EVOS PROPOSAL SUMMARY PAGE

(Trustee Council Use Only)
Project No. *G-030687*
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Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions.

Project Period: FY 03

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EVOS Funding: $90,000

Matching Funds: N/A

Study Location: No field work. Study area is the Gulf of Alaska.

Trustee Agency: U.S. Department of Interior

Abstract:

Over the past several years, a conceptual framework for the GEM nearshore monitoring program has been developed through a series of workshops. However, details of the proposed monitoring program, e.g. what to sample, where to sample, when to sample and at how many sites, have yet to be determined. In this proposal we outline a process whereby specific alternatives to monitoring are developed and presented to the EVOS Trustee Council for consideration. As part of this process, two key elements are required before reasoned decisions can be made. These are: 1) a comprehensive historical perspective of locations and types of past studies conducted in the nearshore marine communities within Gulf of Alaska, and 2) estimates of costs for each element of a proposed monitoring program. We propose to develop a GIS database that details available information from past studies of selected nearshore habitats and species in the Gulf of Alaska and provide a visual means of selecting sites based (in part) on the locations for which historical data of interest are available. In addition, we will identify what other data, if any, are required to select specific sampling locations. We will also provide cost estimates for specific monitoring plan alternatives and outline several alternative plans that can be accomplished

within reasonable budgetary constraints. The products that we will provide are: 1) A GIS database and maps showing the location and types of information available from the nearshore in the Gulf of Alaska; 2) A list of several specific monitoring alternatives that can be conducted within reasonable budgetary constraints; and 3) Cost estimates for proposed tasks to be conducted as part of the nearshore program.

I. INTRODUCTION

The Gulf Ecosystem Monitoring (GEM) program has five major programmatic goals:

DETECT: Serve as a sentinel (early warning) system by detecting annual and long-term changes in the marine ecosystem**,** from coastal watersheds to the central gulf;
UNDERSTAND: Identify causes of change in the marine ecosystem, including natural variation**,** human influences, and their interaction;
PREDICT: Develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers;
INFORM: Provide integrated and synthesized information to the public, resource managers, industry and policy-makers in order for them to respond to changes in natural resources; and
SOLVE: Develop tools, technologies, and information that can help resource managers and regulators improve management of marine resources and address problems that may arise from human activities.

The nearshore portion of the GEM program has these same goals. As an initial step in achieving these, the EVOS Trustee Council is currently developing a sampling design to detect and understand change in the nearshore. A conceptual framework for such a design has been developed, but details have not been determined. This proposal will provide a process and products that will aid the Trustee Council in making reasoned decisions regarding the nearshore monitoring design. The proposed work will provide necessary information that is critical to this process, and will provide the Trustee Council with several specific, cost effective monitoring alternatives that can be implemented over the next several years.

II. NEED FOR THE PROJECT

A. Statement of Problem

Over the past year, a series of workshops were convened to help develop a conceptual model for monitoring in the nearshore (Project 02395) aimed principally at detecting and understanding change. As part of the development process, it was recognized that the changes are likely to occur and to be attributable to a number of different agents (e.g. global climate changes, shoreline development and associated inputs of pollutants) (Table 1). It was also recognized that changes are likely to occur over varying temporal and spatial scales. For example, global climate change may result in a gradual change in the nearshore community that occurs over decades and has impacts over the entire Gulf of Alaska (GOA), and beyond. On the other hand, impacts from shoreline development will likely be more episodic and more local. Thus, one challenge of designing a monitoring program is to detect changes occurring over widely varying scales of space and time. In response to this challenge, the conceptual design for monitoring in the nearshore (Schoch et al 2002) called for a multi-pronged approach consisting of the following:

1) Synoptic sampling of specified physical and biological parameters (e.g. weather, sea surface temperature) over the entire GOA
2) Intensive sampling of a variety of specified biological and physical parameters (e.g. abundance and growth of intertidal organisms, abundance of selected birds and marine mammals) within a few specified areas spread throughout the GOA using a nested sampling approach. The nested design calls for sampling at some number of locations within the GOA, and at a number of sites within each of those locations.
3) Sampling of a smaller suite of selected biological and physical parameters (e.g. the abundance, growth, and contaminant levels in mussels and clams) at a larger number of less intensively studied sites stretching across the GOA. These are referred to as extensive sites.
4) Conduct of shorter-term studies aimed at identifying important processes regulating or causing changes within a given system or subsystem.

Sampling at intensive sites was designed primarily to detect large-scale changes (e.g. those due to global climate change) while sampling at extensive sites was designed primarily to detect changes that might occur as a result of more localized events such as shoreline development or logging activities.

A long list of potential parameters to be measured was developed (Table 2) and priorities were given for each of these within the synoptic, intensive, and extensive components.
This provided a reasonable framework for development of a nearshore GEM monitoring program, but specifics as to the parameters to be measured, the number of sites to be sampled, and the location of sampling sites were not determined. Furthermore, no specific cost estimates were provided and no determination was made as to the appropriate allocation of effort (and costs) among the various components (synoptic, intensive, extensive and process studies).

B. Rationale/Link to Restoration

In establishing the GEM Program, the Trustee Council explicitly recognized that complete recovery from the oil spill may not occur for decades and that full restoration of injured resources will most likely be achieved through long-term observation and, as needed, restoration actions. The Council further recognized that conservation and improved management of injured resources and services will require substantial ongoing investment to improve understanding of the marine and coastal ecosystems that support the resources, as well as the people, of the spill region. In addition, prudent use of the natural resources of the spill area without compromising their health and recovery requires increased knowledge of critical ecological information about the northern Gulf of Alaska. This knowledge can only be provided through a long-term monitoring and research program that will span decades, if not centuries.

As part of the overall GEM program, a comprehensive examination of the nearshore zone is required. The nearshore is a critical component of the GOA system, was one of the components most severely injured by the *Exxon Valdez* oil spill, is utilized to a large extent (both directly and indirectly) by humans, and is likely to be adversely impacted by anthropogenic effects over the next century. Therefore, development of a cost-effective program that is able to detect and understand causes for change in the nearshore is a critical.

C. Link to GEM Program Document

The proposed work will provide a list of cost effective alternatives to nearshore monitoring that will allow the Trustee Council to select and implement a plan that is effective in detecting and understanding change in the nearshore, and does so within imposed budgetary constraints. The development of a set of nearshore monitoring alternatives will use the following process.

1. Based on preliminary recommendations resulting from workshops conducted over the past year, list potential metrics to measure, number and location of sampling sites, and frequency of sampling.
2. Provide the data analyses and representations needed to determine appropriate metrics, the number of sites, location of sites, and frequency of sampling. These will include establishment of a GIS database in which habitat types, locations of historical data, types of historical data available from each site, existing human use, and biological hotspots are identified and presented.
3. Establish a protocol for site selection and select potential sites. We envision that the selection protocol will have the following elements. Intensive sites will be selected that are spread sufficiently throughout the GOA so large-scale geographic trends and changes in these trends can be detected. These sites will also be selected based on similarity of habitat, proximity to logistical support facilities and availability of appropriate historical data, and proximity to areas known or suspected to be biological “hotspots”. Also, intensive sites will be selected that are relatively removed from potential localized anthropogenic effects. This is because the intensive site data will be used primarily to detect changes that result from large-scale, non-localized agents (e.g. global climate change). Extensive sites will be selected as follows. A number of sites (approximately half) will be located near those areas where there are potential impacts from local influences and where humans most heavily utilize resources. These sites of high likely impact would include human population centers, logging sites, etc. The other half will be selected from the same geographic region as the first and of the same basic habitat type, but outside the probable influence of localized

anthropogenic effects. Data from these sites would be used primarily to detect localized changes to the nearshore environment. Sites for which there were historical data of interest would be given priority.

4. Make preliminary cost determinations and based on these, select alternative sampling designs that can be conducted within the preliminary budget. These are to be "core" sampling design alternatives that can be fully sustained based on support received from the EVOS Trustee Council. Alternatives will provide differing emphases with respect to effort afforded to synoptic, intensive, extensive, and process studies. Each alternative would include number and location of specific sites to be sampled, the frequency of sampling, and the metrics to be sampled at each site.
5. Identify and conduct preliminary studies that may be needed to finalize metric, site selection, or sampling frequency determination. For example, additional habitat mapping may be required to finalize sites selection, and preliminary sampling may be necessary in order to estimate the number or sizes of sampling units needed to detect change with reasonable power.
6. Make final determination of metrics, sampling sites, and sampling frequency selections based on the above and develop final protocols for a core-sampling program.
7. Identify potential partnering agreements for "non-core" elements and develop these.
8. Develop a data management system and quality assurance/quality control procedures prior to sampling.

In this project, we will focus on numbers 2 through 4 above. Specifically, we will

- Establish a GIS database that identifies habitat types, locations of historical data, types of historical data available from each site, existing human use, and biological hotspots.
- Make a preliminary list of potential sites and metrics to be evaluated at each.
- Estimate costs for each of the above.
- Provide alternative sampling designs that can detect change, over varying scales of space and time, with reasonable certainty and can be conducted within imposed budgetary constraints.

As indicated above, the immediate use of the GIS database of historical information will be to aid in the selection of long-term monitoring sites. However, it is also anticipated that this database will have longer-term benefits. This database will be especially valuable in efficiently gathering information that may be used to detect changes caused by some future unanticipated event. For example, such a database would have been particularly valuable in designing studies to assess damages following the *Exxon Valdez* oil spill. Because of the immediacy of the need to develop a sampling program after EVOS, and because no central repository of historical data was available, historical data were underutilized in developing a damage assessment sampling designs. For example, none of the sites sampled after the 1964 earthquake (Baxter 1971, Haven 1971, Hubbard 1971, Johansen 1971), in extensive studies conducted around Valdez (e.g. McRoy 1970, Feder and Paul 1974; Paul and Feder 1976, Paul et al 1976, Feder and Keiser 1980), and elsewhere in PWS (Rosentahl et al 1977, 1982, Van Blaricom 1987,1988) were sampled as part of the EVOS Intertidal Coastal Habitat program. These historical studies provided valuable quantitative information on a number of metrics (e.g. littleneck clam abundance and growth, mussel abundance and growth, limpet size distribution, eelgrass abundance) that could have been of great value in helping to detect impacts from the spill.

It is also anticipated that this GIS database will be utilized by other projects in order to coordinate study designs and to help explain potential causes for change. The "human use" element of this database will be particularly valuable in serving as a baseline by which future changes in use can be evaluated and their impacts on the GOA system assessed.

III. PROJECT DESIGN

A. Objectives

The objectives of the proposed study are:

1. Establish a historical database that identifies types and locations of data of interest in selecting monitoring sites for nearshore monitoring.

2. Provide a list of alternative nearshore sampling designs that can detect changes in the nearshore and fit within budgetary constraints. Each alternative will specifically identify the location and number of sampling sites, the metrics to be sampled at each, and the frequency of sampling.

3. Provide cost estimates for a series of alternative nearshore sampling designs to be used to detect and understand changes in the nearshore environment of the GOA.

B. Procedural Methods

1. Establish a historical database that identifies types and locations of data of interest in selecting monitoring sites for nearshore monitoring.

We will use ArcInfo to develop a GIS database to organize available historical and current information, habitat characteristics, and human use for GOA areas of interest. The database will contain the following layers: 1) A base map of the GOA bounded by Sitka to the southeast and the western extent of Kodiak Island to the west. 2) Available habitat information (e.g. bathymetry), 3) The location of historical data for a suite of selected nearshore organisms (e.g. invertebrates, fishes, birds and mammals), 4) The presence of known or suspected "hotspots" that are of special biological significance, 5) The areas of special cultural or biological importance that are to be avoided, and 6) Human use patterns including locations of towns and villages, important recreational areas, and areas of subsistence harvest.

