**FY14 PROGRAM PROPOSAL FORM**

**Program Title:** Long-term Monitoring of Marine Conditions and Injured Resources and Services

**Program Period:** February 1, 2014– January 31, 2015

**Team Lead(s):** Molly McCammon (Alaska Ocean Observing System, 1007 W. Third Ave, suite 100, Anchorage, AK 99501, mccammon@aoos.org, 907-644-6703), Katrina Hoffman (Prince William Sound Science Center), Kris Holderied (NOAA Kasitsna Bay Laboratory)

**Abstract:** The goal of the Long-term Monitoring (LTM) program, now known as Gulf Watch Alaska, is to provide sound scientific data and products that inform management agencies and the public of changes in the environment and the impacts of these changes on *Exxon Valdez* oil spill (EVOS) injured resources and services. The five-year program includes: 1) four monitoring components (environmental drivers, benthic, pelagic, lingering oil); 2) data management services; 3) integrated syntheses of data; 4) historic data recovery and syntheses; and 5) science outreach.
The program has six primary objectives:

1. Sustain and build upon existing time series in the EVOS-affected regions of the Gulf of Alaska.
2. Provide scientific data, data products and outreach to management agencies and a wide variety of users.
3. Develop improved monitoring for certain species and ecosystems.
4. Develop science synthesis products to assist management actions, inform the public and guide monitoring priorities for the next 20 years.
5. Enhance connections between the Gulf Watch Alaska and Herring Research and Monitoring (HRM) programs.
6. Leverage partnerships with outside agencies and groups to integrate data from broader efforts.

Some highlights from our progress in year 2 of the program include:

a) Successful completion of annual field data collection and reporting for all monitoring projects under the program.
b) Published 70 (19%) of the 370 historical, EVOS-funded data sets, with an additional 26 in process of publication.
c) Refined sampling protocol to improve sampling efficiency for forage fish data collection in Prince William Sound.
d) Website featuring program news and summaries and access to the program data portal.
e) Cross specialty communication and participation with shared vessel time and staff time between projects and programs.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $2,904.6 | $2,675.8 | $2,994.4* | $2,803.8* | $2,405.0 | $13,783.5* |

*(Funding requested must include 9% GA)* ***Includes additional funds requested for 14140114-Q Lingering oil and a FY shift of funds from FY14 to FY15 for lingering oil 14140114-S***

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $755.0 | $720.0 | $1,421.0 | $673.0 | $687.0 | $3,726.0 |

**Date: August 30, 2013**

## A. Summary of work performed to date

Most of the work performed by the Gulf Watch Alaska program to date has focused on execution of the monitoring projects, coordination of efforts across the program, development of new collaboration tools within the program, and improvement of public data accessibility, cataloging, and publication. We have also worked to develop integrated program synthesis tools and design and revise a program website for outreach. Specific accomplishments related to the program objectives are described below.

### *Integrated program management, data services, science synthesis & outreach (Leads – McCammon, Holderied and Hoffman)*

Overall program management and administration has proceeded as expected and year two of the program is advancing as proposed. We have made substantial progress toward providing information to the general public and managers through the outreach and data services projects of the Gulf Watch program. The outreach committee has developed a basic suite of materials for the program including a new name (*Gulf Watch Alaska*, *The Long-term Monitoring program of the Exxon Valdez Oil Spill Trustee Council)*, logo, website domain, PowerPoint and poster templates, pop-up displays, display banners, brochure, presentation folder and bookmarks. Our website has undergone substantial revision, including new user interactive graphics and project pages for all projects within the program (see Figure 1, www.gulfwatchalaska.org). The data management team has updated the Ocean Workspace, an internal information and data-sharing portal, with new tools, and has developed the Gulf Watch Alaska live data portal. The public data portal provides data from the program as well as from other monitoring programs in the Gulf of Alaska (http://data.aoos.org/maps/search/gulfwatch.php).

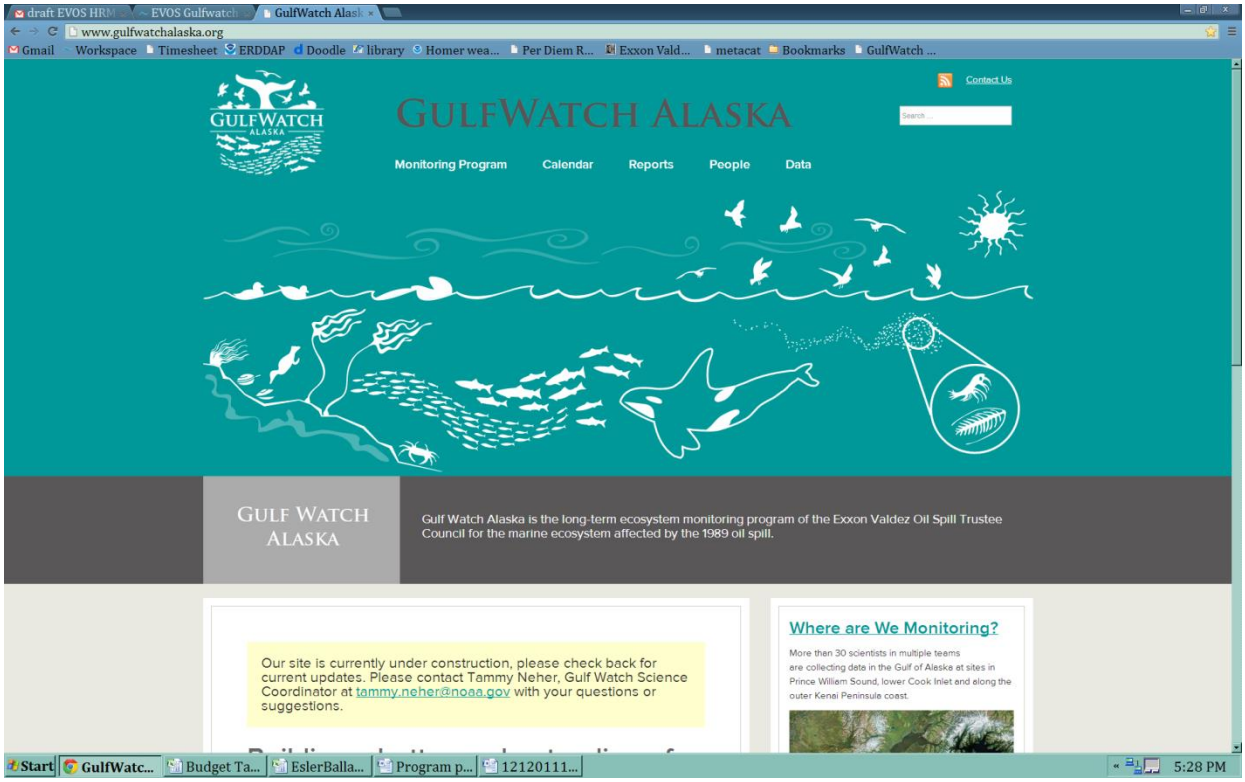


**Figure 1. New Gulf Watch Alaska website home page (www.gulfwatchalaska.org).**

We continue to work to publish data online to provide access to researchers, managers, and the public. Currently, we have documented and published 19% (70) of the 370 data sets that were identified from historical EVOS funding with 7% more in process of publication. The data sets are available on the KNB Metacat server at: http://evos.nceas.ucsb.edu/evos/.

We are also making progress toward both external and internal science synthesis and are in the process of planning time series workshops including Principal Investigators from HRM and NPRB programs to inspire ideas, share information, and develop research products. Another important tool for integration is the conceptual model for which development is ongoing with the visual diagram representing key linkages based on LTM PI input anticipated in the summer of 2014.

***Environmental Drivers Monitoring Component (lead – Weingartner & Hopcroft)***

All of the oceanographic monitoring projects have completed successful field sampling seasons following previous proposals to date. Principal investigators are focused on several interesting topics including working on relating long-term Seward-line sea-level variability to forcing mechanisms and providing derived time-series data products to the Ocean Workspace data sharing portal. Some interesting findings include:

- Tides and atmospheric pressure variations (the inverted barometer effect) are largely responsible for sea level variations.
- The upper 100m of along the Seward Line was 0.7°C colder in 2012 in May than the 15-year mean causing progression of seasonal cycles for plankton to be delayed: the spring bloom was partially captured, while the development rates of key zooplankton species was slowed.

Some field challenges include difficulties with the electronic communications in the AMP profiling station in Prince William Sound and delayed or canceled winter cruises in Cook Inlet due to inclement weather. Principal investigators are working to resolve the communications issues and field testing new hardware this fall.

***Pelagic Monitoring Component (lead – M. Lindeberg)***

All of the Pelagic Component projects have completed successful field sampling season as outlined in the intial program proposal. Progress includes completion and updating of photographic reference catalogs for both Killer and Humpback whale projects, and successful collection of biopsy samples that are currently in progress of analysis. Some sampling plan modifications were tested with the Forage Fish project with apparent successful results, the data is currently being processed.

Several projects have received acceptance from peer reviewed journals on manuscripts based on data collected from projects that began just prior to Gulf Watch, using data collected under methods described for the program.

Some challenges with contracting have arisen and are currently resolved with a delay in project timing. Project principal investigator, Heather Colletti exeperienced some challenges with the Detection of trends in seabird populations project. The contract for analysis has been submitted through NPS contracting and is currently awaiting the bid process. We are anticipating that a contract will be awarded before the end of federal fiscal year 2013 and that a final report will be provided by June 1, 2014.

***Benthic Monitoring Component (lead – Ballachey)***

All of the Benthic Component projects have completed successful field sampling season as outlined in the intial program proposal. Interesting findings include the discovery of a live oyster (*C. gigas*), found during a sampling trip to Johnson Bay (WPWS) in June 2013. The oyster was presumed to be at least 5 yrs old due to the perennial seaweeds growing on it as well as its size. Also notable is that an overall observed reduction in mussels across our GWA sites has been observed in data collected through 2012. Notable findings from Kachemak Bay include a strong recruitment event in mussels observed at one site in Kachemak Bay but not others, indicating at site-specific dynamics in recruitment. We also found that *c*lam composition is site-specific in Kachemak Bay, also suggesting the presence of strong local dynamics within the bay.

**Lingering Oil Monitoring Component (lead – Ballachey)*:***

Both of the Lingering Oil Component projects have completed successful field sampling seasons as outlined in the intial program proposal**.** Samples were taken from both sea otters and harlequin ducks in 2012 and 2013. Previous sampling, through March 2011, had shown higher CYP1A in ducks from oiled areas, relative to those from unoiled areas. Hydrocarbon sample processing has focused on samples and data that contribute to long-term understanding of conditions in Prince William Sound and along the Gulf of Alaska. Hydrocarbon analyses and biomarker measurements have been completed for Gulf of Alaska samples and principal investigators are now writing the report (Irvine et al).

**B. Summary of work to be performed**

We are planning the following overarching activities during the next year of the program:

a) Conduct monitoring efforts in accordance with program milestones.
b) Continue to review and add program data and related historic related data to the Gulf of Alaska data portal.
c) Conduct an in-person principal investigator meeting and time series analysis workshop, with a focus on enhancing integration of efforts within the program and with external partners.
d) Continue outreach and information dissemination efforts at community level events, workshops, and scientific meetings and through the revised website.
e) Continue to refine and coordinate sampling methods for specific projects.
f) Continue data assimilation and archiving efforts in collaboration with NCEAS.
g) Work closely with the Herring Research and Monitoring program to develop the program science synthesis reports and begin planning the 2015 workshop.

Additional funding is requested, per discussions with the EVOSTC staff, for the project on EVOS exposure of harlequin ducks and sea otters (12120114-Q), in order to extend harlequin duck sampling into FY14. Findings from the FY13 sampling, in which the sampled ducks no longer showed exposure to lingering oil, are a significant change from earlier observations. An additional year of sampling will allow us to confirm these results. We are also requesting to delay by one year (move from FY14 to FY15) funding for sampling oil in sediments under the "Oil level and weathering tracking" project (12120114-S; Carls). The purpose of the delay is to position the project to best respond to findings from the bioremediation project (Boufadel, EVOSTC #11100836), the lingering oil distribution modeling (Nixon, EVOSTC #12120117), and to consider new findings from Gulf Watch Alaska monitoring.

A summary of individual project plans has been provided in our semi-annual report (dated Aug 30, 2013) and details are provided in the individual project proposal forms attached in Appendix 1.

**C. Budget changes from prior years**

There are no significant changes to budgets requested in prior years. As described in the individual project proposals, some projects have had a lag in spending due to changes in staffing, equipment issues and invoicing delays for subcontracts. We anticipate that we will meet expected spending levels in the near future.

**D. Completed budget spreadsheet** (attached) with a summary page for the entire program.

**E. Proposals from each individual project contained within the program.** Attached as Appendix 1, with curricula vita for the principal investigators attached as Appendix 2.

**Attachments:**

Program Project Proposal Forms and CVs (Appendix 1 and Appendix 2)
Budget Form

Appendix 1 **for FY14 Program Proposal - Section E: Individual Project Proposals**

# Program Title: Long-term Monitoring of Marine Conditions and Injured Resources and Services

**Program Period: February 1, 2014 – January 31, 2015**

Individual project proposal forms are provided for the Long-term Monitoring program, also known as Gulf Watch Alaska. The individual project forms are organized within integrated program services and under the three monitoring program components.

A. Integrated program management, data services, outreach and science synthesis

1. a. Program coordination and logistics – Prince William Sound Science Center (PWSSC) and Alaska Ocean Observing System (AOOS)
   b. Outreach - AOOS
2. Data management –AOOS/Axiom Consulting
3. Historical data management and synthesis – National Center for Ecological Assessment and Synthesis (NCEAS) – EVOS TC Project# 12120120
4. Science coordination and synthesis – NOAA Kasitsna Bay Laboratory (KBL)
5. Conceptual ecological modeling– Alaska Sea Life Center (ASLC)

B. Environmental drivers monitoring component

6. Gulf of Alaska mooring (GAK1) monitoring – University of Alaska Fairbanks (UAF)
7. Seward line monitoring – UAF
8. Oceanographic conditions in Prince William Sound – PWSSC

9. Oceanographic monitoring in Cook Inlet – Alaska Department of Fish and Game (ADFG) / Kachemak Bay Research Reserve (KBRR)/ KBL
10. Continuous plankton recorder –Sir Alister Hardy Foundation for Ocean Science (SAHFOS)

C. Pelagic monitoring component
11. Ability to detect trends in nearshore marine birds – USNPS Southwest Alaska inventory and monitoring Network (SWAN) – year 1 (no year 2 funding)
12. Long-term killer whale monitoring – North Gulf Oceanic Society (NGOS)
13. Humpback whale predation on herring – NOAA National Marine Fisheries Service (NMFS) Auke Bay Laboratory
14. Forage fish distribution and abundance – U. S. Geological Survey (USGS) Alaska Science Center
15. Prince William Sound marine bird surveys – U.S. Fish and Wildlife Service (USFWS)

D. Benthic monitoring component
16. Nearshore benthic systems in the Gulf of Alaska – USGS Alaska Science Center/ USNPS SWAN, Coastal Resources Associates
17. Ecological Communities in Kachemak Bay – UAF

E. Lingering oil component
18. EVOS oil exposure of harlequin ducks and sea otters – USGS Alaska Science Center
19. Oil level and weathering tracking – NOAA/NMFS Auke Bay Laboratory

**Integrated program management, data services, science synthesis & outreach (Leads – McCammon, Holderied and Hoffman)**

***A.1.a Program coordination and logistics – Hoffman (PWSSC)***

## FY14 PROGRAM PROJECT PROPOSAL FORM

| |
|---|
| **Project Title: Long term monitoring:** Long term monitoring: Program management component – Administration, Science Review Panel and PI Meeting Logistics, and Outreach and Community Involvement |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Katrina Hoffman, Prince William Sound Science Center |

**Abstract:** This project is a component of Gulf Watch Alaska (GWA), the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services program submitted by McCammon et al. To meet Gulf Watch Alaska's long-term restoration monitoring goal, this 5-year long-term monitoring program will:

1) Implement the guidance of Trustee Council planning efforts;
2) Sustain and build upon existing time series;
3) Enhance collaborations between principal investigator projects in the proposed monitoring program and with the proposed Herring Program;
4) Leverage partnerships with outside agencies and groups to integrate data from a broader monitoring effort than that funded by the Trustee Council;
5) Provide data and scientifically-based data products to a wide variety of users; and
6) Develop science synthesis products to assist management actions, inform the public and guide the evolution of monitoring priorities for the next 20 years.

This project addresses administration and fiscal management of the program. To achieve that, the Prince William Sound Science Center is serving as the administrative lead and fiscal agent responsible for: managing award contracts for all non-Trustee Agency projects within the program; ensuring the program and projects adhere to all reporting policies, practices and timelines; serving as a liaison between the program and EVOSTC staff; coordinating travel and logistics for principal investigator annual meetings; coordinating travel and logistics for outreach efforts; participating in an annual audit; and providing administrative support to the outreach and community involvement component of the GWA program. The Outreach and Community Involvement component is coordinated by the Alaska Ocean Observing System. See McCammon's program project proposal form for details.

**Estimated Budget: $1,301.0k Total without the 9%GA - $1,418.2K including 9%GA**
**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $263.3 | $274.7 | $298.6 | $293.4 | $288.1 | $1418.2 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 30, 2014**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Efficient and cost-effective administration of Gulf Watch Alaska (GWA), the Long-term monitoring program of the Exxon Valdez Oil Spill Trustee Council, was required and responsibility for said management is held by the Prince William Sound Science Center (PWS Science Center or PWSSC) in combination the Alaska Ocean Observing System (AOOS), responsible for the Outreach and Community Involvement component of the GWA program. The EVOS Trustee Council requested that a consortium submit one proposal for the GWA program. Our consortium includes three organizations that comprise the Program Management Team (PMT): PWSSC, acting as the administrative lead and fiscal agent, the NOAA Kasitsna Bay Laboratory (KBL) serving as the science program lead, and the Alaska Ocean Observing System (AOOS) providing data management and outreach and community involvement services and also serving as the Team Lead and primary point of contact for the overall program. Collectively, this consortium brings a wealth of knowledge about the spill-affected region, has extensive experience with managing multi-million dollar science programs with multiple partners, and has the capacity to leverage significant additional dollars.

**B. Summary of Project to Date**

This component has met all of its milestones thus far including: conducting annual audits; establishing and managing contracts to all non-Trustee agency organizations funded through this program; completing fiscal reporting; tracking plans for creation of the Scientific Review panels; setting up logistics for and supporting annual PI meetings; providing travel and logistics support to the Outreach Steering Committee; and tracking Outreach and Community Involvement activities coordinated by PI McCammon. For details about Outreach and Community Involvement, please see McCammon's project proposal form.

**II. PROJECT DESIGN**

**A. Objectives**

*Objective 1* **Fiscal management tasks**

a. Award and management of all contracts and subawards for non-Trustee organizations involved in this program (this will total 6 contracts[1] in addition to the 2 PWSSC projects);
b. Timely submission of financial reports;
c. Completion of annual audits; and
d. Monitoring of project spending.

The budget assumes that funding to Trustee Agencies is provided directly to that agency and not through PWSSC. The PWSSC awards contracts to all non-Trustee organizations involved in this proposal[1], with two exceptions for two co-PIs who are working with Trustee agency projects (Straley from University of Alaska Southeast and Dean from Coastal Resources Associates). Straley and Dean's

[1] Contracts are administered to the Univ. of Alaska Fairbanks (Hopcroft, Weingartner, Konar, Ikens), SAHFOS (Batten), North Gulf Oceanic Society (Matkin), Alaska SeaLife Center (Hollmen), Alaska Ocean Observing System/Axiom Consulting (McCammon/Bochenek), and Alaska Ocean Observing System (McCammon).

participation are included as contracts within, respectively, the Moran (NOAA) and Ballachey (USGS) Trustee agency project DPDs and budgets.

*Objective 2* **Formation and operation of a scientific review panel**

Costs associated with the formation and operation of a scientific review panel for the GWA program is included in the administrative fee. These costs include administrative assistance and travel arrangements and expenses. Science Team Leader Kris Holderied will recruit four members for a scientific oversight panel to help guide the program and ensure that the monitoring program is relevant to the long-term goal. We anticipate that the oversight panel will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and local community perspective. There will be annual Principal Investigator meetings each year to provide updates to this oversight panel, improve coordination between projects, and provide outreach and public input opportunities.

*Objective 3* **Travel expenses for the Annual Meeting of GWA PIs**

The travel portion of the administrative budget includes funds to host and support an annual meeting in Anchorage of the project principal investigators.

*Objective 4* **Travel expenses for Outreach Team**

Administrative assistance and travel arrangements and expenses for activities directed by the Outreach and Community Involvement Team, led by McCammon, are included in this project.

*Objective 5* **Outreach and Community Involvement**

The outreach/community involvement component of GWA is facilitated by the Alaska Ocean Observing System (AOOS), with significant leveraging of the resources of these institutions: the Prince William Sound Science Center (PWSSC) and Oil Spill Recovery Institute (OSRI) based in Cordova, the Alaska SeaLife Center (ASLC) in Seward, the Kachemak Bay Research Reserve (KBRR) in Homer, and COSEE Alaska (Center for Ocean Science Education Excellence). For details, see the Outreach and Community Involvement program project proposal form submitted by McCammon.

**B. Procedural and Scientific Methods**

Not applicable.

**C. Data Analysis and Statistical Methods**

Not applicable.

**D. Description of Study Area**

Administrative services will be completed at the PWSSC office in Cordova.
Science review and PI meetings will be held in Anchorage or elsewhere in the EVOS region.
Outreach and community involvement activities will be completed throughout the EVOS region.

**E. Coordination and Collaboration with the Program**

Indicate how your proposed project relates to, complements or includes collaborative efforts with the Program. Identify how this project will assist in the answering of the Program's hypothesis and how data collected as part of this project may be used by other projects. Describe any coordination that has taken or will take place (with other Council funded projects, ongoing agency operations, activities funded by other marine research entities, etc.) and what form the coordination will take (shared field sites, research platforms, sample collection, data management, equipment purchases, etc.). If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

**III. CVs/RESUME**

See program appendix.

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Fiscal Management
*Management of contracts to non-Trustee agency organizations is ongoing.*
*Quarterly fiscal project monitoring is in effect.*
*Annual audits of PWSSC have been conducted.*

**Objective 2**. Assist with Scientific Review Panel
*Setup of the panel has been delayed in order to make the most effective use of panel members' time in advance of the synthesis workshop. Planning of the synthesis workshop begins in the final two quarters of year 2; the panel will be established by the end of year two (approximately one year in advance of the synthesis workshop).*

**Objective 3**. Support travel and logistics for annual PI meetings
*PI meetings are being held annually, typically in November (including an upcoming meeting in November 2013).*

**Objective 4**. Support Outreach Steering Committee
*PWSSC is providing ongoing support for outreach travel and logistics.*

**Objective 5.** Coordinate Outreach and Community Involvement Activities
*See details in McCammon project proposal.*

**B. Measurable Project Tasks**

**FFY 14 (February 1, 2014-September 30, 2015)**

*Assist Science Team Leader with meeting setup and travel logistics for PI meeting*
*Attend annual PI meetings of LTM and Herring Research programs*
*Attend Alaska Marine Science Symposium*
*Meet with EVOS TC Public Advisory Committee*
*Submit annual report on monitoring efforts in the GWA program*
*Submit proposed work plan for FFY 15*
*Conduct annual audits*

**V. BUDGET**

**Budget Form (See attached budget document)**

***A.2.b Outreach*** **– McCammon (AOOS)**

| **FY14 PROGRAM PROJECT PROPOSAL FORM** |
|---|
| **Project Title: Outreach and Community Involvement** |
| **Project Period: February 1, 2014 – January 31, 2015** |
| **Primary Investigator(s):** Molly McCammon, Alaska Ocean Observing System |

**Abstract:**
The Outreach and Community Involvement component uses a Steering Committee, coordinated by the Alaska Ocean Observing System (AOOS), to set priorities for outreach and communication activities for the program. These activities include a public website, science lectures, radio programs and symposia, publications and other materials and identification of potential opportunities for community based monitoring.

In this next year we will continue a number of activities hosted by the Kachemak Bay Research Reserve and the Prince William Sound Science Center and begin new ones at the Alaska SeaLife Center. We will have a larger presence at the Alaska Marine Science Symposium and other more local science symposia. We will continue to expand materials on the Gulf Watch website (www.gulfwatchalaska.org) and the Gulf of Alaska data portal. We will collaborate with sponsors of the spring 2014 Community Based Monitoring Best Practices Workshop hosted by AOOS and Alaska Sea Grant, and use the results as a springboard for a regional planning discussion on potential incorporation of community based monitoring and traditional ecological knowledge as part of the Gulf Watch program. Depending on results of external fundraising appeals, we may continue efforts to initiate a Day in Our Sound filming and other outreach activities.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $60.1 | $69.4 | $77.4 | $75.0 | $66.0 | $348 |

*(Funding requested must include 9% GA)*

****Note that this funding is included with Hoffman, PWSCC-Admin, project number *14140114.***

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 30, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Public outreach and community involvement is a key component of the EVOS Trustee Council's Long Term Monitoring Program and is coordinated by AOOS within the overall Administration and Science Logistics component.

### B. Summary of Project to Date (if applicable)

This component has met all of its milestones thus far by organizing and supporting an Outreach Steering Committee (that includes key outreach staff from AOOS, the PWS Science Center (PWSSC), Kachemak Bay Research Reserve (KBRR), Alaska SeaLife Center, North Pacific Research Board, COSEE Alaska, NOAA, USGS and Alaska Sea Grant); establishing a public website (www.gulfwatchalaska.org) that is newly revised and updated; developing the first phase of an Outreach and Community Involvement Plan; and

implementing the activities described in that plan. In addition, program staff briefed the EVOS TC Public Advisory Committee.about these activities. These activities are closely coordinated with outreach activities sponsored by the EVOS TC Herring Research and Monitoring Program.

**II. PROJECT DESIGN**

**A. Objectives**

*Objective 1* **Travel expenses for Outreach Team**

Administrative assistance and travel arrangements and expenses for activities directed by the Outreach and Community Involvement Team, led by McCammon, are included in this project.

*Objective 2* **LTM Project Outreach and Community Involvement**

**I. Overall Approach**

The outreach/community involvement component of the LTM Project is facilitated by the Alaska Ocean Observing System (AOOS), with significant leveraging of the resources of these institutions: the Prince William Sound Science Center (PWSSC) and Oil Spill Recovery Institute (OSRI) based in Cordova, the Alaska SeaLife Center (ASLC) in Seward, the Kachemak Bay Research Reserve (KBRR) in Homer, COSEE Alaska (Center for Ocean Science Education Excellence), as well as NOAA and USGS. Alaska Sea Grant is now an additional partner. We have met once with the EVOS TC Public Advisory Group and in Year 3 will reach out to the communities in the oil spill region to discuss and refine our activities for outreach and community involvement. Our efforts are also closely coordinated with those for the Herring Program, which are primarily focused in Prince William Sound.

Our partner organizations offer a wide range of capabilities including websites and web materials, teacher workshops, distance learning programs, newspaper and magazine articles, radio and television programs, science camps, and community lectures. They have experienced education and communication staff, and are connected with statewide, regional, national and international education and outreach programs.

We have established an Outreach and Community Involvement Steering Committee made up of education/outreach specialists from AOOS, COSEE Alaska, PWSSC/OSRI, KBRR, and the ASLC, as well as appropriate agency experts from NOAA and USGS. AOOS is facilitating this committee, with the assistance of staff from Alaska Sea Grant. The committee decides on final activities, and either selects an entity to be responsible for a specific product, or in some cases, will hold a small competitive process, or even a mini-grant program, for potential activities.

**B. Procedural and Scientific Methods**

*Not applicable.*

**C. Data Analysis and Statistical Methods**

*Not applicable.*

**D. Description of Study Area**

Outreach and community involvement activities will be completed throughout the EVOS region.

**E. Coordination and Collaboration with the Program**

Our partner organizations offer significant resources to this effort.

