EVOS PROPOSAL SUMMARY PAGE

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Project No. _____
Cluster _____
Date Received _____

Project Title: Alaskan Groundfish Feeding Ecology: An OBIS Information System

"Submitted under the BAA"

Project Period: FY 04

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EVOS Funding: $80,900
Study Location: Gulf of Alaska, Aleutian Islands, and Bering Sea
Trustee Agency: None

Abstract:

We propose to develop an OBIS data server node containing information characterizing the distribution and feeding ecology of Alaskan groundfish in relation to environmental parameters. Capitalizing upon our experience as participants in several OBIS projects and using established OBIS tools and protocols for Web-based access to biogeographic datasets, this information system will archive, analyze, and provide a means to distribute via the Internet information on the spatial and temporal distribution of a large number of groundfish and associated prey species sampled in the Gulf of Alaska, Aleutian Island waters, and the Bering Sea by NMFS Alaska Fisheries Science Center (AFSC). This biogeographic information system will include data on the gut contents of specimens as well as environmental information characterizing the habitats of the species. These datasets provide a biogeographic description of groundfish distribution and dynamics in relation to habitat structure and environmental variability. They also provide a detailed account of interspecific and environmental interactions that are integral to ecosystem-based fisheries assessment and management approaches. Biological databases used in this project will derive from AFSC, while environmental information will come from databases at the Pacific Marine Ecological Laboratory, AFSC and other sources such as the Institute of Marine Science, University of Alaska Fairbanks. Datasets employed are diverse in nature, and will include satellite imagery, hydrographic and fishery surveys data. The information system will address the problem of integrating multivariate data that has been collected on differing spatial and temporal scales. It will also provide GIS tools to analyze, visualize and disseminate information according to OBIS technical protocols. Our goal is to develop a pilot system that will not only augment OBIS, but also characterize the

habitat and behavior of Alaskan groundfish, and provide a model of how the integration of environmental information can aid in the assessment of marine resources.

I. INTRODUCTION

The Census of Marine Life (CoML) is an international, multidisciplinary research initiative seeking to characterize the diversity, distribution and abundance of marine organisms throughout the world's ocean (Alldredge et al., 1999; Bradley, 1999). The extensive scope and scale of this ambitious effort poses numerous conceptual and technical challenges, not least in the area of data management. The Ocean Biogeographic Information System (OBIS) program was established to address this issue. It is ultimately envisioned as a virtual repository or global network of interoperable databases coupled via the Internet that support Census activities. Although previously emphasizing access to museums collections databases via an emerging set of technical protocols, realization of OBIS and CoML will require the development of a comprehensive strategy and set of tools enhancing access to and integration of extensive, multivariate biogeographic and oceanographic datasets held by multiple stakeholders on diverse, distributed platforms and in a variety of formats (Tsontos & Kiefer, 2003). Emphasis will need to be placed on expanding the geographic scope, data types and range of marine ecosystems represented in OBIS. Equally important is the integration of invaluable long-term quantitative survey databases maintained by national agencies such as NOAA/NMFS and international organizations such as ICES and FAO.

We propose to develop an OBIS data server node containing information characterizing the distribution and feeding ecology of Alaskan groundfish in relation to relevant environmental parameters. Building upon our prior experience in information system development for several OBIS projects including GMBIS (Tsontos & Kiefer, 2000; Tsontos & Kiefer, 2003), SEAMAP, PCGoM, and MARECO, the information system server node will comply with OBIS technical standards via the usage of DiGIR and EASy/Netviewer GIS server technologies. These will provide a mechanism for tapping relevant subsets of the important Alaskan groundfish survey and physical oceanographic databases maintained respectively by the Alaska Fisheries Science Center (AFSC) and the Pacific Marine Ecological Laboratory, and other sources such as the Institute of Marine Science, University of Alaska Fairbanks. Access to the node's online interactive GIS, species-based data querying tools, and associated synthetic data products will be via the project website and the OBIS-portal hosted at Rutgers.

The development of the OBIS node will serve several purposes and will be an exciting and unique contribution to OBIS. First, it will provide the first link between Alaskan biogeographic information and the OBIS portal that has been established at the Institute of Marine Science at Rutgers University. Such a link will establish collaboration between GEM program and the International Census of Marine Life Program. The proposed server node will be invaluable asset to OBIS in other ways too. All the databases that have been contributed to the portal thus far lack any tropho-dynamics/species interaction data, information vital for defining the habitat and distribution patterns of species, and (with the exception of GMBIS) there is currently a paucity of environmental datasets comprising OBIS. In addition, the Alaskan groundfish have a commercial importance that far exceeds the value of the species found in the existing OBIS databases. In order to attract additional support, OBIS and more generally the Census of Marine Life must establish the value of collecting and communicating information on marine biogeography and biodiversity. The Groundfish information system will serve as a model of how biogeographic information may help improve the management of marine resources.

Second, it will provide a scientific and communication tool to integrate and analyze the diverse types of data that will help characterize the habit and feeding behavior of commercially important groundfish in

support of fisheries management. Restoration and sustainable usage of marine resources requires a paradigm shift from traditional scientific assessment and management methods to more holistic multi-species and ecosystem-based approaches (Murawski, 1991; ICES, 1999; National Research Council, 1999). It is likely that the groundfish information system will assist in the further development and implementation of ecosystem-based fisheries assessment approaches and help manage and conserve these most valuable natural resources. This could be achieved via integration or complementary usage of the information system with ECOSIM and ECOSPACE (Pauly, Christensen & Walters, 2000) trophodynamic modeling approaches.

Third, the information system will serve as a model for the CAOS (Coastal Alaska Observing System) that will begin development soon. EASy (Environmental Analysis System), developed by System Science Applications (SSA), is the GIS analysis and map-server tool that will reside on the proposed OBIS node. Since EASy handles the full range of data (e.g. relational databases, satellite imagery, aerial photographs, data feeds from moorings, drifters, ships, and tagged organisms) potentially provided by a coastal observing system such as CAOS, the node will be a proof-of-concept, indicating to the oceanographic community Alaska's capacity to develop an advanced, real-time observation system.

II. NEED FOR THE PROJECT

A. Statement of Problem

To fulfill its role as an information management system in support of the CoML, OBIS needs to expand further both in terms of the ecosystems, geographic coverage, temporal range, and data-types represented by its constituent databases. Establishment of the proposed OBIS node with its quantitative information on groundfish species stock structure, distribution, dynamics and predator-prey interactions that are coupled with relevant oceanographic data on potential physical drivers would contribute significantly to OBIS. This follows from the fact that: 1) there is currently a paucity of information for this region of the north Pacific; 2) other than GMBIS, multivariate ecosystem type data critical for understanding the origin of patterns in marine biogeography are presently under-represented in OBIS and not adequately handled technically. Development of the Alaskan groundfish information system would not only contribute an important ecosystem-type database to OBIS, but also facilitate the refinement of the OBIS data model and technical framework to better deal with the integration of oceanographic datasets. In parallel, the assembled information system would also function as an analysis and communication tool in support of ecosystem-based fisheries assessment approaches that are now considered to be central for the restoration and improved management of harvested marine populations. It would also serve as a model for the development an operational observation system for Alaskan waters and associated natural resources in support of both CAOS and GEM.

