Fisheries and the Environment (FATE)

An Ecosystem-Based Approach to Fisheries Management

An Implementation Plan for FY08-12

August 2008

Mission

FATE is a research program that develops and evaluates ecological and oceanographic indicators to be used to advance an ecosystem approach to management by improving fishery stock assessments and integrated ecosystem assessments.

This information is necessary to effectively adapt management to mitigate the ecological, social, and economic impacts of major shifts in the productivity of living marine resources.

The following pages provide a scientific and administrative plan to guide the FATE program through the period FY08-12. FATE investigators are in a strong position to lead a paradigm shift in ecosystem-based fisheries management.

1. Overview

Sufficient understanding of the influence of species interactions and their responses to environmental is required to develop forecasts and assess the long-term impact of climate and fishing on marine ecosystems. Sudden shifts in climate regime, as seen recently in the North Pacific, have immediate and major impacts on fisheries productivity, species interactions and shifts in spatial distributions. The goal of the Fisheries and the Environment (FATE) is to provide the information necessary to effectively forecast these changes to evaluate management strategies needed to sustain fisheries, while preserving ecosystem structure and function. In support of this goal, the FATE program was designed to accelerate the development of next generation decision analysis and forecasting tools. FATE is providing leading indicators of ecological and oceanographic change at the population and ecosystem level and local to ocean basin scales. FATE supports research on the functional relationships between environmental forcing, competition for prey, or predation on the growth, distribution or reproductive success of managed species. The ultimate measure of success of FATE is the incorporation of indices and functional relationships in population dynamics models, ecosystem assessments, and evaluation of fishing and climate forcing on marine resources that can be used to inform managers of the implications of their actions. These models provide early warnings of major shifts in the

productivity of key stocks as well as monitor current year trends in ocean conditions, fish production and ecosystem dynamics. While the program is based on an ecosystem approach, it targets commercially important and protected species. FATE also synthesizes existing data sets to develop and validate ecological indicators that contribute to integrated ecosystem assessments of Large Marine Ecosystems within U.S. waters.

2. Introduction

The National Marine Fisheries Service (NMFS) is responsible for the stewardship of the nation's living marine resources. The Magnuson-Stevens Fishery Conservation Reauthorization Act (MSFCRA), the Marine Mammal Protection Act and the Endangered Species Act all charge NMFS with the conservation and management of these resources. Moreover, the MSFCRA calls for NMFS to expand the application of ecosystem principles in fishery conservation and management, including research. To meet this charge, NMFS convened the "Ecosystem Principles Advisory Panel" that completed its report to Congress in 1999. That report suggests that NMFS must augment information obtained from commercial fisheries, observers and surveys of fish stocks. Research in fisheries oceanography provides an essential element of this ecosystem-based information. It will allow scientists and managers to understand multi-species interactions and the effects of ocean variability on exploited populations and non-exploited elements of the ecosystem such as forage fishes, birds, mammals, zooplankton and phytoplankton.

Regional research programs have laid the foundation for fisheries oceanography research and its application to ecosystem management. Using site intensive investigations, these studies have identified processes affecting the distribution, growth and reproductive success of managed species that are linked to ocean physics and its influence on species interactions. Building on these results, FATE is responding to specific requirements in ecosystem-based fishery management by providing ecological and oceanographic indicators of annual to decadal changes in stock productivity and diagnostic models that will lead to new capabilities in forecasting resource productivity.

FATE proposes a new model for research in fisheries oceanography that differs from past regional process studies. FATE investigators conduct applied science with a focus on ecosystem indicators and forecasting tools that can be utilized to provide advice to managers. FATE

accomplishes this goal through a core team of scientists distributed among NMFS research centers and projects selected from an annual request for proposals. This approach entrains expertise from government and academia. Between 2001 and 2007, investigators developed leading ecological indicators, performance indicators, and status reports on the North Pacific ecosystem. Over the next five years, FATE will refine its approach to understanding the role of environmental variability in ecosystem function, and will lead the National Oceanic and Atmospheric Administration (NOAA) to a working model of ecosystem-based management of living marine resources.

3. Program Structure

FATE continually evaluates an expanding array of ecological and oceanographic products used for fishery stock assessments. In the first few years of operation, FATE has demonstrated the benefits of this approach.

