumentation and protocols that will make biological observations match the geographic scale of physical oceanography measurements. Examples are tracking migratory species, developing methods for interdisciplinary observations of nutrients, chlorophyll, algal blooms, and fisheries and other aquatic resources to link physical-chemical conditions to biological effects. [Priority 5 of 51]

RC 3.6: Establish and enhance hydrological, chemical, and biological monitoring and assessment, including stationary and mobile systems such as shipboard surveys with accompanying modeling of the systems being monitored, to support agency programs to preserve and manage Florida's natural resources. [Priority 19 of 51]

RC 3.7: Establish continuous, long-term monitoring of salinity and dissolved-oxygen conditions in the estuaries to support development of modeling tools, assess the impact of sea-level rise, and assist in resource management (for instance, commercial and sport fisheries). [Priority 3 of 51]

Research Focus Area 5: Regional Monitoring of Toxic Blooms

To understand the factors causing HABs and regulating their toxicity, it is critical that their spatial distribution, taxonomic composition, and toxin levels be regularly monitored, ideally in concert with ongoing water-quality monitoring programs carried out by resource management agencies and/or citizen monitoring programs. Initially this work can be done using existing methods, and then expanded in scope as new rapid methods are developed under Research Focus Area 18.

The expected outcome is an enhanced ability to track the intensity, spatial distribution, and potential toxicity of HABs over time, to better inform the public regarding potential risks, and to provide necessary information for identifying environmental causes.

Research Components

RC 5.1: Coordinate methods of sampling and analysis among the multiple State, Federal, and local agencies and universities and research institutions that monitor and research HABs in Florida. [Priority 32 of 51]

RC 5.2: Use existing water quality monitoring programs to collect samples for algal identification and toxin analysis concurrent with nutrient and other water-quality samples. [Priority 50 of 51]

RC 5.4: Integrate HAB monitoring with data collection in the Ocean Observing System to allow examination of empirical relationships between HAB occurrence, spatial extent and intensity with physical-chemical data and provide an improved understanding of factors controlling HABs. [Priority 17 of 51]

RC 5.5: Use existing technology, including satellite remote sensing, to better link red tide research and monitoring to physical oceanography in order to better predict red tide size, trajectory, intensity, and potential impacts and to provide an early warning system. [Priority 8 of 51]

Research Category C: Modeling Systems

The tools by which managers can fully realize the benefit of good monitoring data are models that allow the prediction of the results of alternate management actions. Development of models that reliably predict outcome must be based on data from monitoring systems designed with this use in mind. Data from monitoring systems developed for other uses help to develop good models, but aren't likely to answer the specific questions the models need resolved. When proper data is available, then Florida must develop the models that provide its managers with these prediction tools.

Model development also inherently helps understanding of how ecosystems work, thereby helping to design more cost-effective research strategies.

Research Focus Area 6: Modeling Component of the Integrated Observation and Prediction System for Coastal Marine Ecosystems.

Existing models of currents, temperature, and salinity changes of Florida's coastal waters need to be linked to provide circulation forecasts for the entire Florida coastal waters. These circulation models also need to be linked to estuarine models to provide the necessary information on fresh water discharge to the coasts and atmospheric effects as well as to a large-scale oceanic model that includes the strong offshore current systems that surround the state. The resulting linked system of models would then provide the boundary information necessary for water quality and biological models that will provide the information needed by Florida's managers regarding ecosystem change.

Recommendations for this Center were given in the RC13 of the Monitoring section. Additional Research Components are recommended below to provide modeling support for making ecosystem predictions:

Research Components

RC 6.3: Develop coastal, estuarine, riverine, and lagoonal models to be nested with adjacent shelf models to improve understanding of land-sea linkages . [Priority 12 of 51]

Research Category D: Understanding Effects From Climate Change

Introduction

The State of Florida is particularly vulnerable to the effects of climate change and the resulting impacts will have an ever-increasing effect on the sunshine state's citizens, economy and environment. Global climate change poses risks to human health and to terrestrial and aquatic ecosystems.

Scientists have already observed changes in Florida consistent with the early effects of global climate change: warmer air and sea-surface temperatures; declining coral reefs in the Florida Keys due to the effects of coral bleaching; retreating and eroding shorelines; saltwater intrusion into inland freshwater aquifers; an upswing in forest fires; and a recorded increase in sea level. There is evidence that increased seawater temperatures are involved in the increasing frequency and severity of major storms and hurricanes as well as changes in ocean circulations patterns

According to the United States Environmental Protection Agency, the earth's climate is predicted to continue to change as a result of human activities. These changes are most likely to be increases in temperature and changes in precipitation, soil moisture, and sea level, which could affect many ecological systems, as well as on human health and the economy.

Two independent commissions that recently published reports on the health of the nation's oceans, the Pew Oceans Commission (May 2003) and the President's U.S. Commission on Ocean Policy (July 2004), both reported on the threats of climate change. The Ocean Commission reported that the causes and impacts of climate variability and climate change are among the most pressing scientific questions facing our nation and the planet.

State decision-makers and resource managers will require reliable scientific information on which to establish short-term and long-term strategies to address the impacts due to climate change. This will require a science plan that will rigorously address climate change issues. Long-term, as well as short-term changes in water quality (the link between water temperature and algae population dynamics, for example) are important in the State of Florida to the health of marine resources, including corals. Using historical data from buoys, as well as from satellite remote sensing, in addition to supporting the long-term monitoring of water quality and circulation are critical for understanding changes in climate variation. Sustained, synoptic monitoring of the physical, biological, geological and chemical aspects must be systematically supported by the State of Florida. It will be fundamental to distinguish between man-made changes in the ecosystem and changes resulting from natural environmental change.

Because of the enormous environmental and economic risks that climate-change variability poses for the State of Florida, it is crucial that the state take the lead in focusing research on its effects. The long-term solutions to climate change occur at the local, regional and national scales. In order to raise national awareness of the ecological and economic impacts to the state, it will require focused research.

Research Focus Area 9: Effects of Ambient Temperature Trends on marine ecosystems and biological processes

Research Components

RC 9.2: Determine the relationship, if any, of the increased frequency of coral diseases and elevated seasonal seawater temperatures to better target management activities that may focus on other possible causes. [Priority 51 of 51]

RC 9.5 Evaluate the long-term stability of coastal wetlands (marshes, mangroves, seagrasses) in relation to sea-level rise and episodic disturbances (i.e., hurricanes). [Priority 14 of 51]

Research Category E: Watershed and Freshwater Flow

Introduction

Ocean scientists and resource managers have long understood that watershed properties and uses, and the flow of freshwater to the coast, are significant determinants of coastal ocean health. Despite this understanding, these terrestrial issues have been poorly incorporated in the guidance of ocean and coastal research priorities and programs. As late as 1994, the National Research Council's *Environmental Science in the Coastal Zone: Issues for Further Research*, stated a concern for terrestrial effects generally, and river flow manipulations specifically, as an overlooked problem. Because of the many non-river means of freshwater flow to the coasts of Florida, this concept must be extended to include other types of freshwater flow as well.

Watershed issues are mentioned--but freshwater flow issues are not--in Florida's Ocean Strategies (1999), and freshwater flow issues are not mentioned by the Commission on Ocean Policy (2004) or the U.S. Ocean Action Plan (2004). On balance, the State of Florida has developed an acute awareness of the importance of watersheds and freshwater flows from its experiences in the Apalachicola-Chipola-Flint Rivers Basin and Apalachicola Bay, Everglades restoration, and the programs and projects of numerous water management districts, national estuary programs, and allied endeavors.

Of special relevance to the development of Florida's ocean and coastal research priorities is the expression by state agencies of numerous management needs for more effort addressing the watershed-ocean and watershed-estuary linkages that affect agencies' abilities to fulfill their respective missions. Almost twenty percent of agency input received by the Council concerned watershed and freshwater inflow issues, with major themes concerning:

a) The hydrological connectivity of Florida's land and inland waters to the coast and oceans, via surface and sub-surface conduits;

b) the existing and future forms and uses of watersheds, and the manner of downstream hydrological changes expected with changes thereto;

c) how the totality of changes to Florida's water cycle will affect the quantity, timing, and locations of fresh water provided to the coast, especially in terms of salinity;

d) how past, present, and future changes to freshwater flows will cumulatively affect habitat, biodiversity, and useful productivity of specific estuaries and Florida's coastal ocean as a whole; and,

e) how to best identify and use biologically-based criteria and targets in estuaries and coastal oceans as guides to effective water management.

These major themes inform the following research focus areas and specific projects. Focus areas and the specific projects identified within each are presented in order according to how each builds on prior steps. No ranking according to importance is implied, and some areas and projects are amenable to being combined.

All of the proposed projects are intended for statewide application. In some cases, where watersheds extend into other states, the projects should, as well. Though space limitations prevent their explicit recognition, exemplary models for many recommended projects already exist for specific areas of the state, often as the result of water management district initiatives.