*AOOS*: AOOS is the only organization in the state with a board made up of all the federal and state resource management agencies and all the marine research entities in Alaska, including the University of

Alaska. The AOOS mission is to coordinate and facilitate the gathering and dissemination of ocean and coastal information and data products to meet stakeholder needs in the three Large Marine Ecosystems, including the Gulf of Alaska. AOOS has committed significant resources to its web-based data portal (www.aoos.org) and data products developed in response to stakeholder needs. As part of a national - as well as a global - network of ocean observing systems, AOOS has access to significant national and international resources as well. AOOS will facilitate the outreach/community involvement program, and use its web portal as a key outlet for products to be developed.

AOOS is a major partner of COSEE Alaska, a network of ocean education and science partners that engages ocean scientists, teachers, informal educators and community members in the region in a broad range of programs, including statewide ocean science fairs, teacher workshops, Communicating Ocean Science Workshops and hands-on sessions for scientists at the Alaska Marine Science Symposium, plus distance learning and virtual field trips through the COSEE Alaska website (www.coseealaska.net).

*PWSSC and OSRI*: Based in Cordova, these organizations are the primary contact point for communities and education programs in the sound. The organizations' education resources will provide articles in the Delta-Sound Connections, a broadly distributed annual paper describing research in PWS and Copper River Delta. They also will develop Field Notes radio programs each year to be aired by KCHU, the PWS public radio station. The organizations will also take advantage of the PWSSC community lecture series held weekly through the winter and transmitted to Valdez through the Prince William Sound Community College. Results from the research will also be incorporated into the PWSSC classroom and summer camp activities. These camps involve youth from around Prince William Sound and the Anchorage area.

*KBRR*: For Cook Inlet/Kachemak Bay, the Kachemak Bay Research Reserve and the Kasitsna Bay Lab will support outreach and education services at: KBRR Discovery Labs (free-learning science education events for general public and K-12); "Bay Science" articles in Homer News, Homer Tribune and Peninsula Clarion papers; "Kachemak Currents" informational radio spots on science topics; K-12 science camps at Kasitsna Bay Lab (serving approximately 25 groups and 700 students) and marine science classes (university as well as continuing education for tribal environmental coordinators and teachers) at Kasitsna Bay Lab.

*ASLC*: The SeaLife Center operates America's northern-most research aquarium as a non-profit organization and is both a major marine research center and one of Alaska's largest marine tourism attractions. The ASLC has a multi-faceted formal and informal education and outreach program, employing 6 full time educators, year round and seasonal interpreters, with 2 full time exhibit design experts. These staff work closely with both in house and external scientists and educators to develop education and outreach exhibits within and outside the Center. The Center is also the designated Alaska Coastal Ecosystem Learning Center under the Coastal America Partnership – a network of some 23 aquariums nationally who receive more than 20 million visitors/year. This network is now supported by the NOAA-Smithsonian Ocean Today Kiosk program and the ASLC has a direct daily download link to the OTK hub at the Smithsonian. The Center has a long established and interactive Exxon Valdez Oil Spill exhibit featuring the latest updates from the EVOSTC science program. This exhibit is popular, but could be readily enriched by improved interactive exhibits, expanded distance education offerings (the ASLC is currently Alaska's largest provider of marine distance education programs to lower 48 and international schools with some 300 lessons provided in 2010), shared mobile exhibit materials, and portable presentation materials on the monitoring program that could be made available to monitoring team members to use in a range of professional and school/community based presentation forums

Community involvement: Communities in the spill-affected region include both the larger communities of Valdez, Cordova, Homer, Kenai and Kodiak, as well as the smaller Alaska Native villages such as Tatitlek and Chenega, Port Graham and Nanwalek, and Kodiak Island villages. We propose to develop outreach materials specifically targeted to these communities, in essence bringing science to the communities. We propose to host mini-science symposiums in spill area communities, and contribute to the proposed Wisdomkeeper conference sponsored by spill area communities. In this 5-year proposal, we propose to begin discussions with spill-area communities (primarily Prince William Sound and lower Cook Inlet) concerning development of a potential community-based citizen science monitoring program. We propose to hold a conference on this issue in Year 2 of this proposal, and seek additional funding sources (primarily through private sources) to implement such a program that would incorporate local and traditional Alaska Native knowledge into ongoing monitoring efforts.

**III. CV's/RESUMES- Please see Appendix 2.**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Provide travel expenses for Outreach Team.
*Ongoing support for travel and logistics*

**Objective 2**. Coordinate program outreach and community involvement activities.
*Develop Phase II of Outreach and Community Involvement Plan by February 1 2014*
*Identify options for potential community involvement and community based monitoring in program by September 1, 2014*
*Implement Plan - ongoing*

**B. Measurable Project Tasks**

**Program Year 3 (February 1, 2014-January 31, 2015)**

*Develop Phase II Outreach and Community Involvement Plan*
*Co-sponsor and participate in Communicating Ocean Science Workshop at Alaska Marine Science Symposium (AMSS)*
*Host exhibit and posters at AMSS*
*Co-sponsor Community Based Monitoring Best Practices conference (to be held in April 2014)*
*Share conference results and use to develop options for potential CBM activities in region*
*Develop 3-4 Field Notes short radio programs that may include video or slide show*
*Host 3 Discovery Labs at Kachemak Bay Research Reserve*
*Participate in regional science symposia (Kodiak, Homer, Cordova, Valdez)*
*Contribute content to annual Delta Sound Connections newsletter*
*Maintain www.gulfwatchalaska.org website*
*Update written and web-based materials describing LTM program*
*Meet with EVOS TC Public Advisory Committee*
*Depending on results of Day in Our Sound funding appeals, decide on next project activities*

**V. BUDGET**

**Budget Form (See attached budget spreadsheet)**

**FY14 PROGRAM PROJECT PROPOSAL FORM – A.2**

**Project Title:** Data Management Support for the EVOSTC Long Term Monitoring Program

**Project Period:** Feb 1st 2014 to Jan 31st 2015

**Primary Investigator(s):** Rob Bochenek, Axiom Consulting & Design, rob@axiomalaska.com, (907)230-0304

**Abstract:** This project supplies the EVOS Long Term Monitoring (LTM) effort with critical data management support to assist study teams in efficiently meeting their objectives and ensuring data produced or consolidated through the effort is organized, documented and available to be utilized by a wide array of technical and non technical users. This effort leverages, coordinates and cost shares with a series of existing data management projects which are parallel in scope to the data management needs of the long term monitoring program. In the first two years, this project would focus on providing informatics support to streamline the transfer of information between various study teams and isolate and standardize historic data sets in the general spill affected area for use in retrospective analysis, synthesis and model development. These efforts would continue into year three through five but efforts would also focus on developing management and outreach applications for the data and data products produced from the LTM program.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $163.5 | $163.4 | $164.0 | $164.0 | $162.6 | $817.4 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | $620 | | | |

**Date: August 6th 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

In the two decades following the *Exxon Valdez* oil spill (EVOS), and after extensive restoration, research and monitoring efforts, it has been recognized that full recovery from the spill will take decades and

requires long-term monitoring of both the injured resources and factors other than residual oil that may continue to inhibit recovery or adversely impact resources that have recovered. Monitoring information is valuable for assessing recovery of injured species, managing those resources and the services they provide, and informing the communities who depend on the resources. In addition, long-term, consistent, scientific data is critical to allow us to detect and understand ecosystem changes and shifts that directly or indirectly (e.g. through food web relationships) influence the species and services injured by the spill.

An integrated monitoring program requires information on environmental drivers and pelagic and benthic components of the marine ecosystem. Additionally, while extensive monitoring data has been collected thus far through EVOS Trustee Council-funded projects as well as from other sources and made publicly available, much of that information needs to be assessed holistically to understand the range of factors affecting individual species and the ecosystem as a whole. Interdisciplinary syntheses of historical and ongoing monitoring data are needed to answer remaining questions about the recovery of injured resources and impacts of ecosystem change.

Managing oceanographic data is particularly challenging due to the variety of data collection protocols and the vast range of oceanographic variables studied. Data may derive from automated real-time sensors, remote sensing satellite/observational platforms, field/cruise observations, model outputs, and various other sources. Variables can range from mesoscale ocean dynamics to microscale zooplankton counts. The resulting datasets are packaged and stored in advanced formats, and describe a wide spectrum of scientific observations and metrics. Due to the complexity of the data, developing data management strategies to securely organize and disseminate information is also technically challenging. Distilling the underlying information into usable products for various user groups requires a cohesive, end-to-end approach in addition to a fundamental understanding of the needs and requirements of the user groups and stakeholders.

Data management activities for oceanographic information occur in isolated, physically distributed agencies, leading to low cross-agency utilization of data. Technical barriers, complex data formats, a lack of standardization and missing metadata have limited access to data and made the utilization of available scientific information cumbersome and daunting. As a consequence, existing data is underutilized and often has not undergone quality assurance.

**B. Summary of Project to Date (if applicable)**

During the first few months of the EVOS LTM Program Data Management project investigators have been focused on establishing protocols for data transfer, metadata requirements and initiating the data salvage effort. Investigators have been meeting and planning with Matt Jones to coordinate future activities. PIs have participated in several PI meetings and are coordinating activities between the Herring and LTM programs. In addition, the AOOS ocean workspace has been rolled out to PIs and their user and group profiles have been created. Several training seminars have been held via webinars and PIs are beginning to use the system to organize and consolidate their project level data. Software engineers at Axiom have also been working to support workspace, resolving bugs and implementing

new functionality in response to user feedback. Significant progress has been made on the Gulfwatch Data Portal to be released in September, 2013.

## II. PROJECT DESIGN

### A. Objectives

1) Provide data management oversight and services for EVOS LTM project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

2) Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

3) Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM effort.

4) Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

### B. Procedural and Scientific Methods

**Objective 1.** Provide data management oversight and services for EVOS LTM project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

AOOS data management staff will work with EVOS LTM investigators to assess the types of data which will be collected during sampling efforts, assess Standard Operating Procedures (SOPs) for data collection to create metadata templates in addition to gauging general data management needs of PIs. This assessment is critical to identify the data management needs and the types of tools needed by researchers to increase their abilities to manage their data in an automated, standard fashion. Table 1 (included at the end of this proposal) details an initial effort by the AOOS data management team to assess the characteristics of each individual LTM project's data collection activities. This initial assessment has provided key details which will assist and guide investigators in developing data management plans and strategizing for the overall data management approach to the program. This exercise further validates the fact that project level data is heterogeneous in nature and is composed of a wide array of observational types requiring novel data management approaches to facilitate integration. It is clear that PIs need both flexible and powerful tools to assist them in sharing, archiving and documenting their research products.

The AOOS data management group is currently developing a web base platform for PIs to manage project level data sets and author metadata. System development is currently funded through internal AOOS funds in additional to dedicated funding from the Prince William Sound Science Center. The AOOS Ocean Workspace will provide a web based platform for PIs to post and share data sets and rapidly author metadata. The system will be enabled with security authentication in order to limit access to LTM investigators, project managers and administrators. The system will also provide PIs with tools to generate metadata profiles which comply with national standards. Initially, this system will focus on

authoring FGDC metadata formats including tools for authoring the biological extension for taxonomic classifications and measurements. The software development phase of this application was initiated in March 2011. An initial beta release/testing of this system will commence in August 2011 with a planned release date of October 1st, 2011. This platform will provide LTM investigators and project managers with a transparent view of data collection and metadata authoring progress in addition to providing a framework for data integration. It is envisioned that this platform will function as the primary vehicle to facilitate data transfer, metadata generation and archiving for the entire LTM project data management lifecycle. This proposed effort will provide a user base and focused environment for the expansion and refinement of this project level data management system.

**Objective 2.** Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

This task will involve isolating and standardizing historic data sets deemed necessary for retrospective analysis by EVOS LTM synthesis efforts. Early in the effort the EVOS LTM researcher team will be engaged to prioritize sources of relevant data deemed of high value for the synthesis effort. Data will be prioritized by several metrics including length of time series, scientific importance, and quality and precision of the data storage format. All data acquired through efforts of this project will be merged into the AOOS data system for long term archival and access.

Members of the LTM integrated team were surveyed to document historical data sources under their stewardship which could be of potential value to the LTM program and synthesis effort. These data resources are listed in Table 2 (included at the end of this proposal). This list will provide a starting point for consolidation/prioritization of data in preparation for synthesis efforts. Table 3 (included at the end of this proposal) provides a list which delineates the data sets researchers would be interested in getting access to but are currently unaware of any sources of data.

Many herring and PWS ecosystem data sets not easily accessible to restoration researchers and managers have been standardized and made available through the actions of the PWS Herring Portal (EVOS Project 070822, 080822 and 090822). Building upon results of the PWS Herring Portal Project, investigators will expand their efforts to additional project level data sets, long term time series produced from sensor platforms, remote sensing/satellite imagery data products, oceanographic/atmospheric/ecological model outputs and relevant GIS data layers. The AOOS data system currently has the capacity to manage all of these data types except for project level data. AOOS will be deploying a project level data management system in the fall of 2011 to address this need. This is the same system referenced in methods of objective 1. Data analysts preparing and salvaging historic project level datasets will leverage this system to consolidate, centralize and document data resources so that LTM investigators can access these data as they are discovered, processed and made available for use.

Additionally, data management staff will leverage existing data management efforts and data sets currently under the stewardship of AOOS in this activity. These resources and efforts are detailed more fully in the “Coordination and Collaboration with Other Efforts” section of this proposal. These existing data resources include a wide array of physical and biological data sets in the general spill affected areas. These resources can be accessed at http://data.aoos.org.

**Objective 3.** Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM effort.

Working with regional agency and outreach staff develop products and management tools that are based upon data produced or acquired from EVOS LTM project activities. Effective data visualization exposes problems, manifests trends, and allows for high level comparisons with other sources of information. Data visualization products are also ideal tools to communicate information to audiences with varying degrees of familiarity in meaningful and easily understandable ways. Providing these types of high level data products allows members of all user groups to rapidly discover assess and comprehend complex data sets. These tools could include emergency response and management applications that provide users with rapid detailed access to threatened habitat, species distribution and real time ocean conditions or outreach and education products that provide users visualizations of relevant data at informational kiosks.

Investigators propose to develop web based data driven tools based upon prioritization and direction from user groups. The process will initiate in year two with the development of a user access tool work plan which will be distributed for review and feedback in May of 2013. The work plan will be finalized in October of 2013 at which time platform development will commence with a target release date of June 2014 for the first version of user data access tools. Addition release versions are planned annually in June alongside annual access tool work plan publishing for review at the Alaska Marine Science Symposium in January.

Figure 1 below provides screen captures of existing AOOS data portals which provide access to data systems that manage sensors, models/remote sensing and GIS data sets. These portals can be accessed off the AOOS website at http://data.aoos.org/.

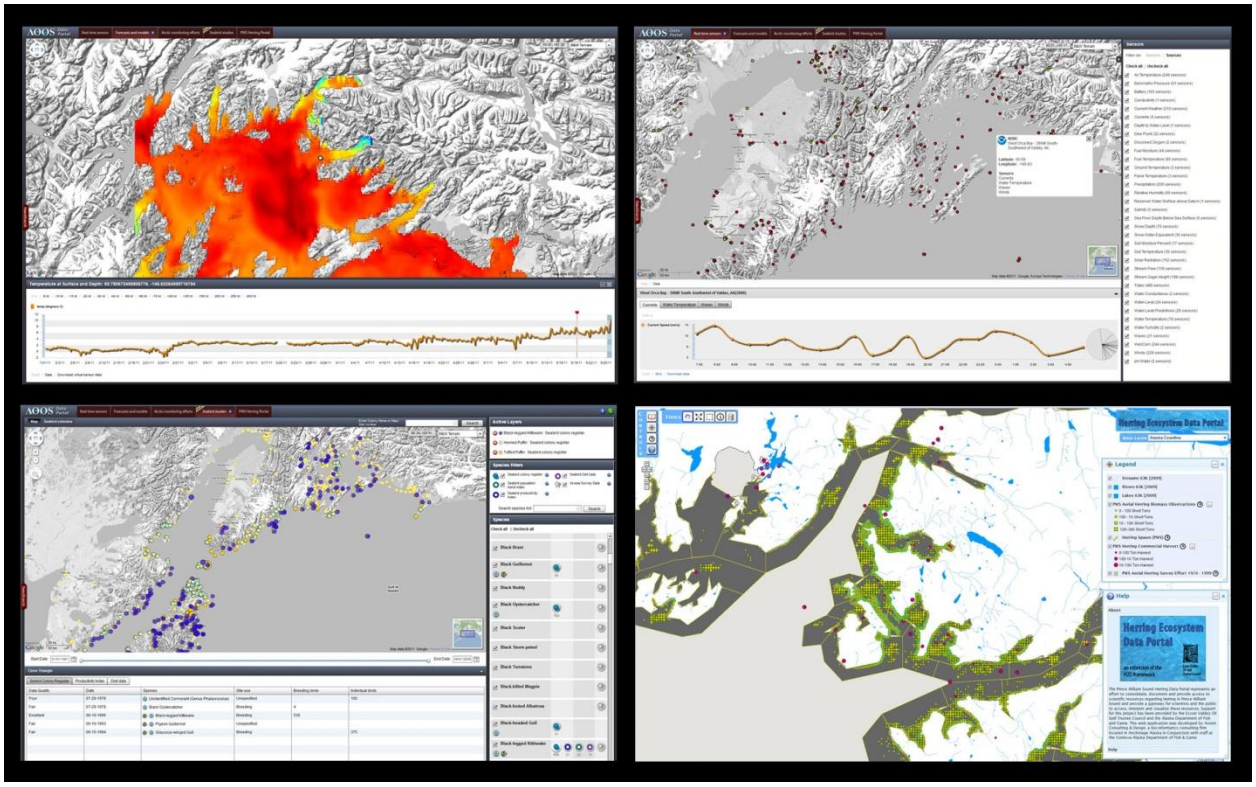


Figure 1. Screenshots of existing AOOS data management and visualization systems which are available at http://data.aoos.org. At the top left is a screenshot of the AOOS model explorer displaying a ROMS circulation model of Prince William Sound and an ocean temperature point source time series extraction near Port Fidalgo. On the top right of the figure is a screen capture of the AOOS real time sensor portal. On the bottom of the figure from the left to right are screenshots of the North Pacific Seabird Portal and the PWS Herring Portal.

**Objective 4.** Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via EVOS IHRP project activities so that it can be transferred efficiently to long term data archive and storage centers and made available for future use by researchers and other user groups. This task will leverage the AOOS cyber infrastructure, long term funding and other active data management projects being undertaken by that organization. Data sets produced from the integrated research effort will be served to users by extending existing data access, analysis and visualization interfaces currently supported and under development by the AOOS data management team.

## C. Data Analysis and Statistical Methods

The overarching strategic plan for the AOOS data system involves implementing an end-to-end technological solution which allows data and information to be channeled and distilled into user-friendly

products while simultaneously enabling the underlying data to be assimilated and used by the emerging external data assembly systems. The following diagram (Figure 2) details the four logical technical tiers of the approach. At the base (Tier 1) of the pyramid lie the source data produced by researchers, instruments, models, and remote sensing platforms which are stored as files or loaded within geospatial databases. Interoperability systems (Tier 2), such as Web Map Services (WMS) and Web Coverage Services (WCS), are then implemented and connected to these underlying data sources. The asset catalogue (Tier 3) connects to internal interoperability systems in addition to known external sources of interoperable data and populates a database describing the dimensional characteristics (space, time, measured parameter, and taxonomy) of each data resource. Also in this third tier are web services which provide access to the descriptive information contained in the asset catalogue database so that applications can more easily utilize data from multiple sources, formats, and types. The final technical level (Tier 4) is composed of the web based applications and tools which provide users access to data and products. Users sit at the top of the pyramid with all underlying systems working together to create a powerful and intuitive user experience. The intended result is the facilitation of rapid data discovery, improved data access, understanding, and the development of knowledge about the physical and biological marine environment.

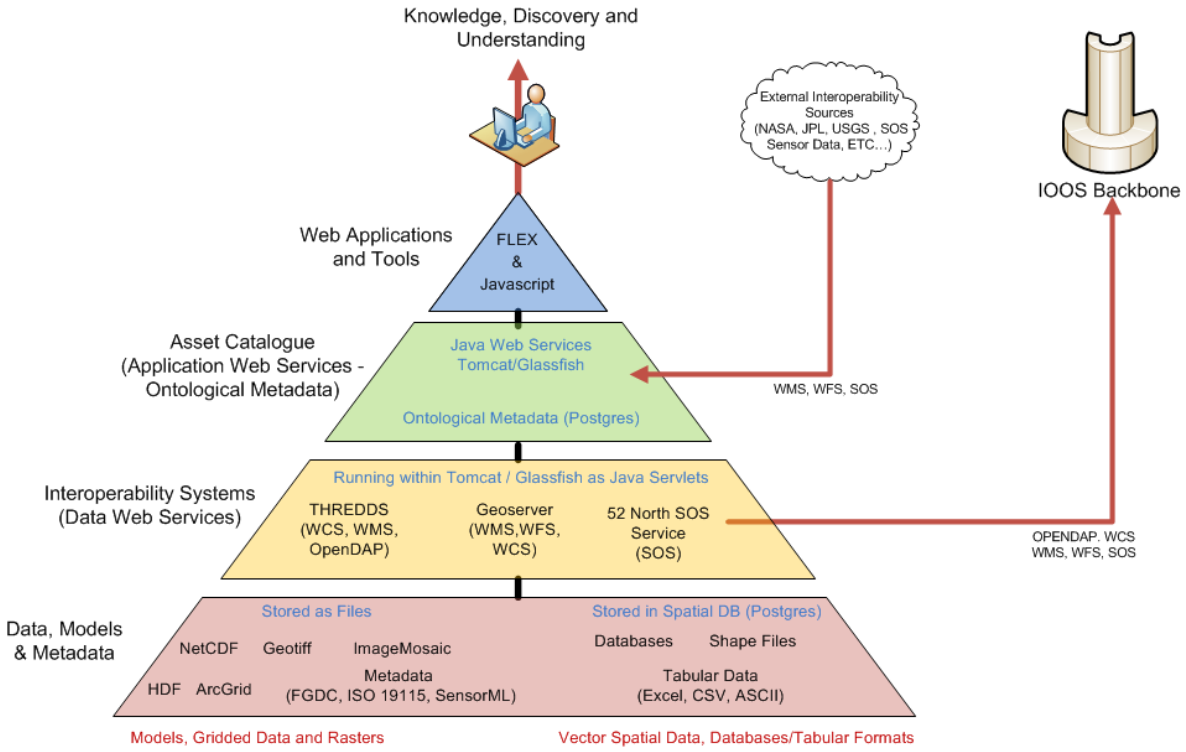


Figure 2. Data knowledge pyramid detailing the flow of data through logical technology tiers so that it can be consumed by users to enable discovery and understanding about the ocean environment.

Tiers are discussed in technical detail below.

- **Tier 1 (Data, Models and Metadata)** – At the base of the proposed data management framework are the datasets, metadata, and model outputs that provide the foundation for applications and user tools. These resources can be stored either in native formats or spatially enabled databases. The decision to choose one method over the other is dictated by the requirements of the interoperability system which will be serving the data. Data which has a tabular or vector form (Shapefiles, databases, Excel spreadsheets, comma separated values (CSV) text files, etc.) will be loaded into a PostgreSQL database and spatially indexed. GeoServer, an open source geospatial data server, will then connect to the PostgreSQL database and serve the data via WFS and WMS protocols. Imagery, raster, and model data will be stored in a file server in their native file formats. THREDDS and/or ncWMS will be used to serve NetCDF and HDF files which may contain two, three, four or higher dimensional gridded datasets. GeoServer or other OGC compliant mapping servers will be utilized to serve GeoTIFF, ArcGrid, ImageMosaic and other two dimensional imagery/raster data.

- **Tier 2 (Interoperability Systems)** – Various interoperability servers (GeoServer, THREDDS, ncWMS, 52 North SOS, etc.) will be implemented on top of source data. By design, these servers will expose a powerful set of interfaces for other computing systems and humans to extract, query, and visualize the underlying source data. These systems will facilitate all aspects of data delivery to users in addition to providing the muscle for the machine-to-machine data transfer to national data assembly systems as required. Because these systems have been developed using the Java programming language, they will run within a servlet container such as Tomcat or Glassfish.

- **Tier 3 (Asset Catalogue, Ontological Metadata and Services)** – The asset catalogue provides a description of known internal and external available data resources, access protocols for these resources (interoperability services, raw file download, etc.), and directives on how to ultimately utilize these data resources in applications. Because documentation and access methods vary widely between data sources, a system which catalogs data sources and reconciles these inconsistencies must be implemented if the data are to be used in an efficient manner.

  In addition to managing information about data availability and access methods, the asset catalogue will also contain an ontology that maps source data descriptions and metadata to a common set of internally stored terms with strict definitions. This mapping will allow users to easily locate related sets of information without having explicit knowledge of the internal naming conventions of each data-providing agency. The development of an internal ontology will also enable future endeavors to connect the asset catalogue to global ontologies in the semantic web. The following dimensions are to be stored in the database for mapping the heterogeneous characteristics of source data to common metrics:

  - **Source** – Service URLs and methods of interaction for these services.
  - **Data formats and return types** – Data format returned by the service and how data can be equated between various formats.
  - **Space (x, y, z)** – Spatial dimensions of dataset (1D, 2D, 3D). Upper and lower spatial bounds (bounding box or cube) stored in common projection (EPSG 4326).
  - **Time (t)** – For data resources with a time component: document time span, whether time corresponds to a single moment or if it is representative of a time period. If data is in discrete periods, document individual available periods.

- **Taxonomy** – Taxonomic data mapped to International Taxonomic Information System (ITIS) codes.
- **Parameter** – Parameter(s) and units in the data resource and how they map to internally defined universal terms. For example: Datasets SST, AVHRR, and Sea_Surface all contain parameters that map to internal universal term Sea Surface Temperature.

Web services written in the Java programming language will be developed to connect to the asset catalogue and provide applications with access to the underlying descriptions of all known data sources. Because the asset catalogue contains a structured ontological definition of data sources and maps all known data sources to a common definition, applications can be developed which connect users to vast arrays of data through simple but powerful interfaces. The following is a list of example functionality that is possible utilizing this methodology:

- Users can load multiple data layers (potentially existing in different physical locations and being served by different systems) onto a single web based map. Users can also filter all layers simultaneously by time or request spatial and temporal subsamples of data that can be pulled from multiple sources and automatically packaged into a single download.
- All real time sensor feeds can be accessed and visualized on a single uniform user interface by parameter even though the sources of the sensor feeds may exist in a wide array of formats and service protocols.
- Users can query the asset catalogue to discover which data is available for an area, time period, parameter, and species.

- **Tier 4 (User Applications)** – Users interface with web based applications that bring together combinations of underlying data and allow users to make discoveries, improve understanding, and develop knowledge through visualization and data access. These types of applications would most likely be interactive map based data portals. Applications will also be developed which provide specific targeted functionality. These focused applications could include marine spatial planning tools, emergency response applications, and educational/outreach portals. Developed tools are designed to meet user needs and thus require user input into their initial design and periodic feedback to direct functional improvements for future design iterations.

## D. Description of Study Area

The majority of this project will involve consolidating existing data, metadata, and other electronic resources related to herring in Spill Affected Area. Specific areas of focus include those areas in PWS, Lower Cook Inlet, and Kodiak where herring fisheries currently do, or historically did occur. The north, east, south, and west bounding coordinates of this area are 59.767, -145.837, 61.834, and -154.334

## E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "Long-Term Monitoring of Marine Conditions and Injured Resources and Services" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring PWS Herring Research and

Monitoring proposal submitted by the Alaska Ocean Observing System. This project is also highly coupled with the proposed data management component of the EVOS Herring Research and Monitoring program.

AOOS brings a significant level of leveraged resources, infrastructure, regional data management projects and partnerships to this proposed effort. The data management effort for the LTM and herring projects could not be accomplished for the budgeted amount by a team without these leveraged resources.