Much of the database development will entail gathering and collating existing databases and building GIS coverages, including past EVOS studies. For example, base maps for most of the region are currently available from USGS, habitat data are available from Environmental Sensitivity Index (ESI) databases (e.g. RPI, 1983) and on recent video surveys of Harper et al (1991 and unpublished), recreational use within Prince William Sound has been gathered by Murphy et al. (1999), and biological hotspots have been identified by the National Wildlife Federation (2002) and on ESI maps. Additional sources of information will include existing catalogs of data sets (Michaelson 1995, Michaelson 1996) and Environmental Impact Statements (USDA 2002). While we have a reasonable understanding of the data and coverages currently available, we clearly do not know all of them, and part of this task will be to seek out appropriate databases and incorporate them into a unified set of coverages. Community representatives will be asked to provide locations used for subsistence harvest and areas of special cultural significance that are to be avoided as sampling sites.

The historical biological information will necessarily be restricted to those metrics that are of interest to a nearshore monitoring program, and will not attempt to be inclusive of all marine habitats and species (e.g. historical catch data for commercial fishes). Sites where historical data have been gathered will be identified in a GIS layer and coded as to type (e.g. bird abundance, sea otter abundance, intertidal invertebrate abundance, PAH concentration in mussels). Each GIS layer will be accompanied by meta-data that briefly describes the type of data available, methods used in collection, the time period over which it was collected, and the reference where the data can be obtained.

An example of the kind of maps that will be produced is given for a portion of Glacier Bay for which we have compiled these data based on recent surveys (Figure 1).

2. Provide a list of alternative nearshore sampling designs that can detect changes in the nearshore and fit within budgetary constraints. Each alternative will specifically identify the location and number of sampling sites, the metrics to be sampled at each, and the frequency of sampling.

Based on the processes described above, we will compile a list of alternative sampling plans. An example of such plans, based on a preliminary evaluation of metrics, sampling locations and costs is given in Table 3.

3. Provide cost estimates for alternative nearshore sampling designs to be used to detect and understand changes in the nearshore environment of the GOA.

Cost estimates will be provided for each alternative sampling design presented. These will be established by starting with an estimated total budget per year, establishing a reasonable percentage of costs for each element (e.g. synoptic sampling, intensive sampling, extensive sampling, and process studies), and working backwards to determine the sampling design that could fulfill the requirements of detecting change yet fit within this cost structure. An estimated cost per site for conducting sampling of given metrics will be established based on our experience and on cost estimates obtained from other experts within the field.

The metrics to be examined will be selected from the list given in Table 2. Our process for selection of metrics to be examined in synoptic, intensive, and extensive sampling is as follows. First, metrics listed as having highest priority (based on past workshops) will be considered. However, we will make modifications to these as required in order to achieve program goals. For example, not all physical data identified has having highest priority are likely to be included because initial estimates of costs suggest that measuring all of these would leave little or no funding for biological measurements that are also considered as essential. Second, we will give priority to metrics necessary to detect change over those used to understand change. While we see understanding change as an important component of the GEM program, it is critical to first be able to detect change with reasonable certainty. Finally, we will focus on metrics that fit the temporal and spatial scale of the impacts we that we are attempting to detect within each component. For example, the goal of intensive sampling is to detect changes that might occur over large geographic areas and long time periods. As a result, we will rely on metrics that integrate environmental changes over large spatial and temporal scales.

C. Statistical Methods

It is anticipated that the power associated with a selected sampling design will be evaluated after a first year of preliminary sampling and the designs will be modified accordingly. The initial sampling is not a part of this proposal. However, where estimates of sampling variances are available, power analyses will be included in each sampling design, and as part of the metric selection process.

D. Description of Study Area

The study will focus on a sampling design aimed at evaluating changes over the entire GOA. It is anticipated that sampling designs will be bounded to the southeast by Sitka, and to the northwest by Kodiak, with sampling concentrated within the PWS and Kenai (Cook Inlet and Resurrection Bay) areas. The Sitka site, although outside of the influence of EVOS, is critical in evaluating large-scale spatial patterns (e.g. climate change) and distinguishing changes due to large-scale events from more localized influences (e.g. local variations in weather). It is anticipated that a portion of the sampling design will focus on sampling at extensive sites centered in communities of Kodiak, Homer, Seward, Valdez, and Cordova as well as native villages throughout the region (e.g. Tatitlek, Chenega, English Bay).

E. Coordination and Collaboration with Other Efforts

It is anticipated that the GIS database development portion of the project will be coordinated with other efforts being conducted as part of Alaska watershed and coastal current projects. This portion of the project will rely on past and current efforts funded by the EVOS Trustee Council and the USGS that have developed GIS databases. In addition, we will coordinate and collaborate with other federal, state, public and private institutions and communities in acquiring and sharing GIS layers required for this proposal.

In this proposal we will identify where proposed sampling efforts may in part be routinely or episodically undertaken by other federal, state, public or private institutions or communities (e.g. bird or mammal surveys conducted by the Departments of Interior or Commerce).

IV. SCHEDULE

A. Project Milestones

Objective 1. Establish a GIS database that identifies types and locations of data of interest in selecting monitoring sites for nearshore communities in the GOA.

To be met by September 2003

Objective 2. Provide a list of alternative nearshore sampling designs that can detect changes in the nearshore and fit within budgetary constraints. Each alternative will specifically identify the location and number of sampling sites, the metrics to be sampled at each, and the frequency of sampling.

To be met by December 2003

Objective 3. Provide cost estimates for alternative nearshore sampling designs to be used to detect and understand changes in the nearshore environment of the GOA.

To be met by December 2003

B. Measurable Project Tasks

FY 03, 1st quarter (October 1, 2002-December 31, 2002)
November 25: Project funding approved by Trustee Council

FY 03, 2nd quarter (January 1, 2003-March 31, 2003)
January 13-17: Annual EVOS Workshop (joint symposium with GLOBEC and NMFS)
Initiate collection and compilation of existing data and initiate development of GIS data coverages

FY 03, 3rd quarter (April 1, 2003-June 30, 2003)
March 30: Continue GIS database
April 30: Prepare sampling alternatives and cost estimates

FY 03, 4th quarter (July 1, 2003-September 30, 2003)

September 1:	Complete GIS data layers and sampling alternatives Submit annual report
December 1, 2003	Submit Final report to the Trustee Council

V. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

Community representatives will be asked to provide input with respect to locations of cultural resources and subsistence harvest areas to be included in the GIS database. This information will be used in helping to select sites for sampling.

The final report will be presented to the Trustee Council and to its community representatives for review. It is anticipated that the final decision regarding selection of a nearshore monitoring plan will be done in consultation with community representatives.

B. Resource Management Applications

The immediate use of the GIS database of historical information proposed for this project will be to aid in the selection of long-term monitoring sites. However, it is also anticipated that this database will have benefit to resource agencies concerned with nearshore habitats. This database will be especially valuable in efficiently gathering information that may be used to detect changes caused by some future unanticipated event, such as an oil spill. The products of this proposal will make important regional data sets more accessible to scientists, managers and other resource dependent individuals, including subsistence users, fishers and teachers.

VI. PUBLICATIONS AND REPORTS

No manuscripts will be submitted as a result of this project. A final report will be prepared and presented upon project completion.

VII. PROFESSIONAL CONFERENCES

We do not anticipate presenting results at a conference.

VIII. PERSONNEL

A. Principal Investigator (PI)

Principal Investigators:

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James Bodkin will be responsible for project objectives and tasks.

B. Other Key Personnel

George Esslinger, Kim Kloecker, and Heather Coletti, USGS, Alaska Science Center

C. Contracts

The U.S. Geological Survey, with Coastal Resources Associates, Inc. serving as a sub-contractor, will carry out the contract. Dr. Dean of Coastal Resources will be responsible for helping to gather historical information to be included in the GIS database (Objective 1), developing cost estimates (Objective 2), and helping to develop the final design alternatives (Objective 3).

IX. PRINCIPAL INVESTIGATOR QUALIFICATIONS

CURRICULUM VITAE

James L. Bodkin

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Responsibilities:	Coastal Systems Project Leader. Responsible for the design and implementation of coastal marine research for the Alaska Science Center. Responsibilities include preparation and approval of study plans, supervision of research projects and preparation and publication of results. Responsible for managing coastal systems project staff. Directs coastal systems research annual funding allocations. Southern Alaska Coastal Ecosystem Team Leader.
Current Position:	Wildlife Biologist (Research) GS-486-13. Alaska Science Center. U.S. Geological Survey. Anchorage, Alaska. August 1996-Present
Previous Positions:	Wildlife Biologist (Research) GS-486-12. Alaska Biological Science Center. U.S. Geological Survey. Anchorage, Alaska. August 1990- 1996.
	Wildlife Biologist GS-486-11, Koyukuk/Nowitna National Wildlife Refuge. U.S. Fish and Wildlife Service. Galena Alaska. 1989-1990.
	Fish & Wildlife Biologist GS-401-11, National Ecology Research Center, U.S. Fish and Wildlife Service. Santa Cruz field station. 1986-1989
	Biological Technician (Wildlife) GS-404-09, National Ecology Research Center, U.S. Fish and Wildlife Service, San Simeon field station. 1980-1986
	Biological Technician (Fisheries) GS-404-05, National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, California, 1977-1980
Education:	1985 -MS, California Polytechnic State University, San Luis Obispo, CA. (Wildlife Biology) 1976- BS, Long Beach State University (Biology), Long Beach, CA 1972 - AS, Cypress College (Biology), Cypress, CA

Memberships: Society for Marine Mammalogy
American Society of Mammalogists
Society for Conservation Biology
Wildlife Society
Western Society of Naturalists
National Geographic Society

Alaska Sea Otter Commission, Scientific Advisor
USGS National Diving Control Board Member

Publications

Bodkin, J.L. 1984. A comparison of fish assemblages in Macrocystis and Nereocystis kelp forests off central California. MS Thesis. California Polytechnic State University, San Luis Obispo. 98 pp.

Bodkin, J.L., R.J. Jameson and G.R. VanBlaricom. 1985. Pup production, abundance, and breeding distribution of northern elephant seals on San Nicolas Island, Winter 1981. Calif. Fish and Game. 71(1):53-59.

VanBlaricom, G.R., D.C. Reed, C. Harrold and J.L. Bodkin. 1985. A sublittoral population of Pleurophycyus gardneri Setchell and Saunders 1900 (Phaeophyceae: Laminariaceae) in central California. Bull. Southern California Acad. Sci. 84(3).

Bodkin, J.L. 1986. Fish assemblages in Macrocystis and Nereocystis kelp forests off central California. U.S. Fishery Bulletin. 84(4):799-808.

Jameson, R.J. and J.L. Bodkin. 1986. An incidence of twinning in the sea otter (Enhydra lutris). Marine Mammal Science. 2(4):304-309.

Bodkin, J.L., G.R. VanBlaricom and R.J. Jameson. 1987. Mass mortalities of nearshore fishes following period of large, long period storm swells. Environmental Biology of Fishes. 18(1):73-76.

Bodkin, J.L. 1988. Effects of kelp forest removal on associated fish assemblages in central California. Journal of Experimental Marine Biology and Ecology. 117:227-238.