B. Rationale/Link to Restoration

Timely and improved access to and integration of environmental and coastal resource usage information and will promote enhanced understanding of ecosystem processes important for improved ecosystem management. Once implemented the information system will be accessible by parties involved in research, restoration and coastal resource management. As fishery management organizations make progress in incorporating ecosystem-oriented thinking into management, there is a need to more clearly define the ecosystem-oriented management goals and develop new tools to attain those goals. Scientific advice provided to management must move beyond traditional single-species stock assessment. Further development and implementation of new approaches, however necessitates improved understanding of marine ecosystem function. A prerequisite for this is the comprehensive cataloguing of biological

diversity and study of species distribution patterns in relation to environmental, biotic and anthropogenic factors (May, 1990). There is a broad spectrum of ecosystem research currently being conducted in the Gulf of Alaska/Bering Sea and beyond that can provide useful advice to managers in this regard including field monitoring such as GLOBEC and FOCI as well as development of ecosystem and multispecies fishery models (Jurado-Molina, & Livingston, 2002; Livingston & Jurado-Molina, 2000). Development of the Alaskan groundfish information system node and its link to other taxonomic and biogeographic databases via OBIS, will provide an integrated set of diverse observational data as well as visualization/analysis tools that will support Gulf of Alaska ecosystem research and management.

C. Link to GEM Program Document

The Gulf of Alaska Ecosystem Monitoring and Research (GEM) program is a long-term commitment to scientific management based on the gathering of information about the physical and biological components of this marine ecosystem and improved dissemination of data and understanding to stakeholders (GEM program website, http://www.oilspill.state.ak.us/gem/). Clearly, the information system proposed will support this longer-term objective. In addition the proposed project, which would be the first link between Alaskan biogeographic information and the OBIS portal, will establish collaboration between the GEM and the International Census of Marine Life Programs. This collaboration represents a useful, broader-scale outreach opportunity for GEM.

III. PROJECT DESIGN

A. Objectives

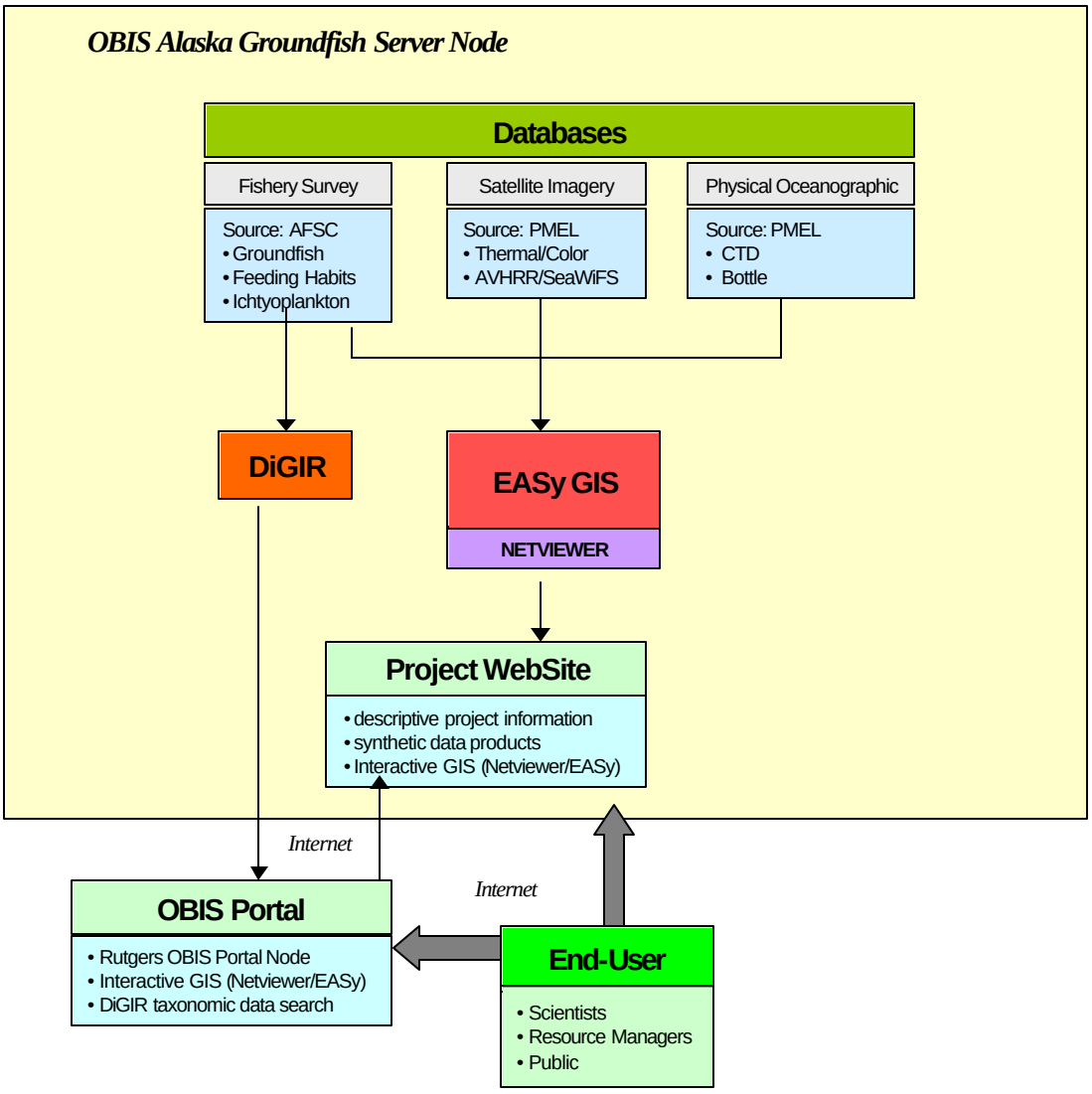
We aim to develop an OBIS server node that contains and integrates diverse information on the distribution and feeding ecology of species of Alaskan groundfish. The system will provide access to a time series of integrated and mapped data products across spatial scales to help identify causal links and ecological relationships. The information system and OBIS server node developed will provide state-of-the-art GIS tools complying with OBIS protocols for the archival, analysis, and dissemination of information on the spatial and temporal distribution of over 100 species of groundfish sampled in the Gulf of Alaska, Aleutian Island waters, and the Bering Sea over the past 20 years by NMFS Alaskan Fisheries Science Center (AFSC) relative to relevant physical oceanographic data provided by the Pacific Marine Environmental Laboratory (PMEL). This biogeographic information will include taxonomic and allometric information on the gut contents on over one hundred thousand groundfish specimens as well as environmental information that will help characterize the habitats of the species and couplings between bio-physical processes. Inherent in these long-term and detailed datasets is extensive information of value to CoML/OBIS programs and marine biogeographic studies more generally.