Research Focus Area 11: Filling Information Gaps

State agencies, working in concert with regional planning councils and water management districts, have compiled a robust body of knowledge concerning Florida's watersheds, land covers and uses, and streams. Despite these significant accomplishments, substantial gaps need to be filled in order to effectively articulate the co-management of land and sea on a *state-wide* basis. Basic questions remain, as in the definition of watersheds where boundaries depend on stage; as in the present-day, cumulative status and trends of dominant land covers (e.g., wetlands) and uses (impervious areas), and as in how much fresh artesian water finds its way to tide. The time has come for Florida to undertake a synthesis of agency, district and council data, updated by such new information as needed, to develop a single state-wide assessment of watersheds and water resources that can inform coastal and ocean management. This need is enhanced by the organization of the Water Management Districts based on surface-water flows, though substantial water flows between some districts through underground flow through the aquifers. Because many watersheds and streams extend into other states, the undertaking will have to consider a landscape larger than Florida's political domain.

Research Components:

RC 11.3: Develop an integrated statewide water budget, considering watersheds outside of Florida as necessary, which accounts for inputs, storages, transfers, and losses of atmospheric, surface, and ground waters to identify the extent of inflow change to the state's coastal waters. [Priority 9 of 51]

Research Focus Area 13: Create Indices and Metrics to Improve Management

The widespread call by management agencies for indices, standards, and metrics is also evident where issues of freshwater inflow are concerned. Across Florida and the world, there are clear examples of harm to living resources in estuarine and marine environments, caused by extreme alterations to freshwater inflow. Studies are underway, but the wide variety of conditions in Florida's coastal waters requires research targeted at specific areas of the state as well as development of bioassessment tools (also discussed in Research Category F, RC 18.1.

Research Components:

RC 13.1: Develop and field-test biotic indicators (species, species groups, habitats, communities) as criteria and targets for statewide use in determining whether watershed and stream management practices are protecting natural estuaries and marine ecosystems, and restoring impaired ones. [Priority 24 of 51]

RC 13.2: Determine the locations and sizes, dominant physico-chemical features, living resources, and unique ecological functions of all oligohaline and tidal-fresh waters in Florida. [Priority 29 of 51]

Research Focus Area 14: The land-sea connection

As living marine resources are linked over broad regions by ocean currents, they are also linked to the land through the outflow of rivers and tidal currents from estuaries. These connections can occur over long distances. For example, the 1993 floods in the Mississippi River drainage entrained the runoff in the Loop Current in the Gulf of Mexico which, some days later, caused significant drop in the salinity of water over Florida Keys coral reefs.

Many marine organisms use estuaries and rivers as spawning and/or nursery areas or, as in the case of sturgeon, spend their adult life in rivers and spawn in the sea.

Research Components

RC 14.1: Determine the relationship of the timing, quantity, and distribution of major river outflows and submarine groundwater discharges to the distribution and abundance patterns of coastal marine organisms. [Priority 26 of 51]

RC 14.3: Using a historical approach, estimate the effect of the loss of coastal mangrove and seagrass habitat on the species that depend upon them. [Priority 4 of 51]

Research Category F: Water Quality

Introduction

Water quality is of critical importance to Florida. A seemingly simple topic, water quality determines what biological communities can live in a water body, whether the water is harmful to humans drinking or exposed to it, and whether the water is suitable for human uses such as manufacturing or cooling. With an economy driven by tourism focused on use and appreciation of water resources, maintenance of high water quality to support reefs, grassbeds, fishing, and beach activities, among many others, must be a high priority.

Nutrients concentrations in Florida's surface, ground, and coastal waters have become a widespread water-quality problem in Florida. Excess nutrients support plant and algal growth which can result in overgrowth of grassbeds with resulting die-off, prevent light from reaching the grassbeds, and smother corals and other organisms.

Contaminant discharges to Florida's waters are less widespread than in the past, but problems remain, especially for coastal waters. Physical-chemical factors result in many contaminants settling out of rivers and streams when they mix with salt water. As a result, the estuaries and areas near coastal streams accumulate contaminated sediments, causing problems for benthic communities at these locations.

Certain contaminants like mercury are causing significant problems by accumulating in the coastal food chains. At present, health advisories have been issued to minimize human consumption (or, in the case of pregnant women, prevent consumption) of many of the sport and commercial fish species along Florida's coasts because of excessive mercury levels in the fish tissues.

Different aspects of human wastewater problems could fall under nutrient, contaminant, and human health categories, but there are aspects of dealing with human wastewater sources that warrant separate consideration.

One of the most significant changes in water quality science in the last decade is the expansion from considering water quality only as the physical and chemical components making up the water to including the water's suitability for supporting healthy aquatic communities. The term biological water quality refers to using the health of the biological community within a water body to better determine whether problems exist with the physical-chemical components of the water. While these biological assessment (or bioassessment) methods are now widely used in Florida's freshwater systems, only initial development has begun for Florida's coastal and ocean waters. There is a critical need to develop estuarine and marine bioassessment methods, which are tools that support many of the other research efforts.

Human-health issues and harmful algal blooms (HABs) are also water-quality issues, but their wide-spread importance and specificity has prompted the Council to assign them their own areas in this Research Plan, so those aspects will not be addressed in this section.

Research Focus Area 15: Nutrients

As a direct result of Florida's large human population, various industries, and agriculture, there are high rates of nutrient transport from watersheds to downstream receiving waters, including the coastal waters that support economically important fisheries, recreational beaches and waterways, reefs, and other natural environments. Resource managers require information to guide management actions that will reduce these nutrient inputs and their deleterious effects. This includes information on relative cost and effectiveness of different methods of nutrient control at the source, effects of alteration of flow pathways (e.g., channelization) on nutrient transport and transformation, opportunities for instream and downstream nutrient controls (e.g., riparian restoration, wetland treatment areas) and a better understanding of how particular concentrations, ratios, and loads of nutrients affect native flora and fauna in rivers, estuaries and offshore coastal waters. This improvement in Florida's marine water quality would protect economically important habitats such as benthic communities and beaches.

Research Components:

RC 15.1: Develop methods for determining sources of nutrients so agencies can improve source regulation. [Priority 48 of 51]

RC 15.7: Identify quantitative relationships between nutrient concentrations in coastal waters and impairment of flora and fauna, so that agencies can use this information to establish scientifically-sound targets (such as nutrient criteria) for nutrient concentrations and loads. [Priority 21 of 51]

Research Focus Area 16: Contaminants

There is a need to better understand water quality issues to allow resource managers to take action before adverse effects take place. For the purposes of this section, contaminants will be used to include both natural and other constituents which put the biological community at risk, but not including nutrients, addressed in Research Focus Area 14, and red tide, addressed in Category G, Harmful Algal Blooms.

Two examples of adverse effects from water borne contaminants are loss of fisheries and esthetic damage to beaches and other recreational areas. These, in turn, can have significant economic impacts by reducing industry and tourism.

Research Components:

RC 16.1: Assess the impacts of non-point source pollution, particularly storm-water runoff from urban areas, and determine the most effective means of abatement. [Priority 22 of 51]

RC 16.5: Define potential impacts of offshore oil and gas development of Florida's coastline with an emphasis on effects on fish, wildlife and their habitats. [Priority 49 of 51]

Research Focus Area 17: Domestic Wastewater

Although many of the problems associated with wastewater management are human health issues (hence placed in a separate part of the Research Plan), there are other environmental issues. Florida's burgeoning population has in some areas out-paced our ability to deal effectively with sewage issues.

Research Components:

RC 17.1: Assess the effect that human waste management, and septic tank use in particular, has on nutrient loading and water quality in nearshore habitats. [Priority 20 of 51]

RC 17.2: Assess the effects of nutrients from ocean outfalls on coastal habitats. [Priority 36 of 51]

RC 17.3: Compare the environmental risk to water quality of area waters from septic systems to that of centralized sewage systems, particularly on islands. [Priority 35 of 51]

Research Focus Area 18: Determining the Health of Biological Communities in order to Measure Ecosystem Health and Assess Water Quality

Water quality is one of the main factors controlling biological communities in Florida's estuaries, coasts, and marine waters.

Over the past decade, research and practical experience in freshwater systems (including in Florida) has demonstrated the advantage of using focused biological monitoring to identify areas of impaired water quality. Biological monitoring provides intuitive information about actual environmental quality and

results are easier for the public to understand. Additionally, it is now recognized that physical and chemical measurements alone often poorly predict the presence of effects on exposed biological communities.

Because of national guidance and leadership demonstrating new biological monitoring approaches, Florida embarked on a major initiative to redesign its monitoring and assessment strategies for managing water resources.

The initiative began in freshwater systems because both the mechanisms driving changes in water quality and the biological communities themselves are simpler to understand and assess than those in salt waters. After extensive research and development efforts, the cost-effectiveness of using a biological assessment approach has been demonstrated and such methods are now important components of numerous freshwater surface water management programs in Florida.

Biological monitoring offers a relatively inexpensive means to document where problems exist and help focus where more intensive chemical and physical monitoring may be required to determine sources and causes of the problems.

In salt waters, however, bioassessment methods-development has been minimal and limited in scope. There is a need to expand meaningful biological monitoring and develop new and improved biological assessment methods for our coastal and oceans waters to provide the management benefits already available for Florida's fresh waters.

In contrast to freshwater communities, the physical and chemical factors underlying biological communities in salt water systems are much more difficult to understand. Therefore, a considerable portion of the work required to develop new biological monitoring tools will consist of research to understand physical and chemical factors combined with biological and geographical settings to develop classification systems for the types of saltwater communities.