Bodkin, J.L. and F. Weltz. 1990. A summary and evaluation of sea otter rescue operations in response to the Exxon Valdez oil spill, Prince William Sound, Alaska, 1989. Proceedings; Sea Otter Symposium, Anchorage, Alaska, 17-19 April, 1990. pp 61-69.

Bodkin, J.L. and R. Jameson. 1991. Patterns of seabird and marine mammal carcass deposition along the central California coast, 1980-1986. Can J. Zool. 69:1149-1155.

Bodkin, J.L. and L. Browne. 1992. Molt frequency and size-class distribution in the spiny lobster (Panulirus interruptus), at San Nicolas Island, California. California Fish and Game. 78(4):136-144.

Bodkin, J. L., B.E. Ballachey and M. Cronin. 1992. Mitochondrial DNA and the conservation and management of sea otters. Research Information Bulletin No. 37. US Fish and Wildlife Service, Office of Information Transfer.

Bodkin, J. L., D. Mulchay and C.J. Lensink. 1993. Age specific reproduction in the sea otter *(Enhydra lutris)*; an analysis of reproductive tracts. Can. J. Zool. 71(9): 1811-1815.

Cowen, R.K. and J.L. Bodkin. 1993. Annual and spatial variation of the kelp forest fish assemblage at San Nicolas Island, California. Pp 464-474. *In*, F.G. Hochberg (ed.) Third California Islands Symposium: recent advances in research on the California Islands. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Udevitz, M.S., J.L. Bodkin and D.P. Costa. 1995. Sea otter detectability in boat-based surveys of Prince William Sound, Alaska. Marine Mammal Science. 11(1) :59-71

Ballachey, B.E., J.L. Bodkin and A.R. DeGange. 1994. An overview of sea otter studies. *in* T. Loughlin editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 47-59.

Bodkin, J.L. and M.S. Udevitz. 1994. Intersection model for estimating sea otter mortality along the Kenai Peninsula. *in* T. Loughlin editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 81-95.

Doroff, A.M. and J.L. Bodkin. 1994. Sea otter foraging behavior and hydrocarbon levels in prey. *in* T. Loughlin, editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 193-208.

Cronin, M.A., J.L. Bodkin, B.E. Ballachey, J.A. Estes, and J.C. Patton. 1996. Mitochondrial DNA variation among subspecies and populations of sea otters (Enhydra lutris). J. Mammalogy. 77(2):547-557.

Bodkin, J.L., R.J. Jameson and J,A, Estes. 1994. Sea otters in the North Pacific Ocean. *In* E.T. LaRoe III, G.S. Farris, C.E. Puckett and P.D. Doran, editors. *Our Living Resources 1994: A report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems.* National Biological Service. Washington D.C. pages 353-356.

J.A. Estes, R.J. Jameson, J.L. Bodkin and D.R. Carlson. 1994. Status and trends of the California sea otter population. *In* E.T. LaRoe III, G.S. Farris, C.E. Puckett and P.D. Doran, editors. *Our Living Resources 1994: A report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems.* National Biological Service. Washington D.C. pages110-112.

Bodkin, J.L., J.A. Ames, R.J. Jameson, A.M. Johnson and G.M. Matson. 1997. Accuracy and precision in estimating age of sea otters using cementum layers in the first premolar. J. Wildlife Management 61(3):967-973.

Bodkin, J.L. and B.E. Ballachey. 1996. Monitoring the status of the wild sea otter population: field studies and techniques. Endangered Species Update. University of Michigan Vol 13(12):14-20.

Estes, J.A., D.F. Doak, J.L. Bodkin, R.J. Jameson, D. Monson, J, Watt and T. Tinker. 1996. Comparative demography of sea otter populations. Endangered Species Update. University of Michigan Vol.13(12):11-13.

Scribner, K.T., J.L. Bodkin, B.E. Ballachey, S.R. Fain, M.A. Cronin and M. Sanchez. 1997. Population and genetic studies of sea otter (*Enhydra lutris*): A review and interpretation of available data. Pages 197-208 *in* A.E. Dizon, S.J. Chivers, and W.F. Perrin, eds. Molecular genetics of marine mammals. Special Publication 3 by the Society for Marine Mammalogy. Allen Press.

Bodkin, J.L. and B.E. Ballachey. 1998. Restoration Notebook Series: Sea Otter (*Enhydra lutris)* Exxon Valdez Oil Spill Trustee Council. Anchorage, AK.

Bodkin, J.L., B.E. Ballachey, M.A. Cronin and K.T. Scribner. 1999. Population demographics and genetic diversity in remnant and re-established populations of sea otters. Conservation Biology 13(6):1278-1385.

Bodkin, J. L. and M.S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. in: Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, (eds.) Marine mammal survey and assessment methods. Balkema Press, Netherlands pg. 13-26.

Bodkin, J.L., A.M. Burdin and D.A. Ryzanov. 2000. Age and sex specific mortality and population structure in sea otters. Marine Mammal Science 16(1):201-219.

Monson, D.H., J.A. Estes, J.L. Bodkin and D.B. Siniff. 2000. Life history plasticity and population regulation in sea otters. Oikos. 90:3 457-468.

Adkison, M.D., B. Ballachey, J. Bodkin, and L. Holland-Bartels. In press. Integrating ecosystem studies: a Bayesian comparison of hypotheses. In: F. Funk, J.N. Ianelli, T.J. Quinn II, and P.J. Sullivan (eds.) Proceedings of the international symposium on fishery stock assessment models for the 21st century. Alaska Sea Grant College Program.

Dean, T.A., J.L. Bodkin, S.C. Jewett, D.H. Monson and D. Jung. 2000. Changes in sea urchins and kelp following a reduction in sea otter density as a result of the *Exxon Valdez* oil spill. Marine Ecology Progress Series. 199:281-291.

Bodkin, J.L. 2000. Sea otters past and present perspectives. Alaska Geographic. 7(2):73-93.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson, and J.L. Bodkin. 2000. Long-term impacts of the *Exxon Valdez* oil spill on sea otters, assessed through age-dependent mortality patterns. Proceedings National Academy of Sciences, USA.97(12):6562-6567.

Estes, J.A. and J.L. Bodkin. 2002. Marine Otters. In W.F. Perrin, B. Wursig,, J.G.M. Thewissen and C.R. Crumly (eds) Encyclopedia of Marine Mammals. Academic Press (invited ms).

Bodkin, J.L. and K.W. Kenyon. in press. Sea Otter. Pages 00-00, in Feldham. G. A and B. Thompson (eds), Wild Mammals of North America, 2nd edition. Johns Hopkins University Press. (invited ms).

Bodkin, J.L. 2001. Marine Mammals: Sea otters. Pages 2614-2621. in Steele, J. S.Thorpe and K. Turekian (eds.) Encyclopedia of Ocean Sciences. Academic Press, London UK. (invited ms)

Gorbics, C and J.L. Bodkin. 2001. Stock Identity of sea otters in Alaska. Marine Mammal Science 17(3):632-647.

Dean, T.A., J.L. Bodkin, A.K. Fukuyama, S.C. Jewett, D.H. Monson, C.E. O'Clair, and G.R. VanBlaricom. in press. Food limitation and the recovery of sea otters in Prince William Sound. Marine Ecology Progress Series.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, A.K. Fukuyama, S.C. Jewett, L.M. McDonald, D.H.Monson, C.E. O'Clair and G.R. VanBlaricom. in press. Sea otter population status and the process of recovery from the Exxon Valdez oil spill. Marine Ecology Progress Series.

Baskaran, M., G.-H. Hong, S. Dayton, J.L. Bodkin, and J.J. Kelly. In press. Temporal variation of natural and anthropogenic radionuclides in sea otter skull tissue in the North Pacific Ocean. J. Env. Radioactivity.

Larson, S., R.J. Jameson, J.L. Bodkin, M. Staedler and P. Bentzen. In press. Microsatellite and MTDNA sequence variation within and among remnant, source and translocated sea otter (Enhydra lutris) populations. J. Mammalogy 18(3).

Bodkin, J.L. In press. Sea Otter Foraging and Implications to Shellfish Aquaculture. Proceedings: Exploring On-Bottom Shellfish Aquaculture for Alaska. A conference and workshop to present information and explore on-bottom shellfish mariculture for Alaska. November 13-14, 2001, Anchorage, Alaska. University of Alaska, Marine Advisory Program.

Bodkin, J.L. and D.H. Monson. In press. Sea otter population structure and ecology in Alaska. Arctic Research.

Ballachey, B.E., J.L. Bodkin, S. Howlin, A.M. Doroff, and A.H. Rebar. In review. Correlates to survival of juvenile sea otters in Prince William Sound, Alaska.

Resume

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President Coastal Resources Associates, Inc.	1988 to Present
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Representative projects

Principal Investigator - Potential injury and recovery of nearshore vertebrate predators in Prince William Sound, Alaska - *Exxon Valdez* Oil Spill Trustee Council.

Principal Investigator - Biological assessment of a potential harbor site in Tatitlek, Alaska. US Fish and Wildlife Service.

Project Director – Review of regulations on the discharge of synthetic based drilling fluids in Cook Inlet, Alaska. Cook Inlet Regional Citizens Advisory Council.

Principal Investigator - Coastal habitat injury assessment project - Effects of the *Exxon Valdez* oil spill on communities of subtidal plants and invertebrates. *Exxon Valdez* Oil Spill Trustee Council.

Principal Investigator - Studies of the effects of the San Onofre Nuclear Generating Station on the giant kelp. Marine Review Committee, Inc.

Publications

Dean, T.A., J.L. Bodkin, A. Fukuyama, S.C. Jewett, D.H. Monson, C.E. O'Clair, G.R. VanBlaricom. 2002. Food limitation and the recovery of sea otters following the *Exxon Valdez* oil spill. Marine Ecology Progress Series (In press)

Deysher, L.E., T.A. Dean, R. Grove, A. Jahn. 2002. Design considerations for an artificial reef to grow giant kelp (*Macrocystis pyrifera*) in Southern California. ICES J. Mar Sci. (In press)

Bodkin, J.L., B. Ballachey, T.A. Dean, F.K. Fukuyama, S.C. Jewett, L.L. McDonald, D.H. Monson, C.E. O'Clair, and G.R. Van Blaricom. 2002. Sea otter population status and the process of recovery following the 1989 *Exxon Valdez* oil spill. Marine Ecology Progress Series (In press)

Golet, H.G., P.E. Seizer, A.D. McGuire, D.D. Roby, J.B. Fischer, K.J. Kuletz. D.B. Irons, T. A. Dean, S.C. Jewett, and S.H. Newman. 2002. Long-term direct and indirect effects of the the *Exxon Valdez* oil spill on pigeon guillemots in Prince William Sound, Alaska. Marine Ecology Progress Series (In press).

Esler, D., T.D. Bowman, K.A. Trust, B.E. Ballachey, T.A. Dean, S.C. Jewett, C.E. O'Clair. 2002. Harlequin duck population recovery following the *Exxon Valdez* oil spill: Progress, process, and constraints. (In press).

Jewett, S.C., T.A. Dean, B.R. Woodin, M.K. Hoberg, and J.L. Stegeman. 2002. Exposure to hydrocarbons ten years after the *Exxon Valdez* oil spill: evidence from cytochrome P4501A expression and biliary FACs in nearshore demersal fishes. Marine Environmental Research. 54:21-48.

Dean, T.A., S.C. Jewett. 2001. Habitat specific recovery of shallow subtidal communities following the *Exxon Valdez* oil spill. Ecological Applications 11:1456-1471.