1. AOOS – (500k to AOOS DM) Alaska oceanographic data management effort. Supports open source, standards based data system that serves up and archives real-time sensor feeds, models & remote sensing data, GIS data layers, and historical datasets. Data system developed on interoperability concepts and meets NOAA Integrated Ocean Observing System standards and protocols for streaming data feeds to national data assimilation centers. Data Management Committee chaired by Dr. Phil Mundy provides ongoing advice, prioritization and direction to the team at Axiom Consulting & Design. AOOS board is made up of federal and state agencies, and major marine research institutions in the state that have committed to data sharing. The AOOS board has committed to supporting a statewide data system for as long as AOOS exists. Federal funding is stable, although we would like to see it increase. In the event AOOS was to end, all data and data products would be transferred to the University of Alaska.
2. PWSSC – PWSSC Data Management Project ($50K to AOOS DM).– Project involves the creation of a prototype data management system for use by PWSSC staff to manage, track, document via metadata and visualize oceanographic and biological data being collected at the center. Project will utilize a stack of open source technologies and protocols with the overall goal of creating a packaged solution for research organizations to better manage and document their data resources. This project is to function as the pilot application for the AOOS project level data management system (Ocean Workbench).
3. Northern Forum/USFWS Seabird Data System – ($50K)Project involves the creation and population of a series of new seabird metric databases (diet and productivity) and integrating these new databases with legacy seabird databases (species distribution and abundance at seabird colonies, pelagic species distribution and abundance, USGS seabird monitoring databases and NPRB's North Pacific Seabird Diet Database). Modern spatially explicit, web based data entry interfaces have and continue to be developed to assist researchers existing in distributed agencies to contribute their historic and current seabird metric data into standard data structures. Project will result in vastly increasing the amount and quality of seabird species distribution, diet and other seabird data available for use in retrospective analysis and management. Though data includes areas around all of Alaska, most available data is located in GOA and PWS.
4. AOOS – 3-year funded partnership (~$200K to ADF&G) with ADF&G Division of Commercial Fisheries to develop data sharing and transfer to make commercial fisheries data more accessible, and to allow ADF&G researchers greater access to oceanographic data. Project

builds upon an effort funded by the Moore foundation to develop improved data management capacity and salmon fishery management tools for the PWS fisheries.

5. AOOS – collaborator with Alaska Data Integration Working Group – an initiative with the Alaska Climate Change Executive Roundtable – to develop protocols for serving up project data to increase data sharing among federal and state agencies.
6. AOOS and NOAA – initiatives to develop data sharing agreements with private sector, including oil & gas companies.
7. Cook Inlet Regional Citizens Advisory Council (27K) – contract with Axiom to develop a data management system for their oceanographic and contaminants data in Cook Inlet.

**III. CV's/RESUMES— Please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Provide data management oversight and services for EVOS LTM project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

*This objective will be addressed throughout the entire span of the project and will follow the annual cycle of field data collection and analysis by principal investigators. Investigators will be engaged before each field season to ensure that preparations have been made to stage data collected by the project so that other members of the LTM project can access the data produced by project participants.*

**Objective 2.** Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

*This objective will be met by the fourth quarter of year two of the effort (September 2013).*

**Objective 3.** Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM effort.

*Initial release of version 1 of the user access tool platform will take place in Quarter three of year three* (June 2014). Version 2 and 3 of the user tool platform will be released June 2015 and June 2016 respectively.

**Objective 4.** Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

*This objective will be addressed throughout the entire span of the project. The AOOS data system is to serve as the vessel to capture all project level data produced through this effort in addition to those*

*datasets salvaged to inform the historic synthesis effort. This task will be ongoing as long as the program is producing or acquiring additional data.*

**B. Measurable Project Tasks**

Y3 1st Quarter (February 1, 14 to April 30, 14)

| | |
|---|---|
| February | Finalize user access tool work plan version 1 and initiate development |
| Winter | EVOS workshop with Herring and Long-term monitoring programs |
| March | Submit annual report |
| March | Submit annual financial report |

Y3 2nd Quarter (May 1, 14 to July 31, 14)

| | |
|---|---|
| May | Participate in annual PI meeting |
| June | Submit Y4 work plan for review |
| June | Release version 1 of user tool platform |

Y3 3rd Quarter (August 1, 14 to October 31, 14)

| | |
|---|---|
| September | Submit semi-annual report |
| September | Oversee transfer of field year 3 data |
| October | Assess year 3 datasets and metadata submitted through Ocean Workspace |
| October | Compile feedback from user access tool platform version 1 |

Y3 4th Quarter (November 1, 14 to January 31, 15)

| | |
|---|---|
| January | Annual Marine Science Symposium |

**V. BUDGET**

**Budget Form (attached)**

| **FY14 PROGRAM PROJECT PROPOSAL FORM – A.3** |
|---|
| **Project Title:** Collaborative Data Management and Holistic Synthesis of Impacts and Recovery Status Associated with the Exxon Valdez Oil Spill (EVOS TC Project #12120120) |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Matthew B. Jones, National Center for Ecological Analysis and Synthesis (NCEAS), jones@nceas.ucsb.edu, (907) 957-6509 |

**Abstract:**
The AOOS-led Long-Term Monitoring (LTM) and the PWSSC-led Herring Research and Monitoring (HRM) programs propose an ambitious monitoring and research agenda over the next five years. These efforts could facilitate a more thorough understanding of the effects of the oil spill if the new data and information on the spill-affected ecosystems are effectively managed and collated along with historical data on these systems, and then used in a comprehensive synthesis effort. We propose a collaboration among NCEAS and the AOOS LTM and HRM teams to help build an effective data management cyberinfrastructure for proposed monitoring efforts and organize these data with historical data, including previous EVOSTC-funded efforts, to prepare for synthesis and ensure all data are organized, documented and available to be used by a wide array of technical and non-technical users. Building on the LTM and HRM syntheses and modeling efforts and the 20-year historical data from EVOSTC projects and any available current data, NCEAS would convene two cross-cutting synthesis working groups to do a full-systems analysis of the effects of the 1989 oil spill on Prince William Sound and the state of recovery of the affected ecosystems.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $444.1 | $464.7 | $372.1 | $379.2 | $73.9 | $1,733.9 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: 8/27/2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

In the two decades following the *Exxon Valdez* oil spill (EVOS), and after extensive restoration, research, and monitoring efforts, it has been recognized that full recovery from the spill will take decades and requires long-term monitoring of both the injured resources and factors other than residual oil that may continue to inhibit recovery or adversely impact resources that have recovered. Monitoring information is valuable for assessing recovery of injured species, managing those resources and the services they provide, and informing the communities who depend on the resources. In addition, long-term, consistent, scientific data is critical to allow us to detect and understand ecosystem changes and shifts that directly or indirectly (e.g. through food web relationships) influence the species and services injured by the spill.

An integrated monitoring program requires information on environmental drivers and pelagic and benthic components of the marine ecosystem. Additionally, while extensive monitoring data has been collected thus far through EVOS Trustee Council-funded projects as well as from other sources and made publicly available, much of that information needs to be collated and assessed holistically to understand factors affecting individual species and the ecosystem as a whole. Interdisciplinary syntheses of historical and ongoing monitoring data are needed to answer remaining questions about the recovery of injured resources and impacts of ecosystem change.

Data collected prior to and in response to the Exxon Valdez oil spill are profoundly heterogeneous. They range from long-term, automated sensing of oceanographic and atmospheric conditions, to short-term, experimental, monitoring, and behavioral studies of biological components of the system. The scientific data to be collected in these studies includes data on population trends, behavior, physiology, disease, and genetics of many species, as well as oceanographic and meteorological data at both regional and local scales. This diversity of data and data collection protocols substantially complicates data management by EVOSTC long-term monitoring projects. In addition, investigators on both the long-term monitoring and herring population studies are affiliated with many different institutions and agencies, each currently collecting data from many sites within the spill region and managing it within the frameworks dispersed among these agencies. Any data management system will necessarily need to accommodate this heterogeneity and dispersion by preserving the original data and providing mechanisms to access, integrate, and analyze the data for crosscutting synthesis. Data management activities for oceanographic information occur in isolated, physically distributed agencies, leading to low cross-agency utilization of data. Technical barriers, complex data formats, a lack of standardization and missing metadata have limited access to data and made the utilization of available scientific information cumbersome and daunting. As a consequence, existing data is underutilized and often has not undergone quality assurance.

In this proposal, we outline the collaboration between the National Center for Ecological Analysis and Synthesis (NCEAS), the Alaska Ocean Observing System (AOOS) and their partner Axiom Consulting, and the investigators of the pending Long Term Monitoring (LTM - proposal submitted by McCammon et al.) and Herring Research and Monitoring (HRM – proposal submitted by Pegau et al.) programs (see Figure below). This project will augment the expertise in data management and synthesis of these groups to maximize the efficiency of data collection and management for the LTM and HRM programs and expand access to these data, collate additional historical data that are useful for synthesis from the EVOS affected area, and conduct a broad-ranging synthesis of twenty years of EVOSTC funded research data to generate a comprehensive assessment of ecosystem impacts and recovery status for the spill affected area.

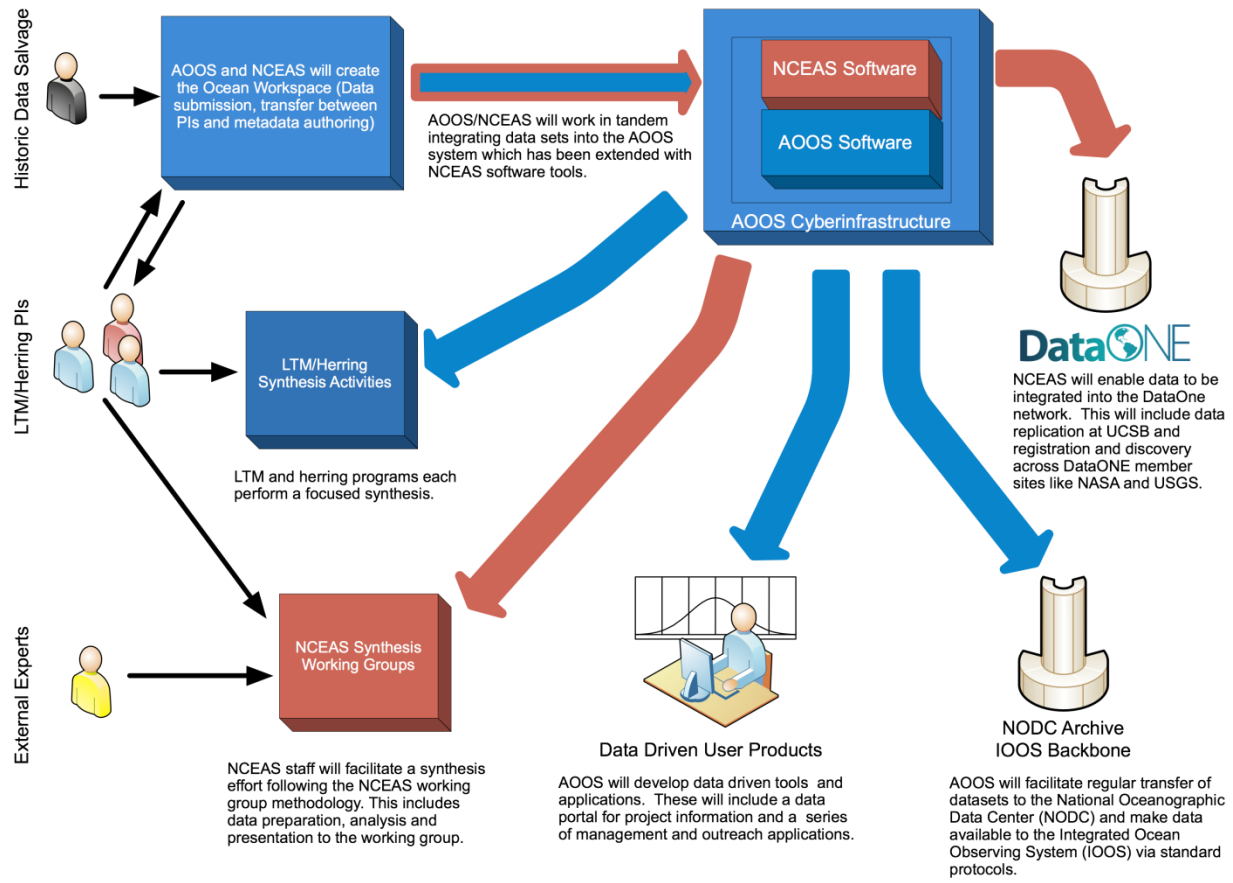


Figure 1. Conceptual description of AOOS/NCEAS/PWSSC collaboration on data management and synthesis activities.

This collaboration document augments the data management, infrastructure development, and synthesis activities previously proposed by the AOOS partners with additional objectives that introduce new technologies from NCEAS to jointly improve the data management infrastructure available to researchers, broaden the scope of data collation and integration, and embark on an ambitious synthesis plan (Figure 1). During the first two years, NCEAS will focus on mining historical data and contributing to development of both the AOOS cyberinfrastructure and the DataONE Federation infrastructure in order to create the necessary data resources for synthesis; during years 3-5, NCEAS will conduct a multi-year working group effort using LTM and HRM principal investigators (PIs) and other internationally renowned researchers to synthesize what is known about spill effects and recovery of ecosystems. These activities will be interwoven with the complementary but distinct data management, technology development, and analysis activities previously proposed by Axiom and AOOS and which are referenced in the objectives below.

**B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities**

The LTM and HRM program proposals outline the relevance of the proposed monitoring, data management and syntheses efforts to the EVOSTC 1994 Restoration Plan goals. This project will further support Restoration Plan priorities for “strategies that involve multi-disciplinary, interagency, or collaborative partnerships” and for efforts that will “include a synthesis of findings and results, and will also provide an indication of important remaining issues or gaps in knowledge” (Restoration Plan p. 16).

This proposed data management and synthesis collaboration builds on the LTM and HRM programmatic efforts and leverages an additional collaboration with the DataONE federation.

**B. Summary of Project to Date (if applicable)**

If the project was funded in previous years, please provide a summary of the goals met to date and what milestones are still outstanding. If there are milestones from the previous year's proposal that have not been met, provide a description of why they could not be met, how much funding remains for the project to complete the milestones and a timeline for their completion.

**II. PROJECT DESIGN**

**A. Objectives**

5) Provide data management oversight and services for project team data centric activities that include data structure optimization, metadata generation, and transfer of data between project teams (AOOS lead, with contributions from NCEAS).
6) Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development (AOOS and NCEAS).
7) Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM and Herring Research efforts (AOOS lead, with contributions from NCEAS).
8) Organize, integrate, analyze, and model the 20-year historical data from EVOSTC-funded projects and other monitoring in the spill area in preparation for synthesis (under LTM and HRM programs and in NCEAS working groups) (NCEAS lead with AOOS contributions).
9) Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use (AOOS lead).
10) Augment AOOS/IOOS preservation and interoperability system with other data systems through integration of DataONE services (NCEAS lead).
11) Conduct additional broad synthesis activities on spill impacts and recovery as part of whole-ecosystem analysis through NCEAS working groups (NCEAS lead with AOOS and PWSSC contributions).

**B. Procedural and Scientific Methods**

**Objective 1.** Provide data management oversight and services for EVOS LTM and HRM project team data centric activities that include data structure optimization, metadata generation, and transfer of data among project PIs and between project teams.

Details of these efforts are provided in the individual detailed project descriptions for the data management components included in both the LTM and HRM projects. Because project level data is so heterogeneous in nature and is composed of a wide variety of observational types (see Table 1 in LTM data management proposal, which details an initial effort by the AOOS data management team to assess the characteristics of individual LTM data collection activities), a broad range of data management approaches are needed to manage the data in an automated, standard fashion and to facilitate integration. In addition, the project Principal Investigators (PIs) need both flexible and powerful tools to assist them in sharing, archiving and documenting their research products. AOOS data management staff will provide the primary support for these efforts with the AOOS Ocean Workspace, a web-based platform for PIs to post and share data sets and rapidly author metadata. The system will be enabled with security authentication in order to temporarily limit access to LTM and HRM investigators, project managers and administrators before data are quality controlled; non-sensitive data will be publicly released after quality processing. The system will also provide PIs with tools to generate metadata profiles that comply with national standards. Initially, this system will focus on authoring FGDC

metadata formats including tools for authoring the biological extension for taxonomic classifications and measurements.

NCEAS engineers will work with the AOOS data team to extend the AOOS data infrastructure to incorporate additional metadata tools and catalogs that are customized for project-based data management for biological data. The design will include both tools for data access and for data contribution and management by the participating scientific staff. The planned AOOS Ocean Workspace (based on non-proprietary open-source standards endorsed by the national Integrated Ocean Observing System) will be enhanced with more biologically-oriented data management tools in order to enable individuals to describe and deposit all of their heterogeneous data in a uniform data repository. Many tools for biological data management, such as metadata generation tools (e.g., Morpho), data analysis tools (e.g., R, Matlab), and synthesis tools (e.g., Kepler) have been developed in parallel to oceanographic tools in use by IOOS; NCEAS will incorporate these tools as appropriate into AOOS systems such as Ocean Workspace, and where that does not make sense, provide interoperability solutions that allow the appropriate tools to work with the AOOS infrastructure (see Objective 6 below). In addition, the heterogeneous data collected by the LTM and HRM projects necessitates a sophisticated data search and discovery system that is effective across data from historical and current LTM and HRM projects. NCEAS will build on their prior work in this area to create a Smart Semantic Search Service that will be deployed as part of the AOOS infrastructure.

This integration of tools from NCEAS contributors into the AOOS cyberinfrastructure will be conducted after a thorough design review and cyberinfrastructure development plan is jointly assembled by AOOS and NCEAS as part of the initial needs and solutions assessment.

**Objective 2.** Consolidate, standardize and provide access to related and historic data sets that are critical for retrospective analysis, synthesis and model development within the LTM and HRM programs. This task will involve isolating and standardizing historic data sets deemed necessary for retrospective analysis by EVOSTC LTM and HRM program synthesis and modeling efforts. Early in the effort the EVOSTC LTM and HRM program researcher teams will be engaged to prioritize sources of relevant data deemed of high value for the synthesis effort. Data will be prioritized by several metrics including its utility to LTM and HRM program syntheses as well as system-wide synthesis efforts (Objective 7), accessibility of the data, length of time series, scientific importance, quality and precision of the data storage format, and the cost of obtaining the data (digitization can be expensive). All data acquired through efforts of this project will be merged into the AOOS data system for long term archival and access.

LTM PIs have already developed a preliminary list of historical data sources under their stewardship which could be of potential value to the LTM program and synthesis effort (see Table 2 in LTM data management proposal), as well as those data PIs would be interested in getting access to are currently unaware of sources (Table 3 in LTM proposal). AOOS funding leverages numerous data sets available through the AOOS website and data system, including the herring and PWS ecosystem data sets that were standardized and made available through the actions of the PWS Herring Portal Project (EVOS Project 070822, 080822 and 090822).

Although data capture will be a collaborative effort, we expect to roughly divide activities into three focal sets of data: 1) LTM and HRM data sets that are newly collected under these projects (AOOS focus); 2) Other EVOSTC project data sets, both current and historical, that lay outside of the LTM and HRM projects (NCEAS focus); and 3) external data sets from other funding groups (joint NCEAS and AOOS focus depending on source).

**Objective 3.** Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM and HRM efforts.

AOOS will take the lead on these efforts, as described in the data management DPDs for the LTM and HRM programs. The AOOS data team will work with project investigators to develop web-based data driven tools based upon prioritization and direction from agency managers, outreach staff and user groups. Effective data summarization and visualization exposes problems, manifests trends, and allows for high-level comparisons with other sources of information. Data visualization products are also ideal tools to communicate information to audiences with varying degrees of familiarity in meaningful and easily understandable ways. NCEAS will provide input and expertise into development of these tools.

**Objective 4.** Organize, integrate, analyze, and model the 20-year historical data from EVOSTC-funded projects in the spill area in preparation for LTM and HRM program and NCEAS working group synthesis efforts.

The current AOOS plan is to emphasize the capture of historical data from previous studies related to the Exxon Valdez oil spill during the first two years of the project, as well as to prepare the system to receive the monitoring data generated during this project. NCEAS will collaborate with the AOOS team in order to collate, summarize, visualize, and integrate these historical data in order to prepare them for synthesis and analysis. NCEAS has developed a group of scientific programmers who specialize in assisting in cross-cutting analysis and modeling, and we will employ one of these scientific programming specialists along with a graduate student assistant to collate, standardize, integrate, summarize, and visualize the data needed for synthesis activities. Digital, graphical and visualization products generated by NCEAS from the 20-year historical datasets will be used for the cross-cutting synthesis activities of the year three EVOSTC joint workshop between the LTM and HRM programs and for the broader EVOS impact syntheses described in Objective 7. Products from these activities will include: data summaries and visualizations from each of the prioritized EVOSTC data sets; quality assurance analyses on input data to resolve issues prior to analysis; integrated data products that resolve methodological differences to combine multiple related primary data sets into long-term, cross-scale derived data products; and analyses of these derived products that illustrate long-term, cross scale aspects of spill impacts and recovery. These activities will build upon the LTM and HRM program synthesis and conceptual ecological modeling efforts focused on the monitoring program data. Please see the detailed project descriptions on LTM synthesis (Holderied), LTM ecological modeling (Hollmen), HRM synthesis (Pegau), and HRM modeling for additional information, as well as the synthesis activities in Objective 7 regarding cross-cutting synthesis efforts.

**Objective 5.** Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use.

The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via EVOS LTM and HRM project activities so that it can be transferred efficiently to long term data archive and storage centers and made available for future use by researchers and other user groups. This task will leverage the AOOS cyberinfrastructure, long-term funding and other active data management projects being undertaken by that organization. Data sets produced from the integrated research effort will be served to users by extending existing data access, analysis and visualization interfaces currently supported and under development by the AOOS data management team. AOOS systems have the capabilities to ingest, archive and serve model output, remote sensing and real time/archived sensor data streams, and, as of fall 2011, ingest and archive GIS and project level data. AOOS is currently developing a mirror site in Portland, OR to ensure long-term security of its data and software. In addition, AOOS has prioritized working with state and federal agencies to ensure long-term access and archiving of agency data and information products.

**Objective 6.** Augment AOOS preservation and interoperability system with other non-IOOS data systems through integration of DataONE services.

NCEAS will augment the capabilities of the AOOS data system by incorporating the services that are part of the DataONE data federation[2]. These include open services for writing data and metadata, controlling access to data products as they are populated in the system, and services for replication and preservation of data. By using the DataONE service framework, this will also link the AOOS and IOOS system to the DataONE federation, which includes partners such as the U.S. Geological Survey, Knowledge Network for Biocomplexity and NASA Distributed Active Archive Centers. This broader federation will be critical in other stages of the project, especially for access to satellite data during synthesis and analysis activities.

In addition, DataONE services include a comprehensive, cross-institutional data preservation model that involves mirroring of data at multiple DataONE participating institutions and continuous active monitoring to ensure data remain valid and that adequate replication is present even in the event of institutional failures. In this project, we will establish the AOOS Asset Catalog as a Member Node in the DataONE network, and thus be able to replicate all EVOS data to DataONE partner institutions to ensure longevity, accessibility, and validity of EVOS data. Funding for these replicas will largely be supported through storage already available on the DataONE network (approximately 1.2 petabytes available for replication), although exceedingly large data sets (above ten terabytes) will need to be discussed.

**Objective 7.** Conduct broad synthesis activities on EVOS impacts and recovery as part of whole-ecosystem analysis through NCEAS working groups.

Since 1995, the National Center for Ecological Analysis and Synthesis (NCEAS)[3] has been advancing the state of ecological and environmental knowledge through synthetic and collaborative research that aims to discover general patterns and principles based on existing data. The premise at NCEAS is that many decades of data have been collected that can be synthesized to produce novel insights into important scientific and societal issues, and that the expertise and information resources necessary to accomplish these syntheses are latent but distributed throughout the science community. To promote effective synthesis of environmental data, NCEAS has sponsored and executed more than 450 working groups over 15 years, many of which have had major scientific and policy impacts (e.g., changes in habitat conservation plans for endangered species, and creation of marine reserve initiatives based on scientific principles). Sociological studies of the working groups in action at NCEAS have demonstrated major shifts in the culture of synthesis in ecology and gains in collaborative productivity via the working group model at NCEAS (Hackett et al. 2008).

Despite decades of monitoring and analysis of EVOS-affected systems, there is still a major lack of understanding of oil spill impacts and recovery at a holistic level. Many of the studies to date have been at the single species level, and recovery status is tracked on a case-by-case basis. In addition, because all of the historical data have never been fully integrated, it has been impossible to conduct a holistic analysis of the effects of the oil spill and recovery of impacted regions. Such a holistic view is critical to guide future monitoring and recovery initiatives, which are expected to continue for decades. NCEAS and PIs from the LTM and HRM programs will conduct two holistic synthesis activities aimed at understanding the long-term, ecosystem-wide consequences of EVOS and the effectiveness of recovery initiatives:

[2] http://dataone.org
[3] http://www.nceas.ucsb.edu

- Synthesis Working Group: Assessing Ecosystem-wide, Long-Term Impacts from the Exxon Valdez Oil Spill
- Synthesis Working Group: Understanding Ecosystem Recovery following the Exxon Valdez Oil Spill

The first will address system-wide impacts from EVOS, and the second will specifically focus on an assessment of recovery of affected systems and reasons for recovery successes and failures that will assist in future recovery initiatives. As detailed below in methods, the products from these syntheses will include a series of reports and academic papers supported by synthesized data, archived models and analyses, and archived model outputs.

These syntheses will build upon the more focused efforts to be conducted by the LTM and HRM programs. For example the working group on *Understanding Ecosystem Recovery* will benefit from the efforts to understand the recovery of an individual species (herring), but expand upon that to include other species including those in the LTM program. It will also provide an opportunity to further explore the connections between environmental variables to the recovery of herring and other species. Because the working group approach takes a more holistic approach than the individual species approach proposed by the HRM program we expect that in answering the question of *Understanding Ecosystem Recovery* we will provide new findings that will guide the LTM and HRM programs in the future.

**C. Data Analysis and Statistical Methods**

***Data Management and Infrastructure Methods***

The overarching strategic plan for the AOOS data system is described in detail in both the LTM and HRM data management detailed project descriptions. It involves implementing an end-to-end technological solution which allows data and information to be channeled and distilled into user-friendly products while simultaneously enabling the underlying data to be assimilated and used by the emerging external data assembly systems. AOOS will lead the development of this system, with NCEAS contributing to the design and implementation, particularly in areas where dealing with data heterogeneity is paramount, such as semantic search. The system has four tiers: 1) data, models and metadata; 2) interoperability systems which facilitate data search, query and delivery; 3) an asset catalogue and Smart Semantic Search Services; and 4) user applications that are web-based. The intended result is the facilitation of rapid data discovery, improved data access, understanding, and the development of knowledge about the physical and biological marine environment. This system meets all the standards of the national Integrated Ocean Observing System.

The asset catalog developed by AOOS will provide an index of all project data and provide direct connections to other Alaska data systems as well as those of the national Integrated Ocean Observing System and Global Ocean Observing Systems. The analysis and synthesis activities described in this proposal however, will also need access to a much broader set of data available not only from AOOS and IOOS, but also from other federated data systems such as NASA's Earth Science Data Information System (ESDIS) and the Earth Observing System Clearinghouse (ECHO). NCEAS engineers will work with the AOOS data team to enhance the AOOS asset catalog, in particular by linking it to the DataONE federated catalog, thereby providing access to non-IOOS data, such as MODIS and other satellite data managed by DataONE Member Nodes. This linkage will require NCEAS to extend AOOS data systems to be compatible with the interoperable web services framework used by DataONE. Current and emerging AOOS web services will be harmonized with DataONE services to allow applications to connect to the asset catalogue and get access to the underlying descriptions of all known data sources. Thus, EVOSTC data will be directly incorporated at the national and global scales into both the IOOS oceanographic data network as well as other data federations via DataONE, thereby greatly expanding agency and

public access. When complete, all data deposited in the AOOS system will also be replicated to participating DataONE member nodes, which are continuously monitored for availability and integrity to enable long-term data preservation.