Bioassessment inherently depends on the ability to identify the species makeup of the biological communities being assessed. For methods to be widely useable, these identifications must be performed in a repeatable manner, with the same attention to QA/QC as is required by any other analytical method. Experience with the freshwater bioassessment program has demonstrated the need for centers of taxonomic expertise to provide statewide quality assurance programs to ensure consistency in identifications and, thereby, consistency of results from using bioassessment methods. These centers also responsible for developing new and improved methods to more cost-effectively perform the identifications.

As a part of developing community bioassessment methods, there is a need to develop techniques and technology that allows researchers to measure biological activity continuously at a level similar to that presently used to monitor water quality, hydrology, and climate.

These technologies include new sensor systems (LIDAR, sonar, passive acoustics, IR), telemetry (radio, satellite, telephone) and bio-chemical (elemental isotopic, genetic) analyses.

Development of biological assessment and monitoring approaches in marine systems will also help support work in many of the other Research Focus Areas in this document. Of the 145 Management Needs identified to the Council by state agencies to help them better fulfill their coastal and oceans responsibilities, 75 depend on development of either new or improved bioassessment methods to address those needs.

Research Components:

RC 18.1: Building on existing initial efforts (DEP, FWC, WMDs, CERP), hold a statewide workshop to identify initial habitats for which to develop bioassessment methods. Discuss possible pilot projects in different regions that pose different expectations. [Priority 41 of 51]

RC 18.4: Identify and evaluate new technologies—including but not limited to sensors (LIDAR, sonar, passive acoustics, infrared), telemetry (radio, satellite, telephone) and bio-chemical analyses (elemental isotopic, genetic)—for their potential to measure biological activity continuously at a level similar to that presently used to monitor water quality, hydrology, and climate. These technologies and/or techniques should be compatible and simultaneously deployed with Integrated Oceanographic Observation Systems (IOOS) that are located in coastal waters around the United States. [Priority 2 of 51]

Research Category G: Harmful Algal Blooms (HABs)

Introduction

Coastal waters of Florida recently have displayed widespread blooms of microscopic algae and bacteria that produce toxins that are potentially harmful to humans, fish, and other living aquatic organisms. In the Gulf of Mexico, 'red tide' blooms of the toxic dinoflagellate *Karenia brevis* (previously *Gymnodinium breve*) have caused mass mortalities of fish, shellfish poisoning, and human respiratory irritation. In the Atlantic Ocean the bioluminescent dinoflagellate, *Pyrodinium bahamense* var. *bahamense*, has been associated recently with the accumulation of saxitoxins (potent neurotoxins) in pufferfish. In coastal rivers and estuaries along the east and west coast of Florida, blooms of the cyanobacterium *Microcystis aeruginosa* and associated high levels of its toxin microcystin (a hepatotoxin) raise concerns about safety of water for drinking, recreation, and fishing.

Dinoflagellate and cyanobacteria blooms of the magnitude experienced in 2005 in the Gulf of Mexico and other Florida coastal waters impact fishing and tourist industries, may alter population levels and/or recruitment of fish and other marine animals, and have the potential to reduce sales of seafood products from within the region and impact values of waterfront property. There is an ongoing discussion regarding why blooms appear to be more frequent and widely distributed in recent years, with explanations including natural mechanisms related to species dispersal, natural climate cycles, and human-related factors such as enhanced nutrient runoff from developed watersheds. Whatever the cause, it is clear that HABs are common in Florida waters, the blooms have negative consequences, and major uncertainties remain regarding their cause and scope of human and ecological impacts.

While understanding of the factors controlling red tides is developing, less is known of the ecology of the other HAB species. Nutrients appear to be a factor in all algal blooms, but there are a number of unresolved questions regarding HABs that need to be addressed if we are to develop a predictive understanding of their occurrence, their risk to human health and natural ecosystems, and importantly, the opportunities for their control. The items listed here are taken from national research planning documents recently under development based on workshops involving leading scientists from around the world who deal with HABs. They also reflect the management questions submitted to the Oceans

Council by state agencies, water management districts, and other governmental entities involved in the management of Florida's coastal waters.

Research Focus Area 20: Environmental controls of toxic blooms

If blooms are to be controlled, then resource managers must have information regarding the factors responsible for their development, movement, and die-off. This information may come largely from field observations, but it ultimately needs to include controlled experiments (where scale of questions makes this feasible) and predictive modeling.

Knowing what factors control blooms is critical to resource managers in regard to decisions regarding whether or not to take actions (e.g., natural vs. anthropogenic cause) and what actions to take (e.g., reduce total nutrient inputs vs. also focus on critical nutrient ratios in effluent waters).

Research Components

RC 20.2: Determine the hydrologic conditions that result in HAB development, using a combination of observations and modeling. Enhance the collection of data on the size, duration, intensity of blooms. [Priority 36 of 51]

RC 20.3: Determine influence of watershed nutrients resulting from land-use practices on HAB formation and collapse. [Priority 38 of 51]

Research Focus Area 23: Ecological effects of non-toxic macro-algal blooms

Several macro-algal species (e.g., *Lyngbya* and *Caulerpa*) are causing problems in nearshore areas, particularly on southeast Florida reefs. Dense blooms of these large algae smother corals and other benthic communities.

Research Components

RC 23.2: Determine factors resulting in macro-algal blooms. [Priority 45 of 51]

RC 23.3: Quantify the impacts of HABs on commercial and recreational fisheries, coastal tourism, contact recreation, and other human activities integral to the economy of Florida's coastal areas. [Priority 28 of 51]

Research Category H: Public Health Issues

Introduction

The ocean is a source of both threats and benefits to human (public) health. A number of National Research Council studies have recommended research priorities for understanding the linkages among physical oceanography, marine biology, public health, epidemiology, and medicine. The U.S. Commission on Ocean Policy recommended that "significant investment must be put into developing a coordinated national research effort to better understand the links between the oceans and human health". The President's Ocean Action Plan recognized the economic and human health impacts of beach closings, seafood contamination, and the toxic effects of harmful algal blooms—all of which have increased in the State of Florida.

Threats to public health include infectious and toxic microorganisms (including harmful algae) that affect humans through ingestion of contaminated seafood, direct contact with seawater and sediment during

recreational or occupational activities, and contact with sea spray containing toxins. Pathogens and chemical pollutants, such as heavy metals, enter coastal waters in runoff from sewers, rivers, and streams. Vivid impacts of the ocean on human health are most dramatically observed when high water associated with storm surges, heavy rainfall, and hurricanes exacerbates the spread of pathogens and chemical pollutants.

The oceans are also the source of benefits to human health, including marine-derived pharmaceuticals to treat diseases such as cancer and Alzheimer's, as well as nutritional supplements and diagnostics. Exploration of Florida's rich marine biodiversity has already resulted in the discovery of novel chemicals with pharmaceutical applications. The first two drugs ever derived from marine organisms were discovered from Florida coastal waters during the 1950's. As a result of more recent discoveries made by scientists at State and private universities and research centers, particularly during the past two decades, Florida is one of the top two states (with California) for marine biomedical research and development.

Toward this end, one of the goals laid out in the Oceans and Coastal Resources Act was to reduce negative health impacts of marine organisms, and promote marine biomedical or biotechnology research and product discovery and development to enhance Florida's opportunity to maximize the beneficial uses of marine-derived bioproducts.

Research Focus Area 24: Develop a comprehensive program to assess the occurrence and persistence of water-borne and sediment-associated disease-producing organisms in fresh, estuarine, coastal, and marine waters and associated sediments.

It is not at present possible to reliably identify where there is risk to humans from exposure to water-borne or sediment-borne disease-causing organisms (pathogens) in Florida's waters. Recent investigations indicate that presently-used methods may not distinguish between conditions where pathogenic bacteria are present and those where only naturally-occurring populations of non-pathogenic bacteria are present. Presently-used methods appear to give frequent false indications that pathogens are present. The economic effects from unnecessary closing of Florida's beaches and shellfish waters as a result of this error are potentially significant. A comprehensive research program for assessment of the environmental conditions that influence the occurrence and persistence of water-borne and sediment-associated pathogens of concern to human health in fresh, estuarine, coastal, and marine waters and associated sediments is needed.

Research Components:

RC 24.1: Develop and implement rapid monitoring and assessment tools and procedures for identifying microbial pathogens in rivers, coastal waters, sediments (including beaches), and seafood. [Priority 34 of 51]

These should be rapid, ultimately inexpensive, sensitive, and robust methods for detection and measurement of all classes of waterborne pathogens and their indicators, and they should be capable of deployment in the field and on coastal and ocean observing platforms.

Research Category I: Living Marine Resources

Introduction

Much of Florida's economy is based on living marine resources. Commercial and sport fishing along the coasts, recreational diving, and tourism are just a few examples of activities based on the coastal ecosystems and having substantial economic impact.

Florida's Ocean Strategies (1999), the Commission on Ocean Policy (2004), and the U.S. Ocean Action Plan (2004), and Florida's Oceans and Coastal Resources Act (2005) all specify the implementation of Ecosystem-Based Management (EBM) in the U.S. Exclusive Economic Zone. EBM is sometimes perceived to apply exclusively to fisheries management, but as a recent scientists' statement (e.g. www.compassonline.org) has emphasized, it is intended to be an overarching, comprehensive approach, whose goal is sustainable human uses of marine resources. It also requires consideration of "upstream" effects from other states and countries.