The information system that we propose is a pilot project that will demonstrate capability. The system will be run locally at both EVOS and AFSC or run over the Internet with appropriate access restrictions. Before running it as a publicly accessible OBIS node, we must first obtain permission from all contributors of data. We feel it is premature to seek such approval now. If permission is denied by some contributors, their data will be either removed from the node or protected by a password.

B. Procedural Methods

The basic approach that will be used for development of the proposed Alaskan Groundfish Information System and OBIS server node is outlined below together with a description of system components.

Figure 1. Components and flow of data within the groundfish information system



Information System Design

The basic architecture and flow of information within the Alaska groundfish information system and is summarized in figure 1. The design of the system builds upon our experience in information system development for several OBIS projects, including GMBIS and the PCGoM-Atlas, and our knowledge as members of the OBIS technical steering committee. The system conforms to OBIS technical standards for data nodes by employing of DiGIR and EASy/Netviewer GIS server technologies to expose back-end databases and imagery archives.

Biological and physical oceanographic databases at the core of the system will consist respectively of relevant portions of the AFSC groundfish assessment and food habits and the PMEL CTD and bottle profile data in addition to SST and chlorophyll-a satellite imagery data archived at PMEL. DiGIR will permit a distributed, species, name-based search of the AFSC database and return of a tabular record to end-users accessing either the Rutgers OBIS portal or the project website. This process is mediated by the DiGIR server system, which requires prior configuration by mapping of AFSC database fields to key biogeographic/museums collection data fields supported by the OBIS XML schema (http://www.iobis.org). Integration and exposure of the full range of PMEL satellite imagery, *in situ* oceanographic observations, and AFSC fisheries datasets will be implemented with EASy-GIS and its

Netviewer map-server plug-in. Again end-user access to the interactive, online GIS will be via either the OBIS portal or the project website. Assignment of appropriate permissions and differing levels of end-user access to data from the proposed OBIS data server node will be implemented according to security requirements of our data providers and their institutions.

Database Components

Alaska Fisheries Science Center Groundfish Databases

The general content and spatial coverage of databases maintained by NMFS/AFSC and resulting from their routine shelf wide surveys of the Gulf of Alaska, the Aleutian Islands, and the Bering Sea are summarized in table 1 and figure 2. Most important from the perspective of the proposed work, databases include the Fish Foods Habits Database and the Groundfish Assessment Database spanning the period 1984 to the present. Associated surveys are conducted during the summer on an annual basis in the Bering Sea and on a biannual basis in the Gulf of Alaska and the Aleutian Islands. Samples are collected from shelf and slope waters that range in depth between 30 and 500 meters. Information on the distribution and gut contents of groundfish as well as supporting oceanographic information have been archived in an Oracle 8i database. GIS layers of sediment type are also available. Roughly, 15,000 groundfish specimens are analyzed each year, yielding a total analysis of between 100,000 to 200,000 specimens for the entire time series. Fish collected with bottom and midwater trawls are identified, counted, weighed, and measured. In addition, gut contents from each of the samples identified and quantified. Many of the over 100 species that are surveyed are commercially harvested; in total these stocks represent one of the major regional fisheries of the world.

Figure 2. A map of the distribution and intensity of sampling of the groundfish surveys**.**

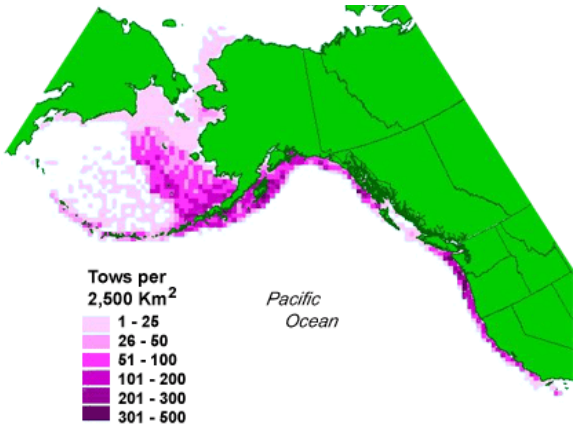


Table1. Long-term fisheries survey databases for the Gulf of Alaska/Bering Sea maintained by the NOAA Alaska Fisheries Science Center containing extensive, quantitative data on species abundance distribution, life history parameters, and predator-prey interactions.

Database	Description
Bering Sea Groundfish Database	Bottom trawl position and catch data from the eastern Bering Sea including cruise description, type of platform, time, sampling location, sampling gear, taxonomic composition of the catch, weight and number, sex and size, reproductive condition, age, length-weight factors, gut contents. Standardized survey data set consists of over 1,430,000 records from international waters and the U.S. EEZ (200-mile zone) from 1982-present.
Standard trawl surveys - Eastern Bering Sea (US)	Weight and number by species (plus size and sex composition for economically important species) for bottom and near bottom fish and invertebrates taken in standardized bottom trawl hauls. Standardized systematic trawl survey based on 20 nm grid. Annual for shelf, triennial for slope 1971 - present (1982 - present utilized standard gear), triennial slope surveys conducted 1979 - 1991.

Food Habits Database	Contains stomach content information of selected commercial Bering Sea species. Data include location parameters, stomach content descriptions, intestinal content information, and length of prey items. This data is used to determine feeding habits and consumption rates of commercially important species.
Early Life History Literature Database	Data from 140 ichthyoplankton cruises from 1977 until the present covering the Gulf of Alaska,Eastern Bering Sea and Washington/Oregon/California coastal area (Seasonal coverage depends on year). Survey data includes observations on ichthyoplankton taxa caught, catch statistics, egg identification, pollock egg staging, larval and juvenile identification and lengths. Associated cruise, location, time and sampling gear information is provided.

Unique among the databases from the shelf wide surveys is the Fish Foods Habits Database. This database contains information on the diet of key groundfish. The samples are primarily collected from groundfish trawls by NOAA scientists during research cruises. In addition Fishery Observers have obtained samples from regions and seasons outside of our survey areas. Fish stomach samples preserved in the field are returned to the lab for analysis, and account for the majority of the database. A small number of samples are analyzed at sea in a qualitative manner and account for the remainder of the data. The Alaskan data are split into 3 regions; Bering Sea, Gulf of Alaska, Aleutian Islands with identical data table structure in each regional data set.

