**LONG-TERM REGIONAL RESEARCH ON CORAL REEF ECOSYSTEMS
DRAFT IMPLEMENTATION PLAN**

**Prepared by the Working Group on Ecosystem Science and Conservation
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I. Introduction

The 1998 Executive Order on Coral Reef Protection directs Federal agencies to map, research, monitor, manage, and restore coral reef ecosystems. In response to the Executive Order, a US Coral Reef Task Force established interagency working groups to address five areas: (1) Coastal Uses, (2) Ecosystem Science and Conservation, (3) Mapping and Information Synthesis, (4) Water and Air Quality, and (5) International Dimensions. Long-term coral reef ecosystem research addresses one of the priority research needs identified by the Ecosystem Science and Conservation working group and is outlined at the Internet site: http://www.coralreef.gov.

II. Background

Threatened by various natural and anthropogenic stresses, including nutrient over-enrichment, over-fishing, and increases in sedimentation rates, coral reef ecosystems are deteriorating worldwide. Increasingly severe bleaching events, disease outbreaks, anthropogenic alterations of local and global environments, and the synergistic effects of these stresses are thought to contribute to this decline. Currently, there is no nationally coordinated effort to determine the status of coral reefs, the causes of coral reef decline, or the impact of natural and anthropogenic stress on coral reef and associated ecosystems. Obtaining this basic information is critical to making sound, science-based management decisions and evaluating the effectiveness of coral protection policies. To develop a comprehensive research and monitoring program, the Ecosystem Science and Conservation Working Group of the U.S. Coral Reef Task Force, recommends the following actions: (1) initiate and implement a standardized, nationally coordinated coral reef monitoring program; (2) establish regionally-focused, long-term (5 year) research programs in the Atlantic and Pacific; and (3) create a center for coral reef pathology to

improve coral reef disease and bleaching research. This implementation plan describes the long-term research program.

Coral reef ecosystems include much more than the reef structure alone; they encompass a wide range of inter-dependent biotic and abiotic features and processes. In addition, the health of coral reef ecosystems is closely tied to processes that regulate the health of adjacent habitat types such as grass beds, mangroves, water columns, and soft bottom areas.

Gaining a better understanding of the complex connections and interactions of coral reef ecosystems is critical to understanding and predicting coral reef response to natural and anthropogenic stresses. Biological and physical linkages among different coral reef systems, as well as those between coral reefs and adjacent ecosystems, affect the type and geographical range of events that impact coral reef health. Ocean currents, for example, can influence how a particular pollutant affects coral reef communities, or how far a land-based pollutant travels. Similarly, these currents disperse larvae of many reef species, influencing recruitment and recovery of coral communities. Recent evidence suggests that global processes, such as changes in global climate and carbon dioxide levels, also have the potential to affect coral reef health and survival. Unfortunately, we know very little about the biological, chemical, and physical linkages within and among coral reefs, their relative importance, or how they interact to affect coral reefs.

Historically, lack of funding for long-term coral reef research has limited the geographical and ecological scope of coral reef studies. Coral reef research has tended to focus on small-scale processes on individual reefs; it has rarely addressed coral reef issues on a regional scale, examined the linkages between reefs and their associated ecosystems of mangroves and seagrasses, or evaluated long-term change in coral ecosystems. Long-term, holistic ecological studies are needed to improve our understanding of the complex mechanisms that govern coral reef ecosystems. Information generated by these projects will help us distinguish anthropogenic change from natural variation, understand the combined effects of various stresses, predict how different parts of the reef community may be affected by environmental change, and identify activities both within and outside coral reef ecosystems that affect the survival of coral reefs.

III. Goals and Objectives

The primary goal of this coral reef research program is, through hypothesis-based research, to better understand the interactions between land-based activities and coral health. Research will focus on the nature and extent of anthropogenic and natural stress on coral reef ecosystems with the following objectives:

> *(1) Understand critical factors that contribute to the decline of coral reefs and provide resource managers with information needed to restore and promote the sustainability of coral reefs; and*

(2) Develop models and syntheses as tools to assess alternative management strategies focusing on larval transport mechanisms (e.g., to assist in site selection for marine reserves); effects of land-based pollutants (e.g., to improve water quality and health of coral reef ecosystems); and to support coastal zone management decisions (e.g., siting of industrial facilities).