Implementation of EBM involves most of the categories of research that the Florida Ocean and Coastal Resources Council has considered, beginning with comprehensive mapping of the geographic distribution of habitats and resources, the currents linking areas around the state, key areas such as spawning aggregations and migration routes, and existing human uses in the coastal ocean. Using the map information in Research Category A as a background, EBM can be envisioned to move forward regionally within the state, driven by stakeholders, for which the definition of the "*ecosystem*" in EBM could be described as the "*area of concern*."

Most fishery species have suffered declines in distribution and abundance, such that their contemporary populations are a fraction of what they once were. Jackson et al. (2001) and Pandolfi et al. (2003, 2005) have pioneered a historical approach to ecology, using scientific records, archaeological records, popular accounts, and other sources to provide great detail on the historical trajectory of decline. Some of the best historical records are the commercial fishing records mandated by the FAO and by other government authorities. The use of marine "zoning" to identify—among others—areas to preserve (like Aquatic Preserves and Marine Protected Areas), areas for commercial/industrial activities (like ports and shipping channels), areas for fishery harvesting, areas for fishery replenishment (like Marine Reserves), and areas for research (like National Estuarine Research Reserves) is effective. For instance, five different types of marine zones have been implemented in the Florida Keys National Marine Sanctuary that protect important resources, lessen conflicts between uses, provide research sites, and preserve the authorities of overlapping jurisdictions. However, proper identification of marine zones calls for methods to identify what areas of our waters constitute their best use.

Of course, there is no possibility of re-creating ecosystems as they were before modern human populations expanded. But the historical ecology approach suggests measures that may be effective and can provide quantitative information on the effectiveness of management.

Research Focus Area 27: Connectivity: linking the distribution and abundance of living marine resources to ocean currents

The understanding of ocean currents is as critical to management of the marine environment as the chart. Currents are the highways by which many living marine resources move, particularly eggs and larvae. Currents also move food and nutrients around the system.

Physical oceanographers commonly use make empirical observations data from widely-spaced automated monitoring equipment over broad areas and then use models to provide a comprehensive view of ocean circulation. A basic problem is that the geographic scale of this oceanography is generally much larger than that necessary for understanding the much smaller scales of biological observations of fishes, red tides, or pollution, for example, are mismatched. Research is needed to bring biological observations into line with physical observations and the arena of ocean-circulation models. As with all ecosystem changes, it will be critical to distinguish between anthropogenic effects on the ecosystem and natural environmental changes. A combination of fishery independent data along with environmental monitoring of both biological and physical data taken in the same time and space scales are critical. Satellite remote sensing (ocean color-chlorophyll and sea surface temperature) is an important tool for answering some significant issues. These types of data should be combined integrated with useful ocean circulation models to produce both diagnostic and predictive bio-physical models. Understanding the linkages between the physical environment and the biology is fundamental.

Almost all marine species have a free-swimming, planktonic larval stage of several days to months in duration. This is an important and still mysterious stage in the life of any marine organism and better understanding is basic to management. Marine organisms commonly have particular spawning areas and/or spawning seasons that often are well known. Larvae produced at these times can be distributed over great distances. Understanding the "source" areas for larvae is critical for the management of target species.

Research Components

RC 27.1: Conduct studies linking key fish spawning areas to larval distribution and adult population-distributions on the Florida shelf, for example Riley's Hump in the Tortugas Ecological Reserve. [Priority 29 of 51]

RC 27.2: Assess effectiveness of Marine Protected Areas and Marine Reserves and other types of protected areas to enhance the surrounding ecosystem, for instance through "spillover" effect. [Priority 15 of 51]

Research Focus Area 28: Improve scientific input to fisheries management

All of the recent ocean policy reviews and studies have stressed the need to reform fisheries management. With the current review by Congress of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) the issue has come to the forefront. The fundamental problem is the need to separate scientific assessment of stocks and allowable catch from allocation of those resources to fishing interests.

Finally, improved scientific assessment of fishes must be an integral part of the development of the Coastal Ocean Observing System (COOS) and new techniques must be developed to supplement the traditional fisheries dependent and independent methods of stock assessment.

Research Components

RC 28.1: Develop new methods for the assessment of fishery populations that include acoustical and genetic methods. [Priority 10 of 51]

RC 28.2: Conduct monitoring, assessment, and modeling evaluations of the impacts of fishing on ecosystems. These studies will include impacts of various gear uses; removal of both predator and prey species, sex, size population-dynamic relationships; loss of keystone species; and other trophic-level interactions. [Priority 12 of 51]

RC 28.5: Work with fishers to identify fishery spawning aggregation sites around the state, and then validate and characterize these areas. [Priority 25 of 51]

RC 28.6: Create coastal ocean environmental indices in support of fisheries research and spatial management of the fisheries. Monitoring of habitat conditions on a daily basis will be important to understanding linkages of the environment to marine resources. [Priority 46 of 51]

Research Focus Area 29: Spatial management

Management of marine resources using zoning is integral to EBM. While we often speak of the ocean as a commons, open to all but the responsibility of none, zoning has been extensively used, for example, for ship channels, disposal areas, military activities, minerals leases, aquaculture, and fisheries management. But, unlike zoning on land, the implementation of marine zones has been piecemeal and without planning and sufficient understanding of the distribution of habitats, living marine resources, and potentially-conflicting human uses. This is in large part due to the lack of comprehensive mapping of the seafloor and the habitats and natural resources on it. One must map first, then zone. Any zoning efforts should also consider benefits and values of microhabitats as well as global considerations.

We are entering an era where there will be greatly increased pressure for development, leasing, and exploitation of marine regions, for example, offshore aquaculture, hydrokinetic and wind power generation, pipelines and IT cable corridors, and offshore minerals and mining. Before these decisions are taken, we need to have an idea of what is there, what we can afford to give over to human use, and what we must manage and conserve for sustainability.

Research Components

RC 29.3: Determine which geospatial habitat conditions support an increase in fish recruitment as a result of Marine Reserves. This research should consider the size and location in relation to biotic and abiotic conditions. [Priority 41 of 51]

Research Category J: Habitat Restoration

No research projects from this category were included in this year's final list.

Research Category K: Non-native Invasive Species

No research projects from this category were included in this year's final list.

Research Category L: Aquaculture

Introduction

Floridians pioneered early efforts to culture marine species. Culturing hard clams started during the 1960s in St. George Sound and other coastal locations around the state. Experimental marine shrimp

farming by Floridians led to the development of a global industry in tropical countries where longer growing seasons made production profitable. Experimental work led by Florida's first publicly-employed marine biologist tested the culture of marine finfish at the Department of Natural Resources laboratory in St. Petersburg, (now the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute), the summer feeding of oysters at a laboratory on Cedar Key, and initiated the creation and maintenance of oyster reefs in Apalachicola Bay using oyster cultch in 1949.

Today Florida is the largest producer of the hard clam for national and international markets with production occurring on leased sovereign submerged lands; the largest producer of marine ornamental fish, invertebrates, and hard corals for marine aquarists from inland, recirculating production systems; and the largest producer of live rock for marine aquarists from leased sovereign submerged lands

Florida is a significant seafood consumer and an excellent market entry point for new sources of seafood. The United States is the third largest consumer of seafood in the world, importing 45 percent of its seafood fare by weight or 81 percent by value.

Florida is also at the epicenter of where marine work can be accomplished to (1) replenish depleted marine stocks through the release of cultured fishes and invertebrates, (2) recognize and protect essential or critical habitat for key fisheries stocks, (3) develop a better understanding of life-history and ecological requirements and how to use this knowledge to develop sound fishery regulations (4) advance the understanding of current trends in ecosystem-based management, fisheries stock assessment, and modeling, and (5) develop innovative methods for monitoring fish abundances and exploitation rates.

In an effort to help meet state and national seafood demand; protect, conserve, and restore declining recreational fisheries and reef species; and stimulate economic growth, the Council will focus research efforts on evaluating the potential for inland, recirculating aquaculture technology to produce food or ornamental marine species, offshore technologies, and the implementation of new marine stock enhancement initiatives. The proposals are supported by a planning document, The Florida Aquaculture Plan, as authorized by Chapter 597, Florida Aquaculture Policy Act, Florida Statutes.

Research Focus Area 33: Achieve Sustainable Marine Aquaculture Species and Production Systems

Florida aquaculture must expand production and reduce costs to meet increasing national demand and falling global prices for high-quality seafood and ornamental species. A dedicated and coordinated effort is needed to identify suitable species and design sound production systems. High market value species amenable to intensive production systems and plant-based protein diets must be identified and tested in commercial systems. Marine aquatic animal production systems must be improved through the development and application of innovative biological and engineering approaches to reduce energy consumption, increase carrying capacity, incorporate plant-based biofiltration, and automate command and control functions.