Esler D., T.D. Bowman, C.E. O'Clair, T.A. Dean, L.L. McDonald. 2000. Densities of Barrow's Goldeneyes during winter in Prince William Sound, Alaska, in relation to habitat, food, and history of oil contamination. Water Birds 23:423-429

Esler, D., T.D. Bowman, T.A. Dean, C.E. O'Clair, S.C. Jewett, L.L. McDonald. 2000. Correlates of harlequin duck densities during winter in Prince William Sound, Alaska: Condor 102:920-926

Dean T.A., J.L. Bodkin, S.C. Jewett, D.H. Monson, D. Jung. 2000. Changes in sea urchins and kelp following reduction in sea otter density as a result of the *Exxon Valdez* oil spill. Marine Ecology Progress Series 199:281-291

Dean T.A., L. Haldorson, D.R. Laur, S.C. Jewett, A. Blanchard. 2000. The distribution of nearshore fishes in kelp and eelgrass communities in Prince William Sound, Alaska: associations with vegetation and physical habitat characteristics. Environmental Biology of Fishes 57: 271-287

Jewett, S.C., T.A. Dean, R.O. Smith, A. Blanchard. 1999. The *Exxon Valdez* oil spill: Impacts and recovery in the soft-bottom benthic community in and adjacent to eelgrass beds. Mar Ecol Prog Ser 185:59-83

Dean, T.A. M.S. Stekoll, S.C. Jewett, R.O. Smith, J.E. Hose. 1998. Eelgrass (*Zostera marina* L.) in Prince William Sound, Alaska: Effects of the *Exxon Valdez* oil spill. Mar Pollut Bull 36:201-210

Deysher, L.E., T.A. Dean, R. Grove, A. Jahn. 1998. An experimental reef program to test designs of an artificial reef for kelp mitigation. Gulf of Mexico Science 16: 64-72

Dean, T.A., S.C. Jewett, D.R. Laur, R.O. Smith. 1996. Injury to epibenthic invertebrates resulting from the *Exxon Valdez* oil spill. pp. 424-439 In: Rice SD, Spies RB, Wolfe DA, Wright BA (eds) Proceedings of the *Exxon Valdez* oil spill symposium. Am Fish Soc Symp 18

Dean, T.A., M.S. Stekoll, R.O. Smith 1996. Kelps and oil: The effects of the *Exxon Valdez* oil spill on subtidal algae. In: Rice SD, Spies RB, Wolfe DA, Wright BA (eds) Proceedings of the *Exxon Valdez* oil spill symposium. Am Fish Soc Symp 18, p 412-423

Jewett S.C., T.A. Dean, D.R. Laur. 1996. The effects of the *Exxon Valdez* oil spill on benthic invertebrates in an oxygen-deficient embayment in Prince William Sound, Alaska. In: Rice SD, Spies RB, Wolfe DA, Wright BA (eds) Proceedings of the *Exxon Valdez* oil spill symposium. Am Fish Soc Symp 18, p 440-447

Schroeter, S.C., T.A. Dean, K. Thies, J.D. Dixon. 1995. Effects of shading by adults on the growth of blade-stage *Macrocystis pyrifera* (Phaeophyta) during and after the 1982-1984 El Nino. Journal of Phycology 31:697-702

Tegner, M.J., P.K. Dayton, P.B. Edwards, K.L. Riser, D.B. Chadwick, T.A. Dean, L.E. Deysher. 1995. Effects of a large sewage spill on a kelp forest community: Catastrophe or disturbance? Marine Environmental Research 40:181-224

Dean, T.A., L.L. McDonald, M.S. Stekoll, R.R. Rosenthal. 1993. Damage Assessment in coastal habitats: Lessons learned from *Exxon Valdez*. In: Proceedings of the 1993 International Oil Spill Conference. American Petroleum Institute. Washington, DC, p 695-698

Stekoll, M.S., L.E. Deysher, T.A. Dean. 1993. Seaweeds and the *Exxon Valdez* oil spill. Pages 135-140. In: Proceedings of the 1993 International Oil Spill Conference. American Petroleum Institute. Washington, D.C.

Zabloudil, K., J. Reitzel, S. Schroeter, J. Dixon, T. Dean, T. Norall. 1991. Sonar mapping of giant kelp density and distribution. Pages 391-406. In Coastal Zone '91. Coastal Zone Society, Washington D.C.

Dean, T.A. 1990. Short-term chronic toxicity tests with *Macrocystis pyrifera.* Pages 19-27. In: G. A. Chapman (Ed.) Culture and toxicity testing of west coast marine organisms. U.S. EPA, Washington, D.C.

Dean, T.A., K. Thies, S. Lagos. 1989. Survival of juvenile giant kelp: The effects of demographic factors, competitors, and grazers. Ecology 70:483-495

Dean, T.A., F. Jacobsen, K. Thies, S. Lagos. 1988. Differential effects of grazing by white sea urchins on recruitment of brown algae. Mar Ecol. Prog. Series 48:99-102

Osman, R., T.A. Dean. 1987. Intra- and interregional comparisons of numbers of species on marine hard substrate islands. J. Biogeography 14: 53-67

Deysher, L.E., T.A. Dean. 1986. Interactive effects of light and temperature on sporophyte production in the giant kelp, *Macrocystis pyrifera*. Mar. Biol. 93: 17-20

Deysher, L.E., T.A. Dean. 1986. *In situ* recruitment of sporophytes of the giant kelp, *Macrocystis pyrifera* (L.) C.A. Agardh: effects of physical factors. J. Exp. Mar. Biol. Ecol. 103:41-63

Dean, T.A., F. R. Jacobsen. 1986. Nutrient-limited growth of juvenile kelp, *Macrocystis pyrifera* during the 1982-1984 "El Nino" in southern California. Mar. Biol. 90:597-601

Dean, T.A. 1985. The temporal and spatial distribution of underwater quantum irradiation in a southern California kelp forest. Estuar. Coast. Shelf Sci. 21:835-601

Foster, M.S., T.A. Dean, L.E. Deysher. 1985. Subtidal techniques. In: M. Littler (ed.), Ecological field methods: Macroalgae. Pp. 199-231. Cambridge University Press, Cambridge

Dean, T.A., S. Schroeter, J. Dixon. 1984. Effects of grazing by two species of sea urchins (*Strongylocentrotus franciscanus* and *Lytechinus anamesus*) on recruitment and survival of two species of kelp (*Macrocystis pyrifera* and *Pterygophora californica*). Mar. Biol. 78: 301-313

Dean, T.A., F.R. Jacobsen. 1984. Growth of juvenile *Macrocystis pyrifera* (Laminariales) in relation to environmental factors. Mar. Biol. 83: 301-311

Deysher, L.E., T.A. Dean. 1984. Critical irradiance levels and the interactive effects of quantum irradiance and quantum dose on gametogenesis in the giant kelp *Macrocystis pyrifera*. J. Phycol. 20: 520-524

Dean, T.A., L.E. Deysher. 1983. The effects of suspended solids and thermal discharges on kelp. Pp. 114-135. In: W. Bascom (ed.), The effects of waste disposal on kelp communities. Southern California Coastal Water Research Project, Los Angeles, CA

Dean. T.A. 1981. Structural aspects of sessile invertebrates as organizing forces in an estuarine fouling community. J. Exp. Mar. Biol. Ecol. 53: 163-180

Dean, T.A., L.E. Hurd. 1980. Development in an estuarine fouling community: the influence of early colonists on later arrivals. Oecologia 46: 295-301

***Representative technical reports*. (selected from over 50 major reports)**

Holland-Bartels, L, B. Ballachey, J.L. Bodkin, T.A., T. Bowyer, T.A. Dean, L. Duffy, D. Esler, S.C. Jewett, L.L. McDonald, D. McGuire, C.E. O'Clair, A. Rebar, P. Snyder, G. VanBlaricom. 2000. Mechanisms of Impact and potential recovery of nearshore vertebrate predators following the 1989 *Exxon Valdez* oil spill. Report submitted to the *Exxon Valdez* Trustee Council

Dean, T.A., L.E. Deysher. 1997. Design specifications for the San Clemente artificial reef. Report to Southern California Edison Co

Jewett, S.C., T.A. Dean, 1995. The effects of the *Exxon Valdez* oil spill on Eelgrass communities in Prince William Sound, Alaska 1990-1995. Report to the *Exxon Valdez* Trustee Council.

Jewett, S.C., T.A. Dean, R.O. Smith, L.J. Haldorson, D. Laur, M. Stekoll, L. McDonald. 1993. The effects of the *Exxon Valdez* oil spill on shallow subtidal communities in Prince William Sound, Alaska: 1989-1993. Report to the *Exxon Valdez* Trustee Council.

Dean, T.A., S. Schroeter, J Dixon, L. Deysher, F. Jacobsen. 1987. The effects of the operation of the San Onofre Nuclear Generating Station on the giant kelp, *Macrocystis pyrifera*: Background information and the biology of kelp. Report to the Marine Review Committee

X. LITERATURE CITED

Baxter, R.E. 1971. Earthquake effects on clams of Prince William Sound. In: The Great Alaska Earthquake of 1964. Vol. 3, Biology. National Research Council Publication No. 1604, National Academy of Science, Washington, D.C., pp. 238-245.

Feder, H.M. & A.J. Paul. 1974. Age, growth, and size-weight relationships of the soft-shell clam, *Mya arenaria*, in Prince William Sound, Alaska. Proceedings of the National Shellfisheries Association 64:45-52.

Feder, H.M. & G.E. Kaiser. 1980. Intertidal biology. pp. 143-224. In: Port Valdez, Alaska: Environmental Studies 1976-1979. J.M. Colonell, ed. Occasional Publication No. 5, Institute of Marine Science, University of Alaska, Fairbanks, AK.

Haven, S.B. 1971. Effects of land-level changes on intertidal invertebrates, with discussion of postearthquake ecological succession. In: The Great Alaska Earthquake of 1964. Vol. 3, Biology. National Academy of Science, Washington, D.C., pp. 82-126.

Harper, J.R., D.E. Howes, and P.D. Reimer. 1991. Shore-zone mapping system for use in sensitivity mapping and shoreline countermeasures. Pgs 509-523. InProc. Of the 14th arctic marine oil spill program technical seminar. Environment Canada, Ottawa

Hubbard, J.D. 1971. Distribution and abundance of intertidal invertebrates at Olsen Bay in Prince William Sound, Alaska, one year after the 1964 earthquake. In: The Great Alaska Earthquake of 1964. Vol. 3, Biology. National Academy of Science, Washington, D.C., pp. 137-157.

Johansen, H.W. 1971. Effects of elevation on benthic algae in Prince William Sound. In: The Great Alaska Earthquake of 1964. Vol. 3, Biology. National Academy of Science, Washington, D.C., pp. 35-68.

McRoy, C.P. 1970. Standing stocks and other features of eelgrass (*Zostera marina*) populations on the coast of Alaska. J. Fish. Res. Board Canada 27:1811-1821.

Michaelson, J.A. 1995. An Analysis of spatial data and GIS capabilities for the Prince William Sound-Copper River and Glacier Bay regions, Alaska. Alaska Natural Heritage Program, University of Alaska, Anchorage. 109 pp.

Michaelson, J.A. 1996. Catalog of geospatial data for Alaska: Datasets for the Prince William Sound-Copper River Region. Alaska Natural Heritage Program, University of Alaska, Anchorage. 152 pp.

Murphy, K. A., L. H. Suring, and A. Iliff. 1999. Western Prince William Sound human use and wildlife distrubance model. *Exxon Valdez* Oil Spill Restoration Project. Draft final report - part A (Restoration Project 98339), Chugach National Forest, Anchorage, Alaska.