FATE sponsors innovative research through a core program made up of a FATE steering committee, a core team of permanent investigators, and annual requests for proposals. FATE facilitates the development of cross-cutting projects within NOAA that allow comparisons of fisheries responses to ecosystem change through the use of dedicated staff, annual announcements of opportunity, and annual scientific symposia. When fully staffed the FATE program will have representatives at all NMFS Science Centers. These individuals will facilitate data sharing, regional comparisons and rapid transfer of advanced modeling techniques and ecosystem indices to Science Centers and managers.

The FATE program announces opportunities for competitive research on an annual basis. FATE encourages collaborative proposals between oceanographers or ecologists and scientists responsible for stock assessments or ecosystem assessments. Investigators and FTEs are required to meet on an annual basis to share research findings. The FATE annual science meeting is evolving into a NMFS national forum for the discussion of fisheries oceanography.

4. Analytical Approach

The linkage between climate and biological systems can be established through ecological observations, which produce time series of physical or biological indicators. The FATE program provides indicators for use in predicting responses of species to environmental forcing as well as

indicators for use in integrated ecosystem assessments. Similar in concept to leading economic indicators, leading ecological indicators are indices of ecosystem properties and processes that reflect the condition of the ecosystem and the potential for changes in the distribution, growth, or reproductive success of managed species. FATE supports the analysis of rich data sources from which such indicators can be extracted. These data sources include NMFS fishery-independent surveys, commercial fishery catch data, and sampling of landings at dockside, as well as various ship- and satellite-based oceanographic data streams, oceanographic buoys, and output from ocean circulation models.

FATE takes a multidisciplinary approach to developing leading ecological indicators. Biological indicators have thus far been derived from the analysis of (1) fish distribution and migration, (2) ecosystem community structure, (3) annual fish growth patterns from otoiliths, (4) trends in fishery production, and (5) trends in primary and secondary production. Physical indicators have been derived from a combination of data sources, including (1) remote sensing, (2) *in situ* oceanographic measurements, and (3) large-scale atmospheric and oceanic fields. Although time series of measured parameters are used as indicators, derived products can often be more biologically meaningful. For example, many environmental comparisons with ecological indicators have relied on surface temperature, when subsurface temperature or mixed layer depth would be more appropriate. However, if the latter are unavailable the tendency has been to use less appropriate, but more readily available, physical indices. A primary objective of FATE is to improve this situation through the derivation and validation of biologically relevant physical indices. These improved ecological indicators serve to evaluate the state of the ocean for comparison with observed biological variability, improving our long-term ability to predict changes in fisheries productivity.

A central theme of FATE and a feature that distinguishes it from all other fishery oceanography programs is its focus on delivering leading ecological indicators of change and providing practical, management-relevant applications of these indices. Early indicator development has been dependent on existing data streams and surveys. As the program develops, a second generation of indicators based on new surveys and on the output of diagnostic physical-biological models will be developed. As FATE matures further, a subset of the full suite of FATE indicators will be developed to describe how the ecosystem and its components, including fisheries, are performing. These performance indicators will provide early warnings of major

shifts in the productivity of key stocks as well as monitor current year trends in ocean conditions, fish production and ecosystem dynamics. FATE scientists will continue to work jointly with stock assessment scientists to evaluate performance indicators, thus maximizing the utility of FATE research deliverables to NMFS management needs.

5. Data Management

Data management for this program is largely handled at the individual investigator level through the research phase of development and validation of the ecological indicators. An important feature of the FATE program, however, is its dedication to assure that all of its research and particularly its ecological indicators are readily available to other researchers and the fisheries management community. Thus, while descriptions of individual indices may be maintained on the web pages of individual researchers, FATE has developed a dedicated central web site (http://fate.nmfs.noaa.gov/), housed at the Environmental Research Division of the Southwest Fisheries Science Center that provides access to the accepted indices and any ancillary data developed in the program. Descriptions of the indices and their derivations will also be available on this site, along with links to other environmental data appropriate for fisheries applications. New developments in web-based data product delivery is being implemented at the FATE web site, including a Live Access Server for FATE indices and a suite of environmental data products tailored to fisheries research and management applications. The objectives of this approach are to assure the widest possible dissemination and utility of the ecological indicators developed in FATE, and to seek improvement in the manner that environmental variability is utilized for applied aspects of fisheries such as stock assessment and management.