Due to data heterogeneity, data discovery is difficult for complex, multidimensional and cross-disciplinary data that will be collected by the LTM and HRM program research teams. The AOOS system incorporates a metadata authoring tool that includes extensions for biological metadata. In this project, NCEAS and AOOS will expand on that system and build **Smart Semantic Search Services** that understand the scientific content of data to improve the effectiveness of data searches. The NCEAS team has pioneered a semantic scientific observations model that allows scientists to precisely discover measurements of interest and subset data to only include observations relevant to their studies. NCEAS developed the Extensible Observations Ontology (OBOE; Madin et al. 2008) to enable semantic search and access services that facilitate much higher precision and recall than have been possible with traditional metadata-driven systems. We will incorporate these semantic search services into the AOOS Tier 3 asset catalog, and help to develop the catalog so that semantic markup of data on ingest is easily accomplished. Thus, in addition to managing information about data availability and access methods, the asset catalogue will also contain ontologies that map source data descriptions and metadata to a common set of internally stored terms with strict definitions. This mapping will allow users to easily locate related sets of information without having explicit knowledge of the internal naming conventions of each data-providing agency. The development of an internal ontology will also enable future endeavors to connect the asset catalogue to global ontologies in the semantic web. Because the asset catalogue contains a semantic definition of data sources and maps all known data sources to a common definition, applications can be developed which connect users to vast arrays of data through simple but powerful interfaces.

***Collaborative Synthesis and Analysis Methods***

Two working groups consisting of LTM and HRM program PIs with additional nationally renowned scientists will undertake a broad synthesis of the 20-year data set from EVOSTC-funded projects and other spill area monitoring to improve our assessment of impacts and recovery associated with the EVOS:

- Synthesis Working Group: Assessing Ecosystem-wide, Long-Term Impacts from the Exxon Valdez Oil Spill
- Synthesis Working Group: Understanding Ecosystem Recovery following the Exxon Valdez Oil Spill

The working group syntheses will build on and expand programmatic syntheses conducted under the proposed LTM and HRM programs.

NCEAS has an extensive history of convening highly productive synthesis activities through its use of a working group model, involving face-to-face meetings and ongoing virtual collaboration supported by the Center (Hackett et al. 2008). Under this successful NCEAS model, committed working group participants conduct relevant analysis and modeling on a continuous basis for approximately two years, punctuated by periodic working meetings to come to consensus and drive further work by participants. The momentum of the group is maintained by postdoctoral fellows, funded by this proposal, that reside at NCEAS, working on the group's analysis, modeling, and other synthesis tasks while being able to take advantage of the computational and analytical support services available at NCEAS. Working Groups are composed to represent a wide variety of scientific expertise, including both scientists that are closely involved in the problem at hand, as well as researchers from adjoining disciplines that help broaden the scientific perspective of the group. In addition, Working Groups typically include a mix of more senior scientists and younger scientists that are eager to dive into the required analysis and modeling activities.

Although all travel expenses are paid for by the project, Working Group participants serve voluntarily on these working groups, making the activities especially cost effective.

To initiate these Working Group activities, NCEAS will organize and constitute the groups during year two, and working group activities will commence in year three. Working group leaders will be selected for their knowledge of the issues at hand as well as their ability to effectively motivate a group of up to 14 other working group participants. We would expect that many of the PIs from the LTM and HRM programs would be participants in the synthesis working groups along with nationally renowned experts in population and community modeling, ecosystem modeling, and coupled whole-system analysis. In addition, because NCEAS is already running a working group on ecotoxicology associated with the BP Deepwater Horizon spill[4], we would expect significant coordination and cross-pollination with these new EVOS synthesis groups.

Based on the preparatory data analysis and modeling conducted to assemble and integrate the 20-year historical data set with available current data from the LTM and HRM program syntheses (see Objective 4), NCEAS will work with the leaders of the "Assessing Impacts" and the "Understanding Recovery" working groups to outline an initial set of goals and deliverables for each of the two working groups. At a minimum, each group will produce a comprehensive synopsis report of results from analysis and modeling of the impacts and recovery in the historical and current data that will be written into a series of papers targeting both the science and management communities. The groups will also provide input to the LTM and HRM program teams on recommendations for evolution of the EVOSTC-funded monitoring efforts beyond the initial 5-year programs. All analyses, models, results, and data backing these conclusions will be published alongside these papers in the spirit of open science and to maximize reproducibility of the results (see the previous NCEAS Global Marine Impacts[5] synthesis for an example of this type of output). The actual synthesis activities and products will be selected by working group participants and driven by the data analysis and modeling to maximize working group effectiveness and the relevance of their products. However, example synthesis activities might include cross-scale analysis of the relationship between oceanographic processes and the recovery of forage fish; meta-analysis of the relationship between extent of injury and extent of recovery for organisms crossing taxonomic groups (e.g., mammals, birds, fish, plankton); and, performance of forecasting of cross-trophic recovery scenarios in light of observed population trends.

**D. Description of Study Area**

The study area for this project will include the entire EVOS spill affected area. The north, east, south, and west bounding coordinates of this area are 59.767, -145.837, 61.834, and -154.334

**E. Coordination and Collaboration with the Program**

We propose to integrate the efforts in this project as an additional part of the multi-disciplinary "Long-Term Monitoring of Marine Conditions and Injured Resources and Services" program proposal submitted by McCammon et al. to the EVOSTC. The project represents a collaboration among AOOS, NCEAS, and the other LTM and HRM science project PIs both for individual program data management and in developing syntheses that connect individual project results.

Regarding the data management aspect, AOOS brings extensive experience with creation, collation, and access to extensive oceanographic (physical, chemical and biological) data throughout Alaska, as well as

[4] Anderson, Cherr, and Peterson; Ecotoxicology of the Gulf Oil Spill: A holistic Framework for Assessing Impacts
[5] http://www.nceas.ucsb.edu/globalmarine

a variety of visualization tools and products for resource managers and marine stakeholders. Its initial focus has been on serving up real-time sensor and remote sensing data and forecast models. A new application in October 2011 will include the ability to query, discover and access project level and GIS data sets. In addition, AOOS brings a significant level of leveraged resources, regional data management projects and partnerships to this effort, which could not be accomplished for the budgeted amount without these leveraged resources. These include funded projects for the Alaska Ocean Observing System's Ocean Data Portal, the Prince William Sound Science Center, Northern Forum/USFWS Seabird Data System, the Alaska Department of Fish and Game, and the Cook Inlet Regional Citizens Advisory Council.

NCEAS brings complementary skills to the data management efforts. They have extensive expertise in cyberinfrastructure systems for synthetic environmental science (c.f., Reichman et al. 2011, Jones and Gries 2010, Jones et al. 2006). NCEAS has developed software systems supporting long-term data preservation and sharing, is a leader in metadata systems for science data, and is a progenitor of the DataONE[6] interoperability framework to create a global data federation for open access to scientific data. NCEAS' focus on project-level data management for highly heterogeneous data allow the management of current and legacy data that are critical to synthesis but that often are not captured by large-scale agency data systems, such as the EOSDIS program or the IOOS program. Thus, the initiatives at NCEAS for capturing complex but smaller-scale biological and physical data will be an effective complement to the ocean observatory data management systems that are provided by AOOS.

The syntheses efforts of the LTM, HRM, and NCEAS programs are to be synergistic. The syntheses of the LTM and HRM programs are expected to be program focused. The NCEAS working group syntheses efforts will build upon and augment the programmatic syntheses of the LTM and HRM programs by using a larger-scale synthesis of historical and current monitoring data to provide an assessment of the overall ecosystem impacts of and recovery from the EVOS. There is coupling between the LTM and HRM programs in that the environmental factors important to herring survival are primarily collected in the LTM program and herring represent an important factor in controlling the upper trophic level observations of the LTM. However, the collaboration with NCEAS will allow a more holistic view of how the findings of these programs are connected not only to each other, but with other types of research being conducted. The LTM and HRM program syntheses and personnel are expected to be an important resource for the NCEAS efforts to build upon. In turn the NCEAS led efforts will provide new perspectives to help guide future LTM and HRM efforts. It should be noted that the success of the NCEAS efforts depends on the participation of members of the LTM and HRM programs because of their intimate knowledge of the ecosystem within the EVOS affected region.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Provide data management oversight and services for EVOS LTM project team data centric activities that include data structure optimization, metadata generation, and transfer of data between project teams.

*This objective will be addressed by AOOS and NCEAS throughout the entire span of the project and will follow the annual cycle of field data collection and analysis by principal investigators. NCEAS milestones*

[6] http://dataone.org

*will include incorporation of project-specific data management tools into the Ocean Workspace and development of Smart Semantic Search Services for data discovery.*

**Objective 2.** Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

*This objective will be primarily met by AOOS and NCEAS by the fourth quarter of year two of the effort (September 2013). However, AOOS will continue to add data to the system throughout the entire life of the project, and NCEAS will continue to add data as needed by synthesis efforts through year 4.*

**Objective 3.** Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM and HRM efforts.

*For AOOS, see milestones in LTM and HRM detailed project descriptions. For NCEAS, analysis and visualization tools that are incorporated into the system will be available at the end of year 2 when other software deliverables are produced.*

**Objective 4.** Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use.

*This objective will be addressed throughout the entire span of the project. The AOOS data system is to serve as the vessel to capture all project level data produced through this effort in addition to those datasets salvaged to inform the historic synthesis effort. This task will be ongoing as long as the program is producing or acquiring additional data.*

**Objective 5.** Provide preservation and interoperability with other non-IOOS data systems through integration of DataONE services.

*Initial integration with DataONE will occur in year 1 with a prototype release in Quarter 4, and a final release of DataONE services in year 2 Quarter 4. Once operational, data will continue to be replicated to DataONE as they are produced throughout the span of the project.*

**Objective 6.** Organize, integrate, analyze, and model the 20-year historical data from EVOSTC-funded projects and other monitoring in the spill area in preparation for LTM and HRM program and NCEAS working group synthesis efforts

*Historical and newly generated data will be collated throughout years 1 and 2, with integration and modeling of these occurring as they are collated. Data and modeling summaries will be posted in Quarter 4 of year 1, and the complete historical data set will be available in Quarter 4 of year 2. NCEAS working groups will continue to integrate the data used in their synthesis activities with new data from LTM and HRM projects as it becomes available during years 3 and 4.*

**Objective 7.** Conduct broad synthesis activities on spill impacts and recovery as part of whole-ecosystem analysis through NCEAS working groups.

*Organization of synthesis activities will begin in year 2, with working group meetings and synthesis activities occurring throughout years 3 and 4. Publications and final analyses and conclusions of working groups will be produced in year 5, but we expect some of the publications in earlier years.*

## B. Measurable Project Tasks

**FY14 1st Quarter (February 1, 14 to January 31, 15)**

| | |
|---|---|
| February | Assess year 2 datasets and metadata submitted to AOOS |
| February | Finalize user access tool work plan version 1 and initiate development |

**FY14 2nd Quarter**

| | |
|---|---|
| May | Participate in annual HRM program PI meeting |
| Summer | EVOSTC workshop with LTM and HRM programs supported by LTM and HRM synthesis reports and NCEAS historical data synthesis |

**FY14 3rd Quarter**

**FY14 4th Quarter**

| | |
|---|---|
| November | Participate in LTM program PI meeting |
| December | Create synopsis of FY14 synthesis WG meetings, draft publications |

**FY15 1st Quarter (February 1, 15 to January 31, 16)**

| | |
|---|---|
| February | Assess year 3 datasets and metadata submitted through AOOS |

**FY15 2rd Quarter**

| | |
|---|---|
| May | Participate in annual HRM program PI meeting |

**FY15 3rd Quarter**

| | |
|---|---|
| August | Submit input for five-year plan for FY17-22 |

**FY15 4th Quarter**

| | |
|---|---|
| November | Participate in LTM program PI meeting |
| December | Create synopsis of FY15 synthesis WG meetings, draft and submit publications |

**FY16 1st Quarter (February 1, 16 to January 31, 17)**

| | |
|---|---|
| February | Assess year 4 datasets and metadata submitted through AOOS |
| March | Continue working on acceptance of synthesis group publications |

**FY16 4th Quarter**

| | |
|---|---|
| November | Participate in LTM program PI meeting |
| December | Finalize all synthesis group papers and products |

**V. BUDGET**

**Budget Form (Attached)**

**References**


Hackett EJ, Parker JN, Conz D, Rhoten D, Parker A. 2008. Ecology transformed: The National Center for Ecological Analysis and Synthesis and the changing patterns of ecological research. Pages 277–296 in Olson GM, Zimmerman A, Bos N, eds. Scientific Collaboration on the Internet. MIT Press.

Jones MB and Gries C. 2010. Advances in environmental information management. Ecological Informatics 5: 1–2. doi:10.1016/j.ecoinf.2010.01.001

Jones MB, Schildhauer M, Reichman OJ, and Bowers S. 2006. The new bioinformatics: integrating ecological data from the gene to the biosphere. Annual Review of Ecology, Evolution, and Systematics. 2006. 37:519–544.

Madin JS, Bowers S, Schildhauer M, and Jones MB. 2008. Advancing ecological research with ontologies. Trends in Ecology and Evolution 23 (3): 159-168. doi:10.1016/j.tree.2007.11.007

Reichman, OJ, Jones MB, and Schildhauer MP. 2011. Challenges and Opportunities of Open Data in Ecology. Science 11 February 2011: 703-705. doi:10.1126/science.1197962

**FY14 PROGRAM PROJECT**

**PROPOSAL FORM - A.4**

**Project Title:** Long term monitoring: Program management component – Science Coordination and Synthesis for the Long Term Monitoring Program

**Project Period:** February 1, 2014-January 31, 2015

**Primary Investigator(s):** Kris Holderied, NOAA Kasitsna Bay Laboratory, Kris.Holderied@noaa.gov, 907-235-4004, 2181 Kachemak Drive, Homer, AK 99603

**Abstract:** This project is part of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et al. Long-term monitoring has been implemented within the *Exxon Valdez* Oil Spill (EVOS)-affected region under a variety of organizations and programs. However, many of these efforts have been conducted independently, with emphasis on monitoring of single species or within individual disciplines. By explicitly providing for science coordination and syntheses of data from our long-term monitoring program, as well as incorporating an interdisciplinary framework into program development and implementation, we seek to improve open access to multi-disciplinary data and promote use of integrated information from the entire program for both research and resource management in the EVOS-affected region. The science coordination and synthesis component of our integrated program improves linkages between monitoring in different regions as well within a given region, as a way to better discern the impacts of environmental change on restoration and continued recovery of injured resources. Science coordination includes facilitating program planning and sharing of information between principal investigators, developing annual reports on the science program, and coordinating ongoing evaluation of the overall program. Science synthesis efforts helps integrate information across the entire program and is closely coordinated with the conceptual ecological modeling and data management teams in our integrated program.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $123.5 | $139.0 | $148.3 | $146.1 | $151.6 | $708.5 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 29, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

In the two decades following the *Exxon Valdez* oil spill (EVOS), and after extensive restoration, research and monitoring efforts, it has been recognized that full recovery from the spill will take decades and requires long-term monitoring of both the injured resources and factors other than residual oil that may continue to inhibit recovery or adversely impact resources that have recovered. Monitoring information is valuable for assessing recovery of injured species, managing those resources and the services they provide, and informing the communities who depend on the resources. In addition, long-term, consistent, scientific data is critical to allow us to detect and understand ecosystem changes and shifts

that directly or indirectly (e.g. through food web relationships) influence the species and services injured by the spill.

An integrated monitoring program requires information on environmental drivers and pelagic and benthic components of the marine ecosystem. Additionally, while extensive monitoring data has been collected thus far through EVOS Trustee Council (TC)-funded projects as well as from other sources and made publicly available, much of that information needs to be assessed holistically to understand the range of factors affecting individual species and the ecosystem as a whole. Interdisciplinary syntheses of historical and ongoing monitoring data are required to answer remaining questions about the recovery of injured resources and impacts of ecosystem change.

The overarching goal of the long-term monitoring program is to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources and services. The science coordination and synthesis effort support this goal by documenting the overall science monitoring program, improving information sharing between PIs and with the herring program, assisting in development of multi-disciplinary datasets and tools, and informing an ongoing evaluation of the long term monitoring program's effectiveness and priorities in meeting EVOS TC goals.

**B. Summary of Project to Date**

We have focused our efforts on developing program integration and visualization tools and have continued working on the coordination aspect of the program. Project milestones that have been met in the previous year of the program included: a) development of an interactive shared work calendar; b) updates and improvements to ocean workspace that facilitates use by program participants including providing training opportunities and assistance with metadata development and data sharing; c) development of an integrated 'trend card' framework to facilitate data sharing within and outside the program; d) planning of the annual meeting incorporating synthesis work with the Herring Research and Monitoring group, including a time-series workshop. We have also begun work on external program integration with the North Pacific Research Board programs and science synthesis with the herring program. A science coordinator, Tammy Neher (see attached *CV*), was hired and began working in the Gulf Watch Alaska program in late March. This position provides a facilitator for communication, integration, and synthesis both within the program and to outside entities.

**II. PROJECT DESIGN**

**A. Objectives**

1. *Improve **communication, data sharing and** coordinated field work **planning** between principal investigators (PIs) of the individual monitoring projects, as well as with other agencies and research organizations;*

2. *Improve and document **integration of science monitoring** results across the LTM program* - working with the PIs, data management and modeling teams as well as other agencies and research organizations; and

3. *Improve **communication of monitoring information** to resource managers and the public through data synthesis and visualization products and tools* – working with the data management, conceptual ecological modeling and outreach teams, as well as other agencies and research organizations.

Science coordination and synthesis efforts are closely coordinated with and informed by our LTM program administration, data management, conceptual ecological modeling and outreach efforts, as well as by planning and results from the EVOSTC-funded herring program. As outlined in the proposal submitted by McCammon et al., the science synthesis effort of our LTM program helps fill a coordination gap between science and monitoring programs in the spill-affected region, specifically including the North Pacific Research Board (NPRB) Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), the National Park Service (NPS) Inventory and Monitoring Program, other agency monitoring programs, separately-funded projects of the Alaska Ocean Observing System (AOOS), and multi-agency and university collaborative programs such as the Geographic Information Network of Alaska (GINA), Alaska Statewide Digital Mapping Initiative (SDMI) and Landscape Conservation Cooperatives (LCCs).

**B. Procedural and Scientific Methods**

Kris Holderied serves as the science lead for the LTM program and contribute approximately one month of in-kind labor to program coordination and synthesis efforts. A full-time science coordinator was hired in March of this year to conduct the bulk of science coordination and synthesis efforts proposed. Labor rates for the science coordinator are escalated by approximately 3% each year. Funding is also requested for office space, computers and supplies for the science coordinator and travel for the science lead and science coordinator. Please see detailed budget submission for additional information.

*Objective 1: Improve data sharing and coordinated field work planning between PIs of the individual monitoring projects, as well as with other agencies and research organizations*

a. Coordinate with Team Lead, PIs, adminstrative team and EVOSTC staff on overall LTM program planning, reporting and evaluation.

b. Plan agenda and facilitate annual PI meeting. Meeting logistics will be handled by the administrative team.

c. Develop and maintain ongoing field work schedule for posting on LTM program website.

d. Coordinate with the herring program lead on program implementation and joint information needs.

e. Coordinate with groups outside the LTM program (NPRB GOAIERP, NPS, GINA, LCCs etc.) on joint synthesis of information.

*Objective 2: Improve and document integration of science monitoring results across the LTM program*

a. Prepare annual and final reports on overall science monitoring effort, working with the LTM lead (M. McCammon), Administration team, PIs, data management team, and outreach team.

b. Assist data management and conceptual ecological modeling teams with historical data synthesis. Initial emphasis will be on time series within the LTM program, and then expand to other time series. Level of effort required will be evaluated after year 1.

c. Coordinate development of a monitoring data synthesis report for Year 3 joint workshop between LTM and herring programs.

d. Help plan and facilitate Year 3 integrated workshop between LTM and herring programs with LTM lead, administrative team, EVOS TC staff, and herring program lead

e. Coordinate with PIs to improve integration of multi-disciplinary monitoring activities within geographic regions (PWS, outer Kenai Peninsula coast, lower Cook Inlet) and of monitoring within single disciplines between different regions.

f. Assist in development of conceptual ecological models with the modeling team, herring program lead, and outside groups.

*Objective 3: Improve communication of monitoring information to resource managers and the public through data synthesis and visualization products and tools*

a. Work with data management team, modeling PI, and outreach team to develop data exploration and visualization tools. Initial focus will be to investigate and implement simple tools that are already being used in other monitoring programs. One example would be a simple web-based trend analysis and site comparison visualization tool for physical oceanographic data.

b. Assist in outreach of conceptual ecological models with the modeling team, herring program lead, outreach team, and outside groups.

c. Assist with internal "beta" testing of initial data visualizations and tools developed by the data management team.

d. Network with other monitoring programs and regional stakeholders to identify information needs that may be met by improved data visualization tools for the LTM program data.

Coordination

As described in detail in the summaries for the environmental drivers, benthic and pelagic component plans in Appendix 1 of the proposal submitted by McCammon et al., the monitoring efforts under this program are closely coordinated with existing monitoring by other agencies and research organizations. We are working with several program managers and scientists in these monitoring programs as part of the synthesis effort. Some are participating as principal or collaborating investigators in the program

and others are sharing data and coordinating on monitoring protocols. Some examples include the NPRB GOAIERP, the Alaska Ocean Observing System's GOA programs, National Park Service Inventory and Monitoring Program, Kachemak Bay Research Reserve System-Wide Monitoring Program, Cook Inlet and Prince William Sound Regional Citizens Advisory Council monitoring programs, U.S. Fish and Wildlife sea otter surveys, small mesh trawl fishery surveys conducted by NOAA National Marine Fisheries Service (NMFS) and the Alaska Department of Fish and Game (ADF&G) and new oceanographic monitoring to be conducted by the NMFS Kodiak Laboratory.

Please also see work plans for individual monitoring projects, data management efforts and conceptual ecological modeling efforts for more information on the specific scientific and data handling procedures and methods that will be used within our proposed LTM program.

Synthesis

Necessarily, the initial priorities for science synthesis is to support integration of data collected by project PIs during the initial 5-year program as well as of historical data collected under the same programs in the past. We are in the process of cataloging and indexing many of the available historical datasets and developing a catalog of peer reviewed literature using the interactive Medelay software package to share literature. The science synthesis and data management teams work together on this effort. We recognize the need to also integrate data from other research and monitoring programs such as those listed above, and are doing so to the extent possible within the amount of funds available for the long-term monitoring program. Our data management program ensures that these other science programs have ready access to information from all projects in our monitoring program.

**C. Data Analysis and Statistical Methods**

Please see the detailed project descriptions for the Data Management and Conceptual Ecological Modeling components of the integrated long-term monitoring proposal by McCammon et al for details on proposed data analyses. As described above, integration of data between multi-disciplinary projects and helping to provide improved access to that information by PIs, resource managers, coastal planners, the research community and the general public will be the primary focus of the program-wide science synthesis effort.

**D. Description of Study Area**

The study area includes all areas identified for projects in the environmental, pelagic, and benthic monitoring components of the integrated program "Long-Term Monitoring of Marine Conditions and Injured Resources and Services" submitted by McCammon et. al.

**E. Coordination and Collaboration with the Program**

The primary goals of the LTM program science coordination and synthesis efforts are to:

1) support coordination between the EVOSTC-funded LTM projects, 2) facilitate coordination with the EVOSTC-funded herring program, and 3) support collaborations with other efforts, including state and

federal agency operations and research programs funded by other organizations such as NPRB. Please see above sections and the schedule below for details.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

Most milestones for the science coordination and synthesis effort will be met each year in an ongoing process.

**Objective 1.** Improve data sharing and coordinated field work planning between project PIs and other agencies and research organizations.
*Annual PI meetings to be conducted each year (tentatively in November)*
*Initial coordinated field work schedule*
*LTM program update at Alaska Marine Science Symposium each year*
*Annual LTM proposed work plan submission to be met by August of each year*

**Objective 2**. Improve and document integration of science monitoring results across the LTM program.
*Annual LTM progress report submission to be met by August each year*
*Initial synthesis of historical data available in digital format from LTM projects to be met by September 2013*
*Data synthesis report for Year 3 joint workshop to be met by October 2014*

**Objective 3**. Improve communication of monitoring information to resource managers and the public through data synthesis and visualization products and tools.
*Development of initial tool*
*Workshops and Integrated discussion groups held each year.*
(see Data Management project description for additional milestones)

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**

*Facilitate joint workshop between LTM and herring program PIs (replaces annual PI meeting)*
*Continue to assist development of new data visualization and access tools*
*Attend Alaska Marine Science Symposium and provide update on LTM program*
*Submit report on updated synthesis of historical data.*
*Submit proposed work plan for FFY 15*
*Submit annual report on monitoring efforts in the LTM program*

**V. BUDGET**

**Budget Form (Attached)**

**FY14 PROGRAM PROJECT**
**PROPOSAL FORM – A.5**

**Project Title:** Long-term Monitoring: Synthesis and Conceptual Modeling - Conceptual Ecological Modeling

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator(s):** Tuula Hollmen, Alaska SeaLife Center and University of Alaska Fairbanks, PO Box 1329, Seward, AK 99664; Phone: 907-224-6323; Fax 907-224-6320; Email: tuulah@alaskasealife.org

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. Under this research project, we will develop conceptual ecological models to support the synthesis and planning relating to the long term monitoring program in Prince William Sound, outer Kenai coast, and lower Cook Inlet/Kachemak Bay. To develop these models, we will summarize system components, processes, and influences into a synthetic framework. The conceptual models will assist in identification of data needs and development of further long term monitoring priorities, and support ecosystem based understanding, monitoring, and management of resources within our study area. The conceptual models will also provide guidance for development of numerical and quantitative models of system function and responses to external influences. Finally, the conceptual models will provide a communication tool among scientists, resource managers, policy-makers, and the general public, and will offer outreach opportunities for our project by using data visualization and interactive web-based tools. Development of conceptual ecological models is a multi-step, iterative process, responding to evolving understanding of the structure and dynamics of the system by revising and refining models throughout the process. Specific steps of the process involve: defining goals and scope of the modeling, summarizing current understanding of system structure and processes, defining environmental and anthropogenic influences included in the modeling, development of relevant hierarchies and submodels, refining models with increased understanding of system function, and development of interactive and visualization tools to provide methods to use models for long term planning, development of hypotheses, data exploration, and outreach.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $83.1 | $91.9 | $95.6 | $78.6 | $81.9 | $431.0 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 23, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

In the two decades following the *Exxon Valdez* oil spill (EVOS), and after extensive restoration, research and monitoring efforts, it has been recognized that full recovery from the spill will take decades and requires long-term monitoring of both the injured resources and factors other than residual oil that may continue to inhibit recovery or adversely impact resources that have recovered. Monitoring information is valuable for assessing recovery of injured species, managing those resources and the services they provide, and informing the communities who depend on the resources. In addition, long-term, consistent, scientific data is critical to allow us to detect and understand ecosystem changes and shifts that directly or indirectly (e.g. through food web relationships) influence the species and services injured by the spill.

An integrated monitoring program requires information on environmental drivers and pelagic and benthic components of the marine ecosystem. Additionally, while extensive monitoring data has been collected thus far through EVOS Trustee Council-funded projects as well as from other sources and made publicly available, much of that information needs to be assessed holistically to understand the range of factors affecting individual species and the ecosystem as a whole. Interdisciplinary syntheses of historical and ongoing monitoring data are needed to answer remaining questions about the recovery of injured resources and impacts of ecosystem change.

We propose to develop and implement a long-term monitoring program that meets the need for information to guide restoration activities, including data on the status and condition of resources, whether they are recovering, and what factors may be constraining recovery. The ultimate goal of the long-term monitoring program is to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources and services.

The conceptual ecological modeling component of our study plan will provide a framework for 1. exploration, understanding, and synthesis of key components and processes of our study system, 2. refinement and development of further monitoring strategies, and 3. development of outreach and communication tools among scientists, managers, general public, and other interested parties. The conceptual models are developed to support the synthesis of data and to serve as a framework and

guide for development of monitoring priorities, to meet the overall goals of the long term monitoring program.

**B. Summary of Project to Date (if applicable)**

Project tasks and milestones as outlined in the proposal have included: development of goals for conceptual models, identification of data and system components for the modeling, assembly of a modeling team, facilitation of a modeling workshop to obtain PI input, design of draft conceptual models, development of data visualization tools for model components, and preparation of progress reports.