Paul, A.J. & H.M. Feder. 1973. Growth, recruitment, and distribution of the littleneck clam, *Protothaca staminea*, in Galena Bay, Prince William Sound, Alaska. Fishery Bulletin 71:665-677.

Paul, A.J., J.M. Paul, & H.M. Feder. 1976c. Recruitment and growth in the bivalve *Protothaca staminea* at Olsen Bay, Prince William Sound, ten years after the 1964 earthquake. Veliger 18:385-392.

Rosenthal, R.J., D.C. Lees, & T.M. Rosenthal. 1977. Ecological assessment of sublittoral communities in the northern Gulf of Alaska. Final Report to National Marine Fisheries Service, Auke Bay Fisheries Laboratory, Auke Bay, AK. 150 pp. RU 0078.

Rosenthal, R.J., D.C. Lees, & D.J. Maiero. 1982a. Description of Prince William Sound shoreline habitats associated with biological communities. Final Report to Department of Commerce, NOAA, Office of Pollution Assessment, Juneau, AK. RU 0542.

RPI (Research Planning Institute Inc.) 1983. Sensitivity of coastal environments and wildlife to spilled oil. Prince William Sound, Alaska. An atlas of coastal resources. Report to NOAA, Seattle.

Schoch, K., G. Eckert, and T. Dean. 2002. Long Term Monitoring in the Nearshore: Designing Studies to Detect Change and Assess Cause. Draft Report to the Exxon Valdez Oil Spill Trustee Council, Anchorage.

US Dept. of Agriculture. 2002. Chugach National Forest, Draft Environmental Impact Statement. US Forest Service, Anchorage, Alaska. Vol I-II

Van Blaricom, G.R. 1987. Regulation of mussel population structure in Prince William Sound, Alaska. National Geographic Research 3:501-510.

VanBlaricom, G.R. 1988. Effects of foraging by sea otters on mussel-dominated intertidal communities. Pp. 38-91. In: G.R. VanBlaricom & J.A. Estes (eds.). The Community Ecology of Sea Otters. Springer-Verlag, Heidelberg. 247 pp.

XI. TABLES AND FIGURES

Table 1. Possible agents of change in nearshore systems of the Gulf of Alaska over the next century, their physical effects, biological effects, and temporal and spatial scales on which impacts are likely to occur.

Agents of Change	Physical Effect	Biological Effect	Temporal/spatial scale[1]
Natural			
Climate			
ENSO - El Nino	Temperature increase Decreased upwelling Increase storm activity	Decrease in primary production Northerly range extension of southern species Increase in some diseases	Years/Region
ENSO – La Nina	Temperature decrease Increased upwelling	Southerly range extension of northern species Increase in primary production	Years/Region
PDO	(In warm cycle) Temperature increase Decreased upwelling	Decrease in primary production Northerly range extension of southern species Increase in some diseases	Decades/Region
Weather			
Extreme cold events	Freezing in intertidal Extreme cold air temp	Death of Inverts/algae and some vertebrates	Days (though effects may last years) /Area (with greater effects in northerly exposures)
Extreme heat events	Heat/desiccation in intertidal (especially if coincident with spring tide)	Death of inverts/algae	Days (though effects may last years) /Area (with greater effects in southerly exposures)
Storms	Waves/debris increase Salinity decrease	Death of inverts/algae and some vertebrates	Days (though effects may last years) /Area (with greater effects in more exposed locations, locations with movable substratum, or nearer stream mouths)
Disease		Increased death rate or reduced reproductive rate	Largely unknown

Geologic events			
Earthquakes	Uplift or down thrust/sediment shifting/shifting of stream mouths	Killing of inverts and algae	Minutes/Hours (though effects may last years) /Area (with greater effects in areas of greatest uplift/down thrust
Volcanoes	Increased sedimentation in intertidal	Smothering of inverts and algae	Minutes/Hours (though effects may last years) /Area (with greater effects in areas most exposed to ash
Glacial activity	Increased / decreased sedimentation and calving	Smothering of inverts and algae (on advance) or increase in exposed bottom/intertidal inverts and algae and decreased glacial feeding by birds (on retreat)	Decades/Location or Sites
Anthropogenic			
Global warming	Increased temperature, increased UV radiation, reduced salinity	Northerly shift in species distribution, reduced photosynthesis of kelp, reduction in marine stenohaline spp.	Years/Region
Introduction of exotic spp.	None	Reduction in abundance of competitors/prey	Years/Area
Fishing	None	Reduction in targeted stocks, reduction in predators of those stocks, possible habitat destruction	Years/Area or Location
Aquaculture (especially intertidal clam)	None	Intertidal habitat loss, reduction in intertidal inverts/algae with possible reduction in their predators	Years/Area or Location
Coastal development	Increased sedimentation and eutrophication, introduction of contaminants	Reduction in fish spawning habitat, reduction in inverts and algae intolerant to stress, increases in stress tolerant spp., increased contaminant levels in animals and increased death rate or reduced reproductive rate especially in higher trophic levels.	Years/Sites

Recreational use	None	Disturbance to mammals/birds, entanglement of birds/mammals with trash, reduction in intertidal inverts/algae due to trampling	Years/Sites
Watershed development	Increased sedimentation and eutrophication, introduction of contaminants	Reduction in fish spawning habitat, reduction in inverts and algae intolerant to stress, increases in stress tolerant spp., increased contaminant levels in animals and increased death rate or reduced reproductive rate especially in higher trophic levels.	Years/Sites (especially at stream or river mouths)
Contamination from distant sources	Increased levels of metals and other chemicals	Increased contaminant levels in animals and increased death rate or reduced reproductive rate especially in higher trophic levels.	Years/Region or Areas
Logging activity	Increased sedimentation and eutrophication, introduction of contaminants	Reduction in fish spawning habitat, reduction in inverts and algae intolerant to stress, increases in stress tolerant spp., increased contaminant levels in animals and increased death rate or reduced reproductive rate especially in higher trophic levels.	Years/Sites
Oil or chemical spills	Increased levels of contamination	Reduction in inverts and algae intolerant to stress, increases in stress tolerant spp., increased contaminant levels in animals and increased death rate or reduced reproductive rate especially in higher trophic levels.	Days (although impacts may last years or decades) /locations or sites

[1] Definition of spatial scales (with approximate shoreline extents)

Region – Gulf of Alaska (1,000 plus km)
Area – SEAK, Yakutat, PWS, Cook Inlet/Kenai, Kodiak/AK Peninsula – (200 km)
Location – Sub areas on the order of Western Prince William Sound (50-100 km)
Site - E.g. Herring Bay, Orca Inlet, Jakalof Bay, Etc. (5-10 km)
Spot – 10s to 100s of m

Table 2. Possible physical, chemical, biological, components to measure as indicators of change and identify associated causative agents. Possible metrics and spatial/temporal scales of measurement are also given.

Entire Region

Metric	Sites per region	Frequency	Priority	Comments
Synoptic ocean color, temperature, altimetry	Not applicable	Continuous	1	Develop algorithms for nearshore corrections
Habitat maps	Not applicable	Once / decade?	1	
Human Use maps	Not applicable	Once per decade?	2	
Special Use maps (e.g. fish take)	Not applicable	Annual	2	
Event documentation (E.G. earthquake activity)	Not applicable	As they occur	2	

Intensively sampled sites

Metric	Sites per region	Frequency	Priority	Comments
Physical - chemical				
Substrate Composition	All	Once/5-10 yr	1	
Slope	All	Once/5-10 yr	1	
Exposure	All	Once/5 10 yr	1	
Data Loggers				
Temperature	1-3	Continuous (C)	1	Profiles or near surface and near bottom
Salinity	1-3	C	1	Profiles or near surface and near bottom
DO	1-3	C	1	"
PH	1-3	C	1	"
Turbidity	1-3	C	1	"
Chlorophyll	1-3	C	1	"
PAR	1-3	C	1	Profiles or near surface and near bottom
Nutrients				
Nitrate, Nitrite, Ammonium, Phosphate	1-3	C	2	"
POC	1-3	Monthly	2	"
PON	1-3	Monthly	2	"
DOM	1-3	Monthly	2	"
Energy				
Wave energy	1-3	C	2	"
Current speed/direction	1-3	C	2	"

Habitat Characteristics				
Kelp and eelgrass mapping	All	Once / yr.	1	
Biological				
Abundance - sea otters	Entire area	Yearly	1	Aerial surveys
Mortality rate – sea otters	Entire area	Yearly	2	Based on recovered skulls/carcasses
Diet – sea otters	3-4	Yearly	2	
Disease – sea otters	All	Yearly	2	Based on recovered carcasses
Contaminant levels – sea otters (POPs, PAHs?)	All	Yearly	2	Possible archival of samples
Abundance – selected birds (Oyster catchers, goldeneye, scooters, harlequin ducks)	All	Yearly	2	
Abundance - All birds	All	Once / 5 yr?	2	
Abundance – selected fishes	All	Once / yr	2	Diver surveys
Body burden of contaminants in selected fish (e.g. greenling)	All	Once / yr	2	Possible archival of samples
Intertidal – hard substrates		Once / yr		
Abundance - all macro inverts and algae	All	"	1	
Distribution - selected inverts and algae (Fucus, mussels, kelp)	All	"	1	
Temperature	All	C	2	High and low intertidal;
Size distribution – selected inverts (mussels, stars?)	All	"	2	
Recruitment – selected inverts and algae	All	"	2	
Growth – selected inverts and algae	All	"	2	
Condition – selected inverts/algae	All	"	3	
Body burdens of metals, PAHs, and other contaminants in mussels	All	Rotating subset once per year	2	Possible archival of samples
Intertidal – soft substrate				
Abundance – Protothaca and selected clams. crabs	All	"	2	
Body burdens of metals, PAHs, and other contaminants in clams (Protothaca)	All	Rotating subset once per year	2	Possible archival of samples

Extensively sampled sites

Metric	Sites per region	Frequency	Priority	Comments
Physical – chemical				
Temperature?	All	C	2	High and low intertidal;
Salinity?	All	C	2	Low intertidal
Substrate Composition	All	Once/5-10 yr	2	
Slope	All	Once/5-10 yr	2	
Exposure	All	Once/5 10 yr	2	
Biological				
Body burden of contaminants in selected fish (e.g. greenling)?	All	Once / yr	2	Possible archival of samples
Kelp and eelgrass mapping?	All	Once / yr.	2	
Intertidal – hard substrates?		Once / yr		
Abundance - selected macro inverts and algae (Fucus, mussels, limpets, stars)	All	"	2	
Distribution - selected inverts and algae (Fucus, mussels?)	All	"	2	
Size distribution – selected inverts (mussels, stars?)	All	"	2	
Body burdens of metals, PAHs, and other contaminants in mussels?	All	Rotating subset once per year	2	Possible archival of samples
Intertidal – soft substrate				
Abundance – Protothaca and selected clams. crabs	All	Once/yr	2	
Body burdens of metals, PAHs, and other contaminants in clams (Protothaca)?	All	Rotating subset once per year	2	Possible archival of samples

Table 3. Example of options for different sampling designs to be used for GEM nearshore monitoring.

Option 1. Emphasis on synoptic and intensive sites aimed at evaluating large-scale spatial and temporal changes.