Research Components

RC 33.1: Demonstrate economically-feasible production and marketing of a high-value marine fish species that can be farmed in a land-based recirculating production system. [Priority 43 of 51]

RC 33.4: Evaluate the potential benefits and risks of offshore aquaculture in Florida. [Priority 39 of 51]

Research Focus Area 34: Aquaculture of Marine Fish Species for Stock Enhancement

Many of Florida's economically important marine species have declined in abundance due to over-fishing, estuarine nursery habitat loss and acute environmental impacts such as chemical spills or periodic winter kills. Hatchery production is frequently suggested as one remedy for declines related to early-juvenile-habitat loss and acute impacts. The release of hatchery-reared fish may be particularly effective in restoring a population in areas where the abundance of naturally occurring fish has declined to a level at which natural recovery is unlikely in a reasonable amount of time. Hatchery releases may also increase fishing opportunities by providing a source of juveniles to supplement weak year classes and to stock inland ponds in urban areas suffering from coastal-habitat degradation.

Research Components

RC 34.1: Develop and demonstrate recirculating marine aquaculture technology for marine sport fish stock enhancement and restoration. [Priority 27 of 51]

Research Category M: Measuring Coastal Economies and Assessing Human Impacts on Resources

Introduction

The draw of Florida's coasts is undeniable; people relish the opportunity to work and play as close to Florida's shorelines and waterways as possible. The state's economic and environmental well-being is inextricably linked to its coastal and marine resources. Florida's coastal communities and water-dependent businesses face difficult and critical challenges: how to balance population growth, development pressure, recreational demands and tourism with maintenance and enhancement of coastal environmental quality. Almost 80% of the state's population lives in the 35 coastal counties. By 2025, the population of Florida's coastal counties is projected to be almost the same as the population of the entire state in 2000. There is a compelling need to create strategies for community development and business growth that are compatible with the environment and that are sustainable.

Gaps among diverse, often conflicting interests of all citizens regarding the use of the coasts and ocean are daunting, but they must be closed if coastal communities are to realize their full economic and environmental potential. Policy and decision-makers need the best science-based information to consider as they plan the future of Florida. Research needs in this area require an interdisciplinary approach and they require the involvement of a diverse range of disciplines including the natural, physical and social sciences, architecture and engineering.

Research Focus Area 35: Resource Valuation

Sustainable coastal ecosystems provide a variety of goods and services, including fisheries, recreation, waste assimilation, erosion, flood control and biological diversity. They also provide a desired place to live and provide business services.

Research Components

RC 35.1: Determine the market and non-market values for all sectors of the Florida ocean and coastal economy using a consistent methodology and available data bases that can be repeated periodically to track the performance of each sector dependent on the coast and ocean. Make the information available to the legislature and the public on the web. [Priority 16 of 51]

RC 35.2: Determine the economic value of coastal ecosystems and habitat when left to function as a natural system. [Priority 40 of 51]

Research Focus Area 36: Indicators of Sustainable Development

Planners and decision makers need an integrated set of economic, environmental and social indicators that track progress toward achieving the goal of sustainable coastal development and use.

Research Components

RC 36.1: Determine the social and economic costs and benefits that derive from public and private conversion of coastal and waterway access points to non-water dependent uses. Determine incentives to retain water-dependent and water-related facilities that serve public needs and reflect public values in order to maintain public access to public coastal waters. Produce annual reports stating the length of Florida's sandy beaches that are publicly accessible. [Priority 44 of 51]

RC 36.6: Determine the economic impacts of long term trends in beach loss, including:

a) Determine the economic and environmental costs and benefits of continued beach-renourishment projects, including determining the economic feasibility, extent, availability, quantity and quality of offshore sands suitable for beach renourishment. Link to water quality studies of this issue in the Water Quality section.

b) Determine the effect of continued beach-renourishment projects on turtle, seabird, and adjacent coral and fish populations and on other organisms dependent on beach ecosystems for food, shelter, and reproduction. Include subsequent economic impact as well. [Priority 29 of 51]

Research Focus Area 37: Response to Coastal Hazards

A pre-hazard response is necessary to enhance preparedness and reduce losses of human life, property and coastal ecosystems and habitats from natural hazards. The research projects listed here focus on coastal ecosystems and natural habitats.

Research Components

RC 37.3: Determine coastal construction and design practices related to reducing shoreline erosion. Determine the social, economic, and environmental consequences of increasing rates of beach erosion, coastal armoring, and beach renourishment. [Priority 33 of 51]

RC 37.4: Determine the role of the shoreline in reducing wave and flood damage, including ways to implement shoreline protection measures that do not damage the coastal and offshore natural environment. Develop a scientific basis for determining erosion and coastal setback zones. [Priority 47 of 51]

IV. RESEARCH NEEDS AND COSTS IN ORDER OF FUNDING PRIORITY

The Council offers the following list of research in order of importance. Note that the integrated data management recommendation is not incorporated in this list, but presented separately in the Integrated Data Management and Dissemination section. Budget estimates for the Research Components in the list will be generated by Council staff and added as an appendix. The Council will review the estimates and submit a final table.

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
1	*Establish real-time interdisciplinary observing systems in areas that currently have no or minimal observing. [B. Monitoring; RC3.2]*
2	*Identify and evaluate new technologies—including but not limited to sensors (LIDAR, sonar, passive acoustics, infrared), telemetry (radio, satellite, telephone) and bio-chemical analyses (elemental isotopic, genetic)—for their potential to measure biological activity continuously at a level similar to that presently used to monitor water quality, hydrology, and climate. These technologies and/or techniques should be compatible and simultaneously deployed with Integrated Oceanographic Observation Systems (IOOS) that are located in coastal waters around the United States. [F. Water Quality; RC 18.4]*
3	*Establish continuous, long-term monitoring of salinity and dissolved-oxygen conditions in the estuaries to support development of modeling tools, assess the impact of sea-level rise, and assist in resource management (for instance, commercial and sport fisheries). [B. Monitoring; RC 3.7]*
4	*Using a historical approach, estimate the effect of the loss of coastal mangrove and seagrass habitat on the species that depend upon them. [E. Freshwater Flow; RC 14.3]*
5	*Develop, install, and implement new and improved biological monitoring instrumentation and protocols that will make biological observations match the geographic scale of physical oceanography measurements. Examples are tracking migratory species, developing methods for interdisciplinary observations of nutrients, chlorophyll, algal blooms, and fisheries and other aquatic resources to link physical-chemical conditions to biological effects. [B. Monitoring; RC 3.5]*
6	*Establish an interdisciplinary remote sensing capacity for Florida's coastal and offshore waters. [B. Monitoring; RC 3.4]*
7	*Produce present-day highest-resolution bathymetric maps, identifying physical geologic setting (sediment/rock) and submarine aquatic vegetation with the goal of mapping the entire State's waters by 2015. [A. Mapping; RC 2.1]*
8	*Use existing technology, including satellite remote sensing, to better link red tide research and monitoring to physical oceanography in order to better predict red tide size, trajectory, and intensity and potential impacts and to provide an early warning system. [B. Monitoring; RC 5.5]*
9	*Develop an integrated statewide water budget, considering watersheds outside of Florida as necessary, that accounts for inputs, storages, transfers, and losses of atmospheric, surface, and ground waters to identify the extent of inflow change to the state's coastal waters. [E. Freshwater Flow; RC 11.3]*
10	*Develop new methods for the assessment of fishery populations that include acoustical and genetic methods. [I. Living Marine Resources; RC 28.1]*
11	*Identify and prioritize specific coastal areas around the State for bathymetric mapping - with the goal of mapping the entire State's coast by 2010. [A. Mapping; RC 1.1]*
12*	*Develop coastal, estuarine, riverine, and lagoonal models to be nested with adjacent shelf models to improve understanding of land-sea linkages. [C. Modeling; RC 6.3]*