The "Habits" database consists of four basic tables that are replicated for each region. The primary diet table is the "Predator-Prey" table, which contains data on each stomach analyzed. Within this table are data on the size, weight, sex, stomach fullness and maturity of each predator along with the taxon, number, weight, and state of digestion of each prey within a given predator's stomach. Identification information about the vessel, cruise, haul number and specimen number of each predator sampled are also kept in the Predator-Prey table to allow unique identification of each sample as well as cross-referencing to other tables. The "Haul" table contains spatial, temporal and physical data for each location at which we have fish stomach samples. Within the Haul table are latitude, longitude, date, bottom and gear depth, surface and gear temperature, gear type as well as vessel, cruise and haul identifiers. The "Prey-Length" table primarily contains size information of commercially important prey found in the stomach contents that were in adequate condition to allow measurement. This table contains standard lengths of fish prey, carapace width of brachyuran crabs (snow, Tanner, Dungeness), and carapace length of anomuran (king) crabs and pandalid shrimps. Prey data also includes the corresponding predator length as well as the vessel, cruise, haul identifiers, and specimen number. Finally, the "Intestine" table contains data of those species, primarily small-mouthed flatfishes, for which examine intestine contents as well as stomach contents have been examined. This table is fundamentally structured the same as the "Predator-Prey" table. The combination of these four tables across four regions results in sixteen tables that make up the primary database. Combined, these tables currently account for approximately 500,000 records. The database also contains information on eastern Bering Sea groundfish food habits donated by Japanese scientists who collected these data on Japanese research vessels from 1979 to 1985.

Environmental Databases and Satellite Imagery Archives

Most of the physical oceanographic information that will supplement the shelf-wide surveys will be obtained from PMEL. This data includes CTD profiles of temperature and salinity available from the Live Access Server at the Pacific Fisheries Environmental Lab at the Southwest Fisheries Science Center (Table 2), and from the Pacific Marine Environmental Lab's EPIC site (Table 3). Satellite imagery of sea surface temperature and chlorophyll a concentration from AVHRR and SeaWiFS respectively are also available at PMEL from Ms. Sigrid Salo.

Table 2. Pacific Fisheries Environmental Lab (PMEL) physical oceanographic datasets available online via live action server (LAS)

Data Category/Type	Dataset	Temporal Coverage
PFEL Derived Products	Monthly Upwelling Indices and Anomalies	Jan 1946 - present
	Daily Upwelling Indices and Along-Shore Transports	Jan 1967 - present
	Six-Hourly Upwelling Indices and Along-Shore Transports	Jan 1967 - present
	Monthly Wind Products	Jan 1946 - present
	Environmental Indices (NOIx, SOIx, SOI)	Jan 1948 - present
Monthly Observational Means	GTS Sea Surface Observations	Jan 1997 - present
	GTSPP Real-Time Subsurface Temperature	Aug 1996 - present
	GTSPP Best Copy Subsurface Temperature	Jan 1990 - Dec 1998
FNMOC 1 degree Monthly Fields	Sea Level Pressure	Nov 1996 - present
	Interpolated Sea Level Pressure	Jan 1967 - present
	Surface Winds at 20 meters	Dec 1996 - present
	Surface Winds at 10 meters	Nov 1999 - present
	Geopotential Height at 500mb	Jul 1998 - present
World Ocean Database 1998	Monthly Mixed Layer Depth - Temperature Criterion	Jan 1945 - Dec 1994
	MLD Climatology - Temperature Criterion	
	Monthly Mixed Layer Depth - Density Criterion	Jan 1945 - Dec 1994
	MLD Climatology - Density Criterion	
	Temperature	Jan 1950 - Dec 1990
	Temperature Climatology	
	Salinity Climatology	
Global Upwelling Index (1deg.summaries)	SLP and Air/Ocean Indices	Jan 1967 - present
	Global Upwelling Index	Jan 1967 - present

Table 3. Relevant FOCI physical oceanographic datasets for Alaskan waters publicly available via PMEL's EPIC online data access system.

Time Series Datasets	Number files	Temporal Range	Spatial Coverage	Depth Range (m)
Surface metereology	59	1/1/1946 - 3/10/89	177 0W - 131 35W, 51 50N - 68 0N	10 to 73
Subsurface data	839	7/2/1974 - 9/23/97	170 31W - 150 29W, 51 46N - 78 56N	3-1322

Profile Datasets	Number files	Temporal Range	Spatial Coverage	Depth Range (m)
CTD	14600	10/4/1917 - 13/4/1997	163 42 E - 133 129W, 49 7N - 72 37N	2-4448
Bottle	84	17/4/1988 - 29/4/1988	155 52W - 154 42W	10-251

Table 4. Satellite imagery archives maintained at the Pacific Fisheries Environmental Lab (PMEL).

Type	Temporal Range	Format
SST	Spring: 1998 - present	HDF, GIF
SeaWiFS - Chl A	May-June: 1997-present	HDF, GIF

GIS web-server: application development in EASy/Netviewer

Environmental Analysis System (EASy) is an advanced, PC-based geographical information system designed for the storage, dissemination integration, analysis and dynamic display, of spatially referenced series of diverse oceanographic data. Developed by Systems Science Applications (http://www.systemscienceapp.com/ and http://www.runeasy.com), it has been used in a range of national and international oceanographic projects, including the storage and mapping of bio-optical parameters in the Atlantic Ocean and Mediterranean Sea, and the OBIS-funded Gulf of Maine Biogeographic Information System (GMBIS) project (http://netviewer.usc.edu/web). The software has been custom designed with the particularities of oceanographic applications, the needs of marine research and educational communities, and pathways for information exchange in mind. It facilitates interfacing of multivariate oceanographic data, including satellite imagery, with statistical algorithms and mechanistic models. It graphically renders dynamically in time, within their proper geo-spatial context, both field and remotely sensed data and model outputs as diverse types of plots, including vector, contour, and false color image plots. Vertical structure of data, critical in oceanographic applications, is depicted as vertical contours for user-defined transects or depth profiles at selected point locations. Time series of measurements, and dependencies between data at individual stations can also be visualized interactively as XY-plots. The software also facilitates broad, platform independent access to data, integrated visualization products and analytical tools over the Internet via Netviewer, a client-server, plug-in for EASy. An example of the type of value-added imagery products that can be generated within EASy for the proposed work is illustrated below. Both EASy and Netviewer will be used in this project as principal tools for data integration, visualization and dissemination. GIS application development here will involve ingestion of available remote sensing imagery, hydrographic CTD and bottle, and AFSC fisheries survey data.