## II. PROJECT DESIGN

### A. Objectives

1. *Develop conceptual ecological models, summarizing key components, processes, and functions of the study system*
2. *Develop computer applications and web-based interfaces for interactive data exploration and visualization*

Conceptual ecological models are considered a key element of environmental and biological monitoring programs, and provide a qualitative representation of the structure and dynamic properties of the ecosystem. Models define scope and provide a scientific framework for monitoring programs by describing current understanding of system structure, processes, and function, including key system components and their interactions. Models provide a method to integrate current knowledge of the system originating from a variety of data sources, such us multiple long term studies focusing on different species or components of the system. Models provide critical tools to address uncertainties or incomplete understanding of ecosystem function, and provide the basis for development of causal hypotheses among environmental or anthropogenic stressors, ecological effects, and management actions. Conceptual models provide tools for further development of long term plans in multiple ways. Models can be utilized to identify information needs and suitable indicators for further development and design of long term monitoring plans. Models can be used to demonstrate learning through the course of the research program. Conceptual, qualitative models facilitate further development of quantitative data models (such as predictive scenario models). Models also provide support tools for restoration planning and resource management.

Conceptual models provide a schematic framework to organize and illustrate complex system structure and linkages, thus serving as a tool to facilitate understanding and communication among scientists, managers, and the public. Development of data visualization tools facilitates outreach, education, and communication through web-based applications and presentations.

### B. Procedural and Scientific Methods

1. *Develop conceptual ecological models, summarizing key components, processes, and functions of the study system*

   Development of conceptual ecological models to support synthesis and planning of the long term monitoring program is a multi-phase process. Identification of key components, processes, and functions of the system is a key step involving the PIs of the benthic, pelagic, and

environmental components of the project. PI input is elicited at annual PI meetings, workshops focusing on model development, and other interactions with PIs throughout the year. The conceptual models in development reflect the status of the current knowledge of the system, and they will be refined as understanding of the system evolves through the research program. This approach provides out program a tool to demonstrate learning throughout a long term research and monitoring program.

The basic conceptual model will represent the structure, processes, and key interactions of the system. Models to demonstrate knowledge and hypotheses about linkages between specific stressors (environmental and/or anthropogenic) and ecological responses can be incorporated into the system models, and will include a subset of system components representing key questions as identified by project PIs. Furthermore, submodels may be used to address specific goals and needs of the long term research program and further development of monitoring strategies.

2. *Develop computer applications and web-based interfaces for interactive data exploration and visualization*

   Conceptual models are suited for interactive web-based presentation to offer data visualization tools to audiences at different levels of technical expertise related to the computations behind the models. We develop applications to facilitate outreach about the progress of our project and tools to communicate our research to variety of outside audiences. Visualization products are developed using multiple approaches, including mapping and diagrams. Data visualization tools can be produced at different levels of computational and output complexity, we propose to begin the development of simple data visualization tools representing selected components of the monitoring programs to facilitate outreach and communication efforts for our program.

**C. Data Analysis and Statistical Methods**

The conceptual ecological modeling involves qualitative and quantitative analyses of ecosystem components and processes. Information about the system is elicited from PIs to construct the models. Analytical and visualization tools and methods include structural and influence diagrams, tabulated data, narratives, spatial maps, and quantitative analyses of PI input. Diagrams are used for the development of visualization tools. Data analysis involves synthesis of PI input to develop a generic GOA conceptual ecosystem model, refinement of linkage rating tools to assess state of knowledge and importance of physical and biological processes linking system components, and application of these tools to develop submodels for specific system components. We summarize a parsimonious generic GOA conceptual ecosystem model and develop a visual diagram output based on conceptual model diagrams developed by teams of benthic, pelagic, and environmental driver project PIs, representing key linkages based on PI input. The generic model serves as a visual representation of current state of our knowledge about structure and function of the GOA ecosystem, and an iterative tool to be updated to demonstrate learning contribution by GWA research. We analyze PI input on ecological linkage rating tool exercise from November 2012 PI meeting, summarize results from example submodel from the November 2012 PI meeting, and refine a linkage rating tool applicable to modeling efforts.to address a suite of factors related to the strength of linkages, temporal and spatial scales, and state of knowledge. Submodels can be further utilized to build linkages between scientific goals and management objectives, using conceptual modeling and tools of structured decision analysis. We anticipate that we are able to initiate

the process linking scientific and management objectives during the next year, although the tasks were not specified as a milestone in the original proposal.

**D. Description of Study Area**

The study area will be the same as for the environmental, pelagic, and benthic monitoring components of the GulfWatch Alaska program.

**E. Coordination and Collaboration with the Program**

The modeling project will be closely coordinated with the science synthesis and the long term monitoring projects proposed for this integrated study, including pelagic, benthic, and environmental components. The PI of the model development task will work closely with the Science Team Leader, attend the annual PI meetings, and coordinate additional meetings and a workshop to interact and coordinate input from PIs of the monitoring components. Furthermore, modeling efforts will be coordinated with other existing monitoring and ecological research programs, including the Gulf of Alaska Integrated Ecosystem Research Program funded by the North Pacific Research Board, and the Vital Signs Monitoring Program by the National Park Service. Development of visualization tools will be coordinated with the outreach committee of our program.

**III. CVs/RESUMES- please see appendix 2**
**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Develop a conceptual ecological model of the study system.
*Conceptual ecosystem model: To be met by June 2016*

**Objective 2**. Develop computer applications and web-based interfaces for interactive data exploration and visualization.
*Web based interactive conceptual model: To be met by September 2016*

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**

| | |
|---|---|
| *February 2014* | *Project funding available* |
| *May 2014* | *Develop a draft generic model, refine linkage rating tools* |

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

| | |
|---|---|
| *August, 2014* | *Continue development of /data visualization tools* |
| *August 2014* | *Continue development of conceptual models and submodels* |
| *August 2014* | *Prepare modeling progress update for annual report* |

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

| | |
|---|---|
| *November 2014* | *Continue development of /data visualization tools* |
| *November 2014* | *Continue development of conceptual models and submodels* |
| *November 2014* | *Design and initiate process to link scientific goals with management objectives* |
| *November 2014* | *Attend annual PI meeting* |

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**

| | |
|---|---|
| *January 2015:* | *Attend AMSS* |
| *January 2015* | *Continue development of conceptual models and submodels* |
| *January 2015* | *Continue process to link scientific goals with management objectives* |

**V. BUDGET**

**Budget Form (Attached)**

## Environmental Drivers Monitoring Component (leads – Weingartner & Hopcroft)

| **FY14 PROGRAM PROJECT**<br><br>**PROPOSAL FORM** |
|---|
| **Project Title:** Long-term monitoring: Environmental Drivers component - Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK 1. |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Thomas Weingartner, Principal Investigator, School of Fisheries and Ocean Science, University of Alaska, Fairbanks, AK 99775 (907-474-7993; tjweingartner@alaska.edu) |

**Abstract:**

This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al.

This program continues a 40-year time series of temperature and salinity measurements at hydrographic station GAK 1. The data set, which began in 1970, now consists of monthly CTDs and a mooring with 6 temperature/conductivity recorders throughout the water column and a nitrate sensor at 150 m depth. The project monitors four important Alaska Coastal Current ecosystem parameters that will quantify and help understand interannual and longer period variability in:

1. Temperature and salinity throughout the 250 m deep water column,
2. Near surface stratification,
3. Near and subsurface nitrate supply on the inner shelf.

In aggregate these variables are basic descriptors of the Alaska Coastal Current, an important habitat and migratory corridor for organisms inhabiting the northern Gulf of Alaska, including Prince William Sound.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $109.5 | $112.5 | $115.7 | $119.1 | $122.5 | $579.3 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used: none**

**Date: August 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Justification

The purpose of this proposal is to provide long-term monitoring data on the physical oceanography of the Alaska Coastal Current and the northern GoA shelf. The Alaska Coastal Current (ACC) is the most prominent feature of the Gulf of Alaska's shelf circulation. It is a narrow (~40 km), swift, year-round flow maintained by the integrated forcing of winds and coastal freshwater discharge. That forcing is variable and reflected in ACC properties. The current originates on the British Columbian shelf and leaves the Gulf for the Bering Sea through Unimak Pass. Substantial portions of the ACC circulate through Prince William Sound and feed lower Cook Inlet and Kachemak Bay before flowing southwestward through Shelikof Strait. The current controls water exchange and transmits its

properties into the fjords and bays between Prince William Sound and the Alaskan Peninsula. The monitoring proposed herein quantifies variability of the Gulf's shelf environment. ACC monitoring provides the broader-scale context for understanding variability in adjacent marine ecosystems and its affect on particular species (e.g., herring, salmon, forage fish). The ACC's variability is transmitted to nearshore habitats around the gulf.

Measurements at GAK 1 (Figure 4), at the mouth of Resurrection Bay, began in 1970. Initially the sampling was opportunistic, became more regular in the 1980s and 1990s, and systematic beginning in 1997 with EVOSTC support. Since then it involves involves quasi-monthly conductivity-temperature versus depth (CTD) casts and hourly temperature and salinity measurements at 6 depths distributed over the water column. GAK 1 is *the only station* in the GoA that measures both salinity and temperature over the 250 m deep water column.

The 40-year GAK 1 time series has documented:

1. The large interannual differences associated with El Nino and La Nina events, including substantial differences in the spring bloom between these phenomena (Weingartner et al., 2003, Childers et al., 2005).
2. The intimate connection between coastal freshwater discharge and the depth-varying evolution of winter and spring temperatures over the shelf (Janout et al., 2010; Janout 2009).
3. That GAK 1 is a reliable index of ACC transports of mass, heat, and freshwater (Weingartner et al., 2005).
4. That GAK 1 near-surface salinities are correlated with coastal freshwater discharge from around the Gulf (Weingartner et al., 2005).
5. Variations in mixed-layer depth in the northern Gulf, which affects primary production (Sakar et al., 2006)
6. Decadal scale trends in salinity and temperature, (Royer, 2005; Royer and Grosch, 2006; Weingartner et al., 2005, and Janout et al., 2010).
7. The relationships between temperature and salinity variations and the Pacific Decadal Oscillation and the strength and position of the Aleutian Low (Royer, 2005; Weingartner et al., 2005, and Janout et al., 2010)
8. That the record can guide understanding the variability in iron concentrations, a potentially limiting micro-nutrient required by many phytoplankton. Preliminary efforts indicate that iron and surface salinity are correlated at least in certain seasons (Wu, et al., 2008).

As shown by Meuter et al., (1994), Meuter (2004), and Spies (2009), these issues affect ecosystem processes on both the shelf and within Prince William Sound and Lower Cook Inlet/Kachemak Bay.

**B. Summary of Project to Date (if applicable)**

If the project was funded in previous years, please provide a summary of the goals met to date and what milestones are still outstanding. If there are milestones from the previous year's proposal that have not been met, provide a description of why they could not be met, how much funding remains for the project to complete the milestones and a timeline for their completion.

**II. PROJECT DESIGN**

**A. Objectives**

The fundamental goal of this program is to provide a high quality, long-term data to quantify and understand monthly, seasonal, interannual and longer period variability of the GoA shelf. This measurement provides the broader scale spatial perspective discussed on pages 1 -5. Specifically we will measure:

1. Temperature and salinity throughout the water column,
2. Near surface stratification since this affects phytoplankton bloom dynamics,

3. Near and subsurface nitrate supply on the inner shelf, since this important nutrient affects phytoplankton production,

**B. Procedural and Scientific Methods**

Following past protocols, we propose quasi-monthly (up to 8 per year) CTD measurements and year-long, continuous measurements from a subsurface mooring with temperature and conductivity (T/C) recorders placed at nominal depths of 20, 30, 60, 100, 150, 200, and 250 m. We also include 1 - 2 ISUS (*In Situ* Ultraviolet Sensor) sensors at 20 m and at 150 m depth. These instruments optically determine nitrate based on the nitrate UV-absorption spectrum. This spectrum is unique for nitrate and it is resolved by the 256-channel ISUS spectrometer and interpreted by an algorithm developed by the Monterey Bay Aquarium Research Institute. The 20 m ISUS is within the euphotic zone and complements the fluorometer data. The 150 m ISUS will gauge the annual re-supply of nitrate to this shelf (and also Prince William Sound) through the annual exchange between deep shelf and slope waters. The deep water (and nitrate) is mixed to the surface in winter and is thereby available to phytoplankton at the onset of the spring bloom. ISUS sensors appear to provide sufficiently reliable data (± 2 ?M) for a whole year. The ISUS sensors are provided at no cost to this project because they were provided (and will be maintained) with support from the Alaska Ocean Observing System. However, analytical costs for the ISUS data are not covered by this project, so these data will be collected, although support for their analyses has yet to be identified.

The moored instruments and quasi-monthly CTD sampling schemes are complementary; one provides high vertical resolution at quasi-monthly time scales and the other provides high temporal resolution, but at coarser vertical spacing. The quasi-monthly CTDs provide redundancy in the event an instrument fails on the mooring. The GAK 1 monthly temperature and salinity are statistically significant predictors of monthly anomalies of the alongshelf baroclinic transport in the ACC (from November – August) so ACC transport anomalies are monitored indirectly from the GAK 1 data.

The moored T/C recorders are Microcats (at depths greater than 20 m) and a SeaCat both manufactured by Seabird, Inc. Seabird performs pre- and post-calibrations upon which we determine sensor drift (typically ~0.01$^{o}$C -yr$^{-1}$ and ~0.03, or better, Practical Salinity Unit yr$^{-1}$). The quasi-monthly CTD casts are collected from a chartered fishing vessel resident in Seward using a portable CTD (Seabird SBE-25). The SBE 25 has an accuracy ~0.01 or better for salinity and .005$^{o}$C for temperature. Temperature and salinity data are sampled at 15-minute intervals.

The GAK 1 sampling approach will be identical to that supported by EVOSTC in the recent past: quasi-monthly CTDs and maintenance of the year-round oceanographic mooring. Sampling is cost-effectively serviced from Seward using local charters or small boats operated by the Seward Marine Center.

**C. Data Analysis and Statistical Methods**

The temperature and salinity data analyses are straightforward. We will compute standard statistical estimates for each month and depth and compare these with historical data since the thrust of this effort is to quantify interannual variability. We continue to incorporate an integrated discharge time series and air-sea heat fluxes derived from National Center for Environmental Prediction (NCEP) in our analyses of salinity and temperature variability. We have generated the historical heat flux calculations which show that winter heat losses (from the ocean to the atmosphere) are more variable both interannually and at longer periods than summer heat gains. For example, winter heat loss has decreased by nearly 20% since the mid-1970s and this change was reflected in the warming at GAK 1 through 2005. Since that time winter heat loss has increased substantially and returned to values that

occurred in the early 1970s. Winter heat loss, in conjunction, with runoff, affects the ocean temperature distribution through spring when many young larvae are emerging to feed (*Janout et al*., 2010). On the other hand summer heat gains appear to be relatively consistent from year to year because this is primarily a function of cloud cover. *Royer et al*. (2006) contend that summer surface temperatures over the shelf and in Prince William Sound are primarily a function of the stratification. They suggest that stronger stratification traps heat in the surface layer and elevates surface temperatures, whereas weaker stratification allows the solar energy to diffuse to greater depths. Within the ACC, stratification is primarily a function of the vertical salinity gradients that we are measuring at GAK 1.

We will also quantify spring and summer phytoplankton blooms in relation to changes in stratification, runoff, and winds. Stratification estimates will be made from the 3 uppermost instruments and the quasi-monthly CTD surveys. GLOBEC measurements, as well as those by *Eslinger et al.* (2001) from Prince William Sound, indicate that the timing of the spring bloom varies considerably from year-to-year perhaps by as much as several weeks. *Weingartner et al*. (2003) show that the onset of the spring bloom on the Gulf of Alaska shelf is tied to the quantity and phasing of winter and early spring runoff because freshwater is the principal stratifying agent in the ACC in both seasons. For example, the spring bloom in the ACC was delayed until May in 2007 and 2008 because of the weak stratification; in contrast it occurred between early to mid-April during the GLOBEC years when winters were wetter and warmer.

**D. Description of Study Area**

The fieldwork will be conducted at Station GAK1 at the mouth of Resurrection Bay. The station is at ~59$^{o}$ 51'N, 149$^{o}$ 28'W, and is located on the inner edge of the ACC midway between Prince William Sound and Cook Inlet in approximately 265 m water depth.

**E. Coordination and Collaboration with the Program**

All data sets will be available on the GAK 1 website (http://www.ims.uaf.edu/gak1/). The GAK 1 data will thus be available to other scientists in the Long-Term Monitoring program as well as other interested scientists outside of the program. As discussed above this project is being supplemented by the Alaska Ocean Observing System (AOOS), which is providing the ISUS nitrate samplers (with each sampler costing $30,000). We have assisted the National Park Service in establishing a similar monthly sampling and data processing protocol in Glacier Bay National Park. That data will be made available to this project. The sampling in Glacier Bay therefore provides a complementary data set that is made upstream (in terms of the general circulation characteristics of the GOA shelf. Collectively, the Glacier Bay and GAK1 data sets provide a broad-scale perspective of the GOA shelf environment.

**III. CV's/RESUMES: Please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Quasi-monthly CTDs will be updated quarterly and placed on the website and the moored measurements will be made available by March-April following the year that the mooring is recovered. This allows time for the instruments to be calibrated (at the manufacturer and the post-calibrations applied to the data set.

**Objective 2**. Determine seasonal changes in near surface stratification since this affects phytoplankton bloom dynamics. Updated annually in accordance with the processing of the mooring data.

**Objective 3**. Determine the subsurface nitrate supply on the inner shelf, since this important nutrient affects phytoplankton production. Updated annually in accordance with the processing of the mooring data. NOTE THAT ACHIEVEING THIS OBJECTIVE REQUIRES FINDING SUPPORT FOR THE ANALYSIS OF THE ISUS NITRATE DATA SET.

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**
February, 2014 Project funding available
Begin quasi-monthly CTD sampling at GAK1; recover and re-deploy the GAK 1 mooring

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**
Continue quasi-monthly CTD sampling at GAK1*;*

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**
Continue quasi-monthly CTD sampling at GAK1*;*

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**
Continue quasi-monthly CTD sampling at GAK1. Post data on website

**V. BUDGET**

**Budget Form (Attached)**

**FY14 PROGRAM PROJECT PROPOSAL FORM – B.7**

**Project Title:** Long term monitoring: Environmental drivers component - The Seward Line: Marine Ecosystem monitoring in the Northern Gulf of Alaska

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator(s):** Russell R Hopcroft (rrhopcroft@alaska.edu), Tom Weingartner & Ken Coyle (UAF), Jeremy Mathis (UAF/NOAA)

**Abstract:** The ocean undergoes year-to-year variability in the physical environment, superimposed on longer-term cycles, and potential long-term trends. These variations influence ocean chemistry, and propagate through the lower trophic levels, ultimately influencing fish, seabirds and marine mammals. Over the past 50 years the Northern Pacific appears to have undergone at least one clear "regime shift", while the last 12 years have seen multi-years shifts of major atmospheric indices, leaving uncertainty about what regime the coastal Gulf of Alaska is currently in. Regime shifts are often expressed as fundamental shifts in ecosystem structure and function, such as the 1976 regime shift that resulted in a change from a shrimp dominated fisheries to one dominated by pollock, salmon and halibut. Long-term observations are also critical to describe the current state, and natural variability inherent in an ecosystem at risk of significant anthropogenic impact. Given the potential for such profound impacts, this proposal seeks to continue multidisciplinary observations which began in 1997 along the Seward Line and in PWS that assess the current state of the Northern Gulf of Alaska, during 2012-2017. Such observations form critical indices of ecosystems status that help us understand some key aspects of the stability or change in upper ecosystems components for both the short and longer-term. By analogy, the weather has been for more than a hundred years, yet regular observations are still needed to know what is happening and what can be expected in the near future.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $98 | $59.8 | $100.5 | $104 | $107.7 | $470.2 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $300 | $400 | $400 | $400 | $400 | $2,000 |

**Date: 31 Aug 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Long times-series are required for scientists to tease out pattern (and cause) from simple year-to-year variability. Like other regions, the Northern Pacific undergoes significant inter-annual variability, driven partially by variations in major climatic indices (e.g. El Niños, the Pacific Decadal Oscillation). Larger longer-term variations referred to as "regime shifts" have occurred in the past, and will likely occur again. Regime shifts are expressed as fundamental shifts in ecosystem structure and function, such as the 1976 regime shift that resulted in a switch within the Gulf of Alaska from a shrimp-dominated fishery to one dominated by pollock, salmon and halibut. Long-term observations are also critical to describe the current state, and natural variability inherent in an ecosystem at risk of significant anthropogenic impact. Given the potential for such profound impacts, the Seward Line Long-term Observation Program (http://www.sfos.uaf.edu/sewardline/) provides these critical observations on the current state of the Northern Gulf of Alaska ecosystem.

The Seward Line represents the most comprehensive long-term multidisciplinary sampling program in the Coastal Gulf of Alaska that allows observation of changes in the oceanography of this region that is critical to Alaska's fisheries, subsistence and tourist economies. Seward Line observations over the past 13 years have fundamentally revised our understanding of the coastal Gulf of Alaska ecosystem and allow us an appreciation of not only its major properties, but also their inter-annual variability. To date, we have observed both unusually warm and cold years, which influence the timing of the planktonic communities, but not necessarily their ultimate abundance and biomass. The quantity and composition of both late spring and summer zooplankton, appear to be significantly correlated with PWS hatchery Pink Salmon survival in this region; relationships to herring have yet to be explored. Thus, springtime abundance of zooplankton along the Seward Line appears to be an index of generally favorable years for higher trophic levels throughout the Gulf of Alaska. The larger GOA-IERP program, which the Seward Line provides an oceanographic foundation for, will explore broader regional patterns as well as search for relationships between oceanography and other species of forage and commercial fish.

**B. Summary of Project to Date (if applicable)**

See annual and 6 month reports.
Oceanographically, the Seward Line was at or slightly below the long-term mean temperature during the May 2012 cruise. Temperature during September 2012 were also unremarkable. Macro-nutrient and chlorophyll concentrations measured during May 2012 suggest the spring bloom was in progress along the Line during the cruise. The key-stone zooplankton genus *Neocalanus* was slightly delayed in its life cycle, but near the long-term mean in terms its abundance. There were no notable anomalies during the spring for other species.
In May 2013, the upper 100m of along the Seward Line was 0.7°C colder in May than the 15-year mean. Progression of seasonal cycles for plankton was delayed: the spring bloom peak was partially captured, while the development rates of key zooplankton species were slowed. Sampling in 2013 is embedded in NPRB's Gulf of Alaska project that will help establish if the Seward Line is representative of the western Gulf. An additional "glacial relict" copepod species was confirmed as occurring in Prince William Sound using molecular techniques.

## II. PROJECT DESIGN

The scientific purpose of this project is to develop an understanding of the response of this marine ecosystem to climate variability, and provide baselines against which to access any other anthropogenic influences on the GOA ecosystem. Toward this end, the Seward Line cruises on the Gulf of Alaska shelf determine the physical-chemical structure, primary production and the distribution and abundance of zooplankton, along with their seasonal and inter-annual variations. Some of the data is compared with historical data sets whereas other data sets are a product of this continuing systematic sampling effort on this shelf.

Specifically, cruises:

1. Determine thermohaline, velocity, and macro-nutrient structure of the Gulf of Alaska shelf, emphasizing the Seward Line, and Prince William Sound stations (Fig 1).
2. Determine the state of carbonate chemistry (i.e. Ocean acidification)
3. Determine primary production and phytoplankton biomass distribution.
4. Determine the distribution and abundance of zooplankton.
5. Determine rates of growth and egg production of selected key zooplankton species.

### B. Procedural and Scientific Methods

*Overview*

The Seward Line (Fig.1) is a transect of 21 stations stretching from GAK1 at the mouth of Resurrection Bay (Seward, Alaska) southward approximately 150 miles to beyond the continental shelf, augmented by 11 stations in Prince William Sound. From 1998-2004, cruises occurred 6-7 times annually. From 2005 onward the program consists of two cruises each year, in early May and early September, to capture the typical spring bloom and stabilized summer conditions, respectively. Using the USFWS vessel *Tiglax*, we determine the physical-chemical structure, algal biomass, primary (algal) production, and the distribution, abundance, biomass and productivity of zooplankton (using 2 different net types). We explore seasonal and inter-annual variations, seeking to understand how different climatic conditions influence the biological conditions in each of these years. Since in 2007 we have also monitored carbonate chemistry (i.e. ocean acidity). With EVOS support we have begun routine sampling at an additional 9 stations in the northern and eastern PWS, some of which have been sampled intermittently by the Seward Line program.

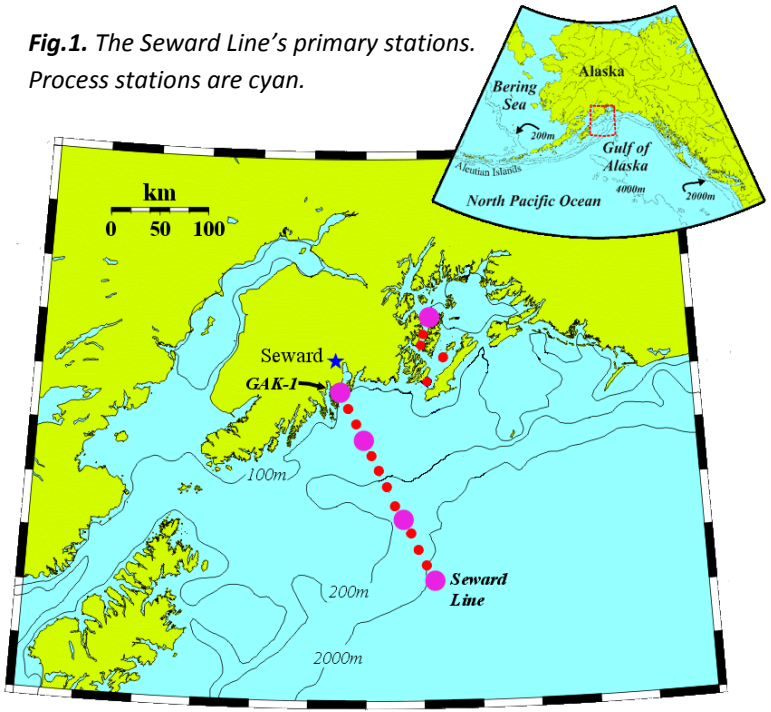


***Fig.1.*** *The Seward Line's primary stations. Process stations are cyan.*

Patterns emerging from the time series and results from each cruise have been posted online at http://www.sfos.uaf.edu/sewardline/ although we awe working with AOOS to display data through their portal.

*General Considerations*

For a long-term observation series, one of the most critical requirements is consistency of sampling locations, timing of observations and methodology. We propose to employ the same set of 13 primary and 9 secondary stations along the Seward Line sampled by the GLOBEC program, which extends from the coast, across the shelf break, to the inner portion of the Alaska Stream (Fig.1). Prince William Sound represents not only a unique habitat but a key "upstream" source to the line. For over a decade we have sampled 3 Knight Island Passage stations and Montague Strait, beginning in 2012 we will add additional station in northern and eastern PWS as well as stations across Hinchinbrook Entrance. Sampling will be conducted on 8-day cruises from the R/V *Tiglax* (home-ported in Homer) in May and early September. The early May period is consistent with sampling form 1998-2006, while the early September period captures late summer conditions as observed in 2005- 2013, but is slightly later than during the GLOBEC program. The shift to September has been necessitated by the availability of the *Tiglax.* Oceanographic sampling methodology will be close to that employed during the previous 7 years of the Gulf of Alaska GLOBEC LTOP program (i.e. U.S. GLOBEC, 1996; Weingartner *et al.*, 2002), and identical to employed during 2005-2009.

*Physical, Chemical, and Phytoplankton*

Weingartner is responsible for the physical measurements and Whitledge is responsible for the nutrient, chlorophyll, and primary production measurements. Mathis is responsible for measuring carbonate chemistry. Shipboard measurements include CTD fluorescence, PAR and discrete bottle samples for nutrients and chlorophyll. UAF provides a hydrographic winch with a conducting cable to the ship to facilitate sampling.