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
12*	*Conduct monitoring, assessment, and modeling evaluations of the impacts of fishing on ecosystems. These studies will include impacts of various gear uses; removal of both predator and prey species, sex, size population-dynamic relationships; loss of keystone species; and other trophic-level interactions. [I. Living Marine Resources; RC 28.2]*
14	*Evaluate the long-term stability of coastal wetlands (marshes, mangroves, seagrasses) in relation to sea-level rise and episodic disturbances (i.e., hurricanes). [C. Climate Change; RC 9.5]*
15	*Assess effectiveness of Marine Protected Areas and Marine Reserves and other types of protected areas to enhance the surrounding ecosystem, for instance through "spillover" effect. [I. Living Marine Resources; RC 27.2]*
16	*Determine the market and non-market values for all sectors of the Florida ocean and coastal economy using a consistent methodology and available data bases that can be repeated periodically to track the performance of each sector dependent on the coast and ocean. Make the information available to the legislature and the public on the web. [M. Coastal Economics; RC 35.1]*
17	*Integrate HAB monitoring with data collection in the Ocean Observing System to allow examination of empirical relationships between HAB occurrence, spatial extent and intensity with physical-chemical data and provide an improved understanding of factors controlling HABs. [B. Monitoring; RC 5.4]*
18	*Create maps to link previously mapped areas on the coast (identified through the State Coastal Inventory) seamlessly to existing offshore data where possible. This will show where gaps exist and identify datasets that are not compatible [A. Mapping; RC 1.2]*
19	*Establish and enhance hydrological, chemical, and biological monitoring and assessment, including stationary and mobile systems such as shipboard surveys with accompanying modeling of the systems being monitored, to support agency programs to preserve and manage Florida's natural resources. [B. Monitoring; RC3.6]*
20	*Assess the effect that human waste management, and septic tank use in particular, has on nutrient loading and water quality in nearshore habitats. [F. Water Quality; RC 17.1]*
21	*Identify quantitative relationships between nutrient concentrations in coastal waters and impairment of flora and fauna, so that agencies can use this information to establish scientifically-sound targets (such as nutrient criteria) for nutrient concentrations and loads. [F. Water Quality; RC 15.7]*
22	*Assess the impacts of non-point source pollution, particularly storm-water runoff from urban areas, and determine the most effective means of abatement. [F. Water Quality; RC 16.1]*
23	*Perform bathymetric and benthic-habitat mapping of important Florida tidal rivers and estuaries by 2010. These are to be used to determine essential environmental conditions needed for living marine resources and to provide data for modeling the environmental impacts of management decisions regarding water use. [A. Mapping; RC 2.3]*
24	*Develop and field-test biotic indicators (species, species groups, habitats, communities) as criteria and targets for statewide use in determining whether watershed and stream management practices are protecting natural estuaries and marine ecosystems, and restoring impaired ones. [E. Freshwater Flow; RC 13.1]*
25	*Work with fishers to identify fishery spawning aggregation sites around the state, and then validate and characterize these areas. [I. Living Marine Resources; RC28.5]*
26	*Determine the relationship of the timing, quantity, and distribution of major river outflows and submarine groundwater discharges to the distribution and abundance patterns of coastal marine organisms. [E. Freshwater Flow; RC 14.1]*
27	*Develop and demonstrate recirculating marine aquaculture technology for marine sport fish stock enhancement and restoration. [K. Aquaculture; RC34.1]*

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
28	*Quantify the impacts of HABs on commercial and recreational fisheries, coastal tourism, contact recreation, and other human activities integral to the economy of Florida's coastal areas. [G. Harmful Algal Blooms; RC 23.3]*
29*	*Determine the locations and sizes, dominant physico-chemical features, living resources, and unique ecological functions of all oligohaline and tidal-fresh waters in Florida. [E. Freshwater Flow; RC 13.2]*
29*	*Conduct studies linking key fish spawning areas to larval distribution and adult population-distributions on the Florida shelf, for example Riley's Hump in the Tortugas Ecological Reserve. [I. Living Marine Resources; RC 27.1]*
29*	*Determine the economic impacts of long term trends in beach loss, including: a) Determine the economic and environmental costs and benefits of continued beach-renourishment projects, including determining the economic feasibility, extent, availability, quantity and quality of offshore sands suitable for beach renourishment. Link to water quality studies of this issue in the Water Quality section. b) Determine the effect of continued beach-renourishment projects on turtle, seabird, and adjacent coral and fish populations and on other organisms dependent on beach ecosystems for food, shelter, and reproduction. Include subsequent economic impact as well. [M. Coastal Economics; RC 36.6]*
32	*Coordinate methods of sampling and analysis among the multiple State, Federal, and local agencies and universities and research institutions that monitor and research HABs in Florida. [B. Monitoring; RC 5.1]*
33	*Determine coastal construction and design practices related to reducing shoreline erosion. Determine the social, economic, and environmental consequences of increasing rates of beach erosion, coastal armoring, and beach renourishment. [M. Coastal Economics; RC37.3]*
34	*Develop and implement rapid monitoring and assessment tools and procedures for identifying microbial pathogens in rivers, coastal waters, sediments (including beaches), and seafood. [H. Public Health; RC 24.1]*
35	*Compare the environmental risk to water quality of septic systems to that of centralized sewage systems to area waters, particularly on islands. [F. Water Quality; RC 17.3]*
36*	*Assess the effects of nutrients from ocean outfalls on coastal habitats. [F. Water Quality; RC 17.2]*
36*	*Determine the hydrologic conditions that result in HAB development, using a combination of observations and modeling. Enhance the collection of data on the size, duration, intensity of blooms. [G. Harmful Algal Blooms; RC 20.2]*
38	*Determine influence of watershed nutrients resulting from land-use practices on HAB formation and collapse. [G. Harmful Algal Blooms; RC 20.3]*
39	*Evaluate the potential benefits and risks of offshore aquaculture in Florida. [K. Aquaculture; RC33.4]*
40	*Determine the economic value of coastal ecosystems and habitat when left to function as a natural system. [M. Coastal Economics; RC35.2]*
41*	*Building on existing initial efforts (DEP, FWC, WMDs, CERP), hold statewide workshops to identify initial habitats for which to develop bioassessment methods. Discuss possible pilot projects in different regions that pose different expectations. [F. Water Quality; RC 18.1]*
41*	*Determine which geospatial habitat conditions support an increase in fish recruitment as a result of marine reserves. This research should consider the size and location in relation to biotic and abiotic conditions. [I. Living Marine Resources; RC29.3]*
43	*Demonstrate economically feasible production and marketing of a high-value marine fish species that can be farmed in a land-based recirculating production system. [K. Aquaculture; RC33.1]*
44	*Determine the social and economic costs and benefits that derive from public and private conversion of coastal and waterway access points to non-water dependent uses. Determine incentives to retain water-dependent and water-related facilities that serve public needs and reflect public values in order to maintain public access to public coastal waters. Produce annual reports stating the length of Florida's sandy beaches that are publicly accessible. [M. Coastal Economics; RC36.1]*

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.
45	*Determine factors resulting in macro-algal blooms. [G. Harmful Algal Blooms; RC 23.2]*
46	*Create coastal ocean environmental indices in support of fisheries research and spatial management of the fisheries. Monitoring of habitat conditions on a daily basis will be important to understanding linkages of the environment to marine resources. [I. Living Marine Resources; RC28.6]*
47	*Determine the role of the shoreline in reducing wave and flood damage, including ways to implement shoreline protection measures that do not damage the coastal and offshore natural environment. Develop a scientific basis for determining erosion and coastal setback zones. [M. Coastal Economics; RC37.4]*
48	*Develop methods for determining sources of nutrients so agencies can improve source regulation. [F. Water Quality; RC 15.1]*
49	*Define potential impacts of offshore oil and gas development of Florida's coastline with an emphasis on effects on fish, wildlife and their habitats. [F. Water Quality; RC 16.5]*
50	*Use existing water quality monitoring programs to collect samples for algal identification and toxin analysis concurrent with nutrient and other water-quality samples. [B. Monitoring; RC 5.2]*
51	*Determine the relationship, if any, of the increased frequency of coral diseases and elevated seasonal seawater temperatures to better target management activities that may focus on other possible causes. [D. Climate Change; RC 9.2]*

* - Tied in rank

V. INTEGRATED DATA MANAGEMENT AND DISSEMINATION

Introduction

This research plan attempts to address the questions that the Florida Ocean and Coastal Resources Council finds to be most critical based on consultation with Florida's coastal resource managers. In addition to specific research topics, managers of coastal resources in Florida stressed the need to deal more effectively with the data and communication portion of the research/management circle.

The great need for and benefits from improvements in this area cannot be overstated. The Council believes improved collection, handling, sharing, and interpretation of research and monitoring data represents a critical first step towards improving the State's resource management. The Council further believes that the steps proposed below should commence as soon as possible to support an enhanced program of oceans and coastal research.

To ensure continued support for this necessary part of the management/research circle, the Council encourages that an appropriate percentage of research funding be targeted to support administrative costs to ensure a strong integrated data management and dissemination program.

A. Key Outcomes of a Comprehensive Data-Management System:

1. A statewide, standardized approach to development and maintenance of a metadata registry is available to expand access to data, prevent duplication of research, and maximize efforts to combine research results by resource managers and research scientists.
2. Resource assessment, long-term monitoring, and real-time or in-situ data collection results are managed in a comprehensive way to avoid duplication among agencies or institutions and maximize the utility of the information to both the research and resource management communities and the public.

3. Requirements for making publicly-funded research data available to the research community, resource managers, and the public are enforced, thereby maximizing the return on public investment in marine and coastal research.
4. Historical data are rescued and archived to allow their continued use in data-integration efforts and to enhance analyses of resource change over time.

B. Goals for Developing a Comprehensive and Integrated Data-Management System:

Data Focus Area 1: Enable more effective use of present and future data by establishing data-exchange (metadata) standards and requiring their adoption by appropriate state entities.

The Council believes that one of the more cost-effective strides toward improved management of Florida's coasts and oceans would be more effective use of data already being collected, but not readily available to managers. The single most important step toward this would be requiring all state organizations to agree on, and use, a single set of data standards that allows exchange of data while not constraining individual data handling, and then making data from all Florida sources easily available.

A core issue is that the state of Florida does not have a standard way of dealing with metadata—information about what data has been collected and when, the QA/QC used in generating the data, the format that was used, who the principle contact is, etc. The metadata show those interested in using the data whether it is suitable for their purpose. A coordinated and standardized approach to handling metadata for publicly-funded research would help avoid duplication and would encourage collaboration across agencies and institutions. In addition, Florida research entities must develop the ability to interact seamlessly with evolving federal and international data standards and management strategies. Finally, the technology associated with data management is advancing rapidly, requiring investments in hardware and training to assure maximum benefit from data-management schemes. It is important to ensure inter-agency cooperation in this task.