Figure 3. EASy software architecture and data integration

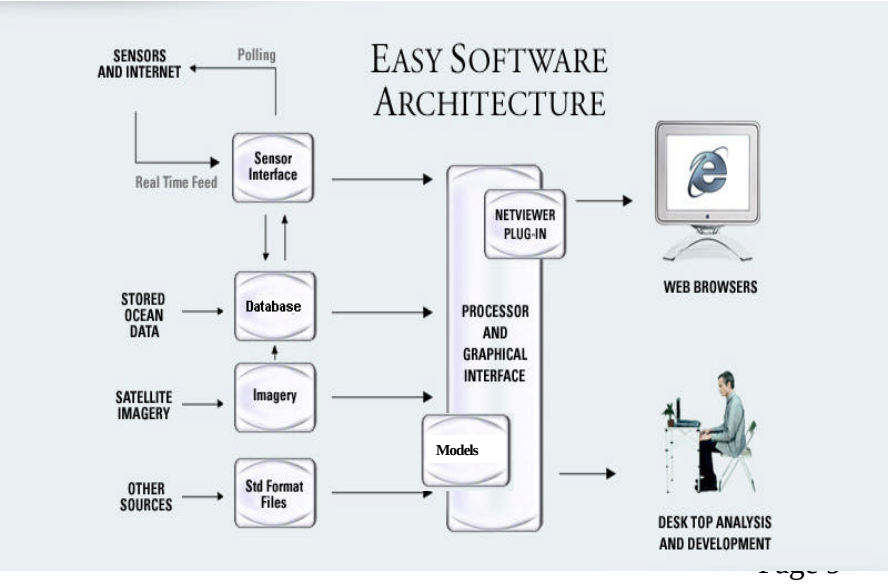
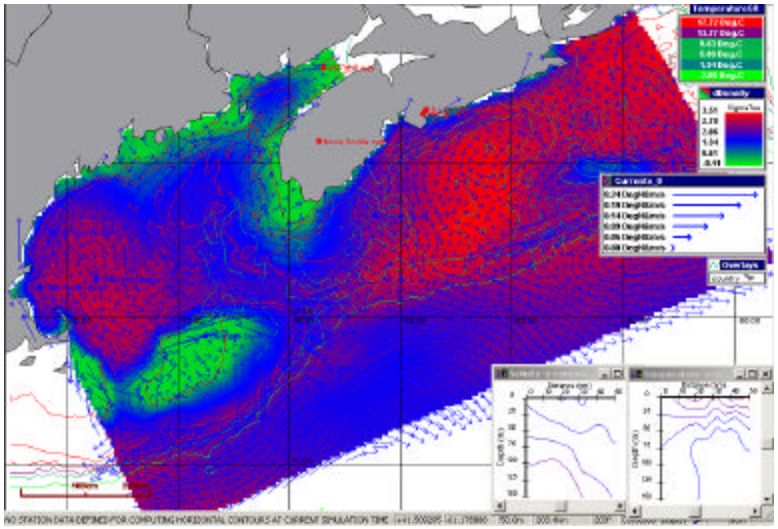
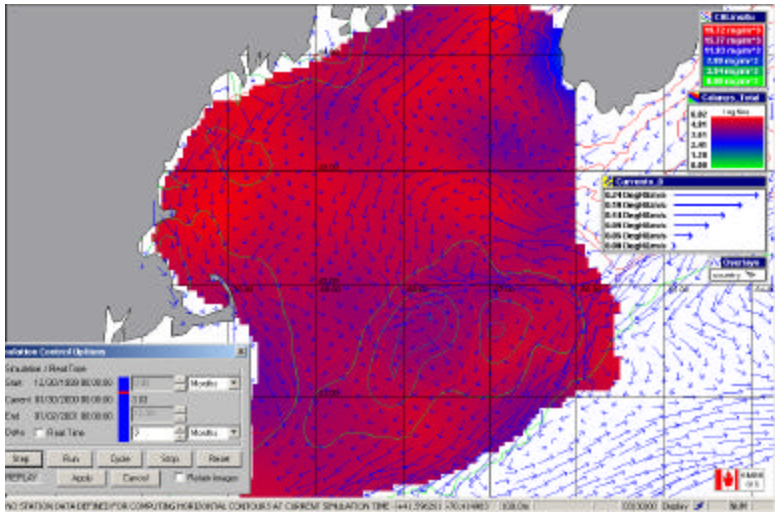


Figure 4. Sample integrated, seasonal climatological imagery products generated by EASy for GMBIS.

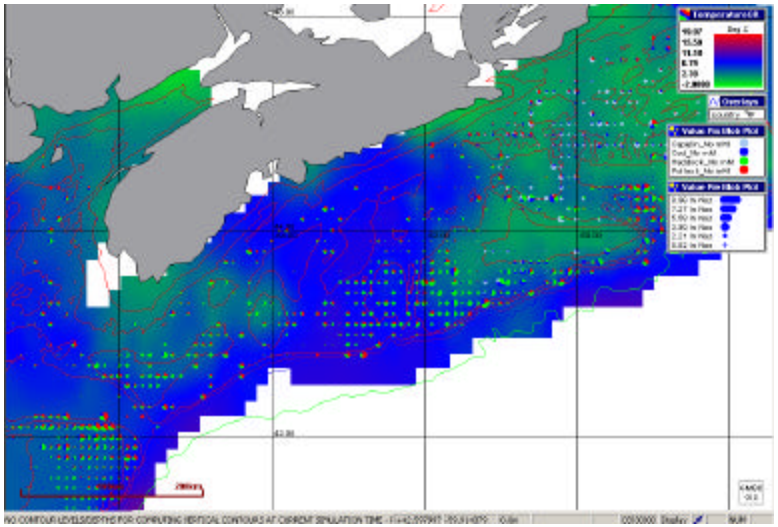
A. Physical structure and circulation patterns of the GoM



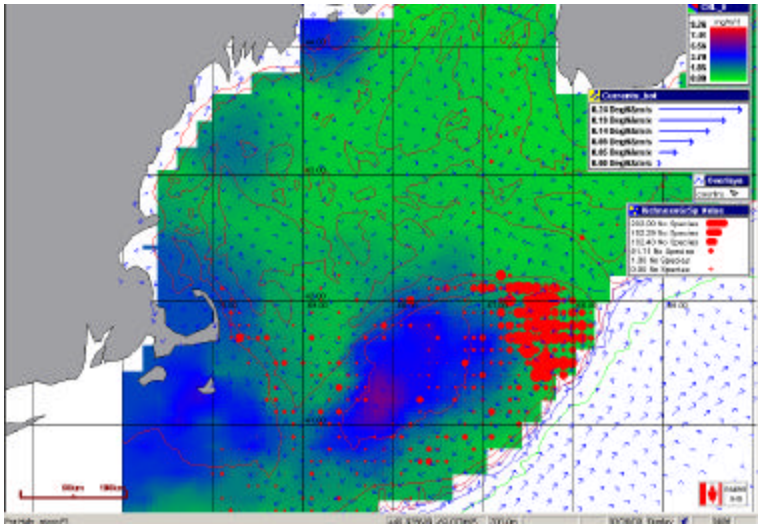
B. Winter zooplankton (*Calanus*) abundance distributions, GoM



C. Selected groundfish species abundance distribution patterns, GoM



D. Winter fish diversity hotspots, Georges Bank



C. Statistical Methods

This pilot project will not include statistical analyses or modeling. Of course data from the system available to others for such analyses. Future work however would include incorporation of statistical algorithms and models such as ECOPATH and ECOSPACE.