Nutrient measurements are made post-cruise on frozen samples using an Alpkem Rapid Flow Analyzer (Whitledge *et al.*, 1981) and will conform to WOCE standards (Gordon *et al.*, 1993). Tests of frozen versus refrigerated samples have indicated no significant difference between storage methods. Analytical precision for triplicate nutrient measurements is approximately 0.03-0.05 µmoles $kg^{-1}$. *Chlorophyll a* concentrations will be measured at all stations to calibrate the *in vivo* fluorescence profiles. The samples will be collected with the rosette on up-casts. Extracted chlorophyll *a* will be determined fluorometrically post-cruise (Parsons *et al.*, 1984).

Daily measurement of primary production rates will be estimated for large (>20 µm) and small (< 20 µm) size classes on some cruises by the modified $^{14}C$-uptake technique (Parsons *et al.*, 1984). Primary production estimates will be made at 4 stations along the Seward Line, plus one in the sound. Water samples inoculated with $^{13}C$-labeled $Na_2CO_3$ will be incubated in 1-liter polycarbonate bottles under natural light conditions on-deck. Following the incubations, both light and dark bottles will be filtered, purged of inorganic carbon, and analyzed by mass spectrometry. Hourly and daily estimates of primary

production rates will be calculated for each sample site. Particulate carbon and nitrogen samples will be obtained for each productivity sample.

We will collect samples at 26 CTD hydro-stations at approximately 5 km spacing along the Seward Line starting at GAK 1 and terminating at roughly to the 2,000 m isobath (GAK 13). We will also sample 15-20 stations inside Prince William Sound, particularly near major glacial outflows. We will use a rosette with 12 5L Niskin bottles and samples will be collected from the surface to the bottom at all locations. We anticipate collecting approximately 850 samples per cruise from the water column and another 300 underway samples. These measurements will be taken from a Sea-Bird 911+ CTD package that will be calibrated before and after the cruise and will have dual temperature and salinity sensors. The CTD package will also have a DO sensor and will be calibrated using discrete DO measurements by Mathis.

Dissolved oxygen (DO) will be sampled and processed before all other measurements to avoid compromising the samples by atmospheric gas exchange. Oxygen samples will be drawn into individual 115 ml BOD flasks, rinsed with 4-5 volumes of sample, and analyzed using an automated Winkler titration method. Samples are usually analyzed within 24 hours. The use of the UV endpoint detector will allow for increased precision (<0.08%; <0.3 μmoles $kg^{-1}$).

DIC and TA samples, which will be used to quantify carbonate chemistry and ocean acidification in the region will be fixed with a saturated mercuric chloride solution (200 μl), the bottles sealed, and stored until analysis. When possible, TA samples will be analyzed onboard, otherwise stored after being poisoned with $HgCl_2$. Samples will be shipped to UAF for analysis. High-quality DIC data is achieved using a highly precise (0.02%; 0.4 μmoles $kg^{-1}$) VINDTA 3C-coulometer system. TA is determined by potentiometric titration with a precision of ~1 μmoles kg-1. Highly accurate DIC and TA is calibrated by routine analysis of seawater certified reference materials (prepared and distributed by Andrew Dickson, UCSD), thereby providing the highest possible accuracy. The remaining carbonate parameters ($pCO_2$, pH, carbonate mineral saturation states) will be calculated from DIC and TA using the $CO_2$ SYS program (Lewis and Wallace, 1995).

The physical and chemical data will be used to quantify the seasonal, interannual, and along- and cross-shelf distributions of water masses and their variability. The data will be used along with historical data from this region (i.e. LTOP plus temperature and salinity record at GAK1 since 1970) to examine spatial and temporal variations in both physical and chemical variables and processes. Inter-decadal time scales will also be addressed through the use of sea surface temperatures (available from Scripps since 1947), Sitka air temperatures (since 1828), upwelling indices (from the Pacific Oceanographic Group/NOAA since 1946), the Pacific Decadal Oscillation (since 1900), oceanographic buoy data (from NOAA since ca. 1975) and the EVOSTC-supported continuous measurements at GAK1.

*Zooplankton*

Coyle and Hopcroft are responsible for the zooplankton component. Hopcroft will assume responsibility for daytime operations (finer meshed vertical plankton nets, copepod incubations) and Coyle will assume responsibility for night-time operations (Multinet collections).

Plankton nets: Day time zooplankton samples will be collected with a Quad net consisting of 25 cm diameter nets of 1.6 m length equipped with GO flowmeters. A pair of these nets is constructed of 0.15 mm mesh and will sample small, primarily early copepodid stages of calanoids (e.g., Coyle *et al.*, 1990; Coyle & Pinchuk, 2003), while nauplii and the smallest copepodid stages of neritic species will be sampled with the pair constructed of 0.05 mm mesh. The tows will be made from 100 m to the surface at the 13 stations along the Seward Line. A 0.25-$m^2$ Hydrobios Multinet system with 0.5 mm mesh nets will be fished at night to assess large zooplankton and micronekton, such as euphausiids that are important components in the diet of many fish, sea-birds and marine mammals. The Multinet is equipped with five nets that can be programmed to open and close at specific depths, or opened and closed electronically from the deck if a conducting cable is available. Depth, flow meter counts, and volume filtered are recorded at 1 second intervals. The nets will be fished at each of the 13 main Seward Line stations (Fig. 3), plus the 3 stations within Prince William Sound. At each station, 5 samples will be collected at 20 m depth intervals from 100 m depth to the surface. Additional Multinet collections will be made to 600m at Gak13 and PWS2 to assess over-wintering populations of *Neocalanus* spp. All zooplankton samples will be preserved in 10% formalin for later analysis by LTOP methods to the lowest taxonomic category possible. Analysis to date indicates the Multinet yields collections consistent with those obtained using a MOCNESS from 1997-2004.

During traditional taxonomic processing, all larger organisms (primarily shrimp and jelly fish) will be removed and enumerated, the sample will then be Folsom split until the smallest subsample contains about 100 specimens of the most abundant taxa. The most abundant taxa will be identified, copepodites staged, measured, enumerated and weighed with each larger subsample examined for the larger, less abundant taxa. Blotted wet weights of all specimens of each taxa and stage will be taken on each sample with ±1 µg with a Cahn Electrobalance until weights stabilize, after which point the wet weight biomass will be estimated using mean wet weight. Wet weights on euphausiids, shrimp and other larger taxa are always measured and recorded individually for each sample.

Growth/reproduction (Hopcroft) Ongoing changes in the Gulf of Alaska will likely be a reflection of underlying change in the rates of growth and reproduction experienced by the most dominant components of the zooplankton. In the Gulf of Alaska, biomass is seasonally dominated by the large *Neocalanus* spp., although on average they may be exceeded in terms of biomass and production by *Pseudocalanus* species (Coyle & Pinchuk, 2003, 2005). We propose to work with both these species on some cruises, collected using fine mesh nets at 4 stations spaced along the Seward Line, plus one inside the sound, as was done in the GLOBEC program (e.g. Napp *et al.*, 2005; Liu & Hopcroft, 2006). For *Pseudocalanus,* we propose to monitor egg production rate (EPR), because it appears to be generally reflective of somatic growth of prior developmental stages for these species in this ecosystem (Liu & Hopcroft, 2006b, 2007, 2008), and EPR generally reflects the current food climate (Runge & Roff, 2000). For these experiments, 100 females representing a mixture of the *P. mimus* and *P. newmani* are incubated individually in 70 ml flasks, and the number of eggs produced over 2 days by each population is determined (Napp *et al.*, 2005). In contrast, *Neocalanus* only spawn at great depth during the winter months, thus we must directly assess the growth rates. In this case, single stages of *Neocalanus flemingeri* are selected and incubated at low densities in 20L carboys (with natural food concentration)

for 4-5 days, harvested, preserved, and the increase in stage and size later determined from the samples (Liu & Hopcroft, 2006). If time permits, EPR may also be determined for other important species (e.g. *Metridia pacifica* – Hopcroft *et al.*, 2005).

### C. Data Analysis and Statistical Methods

The data undergo various forms of quality control during processing. Ultimately, data sets are uploaded to a Microsoft Access database for sorting and analysis, with data and metadata supplied to the consortium's members. The fist analytical pass is visual presentation of the data, and recalculation of long-term means, confidence intervals, and anomalies. Statistically distinct years or periods can already be identified. For biological data, multidimensional scaling of percentage dissimilarities between samples has proven an effective method of revealing cross-shelf patterns (Coyle & Pinchuk, 2005), but becomes complicated when making seasonal or inter-annual comparisons. A variety approaches to separate cyclic and long-term trends continue to be explored, but are hampered by the somewhat stochastic pattern of climate indices – truly long-term (i.e. multi-decadal) observations are required for some of these patterns to emerge.

## REFERENCES


Coyle, K.O., Paul, A.J. & Ziemann, D.A. (1990) Copepod populations during the spring bloom in an Alaskan subarctic embayment. *J. Plankton Res.,* **12**, 759-797.

Coyle, K.O. & Pinchuk, A.I. (2003) Annual cycle of zooplankton abundance, biomass and production on the northern Gulf of Alaska shelf, October 1997 through October 2000. *Fish. Oceanogr.,* **12**, 227-251.

Coyle, K.O. & Pinchuk, A.I. (2005) Cross-shelf distribution of zooplankton relative to water masses on the northern Gulf of Alaska shelf. *Deep-Sea Res. II.,* **52**, 217-245.

Gordon, C., Jennings, A.A. & Krest, J.M. (1993) A suggested protocol for continuous flow automated analysis of seawater nutrients (phosphate, nitrate, nitrite, and silicic acid) in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study. pp. 51, Oregon State University, Corvalis.

Hopcroft, R.R., Pinchuk, A.I., Byrd, A. & Clarke, C. (2005) The paradox of *Metridia* spp. egg production rates: A new technique and measurements from the coastal Gulf of Alaska. *Mar. Ecol. Prog. Ser.,* **286**, 193-201.

Liu, H. & Hopcroft, R.R. (2006a) Growth and development of *Neocalanus flemingeri/plumchrus* in the northern Gulf of Alaska: validation of the artificial cohort method in cold waters. *J. Plankton Res.,* **28**, 87-101.

Liu, H. & Hopcroft, R.R. (2006b) Growth and development of *Metridia pacifica* (Copepoda: Calanoida) in the northern Gulf of Alaska. *J. Plankton Res.,* **28**, 769-781.

Liu, H. & Hopcroft, R.R. (2007) A comparison of seasonal growth and development of the copepods *Calanus marshallae* and *C. pacificus* in the northern Gulf of Alaska. *J. Plankton Res.,* **29**, 569-581.

Liu, H. & Hopcroft, R.R. (2008) Growth and development of *Pseudocalanus* spp. in the northern Gulf of Alaska. *J. Plankton Res.* **30**, 923-935.

Lewis, E.R., & Wallace, D.W.R. (1995) Basic programs for the $CO_2$ system in seawater. Brookhaven National Laboratory, BNL-61827.

Napp, J.M., Hopcroft, R.R., Baier, C.T. & Clarke, C. (*2005*) Distribution and species-specific egg production of *Pseudocalanus* in the Gulf of Alaska. *J. Plankton Res.,* **27**, 415-426.

Parsons, T.R., Maita, Y. & Lalli, C.M. (1984). *A manual for chemical and biological methods in seawater*. Pergamon Press, Toronto. 173 pp.

Runge, J.A. & Roff, J.C. (2000) *The measurement of growth and reproductive rates*. pp. 401-454. *In:* Harris, R.P., Weibe, P.H., Lenz, J., Skjoldal, H.R. and Huntley, M. (ed.) ICES Zooplankton Methodology Manual, Academic Press, London.

Weingartner, T.J., Coyle, K.O., Finney, B., Hopcroft, R.R., Whitledge, T.E., Brodeur, R.D., Dagg, M., Farley, E., Haidvogel, D., Haldorson, L., Hermann, A., Hinckley, S., Napp, J.M., Stabeno, P., Kline, T., Lee, C., Lessard, E., Royer, T. & Strom, S. (2002) The Northeast Pacific GLOBEC program: coastal Gulf of Alaska. *Oceanography,* **15**, 48-63.

Whitledge, T.E., Malloy, S.C., Patton, C.J. & Wirick, C.D. (1981) Automated nutrient analyses in seawater. pp. 216, Brookhaven National Laboratory, Upton, New York.

**D. Description of Study Area**

Central coastal Gulf of Alaska & Prince William Sound (see above: 61.0, -149.5, 58.0, -146.0).

**E. Coordination and Collaboration with the Program**

Project Integration: This project links tightly with the GAK1 mooring, providing a cross shelf context for its observations. It complements the CPR, PWS, and Lower Cook Inlet/Kachemak Bay long-term monitoring efforts by providing more detailed oceanographic evaluation of the GOA shelf and the major passages in PWS than provided by the other programs. All of these components overlap in their sampling locations relatively little, enough to ensure comparability between datasets, but not enough to be duplicative. Hopcroft serves on the Science Coordinating Committee, and participates regularly in associated functions to this end.

Leveraging: This proposal seeks for EVOS to join the consortium of NPRB, AOOS and NOAA currently funding the line. We propose to add additional sampling (the central sound and Hinchinbrook Entrance)

to provide more extensive representation of PWS. Full annual costs are ~400K including ship time, thus the 4 members of the consortium should each contribute ~100K per year. Substantial cost saving are anticipated in 2013 when NPRB's GOA-IERP program will cover a larger-than-normal share of the annual funding as well as provide larger sampling context throughout the Gulf of Alaska Shelf. The proposal also leverages on the consolidation of historical and contemporary information in the Gulf of Alaska planned through GOA-IERP program.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

***As with most long-term observation programs, the Seward Line has the same Milestones annually.***

**Objectives 1-5.** Cruises are executed early each May and in mid September collecting data or samples to address all objectives each cruise. Products associated with each objective are subsequently posted graphically to the project's website at various intervals reflecting the degree or post-processing required. Final datasets are released annually.

Typically:

- Physical oceanography and chlorophyll are available 60 days after a cruise.
- DIC and TA are available 90 days after a cruise.
- Macronutrients and zooplankton are available 6 months after a cruise.
- Results are presented annually at the Alaska Marine Science Symposium

**B. Measurable Project Tasks**

May 2014 – Spring cruise executed
September 2014 – Late Summer cruise executed
January 2015 – Results presented at AMSS

Cruises are executed early each May and in mid September collecting data or samples to address all planned objectives each cruise. Products associated with each objective are subsequently posted graphically to the project's website at various intervals reflecting the degree or post-processing required. Final datasets are released annually.

**V. BUDGET**

**Budget Form (Attached)**

# FY14 PROGRAM PROJECT
# PROPOSAL FORM

**Project Title:** Long term monitoring: Environmental drivers component - Long-term Monitoring of zooplankton populations on the Alaskan Shelf and Gulf of Alaska using Continuous Plankton Recorders.

**Project Period:** Feb 1st 2014 to Jan 31st 2015

**Primary Investigator(s):** Sonia Batten soba@sahfos.ac.uk and Alex Bychkov (bychkov@pices.int)

**Abstract:** Many important species, including herring, forage outside of Prince William Sound for at least some of their life history (salmon, birds and marine mammals for example) so an understanding of the productivity of these shelf and offshore areas is important to understanding and predicting fluctuations in resource abundance. The Continuous Plankton Recorder (CPR) has sampled a continuous transect extending from the inner part of Cook Inlet, onto the open continental shelf and across the shelf break into the open Gulf of Alaska monthly through spring and summer since 2004. There are also data from 2000-2003 from a previous transect. The current transect intersects with the outer part of the Seward Line and provides complementary large scale data to compare with the more local, finer scale plankton sampling on the shelf and in PWS. We propose to continue sampling this transect again each year through 2016. Resulting data will enable us to identify where the incidences of high or low plankton are, which components of the community are influenced, and whether the whole region is responding in a similar way to meteorological variability. Evidence from CPR sampling over the past decade suggests that the regions are not synchronous in their response to ocean climate forcing. The data can also be used to try to explain how the interannual variation in ocean food sources creates interannual variability in PWS zooplankton, and when changes in ocean zooplankton are to be seen inside PWS. The CPR survey is a cost-effective, ship-of-opportunity based sampling program supported in the past by the EVOS TC that includes local involvement and has a proven track record.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $0.0 | $66.8 | $68.8 | $70.7 | $73.1 | $279.5 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | $94.7 | | | |

**Date: July 30th 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf and crosses the slope into the open Gulf of Alaska, providing a record of taxonomically resolved near-surface zooplankton and large phytoplankton abundance over wide spatial scales. Many important species, including herring, forage outside of Prince William Sound for at least some of their life history (salmon, birds and marine mammals for example) so an understanding of the productivity of these shelf and offshore areas is important to understanding and predicting

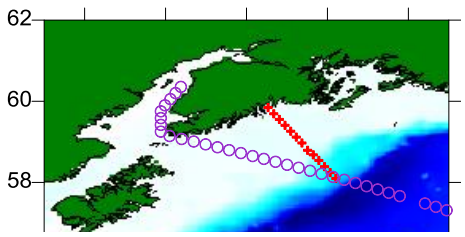


Figure 1 Location of samples on a typical CPR transect (○) together with the Seward Line (+)

fluctuations in resource abundance. Our sampling transect extends from the inner part of Cook Inlet, onto the open continental shelf, across the shelf break and into the open Gulf of Alaska in a continuous fashion (Figure 1), enabling us to identify where the incidences of high or low plankton are and whether the whole region is responding in a similar way to meteorological variability. Evidence from CPR sampling over the past decade suggests that the regions are not synchronous in their response to ocean climate forcing.

The funding requested is modest and because of the Consortium approach (the North Pacific CPR program is funded through a consortium managed by the North Pacific Marine Science organization, PICES) is less than half the actual cost of the data collection. The project has a proven track record with a high sampling success rate, all past deliverables have been fully met and there is a strong record of primary publications resulting from the program; the funding would likely generate a very positive return for the EVOS TC. SAHFOS has trained local technicians to service the CPRs and uses the Horizon shipping company for the sampling so that ~10% of the requested funding will be returned to the region.

**B. Summary of Project to Date (if applicable)**

*Note that in FY 2012 funding was provided under EVOS project 10100624, not the Gulf Watch Alaska project.*

Sampling has continued each year, on six transects per year, usually April to September as planned. In 2012 there were some sampling issues with the loss of the CPR instrument in August (likely due to collision with a large piece of submerged debris). The final 6$^{th}$ transect was sampled in October after new gear had been shipped out for September. Sampling through 2013, the first year funded under this contract, has gone smoothly to date and sample processing is underway.

**II. PROJECT DESIGN**

**A. Objectives**

The fundamental goal of this program is to provide continued large spatial scale data on zooplankton populations to extend the existing time series and integrate the data with more regional, locally more intensive, sampling programs. More specifically, we will provide monthly (spring to fall – typically April to September) sampling of zooplankton and large phytoplankton along the transect from the oceanic Gulf of Alaska to Cook Inlet, analyzing every 4$^{th}$ oceanic and <u>every</u> shelf sample to provide taxonomically resolved abundances. Temperature loggers have been fitted to some CPRs in the past and from 2010 we are endeavouring to maintain in situ temperature data collection on this transect.

<u>Project Integration</u>

Work was undertaken to compare the CPR sampling with historic and concurrent plankton data collected from within PWS to examine the links between zooplankton within and outside of the Sound

under EVOS TC project 10100624, as part of the herring restoration program. This will continue under GWA as only a short time series of taxonomically resolved plankton data from PWS has yet been generated. We also here propose to integrate CPR sampling with the twice-yearly zooplankton sampling along the Seward Line (which intersects the CPR transect at its outermost stations, Fig 1) and the continuous oceanographic framework provided by the GAK-1 sampling.

CPR sampling has strengths (robust, cost-effective and large scale) but it also has limitations (near surface sampling only, small sample volumes and robust sampling mechanism that may cause underrepresentation of rarer and/or fragile organisms). The PWS and Seward Line zooplankton sampling are complementary by providing spatially detailed, full water column sampling in key point locations. The Seward Line sampling is carried out twice/year so the monthly resolution of the CPR will fill-in information on seasonality of shelf and off shore lower trophic levels.

**B. Procedural and Scientific Methods**

We do not propose to make any changes to the sampling regime that has been operating so successfully. The cargo vessel *Horizon Kodiak* will tow a CPR northbound towards Cook Inlet approximately once per month between April and September each year. The samples will be unloaded and the gear serviced each time by Alaskan technicians who have been trained by SAHFOS. Sample processing will be carried out at the DFO laboratory in Sidney, BC and at the SAHFOS laboratory. QC and sample archiving will be carried out by SAHFOS.

**C. Data Analysis and Statistical Methods**

Previous proposals have already described in detail the statistical validity of this approach and demonstrated that the sampling frequency and spacing is suitable to characterize seasonal, interannual and spatial variability at the mesoscale. Further information can be found in Batten et al., (2003) and previous funded EVOS TC proposals, but since our proposed sampling and processing protocols are unchanged and have been previously approved we are not repeating them extensively here.

Large scale patchiness (on the order of 10s to 100s of kms) needs to be considered as a factor that may contribute to observed variability in the plankton data. The greatest resolution possible from CPR data is 18.5 km, however, to maximise coverage with the resources available we process samples spaced 74 km in the open ocean (every fourth sample being processed) but all samples on the shelf. An individual sample will pass through small patches of plankton and so provide an 'average' of the small-scale patchiness. We have established the decorrelation length-scales for common taxa from data collected early in the survey (2000) and determined that samples that are spaced well apart, such as every 74 km, are likely to be representative and not likely to be within or outside of a patch.

Our methodology has remained unchanged since the survey's inception so comparisons with historical CPR data are straightforward. Comparisons with other plankton sampling are more problematic as each sampling system has a bias of some sort caused by, for example, mesh size, depth of sampling,

taxonomic resolution. However, by using indices such as anomalies and pooling taxa to create functional groups useful comparisons can be made. Such work was undertaken during project 10100624 and will continue here.

### D. Description of Study Area

The project will sample waters on a transect from the Straits of Juan de Fuca outside of Puget Sound (48.45°N, 125°W, Captain's discretion) across the Gulf of Alaska to Cook Inlet and Anchorage. Sampling will end at about 60ºN, 151.9°W (at Captain's discretion). See Figure 1 for a map of the transect. Ship tracks vary minimally from month to month.

### E. Coordination and Collaboration with the Program

In addition to the work described above within the GWA program, the CPR sampling is further leveraged. PICES has endorsed the North Pacific CPR project since its inception in 2000. In 2007 PICES initiated a funding consortium to support the project, through relatively small contributions from agencies with interest in all or part of the region. At this time, the Canadian Department of Fisheries and Oceans (DFO) and the North Pacific Research Board (NPRB) have each made commitments through 2014 and we are also supported by the CPR parent organization, SAHFOS. The EVOSTC was instrumental in the establishment of the CPR program and has supported it through projects 030624, 040624, 070624 and currently to the PICES consortium through project 10100624 which extended through the 2012 field season

## III. CV's/RESUMES –Please see Appendix 2

## IV. SCHEDULE

### A. Project Milestones

**Objective 1.** Sample collection on the transect from Cook Inlet to Puget Sound will begin in spring 2014 and continue approximately monthly through to August/September 2014 (6 transects will be sampled). This schedule will be repeated each year to 2016. All shelf samples will be processed and every 4$^{th}$ oceanic sample. *Sampling completed by October 2014.*

**Objective 2.** A subset of samples (25%) will be processed within 3 months of collection at the Institute of Ocean Sciences (DFO, Canada) and results from this processing (e.g. estimated mesozooplankton biomass and comparisons with data from previous years) will available in progress reports and on the project website as soon as practicable. Full, quality controlled data from 2014 will be available by August 2015 though early transects will be available earlier. *Preliminary analysis completed by December 2014.*

**B. Measurable Project Tasks**

**FY 14, 1st quarter (Feb 1, 2014-April 30 2014)**

| | |
|---|---|
| February: | Shipping of serviced CPR from UK to Horizon Kodiak |
| March/April: | First transect sampled |
| | Annual report submitted |
| April: | Begin sample processing (ongoing hereafter) |

**FY 12, 2nd quarter (May 1, 2014-July 31, 2014)**

| | |
|---|---|
| May-July: | Three transects sampled |
| June: | First results from 2014 sampling available (ongoing hereafter) |

**FY 12, 3rd quarter (Aug 1, 2014-October 31, 2014)**

| | |
|---|---|
| Aug-Sept: | Two transects sampled, CPR shipped back to UK for overhaul. |
| August: | 6 month report submitted |
| | Final QC data from 2013 available |
| October: | Attend annual PICES meeting |

**FY 13, 1st quarter (November 1, 2014-January 31, 2015)**

| | |
|---|---|
| November: | Attend annual GWA PI meeting |
| December: | Processing and initial analysis of samples collected in summer/fall 2014 will be completed. |

**V. BUDGET**

**Budget Form (Attached)**

**FY14 PROGRAM PROJECT**

**PROPOSAL FORM – B.9**

**Project Title: Long term monitoring of oceanographic conditions in Prince William Sound**

**Project Period:** February 1 2014 – January 31, 2016

**Primary Investigator(s):** Campbell, Robert W., PWS Science Center, 300 Breakwater Ave., Box 705., Cordova, AK, 99574; rcampbell@pwssc.org

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. This project is intended to provide physical and biological measurements that may be used to assess bottom-up impacts on the marine ecosystems of Prince William Sound. Specifically, it is proposed to deploy an autonomous profiling mooring in central Prince William Sound that will provide high frequency (~daily) depth-specific measurements of physical (temperature, salinity, turbidity), biogeochemical (nitrate, phosphate and silicate) and biological (Chlorophyll-*a* concentration) parameters that will be telemetered out in near real-time. Several regular vessel surveys are also proposed to provide ground-truth data for the mooring, and to attempt to capture some of the spatial variability in PWS. As well as the mooring site, the surveys will visit all four of the SEA bays to maintain ongoing EVOSTC funded time series measurements at those sites and to support proposed herring research (Pegau et. al). The major entrances (Hinchinbrook Entrance and Montague Strait) will also be visited. The surveys will make the same suite of measurements as the mooring, and will also collect water and plankton samples. This project will also link significantly with the herring research efforts proposed by Pegau et al., and will analyze plankton samples collected during intensive studies of juvenile herring feeding and energetics.

**Estimated Budget:**
**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $238.1 | $193.2 | $197.3 | $203.7 | $209.3 | $1,041.6 |

*(Funding requested must include 9% GA)*
**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | $23 | $23 | $23 | $69 |

**Date: 30 Aug 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Marine ecosystems are not static over time, they may change gradually from year to year or shift abruptly; those changes are in part driven by bottom up factors, such as environmental changes (e.g. temperature, salinity, turbidity), and biogeochemical interactions (the availability and recycling of nutrients). Long term monitoring of the spill-effected area is important, both in order to assess the recovery of resources, and to understand how the ecosystem is changing over time.

The ecosystems of the PWS region are influenced by physical environmental factors: metabolic and other vital rates for lower trophic species are generally temperature controlled, and water column production is ultimately limited by the amount of nitrogen made available to primary producers each year. Nitrogen availability is influenced by stratification (i.e. the onset of a seasonal thermocline or halocline) and mixing processes. These physical factors vary in space and in time, with different locations having different drivers (e.g. tidewater glaciers vs riverine estuaries, watersheds of varying size), and those parameters also change both inter- and intra-annually. Superimposed over all those changes in the physical environment are myriad changes in the marine ecosystem, both in terms of the constituents (who is there) and abundance (how many there are, or their biomass). The phenology of ecosystem components (the timing of who appears) is also important, particularly with regards to matches and mismatches between predators and prey.

### B. Summary of Project to Date (if applicable)

All milestones from previous years of the project have been met to date; all milestones are ongoing and we expect to continue to meet our goals.