Option 1-A (Few intensive sites with more sampling per site)

Sampling type	***Synoptic***	***Intensive***	***Extensive***	***Process***
Cost	$100,000	$600,000	$250,000	$50,000
Metrics	1) Habitat mapping	1) Intertidal invertebrate and algal abundance	1) Clam abundance and size distribution	To be determined
	2) Human use mapping	2) Clam growth	2) Mussel abundance and size distribution	
	3) Sea surface temperature and ocean color	3) Mussel growth	3) Gross estimates of cover by Fucus and mussels	
	4) Event monitoring	4) Kelp and eelgrass canopy cover	4) Contaminants in clams (PAHs, organochlorines, metals)	
		5) Sea otter abundance		
		6) Sea otter survival		
		7) Abundance of selected birds		
		8) Water temperature and salinity		
		9) Weather conditions		
Sampling areas	Metrics 1-3: Entire GOA	PWS (1) Kodiak (1) Cook Inlet (1) Sitka (1)	20 – with concentration in PWS / Resurrection Bay / Cook Inlet	Selected intensive sites
	Metric 4: As available, centered around communities			
Locations and sites/location	Not applicable	Metrics 1-3: 6 locations/area and 6 sites/location	5 sites per area	To be determined
		Metrics 4-7: entire area		
		Metric 8: 1 site per location		
		Metric 9: 1 site per area		

Sampling frequency	Metrics 1-2: Once per 10 years	Metrics 1-7:Once / year	Half of locations once /year – rotating every other year or Sample all sites every other year and do analyses in non-sampling years	Too be determined
	Metric 3: 3 times per year	Metric 8-9: Continuous		
	Metric 4: Continuous			
Notes	Community representatives to assist in event monitoring	Areas are approximately 400 sq. km – sites are 200m sections of coast	Areas are approximately 25 sq. km.	None
		Emphasis on sheltered rocky intertidal	Half of areas centered around population centers/villages or areas of expected impact such as logging sites - Emphasis on soft sediment habitats	
		Costs based on 1 team of 4 persons sampling one site per day for intertidal species.	Costs based on 1 team of 2 sampling one sites per day	
		Community representative to assist in sampling of sea otter skulls for estimation of survival and servicing of temperature/salinity recording devices	Community representatives to assist in sampling	

Option 1-B (More intensive sites with less sampling per site)

Sampling type	***Synoptic***	***Intensive***	***Extensive***	***Process***
Cost	$100,000	$600,000	$250,000	$50,000
Metrics	1) Habitat mapping	1) Selected intertidal invertebrate and algal abundance	1) Clam abundance and size distribution	To be determined
	2) Human use mapping	2) Mussel abundance and growth	2) Mussel abundance and size distribution	
	3) Sea surface temperature and ocean color	3) Sea otter abundance	3) Gross estimates of cover by Fucus and mussels	
	4) Event monitoring	4) Sea otter survival	4) Contaminants in clams (PAHs, organochlorines, metals)	
		5) Abundance of selected birds		
		6) Water temperature		
		7) Weather conditions		
Sampling areas	Metrics 1-3: Entire GOA	PWS (3) Cook Inlet (1) Kodiak (1) Yakutat (1) Sitka (1)	20 – with concentration in PWS / Resurrection Bay / Cook Inlet	Selected intensive sites
	Metric 4: As available, centered around communities			
Locations and sites/location	Not applicable	Metrics 1-2: 6 locations/area and 6 sites/location	5 sites per area	To be determined
		Metrics 3-5: entire area		
		Metric 6-7: 1 site per location		
Sampling frequency	Metrics 1-2: Once per 10 years	Metrics 1-5:Once / year	Half of locations once /year – rotating every other year <u>or</u> Sample all sites every other year and do analyses in non-sampling years	To be determined
	Metric 3: 3 times per year	Metric 6-7: Continuous		
	Metric 4: Continuous			

Notes	Community representatives to assist in event monitoring	Areas are approximately 400 sq. km – sites are 200m sections of coast	Areas are approximately 25 sq. km.	None
		Emphasis on sheltered rocky intertidal	Half of areas centered around population centers/villages or areas of expected impact such as logging sites	
		Costs based on 1 team of 2 persons sampling one site per day for intertidal species.	Costs based on 1 team of 2 sampling one sites per day	
		Community representative to assist in sampling of sea otter skulls for estimation of survival and servicing of temperature recording devices	Community representatives to assist in sampling	

Option 2. Effort split between extensive and intensive sites.

Sampling type	***Synoptic***	***Intensive***	***Extensive***	***Process***
Cost	$100,000	$450,000	$350,000	$50,000
Metrics	1) Habitat mapping	1) Selected intertidal invertebrate and algal abundance	1) Clam abundance and size distribution	To be determined
	2) Human use mapping	2) Mussel abundance and growth	2) Mussel abundance and size distribution	
	3) Sea surface temperature and ocean color	3) Sea otter abundance	3) Gross estimates of cover by Fucus and mussels	
	4) Event monitoring	4) Sea otter survival	4) Contaminants in clams (PAHs, organochlorines, metals)	
		5) Abundance of selected birds		
		6) Water temperature		
		7) Weather conditions		
Sampling areas	Metrics 1-3: Entire GOA	PWS (2) Cook Inlet (1) Kodiak (1) Sitka (1)	28 – with concentration in PWS / Resurrection Bay / Cook Inlet	Selected intensive sites
	Metric 4: As available, centered around communities			
Locations and sites/location	Not applicable	Metrics 1-2: 6 locations/area and 6 sites/location	5 sites per area	To be determined
		Metrics 3-5: entire area		
		Metric 6-7: 1 site per location		
Sampling frequency	Metrics 1-2: Once per 10 years	Metrics 1-5:Once / year	Half of locations once /year – rotating every other year <u>or</u> Sample all sites every other year and do analyses in non-sampling years	To be determined
	Metric 3: 3 times per year	Metric 6-7: Continuous		
	Metric 4: Continuous			
Notes	Community representatives to assist in event monitoring	Areas are approx. 400 sq. km – sites are 200m sections of coast	Areas are approximately 25 sq. km.	None

		Emphasis on sheltered rocky intertidal	Half of areas centered around population centers/villages or areas of expected impact such as logging sites	
		Costs based on 1 team of 2 persons sampling one site per day for intertidal species.	Costs based on 1 team of 2 sampling one site per day	
		Community representative to assist in sampling of sea otter skulls for estimation of survival and servicing of temperature recording devices	Community representatives to assist in sampling	

Option 3. Emphasis on extensive sites.

Sampling type	***Synoptic***	***Intensive***	***Extensive***	***Process***
Cost	$100,000	$360,000	$510,000	$50,000
Metrics	1) Habitat mapping	1) Selected intertidal invertebrate and algal abundance	1) Clam abundance and size distribution	To be determined
	2) Human use mapping	2) Mussel abundance and growth	2) Mussel abundance and size distribution	
	3) Sea surface temperature and ocean color	3) Sea otter abundance	3) Gross estimates of cover by Fucus and mussels	
	4) Event monitoring	4) Sea otter survival	4) Contaminants in clams (PAHs, organochlorines, metals)	
		5) Abundance of selected birds		
		6) Water temperature		
		7) Weather conditions		
Sampling areas	Metrics 1-3: Entire GOA	PWS (1) Cook Inlet (1) Kodiak (1) Sitka (1)	28 – with concentration in PWS / Resurrection Bay / Cook Inlet	Selected intensive sites
	Metric 4: As available, centered around communities			
Locations and sites/location	Not applicable	Metrics 1-2: 6 locations/area and 6 sites/location	8 sites per area	To be determined
		Metrics 3-5: entire area		
		Metric 6-7: 1 site per location		
Sampling frequency	Metrics 1-2: Once per 10 years	Metrics 1-5:Once / year	Half of locations once /year – rotating every other year <u>or</u> Sample all sites every other year and do analyses in non-sampling years	To be determined
	Metric 3: 3 times per year	Metric 6-7: Continuous		
	Metric 4: Continuous			
Notes	Community representatives to assist in event monitoring	Areas are approx. 400 sq. km – sites are 200m sections of coast	Areas are approximately 25 sq. km.	None

		Emphasis on sheltered rocky intertidal	Half of areas centered around population centers/villages or areas of expected impact such as logging sites	
		Costs based on 1 team of 2 persons sampling one site per day for intertidal species.	Costs based on 1 team of 2 sampling one sites per day	
		Community representative to assist in sampling of sea otter skulls for estimation of survival and servicing of temperature recording devices	Community representatives to assist in sampling	

Figures 1-6 are examples of the types of GIS data coverages we are proposing to assemble under this proposal for the GOA region. The list of data types in the inset table are for example only and not intended to be representative or comprehensive of potential data types.

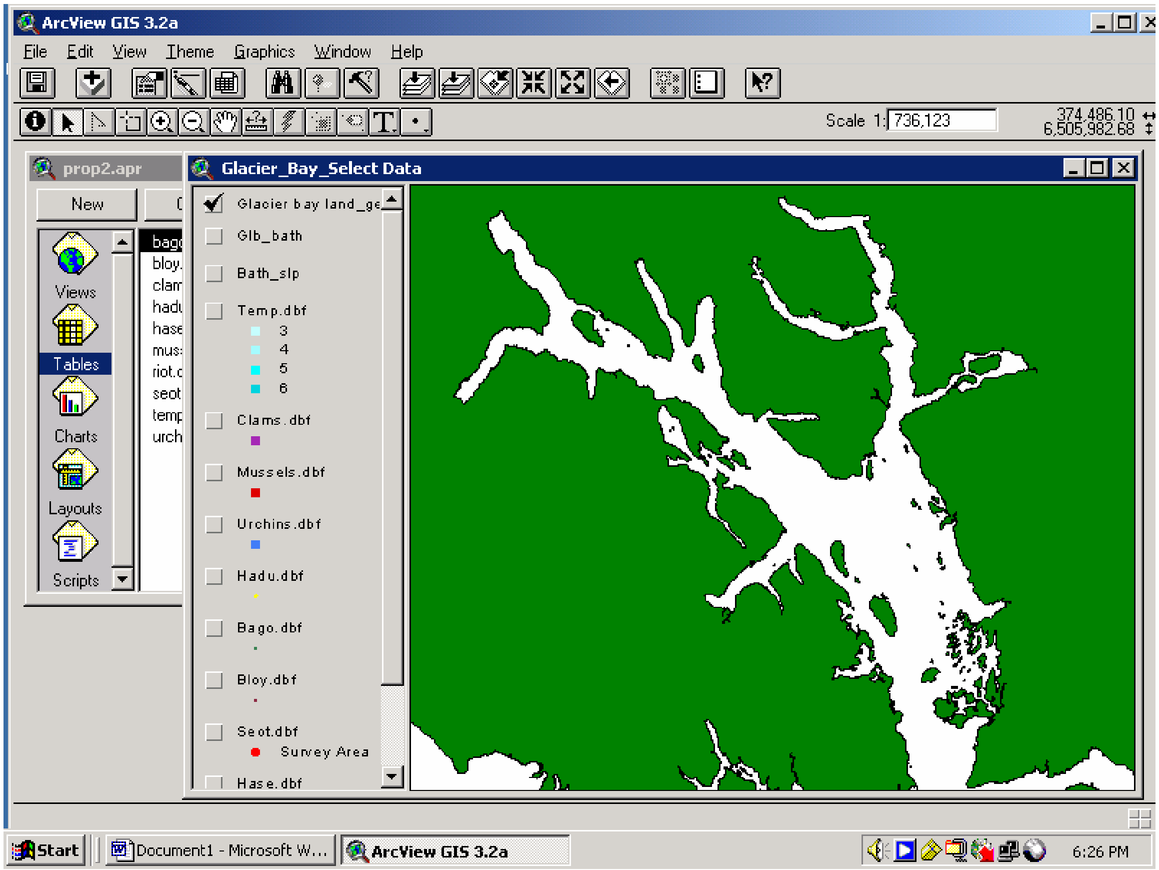

Figure 1. Map of shoreline of Glacier Bay National Park and Preserve, Alaska. Theme list inset illustrates options for querying the GIS database for data types that may be present in the area selected by the user (e.g. Glacier Bay). In this example data types include; habitat attributes (bathymetry, slope, and water temperature), species of marine invertebrates (clams mussels and urchins), marine birds (Harlequin ducks (hadu), Barrows Goldeneye (bago), and Black Oystercatchers (bloy), and mammals (sea otter (seot) and Harbor seal (hase). (See Figs. 2-6).