D. Description of Study Area

The groundfish data in the information system were collected from the shelf and slope waters of the Gulf of Alaska, the Aleutian Islands, and the Bering Sea. (See figure 2.)

E. Coordination and Collaboration with Other Efforts

Development of the OBIS node will require collaboration with developers of the OBIS Portal at Rutgers University, scientists at Alaska Fisheries Science Center and the Pacific Marine Ecological Laboratory, and system engineers at EVOS. As members of the OBIS technical steering committee and as participants in several OBIS projects (GMBIS, MARECO, Pilot Census of the Gulf of Maine, SEAMAP, and OBIS- South America.), we already have close relations with the OBIS community and are active in shaping the course of the program. We have also worked with developers of NVODS and the Live Active Server that was developed at PMEL. Finally, we have two current projects in Alaska, SALMON (headed by Dave Musgrave at UAF) and Ghost Net (funded by NASA and headed by Tim Veenstra of Airborne Technologies).

IV. SCHEDULE

A. Project Milestones

The tasks required to assemble Information System fall into several categories: collection of data, importing this data into the geographic information system, writing computer code to customize the information system, install and test system on servers, and training and outreach.

Task 1. Develop project website and complete general design and determine content of Information System: August, 2004

Task 2. Determine organization and formats of source databases and complete design of GIS database: November, 2004

Task 3. Import all data and information into the Geographic Information System and complete programming of interfaces: December, 2004

Task 4. Install and test DiGIR and web-based GIS on local server: February, 2004

Task 5. Install and test information system at EVOS and Alaska Fisheries Science Center Servers and complete instruction manual: May, 2005

Task 6. Train EVOS and Alaska Fisheries Science Center technicians on use and maintenance of the information system: June, 2005

Task 7. Write final report describing and evaluating system and present paper: July, 2005

B. Measurable Project Tasks

FY 04, 1st quarter (July 1, 2004-September 31, 2004)
July: Project funding approved by Trustee Council
Complete task 1

FY 04, 2nd quarter (October 1, 2004-December 31, 2004)
January 13-17: Annual EVOS Workshop
Complete tasks 2 & 3

FY 04, 3rd quarter (Jan 1, 2004-March 31, 2005)
Complete task 4

FY 04, 4th quarter (April 1, 2005-June 30, 2005)
August 30: Complete tasks 5-7.

V. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

The Groundfish Information System is an interactive communication and outreach tool available to all. Public access will be via the project website and OBIS portal. In addition information about the system will be presented at EVOS conferences. The Groundfish node will be visited by fishery managers and will help guide the development of community monitoring programs.

B. Resource Management Applications

Groups, individuals, and programs as diverse as natural resource agencies, educators, researchers, conservation advocates can benefit from a tool that brings together disparate data sets to one common source. At present, no such tools exist to guide management decisions and scientific efforts within the Gulf of Alaska. The primary product of this proposal is a tool to help fisheries managers apply ecosystem-based analysis for decision support.

VI. PUBLICATIONS AND REPORTS

We will provide quarterly progress reports, and a final report documenting the system and its evaluation. It is our aim to produce one scientific paper on the applications of our statistical and modeling analyses, and another describing the information system.

VII. PROFESSIONAL CONFERENCES

We intend to present the results of this work at OBIS and EVOS conferences and workshops.

VIII. PERSONNEL

A. Principal Investigators (PIs)

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IX. PRINCIPAL INVESTIGATOR QUALIFICATIONS

Dale A. Kiefer

Professional Preparation

Yale University	Biology	B.Sc.	1966
University of Oregon	Marine Biology	M.S.	1967
UC San Diego (Scripps)	Biological Oceanography	Ph.D.	1973

Appointments

Professor, Department of Biological Sciences, University of Southern California, 1990-
SeaWiFS Science Team, NASA, 1993-
Visiting Scientist, Food and Agricultural Organization, United Nations, Rome, Italy 1994-98
Visiting Scientist, Laboratoire de Pierre et Marie Curie, University of Paris, France, 1987
Associate Professor, Department of Biological Sciences, University of Southern California, 1981-90
Assistant Professor, Department of Biological Sciences, University of Southern California, 1976-81
Assistant Research Biologist, U.C. San Diego Visibility Laboratory, 1975-76

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Publications

Kiefer has published 75 papers and 16 published reports, 47 in the field of bio-optical oceanography, 21 relating to phytoplankton dynamics and modeling, 8 on pollution/water quality issues, and 8 on fisheries/information systems.

Publications Related to this Project

Tsontos, V.M. & D.A. Kiefer. 2003. The Gulf of Maine Biogeographical Information System Project: Developing a Spatial Data Management Framework in Support of OBIS. Oceanologica Acta. 25, 199-206.

Tsontos, V.M. & D.A. Kiefer. 2000. Development of a Dynamic Biogeographic information system for the Gulf of Maine. Oceanography, 13 (3) 25-30.

D.A. Kiefer, V.M. Tsontos, M. Sinclair, R. Branton, J,Loder. 2001. The Gulf of Maine Biogeographic Information System. Poster, ICES Symposium, Edinburgh, UK, 7 August 2001

S.E. Lluch-Cota, D. Kiefer, A. Parés-Sierra, D.B. Lluch-Cota, J. Berwald, and D. Lluch-Belda. Toward an Environmental Analysis System for the Gulf of California sardine fishery. "Lowell Wakefield Fisheries Symposium series". November 1999. 20 pgs.

Five Other Publications

Berwald, J., Stramski, D., Mobley, C. D., & Kiefer, D. A. 1998. The effect of Raman scattering on the average cosine and the diffuse attenuation coefficient of irradiance in the ocean. Limnology and Oceanography, 43(4), 564-576.

Reynolds, R. A., Stramski, D., & Kiefer, D. A. 1996. The Effect of nitrogen-limitation on the absorption and scattering properties of the marine diatom Thalassiosira pseudonana. Limnology and Oceanography. 42(6): 1317-1327.