## II. PROJECT DESIGN

## A. Objectives

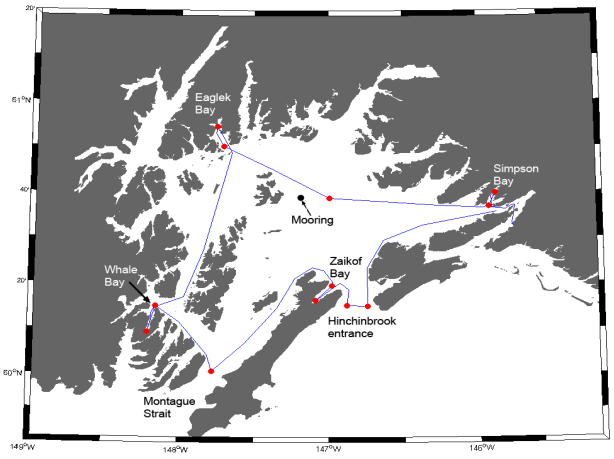


Figure 1. Proposed mooring location, cruise track and station locations visited during vessel surveys.

The goal of this program is to deliver a monitoring program that will return useful information on temporal and spatial changes in the marine environment, at a reasonable cost, and with a reasonable amount of effort. The data should be depth-specific (because water column stability is important to ecosystem productivity), of high enough frequency to capture timing changes (changes that occur on order of weeks), and give an idea of spatial variability in the region. As well, given that PWS herring will remain a funding priority of the EVOSTC in the next 20 years, any long term monitoring efforts should be integrated with future herring studies as well as building upon ongoing work funded by the trustee council. Specific objectives include:

1. Install and maintain an autonomous profiling mooring in PWS that will measure daily profiles of temperature, salinity, chlorophyll-a (as a proxy for phytoplankton biomass), turbidity and nitrate concentration in the surface layer (0-100 m).

2. Conduct regular surveys in PWS to tie in spatial variability to the high frequency time series provided by the mooring.

3. Support continued herring research by maintaining the existing time series (hydrography, plankton and nutrients) at the four SEA bays, and participating in intensive process studies of juvenile herring overwintering.

## B. Procedural and Scientific Methods

Project approach and logistics

The central PWS mooring (Objective 1) is best located near Naked Island (Figure 1). The proposed site is the location of the C-LAB buoy deployed during the SEA project, is slightly to the west of an existing sampling station in the central sound (the current station is between tanker lanes, not a good location for a mooring) and co-located with a Seward Line sampling site (see Hopcroft project proposal). The proposed mooring is an Autonomous Moored Profiler (AMP, WetLabs, Inc.). The AMP is self-contained, and is capable of profiling from 100 m to the surface, with multiple deployments per day and a longevity of approximately 4 months (the system is battery powered, so there will be a tradeoff between the number of casts and longevity). The instrument payload on the AMP includes a CTD (0.01 $^{o}$C, 0.001 S m$^{-1}$ and 0.005 psi resolution), a fluorometer/turbidometer (0.01 µg l$^{-1}$ chl-a and 0.01 NTU resolution), and a UV nitrate analyzer (a Satlantic SUNA: 2 µM resolution); data will be telemetered out in near real-time by cellular modem.

Vessel surveys (Objective 2) will be conducted 6 times per year, and will visit the four SEA bays that have been a focus of prior EVOSTC funded research (and a focus of the Pegau et al. herring proposal), as well as Hinchinbrook Entrance and Montague Strait (as requested by the RFP), and central PWS (to collect ground-truth data and to service the mooring). Each station will include a CTD cast (with the same instrumentation as on the mooring), water bottles for nutrient and chl-a analysis, and a plankton tow. Two stations will be done in each of the bays, one near the head where juvenile herring are more frequently encountered, and one in more open waters at the mouth of the bay where older age classes are more common. The timing of the surveys will be structured around the "productivity season" to attempt to capture the spring and autumn blooms (i.e. pre-bloom, bloom and post-bloom). The data collected during the surveys (particularly phytoplankton abundance and nutrient concentrations) will be compared to the high frequency record in the central sound, in order to assess how the timing and magnitude of production events in the bays differs from the open waters of PWS. Stage composition of the copepod species collected by the plankton net will also give information on annual changes in phenology.

The Pegau et al. herring program is also proposing to do a number of focused process studies in the four SEA bays (Objective 3), and will provide plankton samples to be analyzed. Not all plankton is of equal quality as food to herring, and the plankton data will inform work done on herring feeding and energetics. Hydrographic, nutrient and plankton sampling will also be done during intensive overwintering juvenile surveys done by members of the Pegau et. al herring program in Simpson Bay and Port Gravina.

Methods

All of the instruments will be calibrated annually, and water samples will be taken with Niskin bottles to validate the observations. Water will be filtered through a Whatman GF/F filter (nominal pore size 0.7µm), which will be retained for the extraction of chlorophyll-*a* (Parsons et al. 1984), and the filtrate will be retained for the analysis of nitrate, phosphate and silicate. Following each cruise, quality assurance checks will be made on all the data collected, and the CTD data will be processed with standard methods; the data and associated metadata will be databased for later analysis and distribution. Zooplankton samples will be subsampled with a Folsom plankton splitter (McEwan et al. 1954), and identified to species and stage under a stereomicroscope.

**C. Data Analysis and Statistical Methods**

This program will result in a high frequency (~daily) time series in central PWS that will be directly comparable to a complimentary time series taken during the SEA project. It will also continue time series observations of temperature, salinity, chlorophyll fluorescence, turbidity, and nitrate concentration, all as a function of depth, at two locations in each of the SEA bays, as well as four sites representative of open water habitat and water entering and leaving PWS. Those data will be used to create temporal sections, using standard methods (e.g. Sandwell 1987; Chatfield 1995), which will then be used to describe the changes in oceanographic conditions over time within each of the bays, as well as PWS in general. Comparisons will also be made to previous observations (e.g. Meunch and Schmidt

1975; Gay and Vaughan 2001). Autocorrelation statistics such as the Mantel test (Smouse et al 1986) will be used to infer decorrelation scales between bays and the open PWS, both spatially between sites and temporally within sites.

The zooplankton collections will also provide a time series of plankton concentrations in each of the bays, in the central sound, and in the entrances and exits, although it will be depth-integrated instead of depth-specific. Differences in the concentrations of each species among the bays and open water sites will be examined with multivariate statistical methods, including hierarchical clustering and nonmetric dimensional scaling (Manly 1994). The association between plankton species and environmental parameters will also be examined with ordination techniques, including Principle Components Analysis and Redundancy Analysis (Legendre and Gallagher 2001; Clarke et al 2008).

The data will also be used to refine conceptual models of ecosystem-level production processes in PWS (Cooney et al., 2001), and the results of several years of data collection will permit inferences about how the oceanographic climate influences the biological productivity in the nearshore and offshore waters of PWS. Data on plankton taxonomy and abundance, combined with measurements of gut contents done during the intensive herring studies proposed by Scott Pegau et al. will permit testing of hypotheses about the potential for food limitation of juvenile herring in PWS.

## D. Description of Study Area

This project is conducted throughout PWS; the stations are shown in Figure 1 and Table 1.

**Table 1: Station locations**

| Station | Latitude | Longitude |
|---|---|---|
| Simpson Bay head | 60.67 | -145.87 |
| Simpson Bay mouth | 60.61 | -145.93 |
| Hinchinbrook Entrance East | 60.25 | -146.73 |
| Hinchinbrook Entrance West | 60.25 | -146.89 |
| Zaikof Bay head | 60.27 | -147.09 |
| Zaikof Bay mouth | 60.34 | -146.96 |
| Montague Strait | 60.01 | -147.77 |
| Whale Bay head | 60.15 | -148.21 |
| Whale Bay mouth | 60.23 | -148.17 |
| Eaglek Bay head | 60.93 | -147.74 |
| Eaglek Bay mouth | 60.85 | -147.71 |
| Central PWS | 60.67 | -147.17 |

## E. Coordination and Collaboration with the Program

This project links directly with the herring research program submitted separately to the Trustee Council by Scott Pegau et al, it will provide a bottom up context for the proposed work on juvenile herring. This project also links materially with the Lower Cook Inlet/Kachemak Bay long term monitoring effort: plankton and nutrient samples collected under that program will be analyzed at PWSSC by this project.

This program collaborates closely with the Alaska Ocean Observing System, which has funded some prior surveys in PWS, and is currently funding oceanographic and ecosystem modeling in the region. Some of the instrumentation and equipment used in this project was initially purchased with AOOS funds.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Install and maintain an autonomous profiling mooring in PWS.

**Objective 2**. Conduct regular surveys in PWS.

**Objective 3**. Support continued herring research by maintaining the existing time series (hydrography, plankton and nutrients) at the four SEA bays, and participating in intensive process studies of juvenile herring overwintering.

*Time series work is described above. The intensive process studies will be conducted in 2013.*

**B. Measurable Project Tasks**

**FFY 14, 1st quarter (October 1, 2014-December 31, 2014)**

| | |
|---|---|
| *October-December:* | *Mooring operational, sample processing ongoing* |
| *October:* | *Vessel survey/service mooring* |
| *November:* | *Vessel survey* |
| *December:* | *Vessel survey* |

**FFY 14, 2nd quarter (January 1, 2014-March 31, 2014)**

| | |
|---|---|
| *January-March* | *Mooring operational, sample processing ongoing* |
| *January:* | *Annual Marine Science Symposium* |
| *March:* | *Vessel survey/service mooring* |

**FFY 14, 3rd quarter (April 1, 2014-June 30, 2014)**

| | |
|---|---|
| *April-June:* | *Mooring operational, sample processing ongoing* |
| *April:* | *Vessel survey* |
| *June:* | *Vessel survey/service mooring* |

**FFY 14, 4th quarter (July 1, 2014-September 30, 2014)**

| | |
|---|---|
| *July-September:* | *Mooring operational, sample processing ongoing* |
| *July:* | *Service mooring* |
| *August:* | *Submit annual report* |

**V. BUDGET (attached)**

**Literature Cited:**


Chatfield, C. 1989. The analysis of time series (4th ed.).Chapman & Hall, London. 241pp.

Cooney, R.T., Coyle, K.O., Stockmar, E. and C. Stark. 2001b. Seasonality in surface-layer net zooplankton communities in Prince William Sound, Alaska. Fisheries Oceanography. **10(Suppl. 1):**97-109.

Gay., S.M. and S.L. Vaughan. 2001. Seasonal hydrography and tidal currents of bays and fjords in Prince William Sound, Alaska. Fisheries Oceanography. **10(Suppl. 1):**159-193.

Legendre, P. and E.D. Gallagher. 2001. Ecologically meaningful transformations for ordination of species data. Oecologia. **129:**271-280.

Manley, B.F.J. 1994. Multivariate Statistical Methods (2nd ed.). Chapman & Hall, London. 215 pp.

McEwen, G.F., Johnson M.W. and T.R. Folsom. 1954. A statistical analysis of the performance of the Folsom plankton sample splitter, based upon test observations. Archiv fur Meteorologie, Geophysik und Bioklimatologie A **6:**502-527.

Meunch, R.D. and C.M. Schmidt. 1975. Variations in the hydrographic structure of Prince William Sound. IMS/Sea Grant Report R75-1. University of Alaska Institute of Marine Science, Fairbanks.

Parsons, T.R., Y.Maita and C.M. Lalli. 1984. A manual of biological and chemical methods for seawater analysis. Pergamon Press, Oxford. 173 pp.

Sandwell, D.T. 1987. Biharmonic Spline Interpolation of GEOS-3 and SEASAT Altimeter Data. Geophysical Research Letters **2:**139-142.

Smouse, P.E., J.C. Long, and R.R. Sokal. 1986. Multiple regression and correlation extensions of the Mantel test of matrix correspondence. Systemic Zoology. **35:** 627-632.


| **FY14 PROGRAM PROJECT PROPOSAL FORM – B.8** |
|---|
| **Project Title:** Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay to understand recovery and restoration of injured near-shore species |

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator(s):** Angela Doroff (Kachemak Bay National Estuarine Research Reserve-ADFG, angela.doroff@alaska.gov, 907-226-4654, 95 Sterling Hwy, Homer AK 99603), Kris Holderied (NOAA Kasitsna Bay Laboratory, kris.holderied@noaa.gov, 907-235-4004, 2181 Kachemak Dr, Homer, AK, 99603)

**Abstract:**

This project is designed to assist in the evaluation of recovery and restoration of injured resources in the foot print of the *Exxon Valdez* oil spill (EVOS). It is important to know if oceanic conditions and changes in the Gulf of Alaska are synchronous with near-shore trends, and monitoring at multiple sites will help discern such relationships. Mapping currents and water mass movements of a region contributes to our understanding of patterns in the abundance and diversity of marine plankton, invertebrates, fish, birds, and mammals in coastal Alaska. The complex structure of fronts where water masses meet and the patterns associated with the movement of water masses are still not understood for lower Cook Inlet. In this study, we will be mapping the waters in lower Cook Inlet and Kachemak Bay to understand the intrusions of the Alaska Coastal Current and to identify spatial and temporal changes of various other currents in this region and relate these observations to injured resources. Developing an understanding of the structure of the physical oceanography will help us understand the connectivity of water movement and potential plankton transport between lower Cook Inlet and Kachemak Bay. By determining the local species of phytoplankton and zooplankton and understanding their seasonal distribution we will begin to understand the biological patterns associated with upper trophic levels of the nearshore marine system. Information from this project will also be useful to local mariculture operations, subsistence harvesters of hard shell clams and other invertebrates, NOAA Regional Ocean Circulation Model development, and monitoring programs for harmful algal blooms.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $191.9 | $177.4 | $166.5 | $133.7 | $108.8 | $778.2 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date:** 9 August 2013

## I. NEED FOR THE PROJECT

### A. Statement of Problem

This project is designed to assist in the evaluation of recovery and restoration of injured resources in the foot print of the *Exxon Valdez* oil spill (EVOS). It is important to know if oceanic conditions and changes

in the Gulf of Alaska are synchronous with near-shore trends, and monitoring at multiple sites will help discern such relationships. Kachemak Bay, like PWS, has been impacted by the EVOS and has similar physical stressors on near-shore coastal habitat such as land-level changes from the 1964 earthquake and isostatic rebound from melting glaciers. In this project we are continuing oceanographic monitoring data series for lower Cook Inlet (Okkonon et al. 2009) and Kachemak Bay (Murphy and Iken 2013).

**B. Summary of Project to Date**

Beginning in 2012, we have been conducting oceanography and marine plankton surveys quarterly in lower Cook Inlet (including Kachemak Bay) and monthly in mid-Kachemak Bay. To date, six surveys of lower Cook Inlet/Kachemak Bay seasonal surveys were attempted and five full surveys conducted; inclement weather prevented a full survey of the study area in February 2013 though Kachemak Bay sampling was completed. Collectively, nearly 487 conductivity-temperature-depth (CTD) profiles were made in the first year and a half of the project. Oceanographic profile data are available in Seabird Electronics data format for all surveys, with ongoing data processing to standard 1-meter depths, export to Excel spreadsheets and generation of data visualizations as vertical profile graphs and along-transect contour plots. In November 2012, we also began to compile the historical CTD data for the study area and are preparing data formats for uploading into the Gulf Watch data portal. We provided temperature and salinity profile data to the National Ocean Service (NOS) Coast Survey Development Laboratory for validation of the new NOS Cook Inlet ocean circulation model. This model is being used by NOS to produce a tidal energy assessment of Cook Inlet, in partnership with the Alaska Energy Authority.

Concurrent with the CTD sampling, marine phytoplankton and zooplankton collections are made. Samples are preserved for later analyses by the NOAA Center for Coastal Fisheries and Habitat Research (Kasitsna Bay and Beaufort Laboratories - phytoplankton) and the Prince William Sound Science Center (zooplankton). Data are still being processed for zooplankton. Preliminary results from the oceanographic and phytoplankton monitoring have been presented in three posters at the 2012 and 2013 Alaska Marine Science Symposium and in public talks given in Homer Alaska (July 2012 and July 2013) and Seldovia Alaska (July 2013). The phytoplankton monitoring data is also being used in NOAA harmful algal bloom studies on the species that cause paralytic shellfish poisoning.

Continuous water quality data collection and reporting occurred throughout the study through the Kachemak Bay Research Reserves' System-wide Monitoring Program for meteorological, water quality, and monthly nutrient samples; all data are being quality controlled and archived through the NERR's Central Data Management Office. As part of this study, we purchased a YSI moored buoy system and deployed a data sonde to monitor water quality in Bear Cove during the ice-free months. The station data is telemetered to provide researchers and local oyster farmers with real-time access to the water quality data. In addition to establishing a new water quality monitoring site, we upgraded our monitoring program with four new sondes which have an optical port for continuous monitoring of chlorophyll-a (chl-a); this allows for monitoring all three surface (1m depth) stations for chl-a throughout the summer months.

## II. PROJECT DESIGN

### A. Objectives

Project objectives

Our 5-year program goal is to enhance existing monitoring programs to be able to correlate near-shore monitoring of injured resources with annual and seasonal patterns and trends in oceanographic conditions in lower Cook Inlet.

The objectives of the Cook Inlet and Kachemak Bay oceanographic monitoring include:

4. Improve understanding of water mass movement in Kachemak Bay
    a. Identify surface and subsurface flow and water mass characteristics within Kachemak Bay through measurements of temperature and salinity in historical and present data.
    b. Examine spatial, seasonal and annual changes in the depth and persistence of freshwater lenses in the Bay.
    c. Place an additional YSI data sonde in Bear Cove during the ice-free period to monitor trends in salinity, temperature, and nutrients at the head of the Bay in proximity to clam beds.
5. Determine linkages, and temporal variability in those links, between Kachemak Bay/lower Cook Inlet and the Alaska Coastal Current
    a. Maintain and monitor temperature trends in all sub-bays on the southern side of Kachemak Bay with TiBits temperature loggers.
    b. Analyze data on temperature and salinity signatures that identify Gulf of Alaska water intrusions into Kachemak Bay.
    c. CTD data will be analyzed for spatial, seasonal and annual variability and trends, as well as linkages to oceanographic data from the GAK1 mooring and Seward line and the GoAIERP shipboard sampling along the shelf adjacent to Cook Inlet.
6. Examine the short-term variability and track long-term trends in oceanographic and water quality parameters
7. At a subset of stations along each CTD transect, collect water samples for marine plankton. Zooplankton samples will be analyzed by Rob Campbell as part of the PWS oceanographic monitoring project. Phytoplankton will analyzed by the NOAA Center for Coastal Fisheries and Habitat Research at Kasistna Bay Laboratory and with molecular techniques at our Beaufort Laboratory in North Carolina.

### B. Procedural and Scientific Methods

*Study Area and Sampling Frequency:* We are extending existing time series of oceanographic surveys in lower Cook Inlet and Kachemak Bay (Okkonon et al. 2009, Muphy and Iken 2013) and supplementing an existing water quality monitoring program in Kachemak Bay (Kachemak Bay Research Reserve 2010) with an additional site in Bear Cove during the ice-free months. Surveys will be conducted at stations along transect lines (Figure 1) within Kachemak Bay (Transects 4 and 9) and across lower Cook Inlet (Transects 3, 6 and 7). Kasitsna Bay Laborator and Kachemak Bay Research Reserve small boats will be used for Kachemak Bay sampling and larger chartered boats will be used for Cook Inlet sampling, due to the routine presence of higher sea state conditions in the inlet. Station spacing will be between 400 m and 1.5 km in Kachemak Bay and up to 4 km in Cook Inlet, with closer station spacing near the coast. At

the beginning of each transect, the following information is recorded: cruise ID, vessel, date, transect line, wind speed and direction, and sea state. Additional information recorded at each station, including: station ID, time, position, station depth, event (type of sampling event and sample ID), and comments about the station. Oceanographic measurements are made with conductivity-temperature-depth (CTD) profiler casts at each station along Transects 3, 4, 6, 7, and 9 (n=88) and plankton samples are collected at a subset of the stations (n=15) (Figure 1). Transects in lower Cook Inlet and outer Kachemak Bay (Transects 3, 4, 6, and 7) are scheduled for sampling quarterly for the first three years of the study and reduced to three and two sampling periods, respectively, during years four and five of the project due to budget limitations. Transect 9, at mid-Kachemak Bay is scheduled for monthly oceanographic (n=9) and plankton (n=3) sampling throughout the study period.

*Conductivity-temperature-depth (CTD) profiler oceanographic surveys:* Sea-Bird Electronics (SBE) 19plus SEACAT CTD profilers will be used to acquire surface to bottom profiles of temperature and salinity at each station on the shipboard surveys. Turbidity measurements will be made with a WETLabs ECO Fluorometer chlorophyll and turbidity sensor, dissolved oxygen measurements will be made with an SBE 43 oxygen sensor, and light will be measured with a Licor LI-192 photosynthetically available radiation sensor, with all sensors integrated with the CTD profiler. At each station, the CTD profiler will be lowered at 1 meter/second from approximately 1 meter depth to 1-2 meters from the bottom, with a sample rate of 4 times/second. Station location will be recorded from vessel-mounted or handheld GPS units. Sampling will normally be limited to sea states less than seven feet for safe deployment of the CTD. The SBE-19+ CTD are placed in a cage and a 5 -10 Kg weight on a 1-m long line is suspended beneath the cage to reduce flagging in strong Cook Inlet tidal currents. The data are downloaded at the end of each transect and processed using standard SeaBird processing algorithms.

*Zooplankton Sampling:* Zooplankton are sampled with a bongo style plankton net (2 m length of 333 micron mesh with a 60 cm diameter opening (Aquatic Research Instruments)). We conduct a 50m vertical tow with a tow rate of approximately 0.5m/s. A mechanical flow meter (General Oceans Inc. R2030) is attached to one of the two nets to estimate water volume. When the tow is complete, the mesh and cod end are washed down with salt water to concentrate plankton. The plankton sample is retrieved from the net that does not have the flow meter attached to the opening. Plankton are transferred to plastic bottles with screw-top lids and preserved with either 3 or 5% formalin solution in the field. Preserved samples are shipped to the Prince William Sound Science Center for analysis of species and relative abundance of each species.

*Phytoplankton Sampling:* A surface tow method is used to collect phytoplankton samples in this project. Field methods are as follows:

a. Pour a known volume of surface sea of water (10L, 20L, 40L pending bloom structure), through the 20um net, 20cm diameter plankton net
b. Wash the outside of the net down with ambient sea water
c. Collect sample in a sample jar; preserve the sample with Lugal's solution

**C. Data Analysis and Statistical Methods**

SEACAT CTD profiler data from all transects will be initially processed with standard SBE Seasoft software algorithms and averaged into 1 meter depth bins. Subsequent data processing will use Matlab software algorithms to compute density and construct vertical profiles and along-transect distance versus depth contour plots of temperature, salinity, density and other variables. Density fields will be used to estimate the degree of vertical stratification at each station. Lateral variability across the transect and temporal variability between sampling periods will be assessed by calculating means and standard deviations for temperature, salinity and density fields. A least-squares analysis will be used to assess seasonal and annual patterns along the Homer Spit transect. The amount of freshwater at each station within the upper part of the water column will also be calculated using a reference salinity (~32 psu) consistent with earlier studies. The CTD data will be used to assess the seasonal cycle of water mass movements and density-driven, geostophic circulation. We expect to use the new NOS circulation model (completed in 2013) to help us analyze tidal and subtidal patterns.

Marine plankton data are currently being analyzed to determine species composition, relative abundance, and timing of blooms (phytoplankton). It is important to note, that this project, in conjuction with other Gulf Watch Alaska projects of the University of Alaska Fairbanks and the Prince William Sound Science Center, is helping to develop an in-state capability for marine plankton identification; most zooplankton samples are currently being sent out of the country for analyses. A plankton manual of common and rare species of marine plankton will be developed for this study area. Plankton data will be analyzed both qualitatively and quantitatively, depending on the accuracy of the plankton density estimates. Collectively, these data will be used to assess differences in offshore and nearshore patterns as they relate to biomass distribution and primary productivity within the study area and within the greater GulfWatch program. Methods will likely follow those developed by NOAA's Southeast Area Monitoring and Assessment Program.

**D. Description of Study Area**

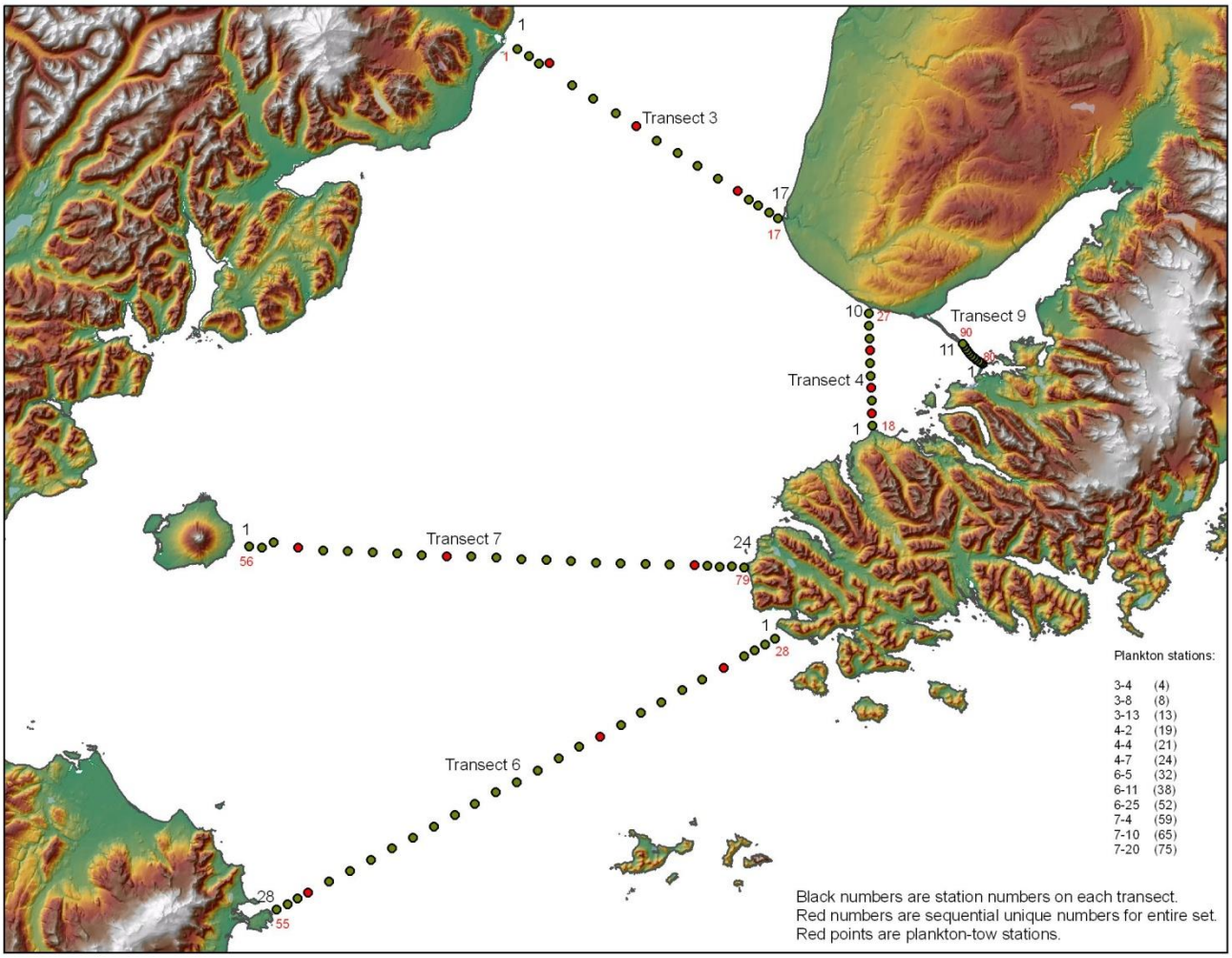


Figure 1. This is the study area for the oceanographic and marine plankton long term monitoring project in Kachemak Bay and lower Cook Inlet, Alaska. Each dot represents an oceanographic profile sampling location; red dots indicate the current sampling stations for marine plankton and water chemistry samples.