Issues to be addressed:

- Creation of a registry of metadata, development and enforcement of data standards, coordination with regional or national data-management systems, and the development of state-of-the-art data tools such as web-based access.
- Coordination with Gulf of Mexico Alliance data-standardization efforts.
- Coordination with Federal data-management efforts, including EPA-ECOS Environmental Data Standards Council and EPA's Environmental Information Exchange Network
- Integration with the Integrated Ocean Observing System.
- Development of methods for ongoing enforcement of data standards.
- Assessment of training and systems, including web/portal access and hardware needed to support the system.

Recommended 1st-year action: ***Establish a working panel by July 1, 2006, to solicit input from stakeholders (state and local agencies, water management districts, private research institutes, and non-***

governmental organizations (NGOs)) and charged with developing a statewide strategy by June 30, 2007, to develop data-exchange (metadata) standards for use by all state agencies. To the extent possible, coordinate with Gulf of Mexico Alliance and federal efforts.

Data Focus Area 2: Establish means for comprehensive management of assessment, monitoring, real-time, and historical data, including support of researchers, storage and archiving of data, and easy access to data.

The Council in this Research Plan recommends significant focus on improving the state's baseline information about Florida's coastal and marine resources, including updated mapping, resource assessments, improvement of long-term monitoring systems, and development of real-time data collection systems. The availability of this kind of information in an organized and accessible way will enhance our ability to cost-effectively understand, protect, and predict resource health. It will improve our ability to provide products to resource managers and policy makers that synthesize, translate, or interpret data in a way that responds to specific management or policy needs. It will also assist in meeting the regulatory responsibilities of state agencies. In addition, the ability to rescue and store historical data collected prior to the development of modern technology and/or modern data/metadata standards would aid researchers in analysis of ecosystem health and change.

Support for the large datasets collected with modern technology is important to their effective use. Data from satellite and other remote-sensing technologies, from IOOS and other ocean observation sampling sites, and from ecosystem monitoring systems creates the need for expert handling and storage facilities to make it readily available to users.

To meet this need Florida must develop the capacity for storage, coordination, and management of mapping data, resource assessments, long-term monitoring programs, and real-time and in-situ data. Additionally, a special effort to make older data available for reanalysis using newer methods and for use in ecosystem models would both help advance ecosystem understanding and leverage the value of data that has already been paid for. Special attention should be given to integrating different agency needs and approaches, to the extent possible, so a single system can serve multiple users.

Recommended 1st-year actions:

1) The Department of Environmental Protection, the Florida Fish and Wildlife Conservation Commission, and the Florida Department of Agriculture and Consumer Services, in consultation with the Florida Oceans and Coastal Resources Council and collaborating with the Water Management Districts and other stakeholders in Florida's coastal and oceans data, will identify specific shared baseline information needs and collaborate on the design of a system that will store, manage, and maintain this data. Funding requirements to implement this proposal will be provided to the Florida Oceans and Coastal Resources Council for inclusion in the FY2007-2008 Annual Research Plan.

2) Undertake a pilot project to identify key historical data for rescue and restoration and develop methods to achieve restoration in a cost-effective manner. Have state and local agencies identify existing databases that are candidates for conversion and compile information describing data contained therein.

Data Focus Area 3: Establish programs to support effective collection of data.

Well-designed research includes during the earliest phases consideration of how the data will be analyzed. In today's research arena, this means that statistical aspects of the study must be incorporated from the beginning. Good researchers are generally competent at the statistics of their particular area. However, statistics itself is a constantly-evolving field where improved methods are continually being developed. Statisticians are generally reluctant to offer advice outside their particular area of statistics because of the difficulty of maintaining expertise across the whole statistical arena.

It is, therefore, unreasonable to expect marine researchers to on their own always be able to use the most up-to-date statistical methods, but this use is clearly desirable. It is equally unreasonable to expect the state to fund research not carried out in the most cost-effective manner, which good statistical support helps ensure.

> **Recommended 1st-year action:** ***Establish a working panel to recommend the best means for providing strong statistical support to researchers during both the design and analysis phases of their research and to ensure that support is incorporated into the state's research programs. They will provide this information to the Oceans Council for possible inclusion in the FY 2007-2008 Annual Research Plan.***

Data Focus Area 4: Establish programs to support effective use of data.

For data to be useful to resource managers, tools are required to convert the raw data into information useable by managers for supporting management decisions and understandable by the public. While many researchers are expert at translating their results into forms understood by other scientists, fewer are expert at translating them into forms easily used by managers and the public. As with the statistical methods above, the methods and software available for this task are constantly changing as improvements are made. Helping to use these tools to convert research data into management decisions might be best achieved with external support.

> **Recommended 1st-year action:** ***Establish working panel to recommend best means for providing strong data-interpretation support to researchers and to ensure that support is incorporated into the state's research programs.***

VI. MANAGEMENT RECOMMENDATIONS

Introduction

The legislation creating the Oceans and Coastal Resources Council includes a charge to "to assist the state in identifying new management strategies to achieve the goal of maximizing the protection and conservation of ocean and coastal resources while recognizing their economic benefits".

This Research Plan has been generated based on information from the State's managers, so management recommendations are inherent in the Plan. Recommendations not directly related to research will be more completely addressed next year. The Council did not feel that the time available this year allowed them to give the full consideration deserved by the issues.

The single management recommendation of the Council this year warranted its own section in this report, *Integrated Data Management and Dissemination*.

VII. LITERATURE CITED

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APPENDIX 1. PRIORITIZED LIST OF RESEARCH WITH BUDGET ESTIMATES.

Budget estimates added by Council staff after Research Plan finalized by Council. Council will review budget estimates and submit Council-approved version.

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.	Budget FY 2006-2007	Est. time
1	*Establish real-time interdisciplinary observing systems in areas that currently have no or minimal observing. [B. Monitoring; RC3.2]*	$7.72 M[1]	10 yr
2	*Identify and evaluate new technologies—including but not limited to sensors (LIDAR, sonar, passive acoustics, infrared), telemetry (radio, satellite, telephone) and bio-chemical analyses (elemental isotopic, genetic)—for their potential to measure biological activity continuously at a level similar to that presently used to monitor water quality, hydrology, and climate. These technologies and/or techniques should be compatible and simultaneously deployed with Integrated Oceanographic Observation Systems (IOOS) that are located in coastal waters around the United States. [F. Water Quality; RC 18.4]*	$400K-$1.5M	2 yr
3	*Establish continuous, long-term monitoring of salinity and dissolved-oxygen conditions in the estuaries to support development of modeling tools, assess the impact of sea-level rise, and assist in resource management (for instance, commercial and sport fisheries). [B. Monitoring; RC 3.7]*	$150K	5 yr
4	*Using a historical approach, estimate the effect of the loss of coastal mangrove and seagrass habitat on the species that depend upon them. [E. Freshwater Flow; RC 14.3]*	$450K	2 yr
5	*Develop, install, and implement new and improved biological monitoring instrumentation and protocols that will make biological observations match the geographic scale of physical oceanography measurements. Examples are tracking migratory species, developing methods for interdisciplinary observations of nutrients, chlorophyll, algal blooms, and fisheries and other aquatic resources to link physical-chemical conditions to biological effects. [B. Monitoring; RC 3.5]*	$750K-$1M	3-5 yr
6	*Establish an interdisciplinary remote sensing capacity for Florida's coastal and offshore waters. [B. Monitoring; RC 3.4]*	$1M-$2.9M	--
7	*Produce present-day highest-resolution bathymetric maps, identifying physical geologic setting (sediment/rock) and submarine aquatic vegetation with the goal of mapping the entire State's waters by 2015. [A. Mapping; RC 2.1]*	$250K-$16M	10 yr
8	*Use existing technology, including satellite remote sensing, to better link red tide research and monitoring to physical oceanography in order to better predict red tide size, trajectory, and intensity and potential impacts and to provide an early warning system. [B. Monitoring; RC 5.5]*	$150K	--
9	*Develop an integrated statewide water budget, considering watersheds outside of Florida as necessary, that accounts for inputs, storages, transfers, and losses of atmospheric, surface, and ground waters to identify the extent of inflow change to the state's coastal waters. [E. Freshwater Flow; RC 11.3]*	$800K-$1.5M	5 yr
10	*Develop new methods for the assessment of fishery populations that include acoustical and genetic methods. [I. Living Marine Resources; RC 28.1]*	$250K	3 yr
11	*Identify and prioritize specific coastal areas around the State for bathymetric mapping - with the goal of mapping the entire State's coast by 2010. [A. Mapping; RC 1.1]*	$100K	1 yr
12*	*Develop coastal, estuarine, riverine, and lagoonal models to be nested with adjacent shelf models to improve understanding of land-sea linkages. [C. Modeling; RC 6.3]*	$650K-$1M	5-10 Yr