Ondercin, D., Atkinson, C. A., & Kiefer, D. A. 1995. The Distribution of Bioluminescence and Chlorophyll During the Late Summer in the North Atlantic: Maps and a Predictive Model. Jour. Geophys. Res., 100, 6575-6590.

Kiefer, D. A. 1994. Light absorption, fluorescence, and photosynthesis: Skeletonema costatum and field measurements. In R. W. Spinrad, K. L. Carder, & M. J. Perry (Eds.), Ocean Optics (pp. 165-188). New York: Oxford Univ.

Kiefer, D. A. 1993. Modeling growth and light absorption in the marine diatom Skeletonema costatum. In G. T. E. a. J. R. Fasham (Eds.), Towards a Model of Ocean Biogeochemical Processes (pp. 93-118). Berlin: Springer-Verlag.

Synergistic Activities

1. Development of a series of information systems in support of fisheries, marine biogeographical, water quality studies, and coastal area management initiatives.
2. Collaboration with the Food and Agricultural Organization of the United Nations (Rome, Italy) on the development of an integrated coastal analysis and monitoring system for operational management of coastal areas and resources.
3. Assessment of water-quality issues and management strategies for LA-DWP drinking water reservoirs around Los Angeles.
4. Collaboration on the NASA SeaWIFS science team and associated work on the development of bio-optical algorithms for satellite ocean color imagery.
5. Consultations on a range of coastal area management matters within Southern California, including pollution/water quality issues and the development of marine protected areas.

Vardis Tsontos

Professional Preparation

- PhD in Population Ecology. Renewable Resources Assessment Group (RRAG), Imperial College, London, UK. 1991-1996.
- MSc. in Fisheries Biology & Management, UCNW, Bangor, UK: 1989-1991.
- BSc. in Biological Oceanography, University of Southampton (UK): 1986-1989.

Appointments:

- Postdoctoral Fellow, Biology Dept., University of Southern California: 1998-present.
- Academic Visitor to FAO (SDRN), Rome, Italy: 1998-2000.
- Research Scientist, Fisheries Management Group, CEFAS/MAFF, Lowestoft, UK: 1997.

Recent Projects:

Application of Remote Sensing Data to the Analysis of Environmentally-mediated Recruitment Variability in Harvested Fish Populations: Case study of Cod and Haddock Stocks within the Gulf of Maine
USC, 9/2001 – 8/2003
Collaborators: NMFS, Woods Hole *Funding Agency*:NOAA (NESDIS)

GMBIS - Gulf of Maine Biogeographic Information System
USC, 8/2000 – 3/2002
Collaborators: Bedford Oceanographic Institute *Funding Agency*: Sloan Foundation

Recent Publications:

Tsontos, V.M. & D.A. Kiefer. 2003. The Gulf of Maine Biogeographical Information System Project: Developing a Spatial Data Management Framework in Support of OBIS. Oceanologica Acta. 25, 199-206.

Tsontos, V.M. & D.A. Kiefer. 2000. Development of a Dynamic Biogeographic information system for the Gulf of Maine. Oceanography, 13 (3) 25-30.

PATRICIA A. LIVINGSTON

Education

1973-1976	Michigan State University: B.S., Fishery Biology (Honor)
1976-1980	University of Washington: M.S., Quantitative Fishery Management
1984-1988	University of Washington: Master of Public Administration, Natural Resource Policy and Administration.

Scientific Experience:

1977-1983	Fishery research biologist, Northwest and Alaska Fisheries Center, Seattle, WA. Member of Ecosystem modeling group which developed models of North Pacific ecosystems.
1984-1996	Supervisory fishery research biologist, Alaska Fisheries Science Center, Seattle, WA. Head of the Trophic Interaction Group/Resource Ecology and Ecosystem Modelling Task in the Resource Ecology and Fishery Management Division which involves planning and conducting research on marine fish feeding interactions and applying and parameterizing single-species, multispecies and ecosystem models.
1997 – now	Program leader, Resource Ecology and Ecosystem Modeling Program, Resource Ecology and Fishery Management Division, Alaska Fisheries Science Center.
1989- now	Affiliate faculty member, University of Washington School of Fisheries

Committees and Societies:

1983-1986	Member, officer, and regional correspondent Marine Fisheries Section, American Fisheries Society
1984-1986	Member, Sea Use Council Scientific and Technical Advisory Board
1989–now	Member, American Institute of Fishery Research Biologists
1990-1991	Committee member, American Fisheries Society, Professionalism committee
1991-1992	Member and membership chair of the International Fisheries Section, American Fisheries Society
1991-1992	Membership committee, American Fisheries Society
1995-2001	Member, MODEL Task Team of PICES CCCC GLOBEC Program
1995-1996	Member, PICES WG5 on Bering Sea
1995-1997	Co-lead, MMPA Bering Sea Ecosystem Study Plan
1996-1997	Associate Director, NW Washington Chapter of American Institute of Fishery Research
1996-1998	National representative, PICES CCCC GLOBEC Implementation Panel
1996-1998	Co-chair, PICES-GLOBEC Climate Change and Carrying Capacity Program
1999-2001	Chairman, PICES Science Board
2001-now	Member, Arctic Climate Impact Assessment, Marine Drafting Group
2001-now	Member, North Pacific Fishery Management Council Ecosystem Committee
2002	Member, EVOS STAC Nominating Committee
2002	Member, PICES Organizational Review Committee

Invited participant and organizer of regional, national, and international workshops and reviews

Some examples include:

- Invited speaker at AFS theme session on Ecosystem Advice (1989)
- Invited keynote speaker at ICES Multispecies theme session at 1994 ICES Annual Meeting
- Invited speaker to review status of models for predicting the effects of climate change on upper trophic level species (PICES MODEL workshop, 1996)
- Invited plenary session keynote speaker at Center for Marine Conservation Biology workshop on Ecosystem Management in the Bering Sea (October 1997)
- Member of organizing group, workshop report editor, and workshop group leader for interagency workshops on developing a research plan for the Bering Sea Ecosystem (1997-1998)(two workshops, two workshop reports, one research plan)
- Member of organizing committee and session co-chair for the Lowell Wakefield symposium on Ecosystem approaches for Fisheries Management (Fall 1998)
- Invited participant in two focus groups at the ICES/SCOR international symposium on Ecosystem effects of Fishing (multispecies modeling and boreal ecosystems)(March 1999)
- Invited Keynote speaker at EVOS Restoration Workshop (Winter 2000)
- Invited speaker and participant in Canadian national workshop on Objectives and Indicators for Ecosystem-based Management. (Feb 2001)
- Invited panel member, Ecosystem-based Management Hearing, Subcommittee on Fisheries Conservation, June 14, 2001
- Invited panelist on the Bering Sea Session, Alaska Forum on the Environment, Feb. 5, 2002.