IV. Approach

To address the need for long-term ecological research on coral reefs, the National Oceanic and Atmospheric Administration (NOAA), in primary partnership with the U.S. Department of the Interior (DOI), are planning to initiate long-term (five-year), ecosystem-level research programs on coral reefs in the Pacific and Atlantic oceans. This research initiative, which is contingent upon the availability of funds in FY 2000 and beyond, will support management-oriented basic research to develop a better understanding of the interactions between land-based activities and coral health. The initial focus of this initiative will be Pacific coral reef ecosystems, to be followed by a counterpart study in the Atlantic in the second year. This research program would be implemented through a competitive, peer-review process to ensure the highest quality science. This process would require formation of a management team for each regional program to facilitate appropriate connections with resource managers and coordinate the availability and delivery of scientific data and findings in a useful form.

Because over 85% of the U.S. coral reefs are in the Pacific, a five-year Pacific coral reef regional study would be developed first. A counterpart study in the Atlantic, where population pressures create significant resource issues, would be initiated in the second year. Products will include research data, assessments, and syntheses reports that will provide resource managers and the public with timely information and new insights; and predictive tools, such as simulation models, that will assist managers in making informed decisions. Because coastal land-use practices and watershed development have significant and immediate effects on adjacent coral reefs and related habitats, heavy emphasis will be placed on producing scientific data and information in support of integrated watershed management programs in the study regions. Multi-disciplinary research at one or more intensive study sites will focus on ecological processes, retrospective data analyses, monitoring, and simulation modeling.

Potential questions to be addressed include:

- What are the linkages between land-use patterns and changes in coral reef ecosystems? How are land-based pollutants transported and distributed to coral reef ecosystems? How would changes in levels of land-based inputs affect the health of coral reef ecosystems?
- What processes regulate coral recruitment and the maintenance and renewal of reefs? How do water circulation patterns affect the distribution of reefs? To what degree are the larvae of coral reef organisms advected from "upstream" areas compared to recruitment from local retention mechanisms?

- From a paleo-biological perspective, how do the anthropogenic degradation processes affecting reefs today compare to events on geological time scales? What is the threshold for collapse of a reef ecosystem and what is the recovery rate?

This program would involve primary partnerships between the NOAA and DOI, and possibly the National Science Foundation, the Environmental Protection Agency (EPA), and the U.S. Department of Agriculture, with potential collaboration with the Department of Defense and the National Aeronautics and Space Administration for remote sensing activities. The interagency approach would follow the successful models of the Ecology and Oceanography of Harmful Algal Blooms, Global Ocean Ecosystem Dynamics, and Long-term Ecological Research programs.

V. Budget

Each regional study would require $3M per year for five years. Total cost for the Pacific and Atlantic regional studies is $30M. The Pacific study would be initiated in year 1, followed by the Atlantic study in year 2 (Table 1).

Table 1. Estimated Budget for Pacific and Atlantic regional studies.

	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005
Pacific Regional Study	$3M	$3M	$3M	$3M	$3M	----
Atlantic Regional Study	----	$3M	$3M	$3M	$3M	$3M

VI. Timelines and Deliverables

Long-term multi-disciplinary research will provide a better understanding of the nature and extent of anthropogenic and natural stress on coral reef ecosystems. Improved understanding will allow scientists and mangers to distinguish anthropogenic stress from the background of natural variability and identify potential impacts that may result from climate variability. Table 2 provides a summary timetable and major program elements for the Pacific and Atlantic regional studies.

Products will include:

(1) Research data, assessments and syntheses reports that will provide resource managers and the public with timely information;

(2) Answers to research hypotheses and new insights for management decision makers, particularly to assist in integrated watershed management; and

(3) Predictive tools such as simulation models that will help managers make informed decisions and assess alternative management strategies (e.g., larval transport and recruitment of reef organisms in the context of variable oceanographic conditions, and information for optimizing site selection for marine protected areas).

Table 2. Timetable and Major Program Elements for Pacific and Atlantic regional studies.

	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005
Workshop	A	A,P[1]	A,P	A,P	A,P	P
Proposal Cycle	A	P	A	P	----	----
Research and Data Collection	A	A,P	A,P	A,P	P	----
Products: Syntheses	----	----	A	P	A	P
Model(s)	----	----	A[2]	P[2]	A[3]	P[3]
Info. Trans	A	A,P	A,P	A,P	A,P	P

[Footnotes: [1] A=Atlantic Regional Study; P=Pacific Regional Study. [2] Preliminary model results available. [3] Final model results available.]