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.	Budget FY 2006-2007	Est. time
12 *	*Conduct monitoring, assessment, and modeling evaluations of the impacts of fishing on ecosystems. These studies will include impacts of various gear uses; removal of both predator and prey species, sex, size population-dynamic relationships; loss of keystone species; and other trophic-level interactions. [I. Living Marine Resources; RC 28.2]*	$200K	3 yr
14	*Evaluate the long-term stability of coastal wetlands (marshes, mangroves, seagrasses) in relation to sea-level rise and episodic disturbances (i.e., hurricanes). [C. Climate Change; RC 9.5]*	$250K	--
15	*Assess effectiveness of Marine Protected Areas and Marine Reserves and other types of protected areas to enhance the surrounding ecosystem, for instance through "spillover" effect. [I. Living Marine Resources; RC 27.2]*	$500K	5 yr
16	*Determine the market and non-market values for all sectors of the Florida ocean and coastal economy using a consistent methodology and available data bases that can be repeated periodically to track the performance of each sector dependent on the coast and ocean. Make the information available to the legislature and the public on the web. [M. Coastal Economics; RC 35.1]*	$375K [2]	1 yr
17	*Integrate HAB monitoring with data collection in the Ocean Observing System to allow examination of empirical relationships between HAB occurrence, spatial extent and intensity with physical-chemical data and provide an improved understanding of factors controlling HABs. [B. Monitoring; RC 5.4]*	$150K	3 yr
18	*Create maps to link previously mapped areas on the coast (identified through the State Coastal Inventory) seamlessly to existing offshore data where possible. This will show where gaps exist and identify datasets that are not compatible [A. Mapping; RC 1.2]*	$300K	2 yr
19	*Establish and enhance hydrological, chemical, and biological monitoring and assessment, including stationary and mobile systems such as shipboard surveys with accompanying modeling of the systems being monitored, to support agency programs to preserve and manage Florida's natural resources. [B. Monitoring; RC3.6]*	$2.1M	long-term
20	*Assess the effect that human waste management, and septic tank use in particular, has on nutrient loading and water quality in nearshore habitats. [F. Water Quality; RC 17.1]*	$150K	2 yr
21	*Identify quantitative relationships between nutrient concentrations in coastal waters and impairment of flora and fauna, so that agencies can use this information to establish scientifically-sound targets (such as nutrient criteria) for nutrient concentrations and loads. [F. Water Quality; RC 15.7]*	$750K	3 yr
22	*Assess the impacts of non-point source pollution, particularly storm-water runoff from urban areas, and determine the most effective means of abatement. [F. Water Quality; RC 16.1]*	$1M	5 yr
23	*Perform bathymetric and benthic-habitat mapping of important Florida tidal rivers and estuaries by 2010. These are to be used to determine essential environmental conditions needed for living marine resources and to provide data for modeling the environmental impacts of management decisions regarding water use. [A. Mapping; RC 2.3]*	$600K	5 yr
24	*Develop and field-test biotic indicators (species, species groups, habitats, communities) as criteria and targets for statewide use in determining whether watershed and stream management practices are protecting natural estuaries and marine ecosystems, and restoring impaired ones. [E. Freshwater Flow; RC 13.1]*	$1.8M	5 yr
25	*Work with fishers to identify fishery spawning aggregation sites around the state, and then validate and characterize these areas. [I. Living Marine Resources; RC28.5]*	$75K	3 yr

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.	Budget FY 2006-2007	Est. time
26	*Determine the relationship of the timing, quantity, and distribution of major river outflows and submarine groundwater discharges to the distribution and abundance patterns of coastal marine organisms. [E. Freshwater Flow; RC 14.1]*	$750K	3 yr
27	*Develop and demonstrate recirculating marine aquaculture technology for marine sport fish stock enhancement and restoration. [K. Aquaculture; RC34.1]*	$600K	--
28	*Quantify the impacts of HABs on commercial and recreational fisheries, coastal tourism, contact recreation, and other human activities integral to the economy of Florida's coastal areas. [G. Harmful Algal Blooms; RC 23.3]*	$150K	1 yr
29 *	*Determine the locations and sizes, dominant physico-chemical features, living resources, and unique ecological functions of all oligohaline and tidal-fresh waters in Florida. [E. Freshwater Flow; RC 13.2]*	$80K	2 yr
29 *	*Conduct studies linking key fish spawning areas to larval distribution and adult population-distributions on the Florida shelf, for example Riley's Hump in the Tortugas Ecological Reserve. [I. Living Marine Resources; RC 27.1]*	$275K	3 yr
29 *	*Determine the economic impacts of long term trends in beach loss, including: a) Determine the economic and environmental costs and benefits of continued beach-renourishment projects, including determining the economic feasibility, extent, availability, quantity and quality of offshore sands suitable for beach renourishment. Link to water quality studies of this issue in the Water Quality section. b) Determine the effect of continued beach-renourishment projects on turtle, seabird, and adjacent coral and fish populations and on other organisms dependent on beach ecosystems for food, shelter, and reproduction. Include subsequent economic impact as well. [M. Coastal Economics; RC 36.6]*	$175K	3 yr
32	*Coordinate methods of sampling and analysis among the multiple State, Federal, and local agencies and universities and research institutions that monitor and research HABs in Florida. [B. Monitoring; RC 5.1]*	$150K	2 yr
33	*Determine coastal construction and design practices related to reducing shoreline erosion. Determine the social, economic, and environmental consequences of increasing rates of beach erosion, coastal armoring, and beach renourishment. [M. Coastal Economics; RC37.3]*	$150K	2 yr
34	*Develop and implement rapid monitoring and assessment tools and procedures for identifying microbial pathogens in rivers, coastal waters, sediments (including beaches), and seafood. [H. Public Health; RC 24.1]*	$450K	2 yr
35	*Compare the environmental risk to water quality of septic systems to that of centralized sewage systems to area waters, particularly on islands. [F. Water Quality; RC 17.3]*	$100K	2 yr
36 *	*Assess the effects of nutrients from ocean outfalls on coastal habitats. [F. Water Quality; RC 17.2]*	$200K	3 yr
36 *	*Determine the hydrologic conditions that result in HAB development, using a combination of observations and modeling. Enhance the collection of data on the size, duration, intensity of blooms. [G. Harmful Algal Blooms; RC 20.2]*	$400K	3 yr
38	*Determine influence of watershed nutrients resulting from land-use practices on HAB formation and collapse. [G. Harmful Algal Blooms; RC 20.3]*	$500K	5 yr
39	*Evaluate the potential benefits and risks of offshore aquaculture in Florida. [K. Aquaculture; RC33.4]*	$150K	1 yr
40	*Determine the economic value of coastal ecosystems and habitat when left to function as a natural system. [M. Coastal Economics; RC35.2]*	$150K	2 yr

Rank	Research Component Exact intent of RC may require context provided by surrounding text in the 2006-2007 Annual Research Plan Note: if research requires more than one year to complete, budgets are costs for first-year.	Budget FY 2006-2007	Est. time
41 *	*Building on existing initial efforts (DEP, FWC, WMDs, CERP), hold statewide workshops to identify initial habitats for which to develop bioassessment methods. Discuss possible pilot projects in different regions that pose different expectations. [F. Water Quality; RC 18.1]*	$30K	1 yr
41 *	*Determine which geospatial habitat conditions support an increase in fish recruitment as a result of marine reserves. This research should consider the size and location in relation to biotic and abiotic conditions. [I. Living Marine Resources; RC29.3]*	$275K	3 yr
43	*Demonstrate economically feasible production and marketing of a high-value marine fish species that can be farmed in a land-based recirculating production system. [K. Aquaculture; RC33.1]*	$450K	4 yr
44	*Determine the social and economic costs and benefits that derive from public and private conversion of coastal and waterway access points to non-water dependent uses. Determine incentives to retain water-dependent and water-related facilities that serve public needs and reflect public values in order to maintain public access to public coastal waters. Produce annual reports stating the length of Florida's sandy beaches that are publicly accessible. [M. Coastal Economics; RC36.1]*	$200K	3 yr
45	*Determine factors resulting in macro-algal blooms. [G. Harmful Algal Blooms; RC 23.2]*	$150K	3 yr
46	*Create coastal ocean environmental indices in support of fisheries research and spatial management of the fisheries. Monitoring of habitat conditions on a daily basis will be important to understanding linkages of the environment to marine resources. [I. Living Marine Resources; RC28.6]*	$75K	1 yr
47	*Determine the role of the shoreline in reducing wave and flood damage, including ways to implement shoreline protection measures that do not damage the coastal and offshore natural environment. Develop a scientific basis for determining erosion and coastal setback zones. [M. Coastal Economics; RC37.4]*	$250K	2 yr
48	*Develop methods for determining sources of nutrients so agencies can improve source regulation. [F. Water Quality; RC 15.1]*	$1M	5 yr
49	*Define potential impacts of offshore oil and gas development of Florida's coastline with an emphasis on effects on fish, wildlife and their habitats. [F. Water Quality; RC 16.5]*	$150K	2 yr
50	*Use existing water quality monitoring programs to collect samples for algal identification and toxin analysis concurrent with nutrient and other water-quality samples. [B. Monitoring; RC 5.2]*	$25K	--
51	*Determine the relationship, if any, of the increased frequency of coral diseases and elevated seasonal seawater temperatures to better target management activities that may focus on other possible causes. [D. Climate Change; RC 9.2]*	$500K	--

* - Tied in rank [1] Estimate may include federal funding; [2] Second phase, first phase funded by Oceans Initiative