SELECTED PUBLICATIONS

Jurado-Molina, J. and P.A. Livingston. 2002. Multispecies perspectives on the Bering Sea groundfish fisheries management regime. N. Amer. J. Fish. Management 22:1164-1175.

Jurado-Molina, J. and P. A. Livingston. 2002. Climate-forcing effects on trophically linked groundfish populations: implications for fisheries management. Can. J. Fish. Aquat. Sci. 59:1-11.

Livingston, P.A. 1993. Importance of walleye pollock, Theragra chalcogramma, and Pacific herring, Clupea pallasi, to groundfish, marine mammals, birds, and the commercial fishery in the eastern Bering Sea. Mar. Ecol. Progr. Ser. 102:205-215.

Livingston, P.A. (Editor). 2002. Ecosystem considerations for 2003. Appendix: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the EBS/AI and GOA. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501. 230p.

Livingston, P.A. and J-J. Jurado-Molina. 2000. A multispecies virtual population analysis of the eastern Bering Sea. ICES J. Mar. Sci. 57:294-299.

Livingston, P.A., L-L. Low, and R.J. Marasco. 1999. Eastern Bering Sea ecosystem trends. p. 140-162. In: Sherman, K. and Q. Tang (eds) Large Marine Ecosystems of the Pacific Rim: Assessment, Sustainability, and Management. Blackwell Science, Inc. Malden, MA. 465p.

Livingston, P.A. and R.D. Methot. 1998. Incorporation of predation into a population assessment model of eastern Bering Sea walleye pollock. P. 663-678. In: Fishery Stock Assessment Models. Alaska Sea Grant College Program Publication AK-SG-98-01. 1037p.

X. LITERATURE CITED

Aldridge, L.A., Bradley, D.L., Butterworth, D., and J.H. Steele, 1999. Assessing the Global Distribution and Abundance of Marine Life: Summary of a Workshop Sponsored by the Sloan Foundation and the Office of Naval Research, January 13-15, 1998, Monterey, California. Oceanography, 12(3), 41-46.

Bradley, D.L., 1999. Assessing the Global Distribution and Abundance of Marine Organisms. Oceanography, 12(3), 19-20.

Jurado-Molina, J. and P.A. Livingston. 2002. Multispecies perspectives on the Bering Sea groundfish fisheries management regime. N. Amer. J. Fish. Management 22:1164-1175.

Livingston, P.A. and J-J. Jurado-Molina. 2000. A multispecies virtual population analysis of the eastern Bering Sea. ICES J. Mar. Sci. 57:294-299.

May, R.M., 1990. How Many Species? Phil. Trans. R. Soc. Lond. B, 330, 293-304.

Murawski, S.A. 1991. Can we Manage our Multispecies Fisheries? Fisheries, 16(5), 5-13.

National Research Council. 1999. Sustaining Marine Fisheries, Report of Committee on Ecosystem Management for Sustainable Marine Fisheries, Oceans Studies Board, 168pp.

Pauly, D., Christensen, V. & Walters, C. 2000. ECOPATH, ECOSIM and ECOSPACE as tools for evaluating impact of fisheries. ICES J. Mar. Sci. 57, 697-706.

Tsontos, V.M. & D.A. Kiefer. 2003. The Gulf of Maine Biogeographical Information System Project: Developing a Spatial Data Management Framework in Support of OBIS. Oceanologica Acta. 25,199-206.

Tsontos, V.M. & D.A. Kiefer. 2000. Development of a Dynamic Biogeographic information system for the Gulf of Maine. Oceanography, 13 (3) 25-30.

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Budget Category:	Proposed FY 04	Proposed FY 05	Proposed FY 06		TOTAL PROPOSED
Personnel	$71.5	$0.0	$0.0		$71.5
Travel	$2.7	$0.0	$0.0		$2.7
Contractual	$0.0	$0.0	$0.0		$0.0
Commodities	$0.0	$0.0	$0.0		$0.0
Equipment	$0.0	$0.0	$0.0		$0.0
Subtotal	$74.2	$0.0	$0.0		$74.2
Indirect (included in Personnel)					
Project Total	$74.2	$0.0	$0.0		$74.2
Trustee Agency GA (9% of Project Total)	$6.7	$0.0	$0.0		$6.7
Total Cost	$80.9	$0.0	$0.0		$80.9

Cost-share Funds:
In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY 04-06

Date Prepared:

Project Number:
Project Title:
Proposer:

FORM 4A
NON-TRUSTEE
SUMMARY

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
Vardis Tsontos	Database design and GIS cons		5.0	8.3		41.5
Frank O'Brien	Programmer		1.5	16.0		24.0
Dale Kiefer	System design and Co-ordinati		0.5	12.0		6.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	7.0	36.3	0.0	
					Personnel Total	$71.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
LA/Seattle rt: identification of databases and imagery	0.6	1	3	0.1	0.9
LA/Ancorage rt: training, installation	0.6	1	3	0.1	0.9
LA/Ancorage rt: EVOS Wrokshop	0.6	1	3	0.1	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.7

FY 04

Project Number:
Project Title:
Proposer:

FORM 4B
Personnel
& Travel
DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contract Sum
Description	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0
Commodities Costs:	Commodity Sum
Description	
Commodities Total	$0.0

FY 04

Project Number:
Project Title:
Name:

FORM 4B
Contractual & Commodities DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases:		Number	Unit	Equipment
Description		of Units	Price	Sum
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
			New Equipment Total	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY 04

Project Number:
Project Title:
Proposer:

FORM 4B
Equipment
DETAIL

***EXXON VALDEZ* OILSPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 05

Project Number:
Project Title:
Proposer:

FORM 4B
Personnel
& Travel
DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contract Sum
Description	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs:	Commodity Sum
Description	
Commodities Total	$0.0

FY 05

Project Number:
Project Title:
Proposer:

FORM 4B
Contractual &
Commodities
DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases:		Number	Unit	Equipment
Description		of Units	Price	Sum
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
			New Equipment Total	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY 05

Project Number:
Project Title:
Proposer:

FORM 4B
Equipment
DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 06

Project Number:
Project Title:
Proposer:

FORM 4B
Personnel
& Travel
DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contract Sum
Description	
Contractual Total	$0.0

Commodities Costs:	Commodity Sum
Description	
Commodities Total	$0.0

FY 06

Project Number:
Project Title:
Proposer:

FORM 4B
Contractual & Commodities DETAIL

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases:		Number	Unit	Equipment
Description		of Units	Price	Sum
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
			New Equipment Total	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY 06

Project Number:
Project Title:
Proposer:

FORM 4B
Equipment
DETAIL