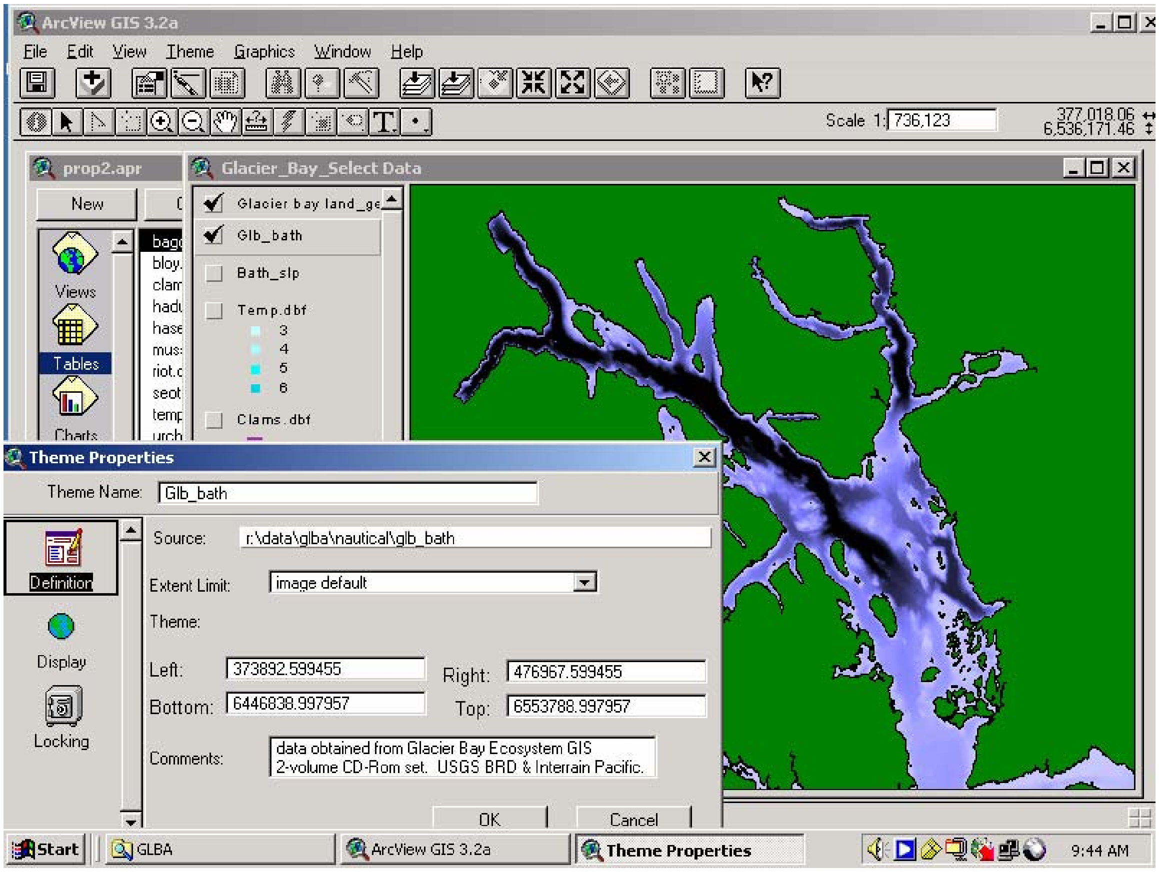

Figure 2. Map of Glacier Bay illustrating selection of the bathymetric data, and identifying other potential habitat data types (e.g. geomorphology and temperature). Attribute data for the selected data type are illustrated in the inset table.

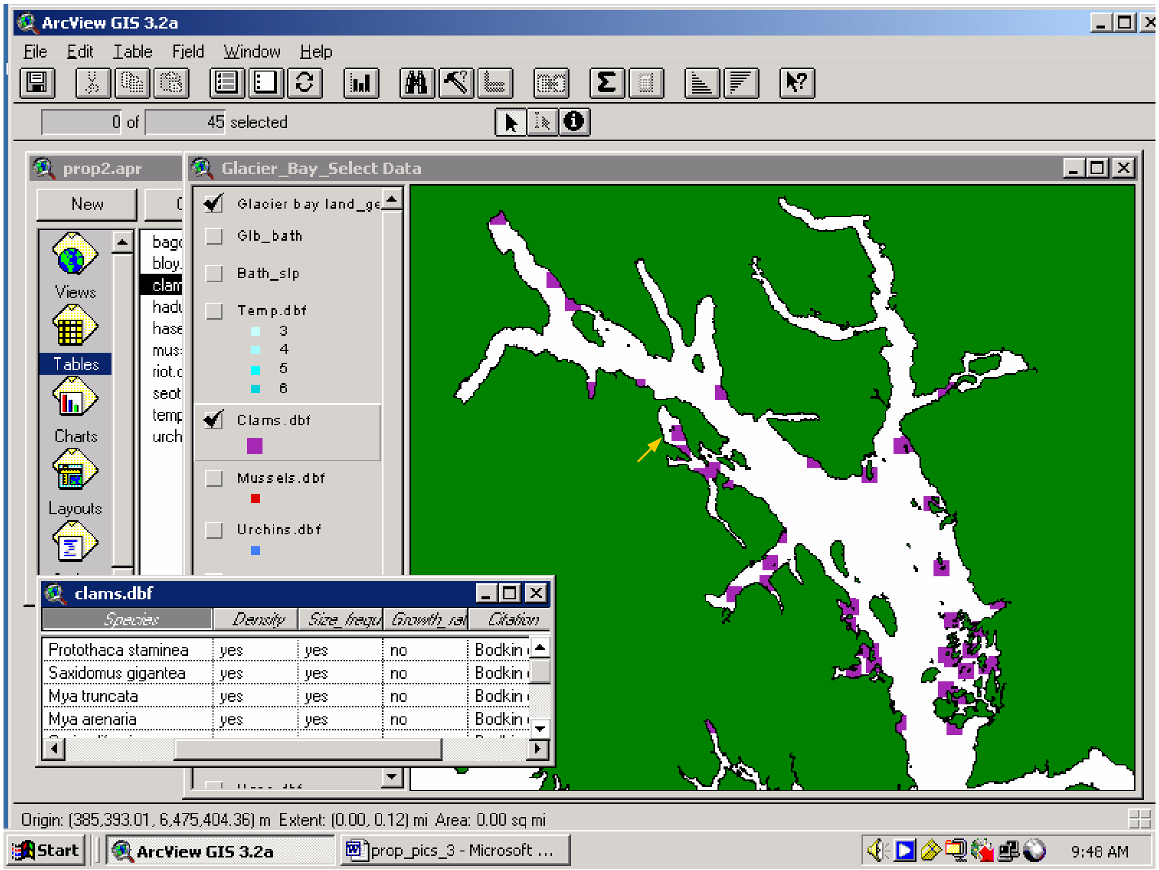

Figure 3. Map of Glacier Bay illustrating the selection of intertidal clam data, and identifying other potential invertebrate data types (e.g. urchins and mussels). Attribute data for the selected data type are illustrated in the inset table. Yellow arrow indicates clam data location selected by user.

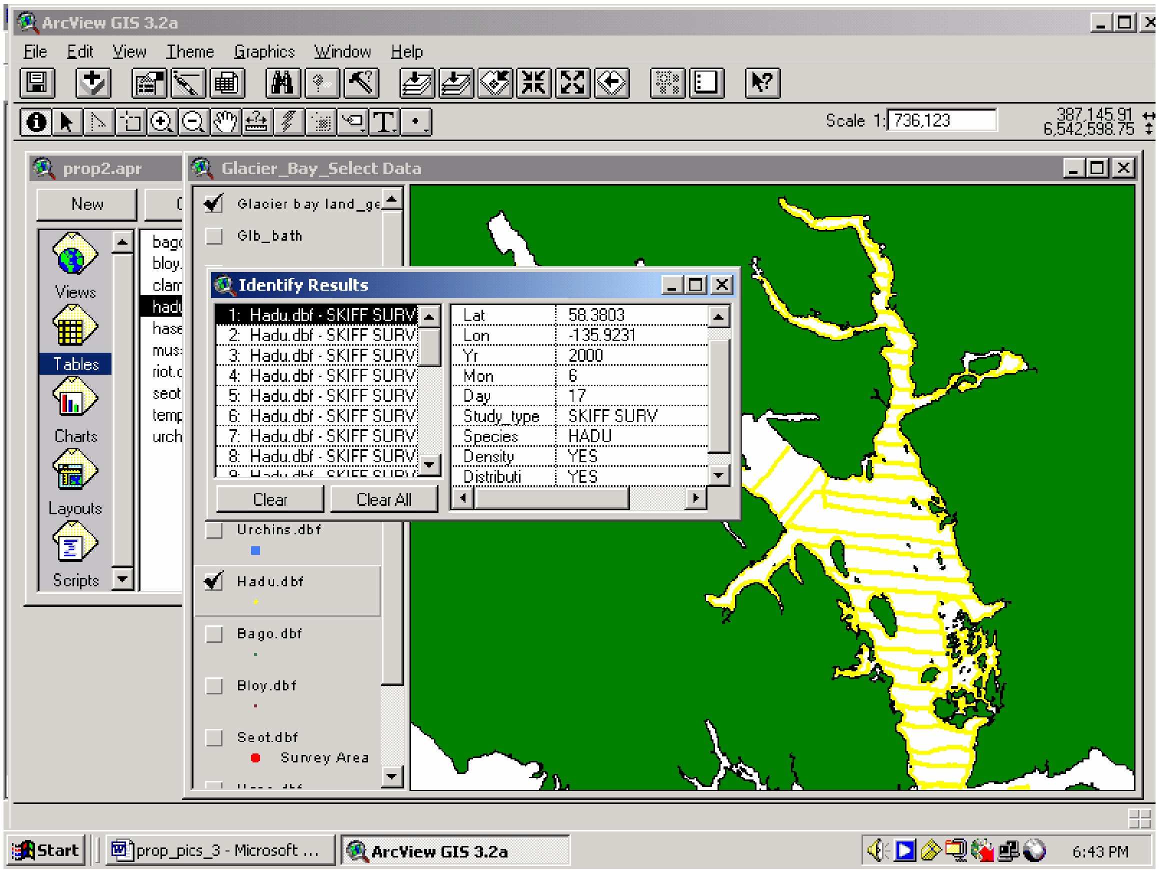

Figure 4. Map of Glacier Bay illustrating the selection of Harlequin duck data (hadu), and identifying other potential marine bird data types (e.g. Black Oystercatchers and Barrows Goldeneye). Attribute data for the selected data type are illustrated in the inset table. Yellow lines indicate extent of survey.

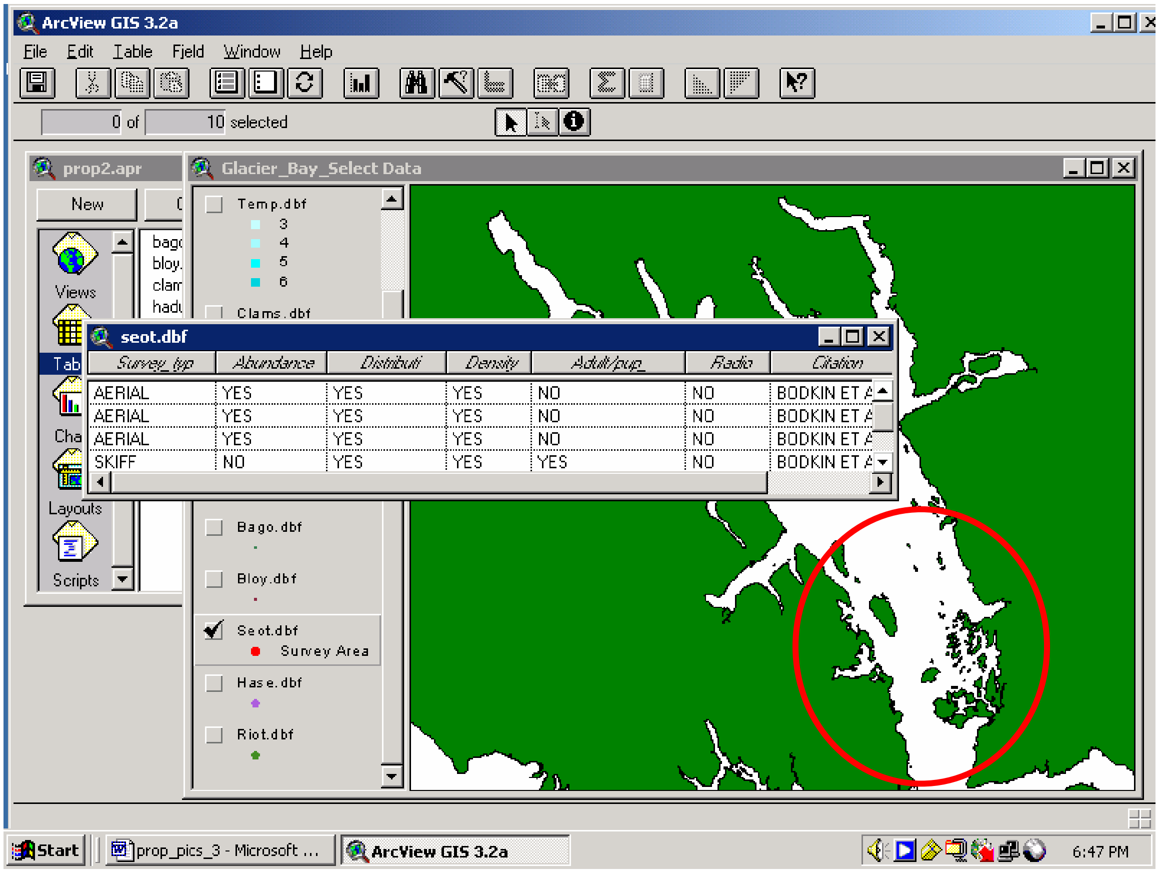

Figure 5. Map of Glacier Bay illustrating the selection of sea otter data, and identifying other potential mammal data types (e.g. harbor seals and river otters). Attribute data for the selected data type are illustrated in the insert table. Red circle indicates extent of survey area.

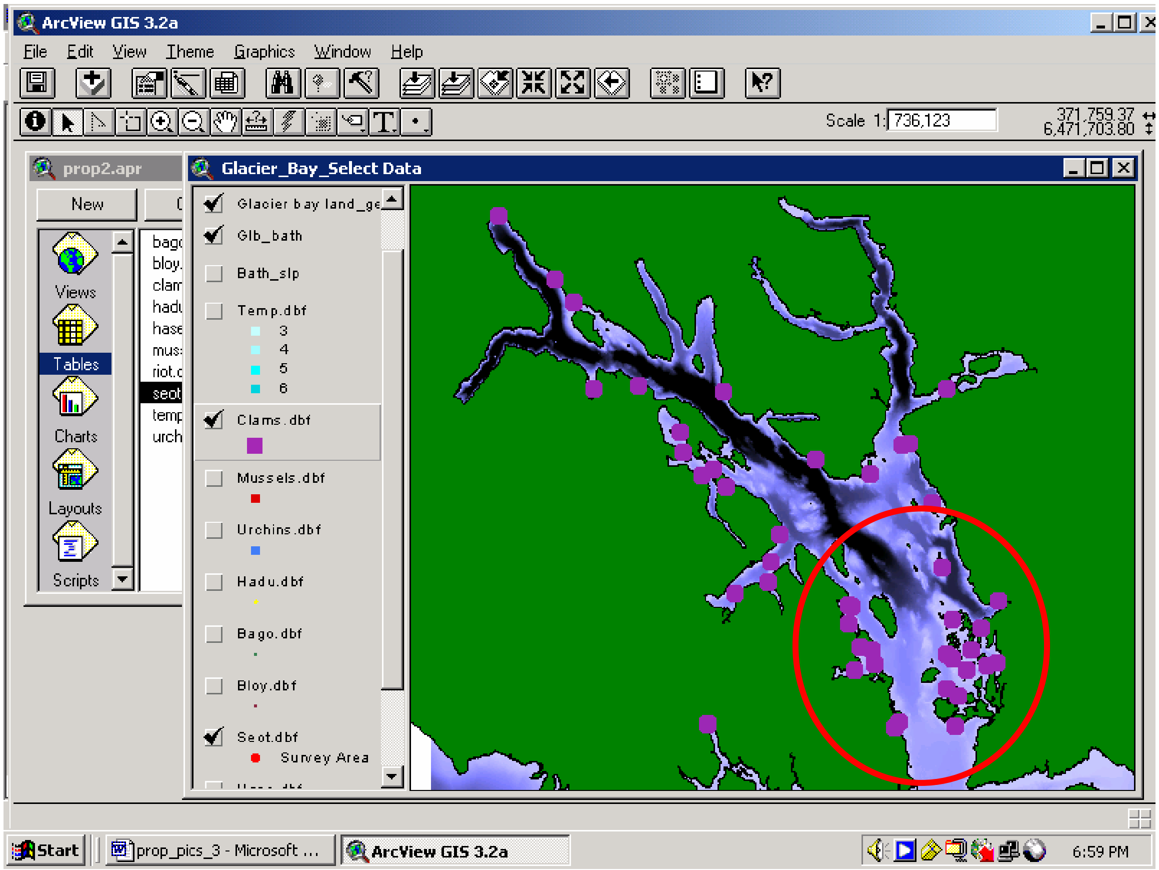

Figure 6. Map of Glacier Bay and GIS coverages illustrating 1) shorelines, 2) bathymetry, 3) intertidal clam sampling locations, and 4) sea otter aerial survey area. In this example the sea otter survey area includes only the lower portion of Glacier Bay.

Signature Form

THIS FORM MUST BE SIGNED BY THE PROPOSED PRINCIPAL INVESTIGATOR AND SUBMITTED ALONG WITH YOUR PROPOSAL. If the proposal has more than one investigator, this form must be signed by at least one of the investigators, and that investigator will ensure that Trustee Council requirements are followed. Proposals will not be reviewed until this signed form is received by the Trustee Council Office.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council/GEM Data Policy**, adopted July 9, 2002) and reporting requirements *(Procedures for the Preparation and Distribution of Reports**, adopted July 9, 2002).

Signature of PI   Date

Signature of PI   Date

Signature of co-PI   Date

* These documents are available on the web at www.oilspill.state.ak.us or upon request from the Trustee Council Office.

EXXON VALDEZ **OILSPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Budget Category:	Proposed FY 2003
Personnel	$48.0
Travel	$1.7
Contractual	$31.4
Commodities	$0.0
Equipment	$1.5
Subtotal	$82.6
General Administration	$7.4
Project Total	$90.0
Other Funds	

Comments: USGS will lead the GIS database work. CRA will lead the research on monitoring alternatives.
Supervision of GS-09 contributed by J. Bodkin.
Additional GIS participation and database support contributed by USGS staff (D. Monson, G. Esslinger, K. Kloecker, B. Ballachey, and H. Coletti.

FY03

Revised:11/27/02

Project Number: 030687 (TC approved 11/25/02)
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

EXXON VALDEZ **OILSPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Personnel Costs:		GS/Range/	Months	Monthly		Pe
Name	Description	Step	Budgeted	Costs	Overtime	
Research Scientist	Wildlife Biologist	GS 12/04	1.0	7.5	0.0	
data and GIS technician	Biologist	GS 09	9.0	4.5	0.0	
	Subtotal		10.0	12.0	0.0	
					Personnel Total	

Travel Costs:	Ticket	Round	Total	Daily	
Description	Price	Trips	Days	Per Diem	
Airfare & per diem, Anc-CA RT	0.7	1	5	0.2	
				Travel Total	

FY03

Prepared:

Project Number: 030687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

Contractual Costs:	C
Description	
Coastal Resources Associates: salary, 3.5 months x $8K per month airfare & per diem, 2 trips, CA-AK Site license, SAS software, 1 year	
When a non-Trustee organization is used, the 4A and 4B forms are required. **Contractual Total**	

Commodities Costs:	Cor
Description	
no commodities proposed	
Commodities Total	

FY03

Prepared:

Project Number: 030687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
PROJECT BUDGET

New Equipment Purchases: Description	Number of Units	Unit Price	Eq
ArcView license for 1 workstation	1	1.5	
Indicate replacement equipment purchases with an R.		**New Equipment Total**	

Existing Equipment Usage: Description	Number of Units	In
USGS AK Science Center:		
desktop computers and associated software	4	
laptop computers and associated software	1	
SAS statistical software	2	
ArcView license for 1 workstation	1	

FY03

Prepared:

Project Number: 030687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
PROJECT BUDGET

Budget Category:	Proposed FY 2004
Personnel	$0.0
Travel	$0.0
Contractual	$9.2
Commodities	$0.0
Equipment	$0.0
Subtotal	$9.2
General Administration	$0.8
Project Total	$10.0
Other Funds	

Comments: FY04 is for report preparation.

FY04

Revised:11/27/02

Project Number: 040687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

***EXXON VALDEZ* OILSPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Personnel Costs:		GS/Range/	Months	Monthly		Pe
Name	Description	Step	Budgeted	Costs	Overtime	
					0.0	
					0.0	
	Subtotal		0.0	0.0	0.0	
					Personnel Total	

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

FY04

Prepared:

Project Number: 040687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
PROJECT BUDGET

Contractual Costs:	C
Description	
Coastal Resources Associates: salary, 1 month x $8K per month Site licenses for both SAS and ARCVIEW software, 1/2 year	
When a non-Trustee organization is used, the 4A and 4B forms are required. **Contractual Total**	

Commodities Costs:	Con
Description	
no commodities proposed	
Commodities Total	

FY04

Prepared:

Project Number: 040687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
PROJECT BUDGET

New Equipment Purchases: Description	Number of Units	Unit Price	Equ
Indicate replacement equipment purchases with an R.		**New Equipment Total**	

Existing Equipment Usage: Description	Number of Units	In
USGS AK Science Center:		
desktop computers and associated software	4	
laptop computers and associated software	1	
SAS statistical software	2	
ArcView license for 1 workstation	1	

FY04

Prepared:

Project Number: 040687
Project Title: Monitoring in the Nearshore: A Process for Making Reasoned Decisions
Agency: USGS- Alaska Science Center