## E. Coordination and Collaboration with the Program

The Kachemak Bay Research Reserve provides resources for continuous monitoring of water quality and meteorological data; this proposed project leverages and supplements an existing program. Oceanographic monitoring in Kachemak Bay will combine: 1) continuous data from existing KBRR water quality monitoring stations (YSI sondes measuring temperature, salinity, dissolved oxygen, turbidity, pH) at the Homer and Seldovia harbors; 2) an additional shoreline water quality station to be deployed during ice-free months in Bear Cove (near head of Bay); and 3) small-boat transects of temperature and salinity profiles (CTD) and plankton sampling, conducted by monthly on a transect across from the Homer Spit. Oceanographic monitoring in lower Cook Inlet leverages existing CTD survey data collected along these transect lines as well as four other transects in lower Cook Inlet. The NOAA Kasitsna Bay

Laboratory is contributing staff time and in-kind use of small boats and equipment to the project. We are also leveraging support from undergraduate NOAA Hollings Scholars that have 2-month summer internships at Kasitsna Bay Laboratory, with two to three students participating each year. Collectively, the proposed near-shore and offshore long-term monitoring will have $155K/year match from the Kachemak Bay Research Reserve and the Kasistna Bay Laboratory, combined.

This project directly links to Gulf Watch projects Long-term Monitoring of zooplankton populations on the Alaskan Shelf and Gulf of Alaska using Continuous Plankton Recorders which has a goal to provide continued large spatial scale data on zooplankton populations to extend the existing time series and integrate the data with more regional, locally more intensive, sampling programs and to Long term monitoring of oceanographic conditions in Prince William Sound which is providing data consistency for zooplankton identification of samples collected in our study area. The Gulf Watch project, The Seward Line: Marine Ecosystem monitoring in the Northern Gulf of Alaska is important to understanding anomalies and broad-scaling events in the current study.

Thus far, this research and monitoring program have provided the following linkages to related projects in the study area:

a. Oceanographic data (temperature and salinity) from this study is being used to validate an ocean circulation model being developed by NOAA's National Ocean Service for Cook Inlet. The model is being used by NOS to produce a tidal energy assessment of Cook Inlet, in partnership with the Alaska Energy Authority, and the model will be part of an operational Cook Inlet marine forecast system.
b. The phytoplankton species that causes paralytic shellfish poisoning, *Alexandrium fundyense,* were found at all Kachemak Bay sampling locations throughout the summer, although at relatively low concentrations. *A. fundyense* concentrations were found to be significantly correlated with both water temperature and salinity conditions.
c. The project leveraged partnerships with AOOS and UAF to collect water samples to quantify variability in water chemistry associated with ocean acidification. Coastal water chemistry changes with freshwater input from glacial watersheds and snowmelt, upwelling of ocean waters and phytoplankton blooms and understanding this variability is needed to assess how much ocean acidification may threaten nearshore species and habitats.
d. Through a partnership with the U.S. Fish and Wildlife Service, we are enhancing the Gulf Watch Alaska program to provide data that will improve understanding of relationships between marine conditions, primary productivity, and seabirds and marine mammals.

**III. CV's/RESUMES- please see appendix**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Quarterly CTD/marine plankton surveys will be conducted throughout the study area. Monthly CTD/marine plankton surveys will be conducted in Kachemak Bay. The

Kachemak Bay Research Reserve's water quality monitoring program will collect continuous water quality data at 5 stations during ice-free months and 3 stations during heavy icing.

**Objective 2**. Quarterly CTD/marine plankton surveys will be conducted throughout the study area. Monthly CTD/marine plankton surveys will be conducted in Kachemak Bay. The Kachemak Bay Research Reserve water quality monitoring program will collect continuous water quality data at 5 stations during ice-free months and 3 stations during heavy icing. The Reserve will also monitor sub-bay temperatures throughout the year in Kachemak Bay.

**Objective 3**. Using data collected in objectives 1 and 2, we will track anomalies in temperature and conductivity in the outer shelf of the Gulf of Alaska and in Kachemak Bay.

**Objective 4**. The species composition, timing, and where applicable, relative abundance of marine plankton will be determined for the study area. When complete, these trends will be related to other GulfWatch studies.

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**

| | |
|---|---|
| *February, 2014* | *Project funding available* |
| | *1st & 2nd Quarterly survey of the study area* |
| | *Monthly survey of inner Kachemak Bay* |
| | *Continuous water quality monitoring 3 stations* |
| | *Continuous water temperature monitoring in sub-bay* |
| | *Data management* |

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

| | |
|---|---|
| *June :* | *Monthly survey of inner Kachemak Bay* |
| | *Continuous water quality monitoring 5 stations* |
| | *Continuous water temperature monitoring in sub-bay* |
| *July:* | *3rd Quarterly survey of the study area* |
| | *Data management* |

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

| | |
|---|---|
| *September 1:* | *Monthly survey of inner Kachemak Bay* |
| | *Continuous water quality monitoring 3 stations* |
| | *Continuous water temperature monitoring in sub-bay* |
| *October:* | *4rd Quarterly survey of the study area* |
| | *Data management* |

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**

| | |
|---|---|
| *December 1:* | *Report writing* |
| | *Monthly survey of inner Kachemak Bay* |
| | *Continuous water quality monitoring 3 stations* |
| | *Continuous water temperature monitoring in sub-bay* |

**V. BUDGET**
**Budget Form (Attached)**

## Pelagic Monitoring Component (lead – Lindeberg)

**FY14 PROGRAM PROJECT**

**PROPOSAL FORM**

**Project Title:** Data synthesis, analysis and recommendations for sampling frequency and intensity of nearshore marine bird surveys to detect trends utilizing existing data from the Prince William Sound, Katmai and Kenai Fjords coastlines.

**Project Period:** (Please use the fiscal year of February 1 – January 31)

**Primary Investigator(s):** Heather Coletti, Marine Ecologist, Southwest Alaska Network Inventory and Monitoring Program, National Park Service, Heather_Coletti@nps.gov, 907-644-3687

**Collaborators:** David Irons, James Bodkin, Brenda Ballachey, Tom Dean

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et al. Skiff based surveys for marine birds along the Prince William Sound, Katmai and Kenai Fjords coastlines have been conducted for over 5 and 20 years, respectively. The results of these surveys provide estimates of the species composition, relative abundance, and distribution of all marine birds and mammals within this nearshore zone. The focus of these surveys is on marine birds that are trophically linked to the nearshore food web, and include species of sea ducks (Harlequin ducks, Barrow's and common goldeneye, and scoters), mergansers (common and red-breasted), and shorebirds, specifically the black oystercatcher, cormorants, glaucous-winged gulls and pigeon guillemots. Sustainability of long-term monitoring programs requires the optimization of sampling intensity and efforts to minimize costs while concurrently having sufficient power to detect a trend. While there has been critical thought in the past regarding these questions, current available analytical methods now allow for the use of existing data in simulations, using a Bayesian framework, to estimate number of samples and sample frequency required to detect a specified trend as well as examine effects contributing to variation, such as imperfect detection.

**Estimated Budget: $52.7K**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $32.7K | 0.00 | 0.00 | 0.00 | 0.00 | $32.7K |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $10 | $20 | $10 | $0 | $0 | $40 |

*In-kind salary support from NPS – has changed because of shifts in timeline – see project milestones & objectives*

**Date: July 18, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

The National Park Service (NPS) Southwest Alaska Network (SWAN) Inventory and Monitoring Program (I&M) and the US Fish and Wildlife Service (USFWS) have been conducting skiff based surveys for marine birds along the Prince William Sound, Katmai and Kenai Fjords coastlines for over 5 and 20 years, respectively. These surveys do not currently account for imperfect detection nor do they focus on any single species in particular or nearshore habitat type. However, within the SWAN program, the goal is to estimate trends for a select group of marine bird species reliant on the nearshore food web and and that were impacted by the *Exxon Valdez* Oil Spill. These include: black oystercatchers (*Haematopus bachmani*), cormorants (*Phalacrocorax spp.*), glaucous-winged gulls (*Larus glaucescens*), goldeneyes (*Bucephala spp.*), harlequin ducks (*Histrionicus histrionicus*), mergansers (*Mergus spp.*), pigeon guillemots (*Cepphus columba*), and scoters (*Melanitta spp*.).

From preliminary analysis of NPS data, the current survey design does not provide variance estimates for detecting trends for the identified indicator species with suitable confidence (<0.50) depending on the species. We utilized coefficients of variance (CVs) to determine within year as well as across year variation for each species. NPS determined that we may not be adequately surveying for some species possibly because: (1) certain species are highly aggregated (2) we are focusing on inappropriate habitat for the species in question, (3) our sample size is too small or (4) the year to year variation in distribution is great enough that we should be conducting replicate surveys within a single season.

We are proposing to continue to monitoring existing transects to have continuity with legacy data, but to improve on existing protocols by minimizing variation by examining the effects of sampling error and imperfect detection while also making recommendations to improve efficiency through sample intensity and frequency. Improving sampling methods will provide a better sense of population trends of specific species (listed above) across the western Gulf of Alaska are and increase efficiency as we move forward in our efforts to monitor species of interest within the *Exxon Valdez* spill area.

### B. Summary of Project to Date (if applicable)

If the project was funded in previous years, please provide a summary of the goals met to date and what milestones are still outstanding. If there are milestones from the previous year's proposal that have not been met, provide a description of why they could not be met, how much funding remains for the project to complete the milestones and a timeline for their completion.

Initial funding was provided in February of 2012. No work began on the project until funding was secured. Once funding was secured, meetings were held during Sept. of 2012 and a draft proposal was developed. The resulting proposal was finalized but further delays arose as NPS converted to a new financial system while simultaneously determining how best to deal with sequestration. This resulted in contracts that were not considered time sensitive to be delayed until June / July of 2013 for submission. The contract for analysis has been submitted through NPS contracting and is currently awaiting the bid process. We are anticipating that a contract will be awarded before the end of federal fiscal year of 2013. Timelines have been adjusted accordingly (see objectives section). No additional funding has been provided or requested. The only modification to the budget is the increase in in-kind support from NPS (ecologist salary) to oversee the protracted contracting process.

**II. PROJECT DESIGN**

**A. Objectives**

List the objectives of the proposed research, the hypotheses being tested during the project, and briefly state why the intended research is important.

**Concept:** We propose to use existing datasets from Prince William Sound, Katmai and Kenai Fjords to conduct data synthesis and analysis to answer questions regarding sampling intensity and sample frequency for detecting trends. These are essential components to building a long-term monitoring program. Even though critical thought has gone into this in the past, it seems prudent to utilize existing data to examine the following:

A. Use existing data in simulations to estimate number of samples and sample frequency required to detect a specified trend or change with some level of confidence for selected species/species groups' density/abundance.
    i. The levels of change or trend deemed ecologically significant will be specified by the investigators.

B. Determine impact of imperfect detection
    i. Conduct a series of simulations applying different levels of detection bias, based on best available information, to evaluate the effects of various levels of detection bias (and variability therein) on some true population trend.
    ii. Assuming detection probabilities are not constant through time; determine the magnitude of the effects of variation in detection probability on trend estimates and the ability to detect trends if present.

This approach to the long-term monitoring effort may be a way of displaying for the Trustees that we are thinking about a long-term, sustainable monitoring program that will allow us to estimate trends that we deem ecologically important across a variety of temporal and spatial scales and providing information to inform the group of the scale and intensity of monitoring needed over potentially 20 yrs and cost saving due to reduced sampling where feasible based on simulation results.

There may be increased costs on the front-end for data synthesis and analysis, but if results allow for a decrease in sample intensity OR can identify areas that may require more efforts, the upfront costs may be minimal to the long-term costs of unnecessary sampling or poor power to detect trend.

**Linkages:** This exercise with utilize and link datasets spanning several years within Prince William Sound, Kenai Fjords and Katmai. Focal species include those that have exhibited protracted recovery

from EVOS. This work would be an interagency effort between NPS, USFWS and USGS to improve the power to detect trends of coastal marine birds across the entire spill area.

**B. Procedural and Scientific Methods**

For each objective listed in A. above, identify the specific methods that will be used to meet the objective. In describing the methodologies for collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methodologies considered, and explain why the proposed methods were chosen. In addition, projects that will involve the lethal collection of birds or mammals must comply with the Trustee Council's policy on collections, available at http://www.evostc.state.ak.us/Policies/other.cfm.

See Project Design Section A.

**C. Data Analysis and Statistical Methods**

Describe the process for analyzing data. Discuss the means by which the measurements to be taken could be compared with historical observations or with regions that are thought to have similar ecosystems. Describe the statistical power of the proposed sampling program for detecting a significant change in numbers. To the extent that the variation to be expected in the response variable(s) is known or can be approximated, proposals should demonstrate that the sample sizes and sampling times (for dynamic processes) are of sufficient power or robustness to adequately test the hypotheses. For environmental measurements, what is the measurement error associated with the devices and approaches to be used?

See Project Design Section A.

**D. Description of Study Area**

Where will the project be undertaken? Describe the study area, including if applicable decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates). The formula for converting from degree minute seconds to decimal degrees is: degrees + (minutes/60) + (seconds/3600) so 121°8'6" = 121. + (8/60) + (6/3600) = 121.135

See Project Design Section A.

**E. Coordination and Collaboration with the Program**

Indicate how your proposed project relates to, complements or includes collaborative efforts with the Program. Identify how this project will assist in the answering of the Program's hypothesis and how data collected as part of this project may be used by other projects. Describe any coordination that has taken or will take place (with other Council funded projects, ongoing agency operations, activities funded by other marine research entities, etc.) and what form the coordination will take (shared field sites, research platforms, sample collection, data management, equipment purchases, etc.). If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

See Project Design Section A.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

For each project objective listed above (II.A.), specify when critical project tasks will be completed. Project reviewers will use this information in conjunction with annual project reports to assess whether projects are meeting their objectives and are suitable for continued funding. Please format your information like the following example.

**Objective 1.** Complete all necessary documents to the National Park Service contracting officials for review and submission. This date was originally modified from November of 2011 since funding was not available until Feb. of 2012 and no work began on the project until funding was secured. Once funding was secured, meetings were held during Sept. of 2012 and a draft proposal was developed. The resulting proposal was finalized but further delays arose as NPS converted to a new financial system while simultaneously determining how best to deal with sequestration. This resulted in contracts that were not considered time sensitive to be delayed until June / July of 2013 for submission. The contract for analysis has been submitted through NPS contracting and is currently awaiting the bid process. We are anticipating that a contract will be awarded before the end of federal fiscal year 2013. Timelines for objective 3 have been modified based on objective 1's updated date.
*To be met by September 2013*

**Objective 2**. Compile marine bird survey data from Prince William Sound, Katmai National Park and Preserve and Kenai Fjords National Park. - COMPLETED
*To be met by June – August 2012*

**Objective 3**. Provide report with recommendations for continued monitoring.
*To be met by June 2014*

**B. Measurable Project Tasks**

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed. This information will be the basis for the quarterly project progress reports that are submitted to the Trustee Council Office. Please format your schedule like the following example.

**FY 14, 1st quarter (February 1 – May 31, 2014)**

*February, 2014* *Project in progress, no additional funding required*

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

*June 30:* *Provide final report with recommendations for continued monitoring.*

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

*September 1:* *NA*

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**
*December 1:* *NA*

**V. BUDGET**

**Budget Form attached.**

| **FY14 PROGRAM PROJECT**<br><br>**PROPOSAL FORM** |
|---|
| **Project Title:** Long-term Monitoring: Pelagic monitoring component - Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords |
| **Project Period:** February 1 – January 31 |
| **Primary Investigator(s):** Craig O. Matkin, Executive Director, North Gulf Oceanic Society 3430 Main St. St B1 Homer, Alaska 99603 907 299-0677 |

**Abstract:**

The proposed project is a continuation of the annual monitoring of AB pod and the AT1 population killer whales in Prince William Sound-Kenai Fjords. These groups of whales suffered significant losses at the time of the oil spill and have not recovered at projected rates. Monitoring of all the major pods and their current movements, range, feeding habits, and contaminant levels will help determine their vulnerability to future perturbations, including oil spills. The project also extends the scope of the basic monitoring to include an innovative satellite tagging program used to examine habitat preference, feeding ecology and assist in relocating whales for feeding studies. It continues examination of feeding habits using observation, prey sampling and innovative chemical techniques. The study will delineate important habitat, variations in pod specific movements and feeding behavior within a temporal and geographic framework. We will examine the role of both fish eating and mammal eating killer whales in the near-shore ecosystem and their impacts on prey species. Community based initiatives, educational programs, and programs for tour boat operators will continue to be integrated into the work to help foster restoration by improving public understanding and reducing harassment of the whales.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $7.2 | $132.8 | $132.8 | $132.9 | $132.9 | $538.7 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | $23.5 | | | $23.5 |

**Date: 31 July 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Both resident ecotype (AB pod) and transient ecotype (AT1 population) killer whales suffered significant mortalities following the *Exxon Valdez* oil spill in 1989. AB pod is recovering after 22 years but has still not reached pre-spill numbers. The AT1 population is not recovering and may be headed toward extinction. This project has determined that killer whales are sensitive to perturbations such as oil spills, but has not yet determined the long term consequence (extinction) or the recovery period required for AB pod. As an APEX predator, this species has impact on the ecosystem (fish and marine mammals); additionally they are a primary focus of viewing for a vibrant tour boat industry in the region, and can be closely monitored. This is a unique opportunity to continue a comprehensive database for a keystone species in the region. The wisdom of long-term killer whale monitoring has been borne out in other regions such as Puget Sound and British Columbia. Data from this project is used by tourboats in the region to enhance viewers experience and understanding of the local environment and fauna.

**B. Summary of Project to Date (if applicable)**

As an ongoing monitoring project, many of the goals associated with this project are continuing measurements designed to map changes in population numbers, range and distribution, contaminant levels, feeding habits and feeding/diving ecology. Recent milestones include publication of "The Life History and Population Dynamics of Resident Killer Whales" in the journal Marine Mammal Science, and "Contrasting Abundance and Residency Patterns of Two Sympatric Populations of Transient Killer Whales in the Northern Gulf of Alaska" in the journal Fishery Bulletin, as well as the publication of the book "Into Great Silence", a popular account of some of our research and findings. Development of ARGOS based satellite tags which now include dive time and depth has continued with a new design produced for the 2013 season. Biopsy sampling for feeding habits studies continues and is now providing information on changes in diet of killer whales and changes in the feeding ecology of killer whales possibly related to other changes in the Gulf of Alaska. We continue to develop and improve our website and Facebook page information and to work closely with tourboats in providing the latest information on these whales

**II. PROJECT DESIGN**

**A. Objectives**

1) Photo-identification of all major resident pods and AT1 transient groups that use Prince William Sound/Kenai Fjords on an annual basis. Realistically, all pods are completely documented on a biennial basis, despite annual field effort. Extension of individual histories, identification catalogues of individuals and an annual update of population model are products of these data.
2) Collection of blubber samples for chemical monitoring of PCBs, DDT's and PBDE's, lipids /fatty acids and stable isotope values to gauge changes in contaminant loads as well as feeding habit changes. Most analytical costs are borne by NOAA fisheries.
3) Collection of fish scale samples and marine mammal tissue from kill sites to monitor potential changes in feeding habits
4) Collection of genetic tissue samples (Genetic analytical costs paid by NMML/UBC)
5) Tracking of individuals/pods using ARGOS satellite telemetry to improve re-sighting rate and foster completion of objectives 1-3. Use of time/depth recorders to examine feeding patterns and diel behavior.
6) Determine details of range of pods/populations using both ARGOS and photoidentification data and identify important habitat on a pod specific basis

**B. Procedural and Scientific Methods**

The field work consists of three major activities. Photo-identification will be completed using Nikon D700 digital cameras to obtain photos of every individual in major resident pods and AT1 transient groups, and offshore killer whales that are encountered. (Humpback whales are photographed opportunistically as time allows.)

Biopsy samples for chemical analysis and genetics will be collected using an air powered rifle and small floating biopsy darts that are easily retrieved. This technique has been used since 1994. ARGOS Spot 5 satellite tags manufactured by Wildlife computers will be attached with specially designed darts to specific whales to track movements over periods ranging from weeks to months.

Survey days and encounter data is logged in an Access database maintained by NGOS and as part of the Gulf Watch Database. Data analysis includes a frame by frame analysis of all digital images, with individual identifications digitally recorded and attached to the photo. Improvement photos of each individual are selected and placed in appropriate folders and used to update catalogue (for NGOS and

public access) and provide reference for future identifications. The population dynamics data base that lists data on each individual (including newly recruited calves) is updated annually. All vessel and encounter tracklines are stored in GIS format, ready for analysis. ARGOS tracklines are also placed in GIS format and initial analysis and mapping completed on an annual basis.

**C. Data Analysis and Statistical Methods**

Because photographic and observational data are being made in the same format as during the past 23 field seasons and using the techniques now standardized for studying killer whales, the data will be comparable with other data collected around the North Pacific. Since we identify every individual in each pod of resident killer whales, and pod membership only changes through death or calf production, we can accurately assess changes in pods/population.

The report for the monitoring segment will include a summary of all field effort including that funded outside of this DPD, and will include a summary of the pods and individuals encountered and a status report on AB pod and the AT1 group. Changes within AB pod will be examined with consideration for the age and sex structure of the pod and maternal groups within the pod and related to the population model now under development. Trends in transient killer whale sighting rates and demographics will also be presented.

Feeding data will be summarized and field observations and data from scales (species and age) will be summarized and statistically compared by area and by pod. In conjunction with the NWFSC we have used contaminant/fatty acid/stable isotope analysis to describe aspects of killer whale predation in other areas (Herman et al 2005, Krahn et al 2006). Analysis and publication for this aspect of the project will follow the model presented in these papers. We will also statistically compare chemical markers indicative of diet between pods and from different times of year (late winter/spring and late summer/fall). In our field sampling will take into account that chemical markers usually indicate prey from approximately one to two months prior to the sample in temporal comparisons. Genetic analysis, when appropriate, will be conducted using the methods detailed in Matkin et al (2003) and Barrett-Lennard 2000 and will include mtDNA and nuclear DNA analysis. Track lines from whales tagged with satellite tracking devices will be presented and analyzed in GIS format. Tracks will be examined for patterns in movements, and in relation to bathymetry, to known migratory pathways of prey and to areas of potential prey abundance. We will establish home range estimates and kernel density estimates to determine important habitat and migratory pathways.

Frame by frame identifications of individuals tabulated by pod and by individual and added to our database. Individual sighting data from each encounter is provided to NCEAS and uploaded to Gulf Watch site by Sarah Clark. NCEAS is also maintaining a database of all surveys and encounters from this project since its inception on the Gulf Watch site. Copies of the GIS program and data base will be available by request to NGOS.

PC (Windows) compatible computers owned by NGOS will be used to analyze field data. The various long-term databases will be housed at NGOS offices as well as on the Gulf Watch website and with other Gulf Watch databases, although copies will be made available to other management agencies on request.

**D. Description of Study Area**

This project is part of an ongoing killer whale research in Prince William Sound and the Kenai Fjords region, Alaska (Matkin et al 2008). The overall study area stretches from the Nuka Bay, outer Kenai Peninsula region to Cordova on the eastern edge of Prince William Sound. However, the funding specifically requested in this proposal will be used primarily in western Prince William Sound and Kenai Fjords where likelihood of encountering the focal whales is most likely. We cannot predict the specific locations where encounters will occur.

**E. Coordination and Collaboration with the Program**

The monitoring of killer whales and analysis of current data is part of a long-term program to investigate killer whale recovery, monitor populations and examine the interactions of killer whales with other species. The PI, Matkin, will work closely with collaborators Russ Andrews at the Alaska Sea Life Center, who has designed the satellite tags and with Dave Herman and Peggy Krahn at the Northwest Fisheries Science Center, who conduct diet and contaminant analysis, and Kim Parsons who conducts the genetic analysis. We have been and will continue to be active collaborators on the studies examining the interaction of humpback whales and herring ( see other projects, John Moran, PI) and have contributed our substantial long-term humpback whale photo database to their analysis. We will continue to collect humpback whale fluke identification data during the course of the proposed work and share research platforms when possible. As possible the proposed study will be integrated with near shore studies that focus on sea otters and with the oceanographic studies of the Alaska Coastal Current.

This project will rely on approximately $15,000 annually in additional analytical time provided by the NWFSC, Environmental Contaminant Laboratory, $5000.00 annually in additional vessel time contributed by NGOS, and $3500 annually by the Norcross Foundation in equipment. In addition we are supported and work cooperatively with the NMFS regional office (Aleria Jensen) in providing observation and education of the tour boat fleet in the Prince William Sound/Kenai Fjords region. As a non-profit research institution familiar with private funding sources and cooperative programs, NGOS can work with the Trustee Council to maximize return for current and future funding.

**III. CV's/RESUMES-please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

Objective 1. To prepare and launch field collection of data, including identification photos, prey samples and observations, biopsy samples and satellite tag attachments. Field work will begin in May 20124and end by October 2014.

Objective 2. Conduct analysis blubber samples, scale samples, skin samples, and plot results of tagging efforts.

Objective 3. Annual update photographic catalogue, Argos tracking data, and population dynamics database. Statistical analysis and compilation of data from all years of the project to be published and included in final report

**B. Measurable Project Tasks**

**FY14, 1st quarter (October 1, 2013-December 31, 2013)**

Workup satellite tag data in GIS format and update databases. Lipid/fatty acid, contaminant, stable isotope and genetic analysis.

**FY14, 2nd quarter (January 1, 2014-March 31, 2014)**

January 23-27 Annual Marine Science Symposium. Finish analysis of photographs from fieldwork catalogue, workup satellite tag data in GIS format and update databases. Lipid/fatty acid, contaminant, stable isotope, prey sample and genetic analysis completion.

**FY14, 3rd quarter (April 1, 2014-June 30, 2014)**

Prepare for April field work Conduct fieldwork in April (10 days) and May- June (10 days)
**FY14, 4th quarter (July 1, 2014- September 30, 2014)**
Conduct fieldwork in July-August (14 days) and September-November (14 days) Initiate analysis of 2014 data.

**V. BUDGET**
**Budget Form (Attached)**

| **FY14 PROGRAM PROJECT PROPOSAL FORM** |
| --- |
| **Project Title: Long-term Monitoring: Pelagic Monitoring Component – Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound** |

**Project Period:** Feb 1 – July 31, 2013

**Primary Investigator(s):** John R. Moran (NOAA) and Janice M. Straley (UAS)

**Collaborating investigator**: Terry Quinn (UAF)

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. We will evaluate the impact by humpback whales on Pacific herring populations in Prince William Sound. Following protocols established during the winters of 2007/08 and 2008/09(EVOSTC project PJ090804). We will continue to monitor the seasonal trends and abundance of humpback whales in Prince William Sound. Prey selection by humpback whales will be determined through acoustic surveys, visual observation scat analysis and prey sampling. Chemical analysis of blubber samples (stable isotopes and fatty acid analysis) will provide a longer term perspective on whale diet and shifts in prey type. These data will be combined in a bioenergetic model to determine numbers of herring consumed by whales, with the long term goal of enhancing the age structure modeling of population with better estimates of predation mortality.

**Estimated Budget:**
**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $127.4 | $128.8 | $139.6 | $141.6 | $54.4 | $591.9 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $25.0 | $75.0 | $75.0 | $25.0 | $25.0 | $225.0 |

**Date: August 9, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Humpback whale predation has been identified as a significant source of mortality on wintering Pacific herring in Prince William Sound (EVOSTC project PJ090804). At current herring and whale population levels the loss of pre-spawning herring during the fall and winter months is equivalent to the percentage of herring removed during the final years of the commercial herring fishery. Hence, top down forces (predation and disease) are the likely dominating forces constraining the current recovery. Humpback whales in Prince William Sound have a higher percentage of herring in their diet during the winter months and forage longer on wintering herring shoals than their counterparts in Southeast Alaska. With humpback whale population in the North Pacific increasing at 5-7% annually, there is a need to continue evaluating predation pressure on herring until stocks in Prince William Sound fully recover, and to proceed toward enhancing the age structure model to include a better estimate of predation for a more accurate predictor of the herring population.

**B. Summary of Project to Date (if applicable)**
We have completed three winter field seasons.

**II. PROJECT DESIGN**

**A. Objectives**

Objectives:

1) *Population estimates of humpback whales through the use of photographic mark- recapture models.* Knowing the number of whale present in PWS is essential for assessing their impact on the PWS ecosystem.
2) *Monitor the seasonal trends of humpback whales in Prince William Sound relative to prey.* EVOSTC project PJ090804 identified an correlation between the movements of whales and herring in PWS
3) *Estimate inter-annual trends in humpback whale abundance.* This objective allows us to determine if the conclusion from EVOSTC project PJ090804 are an anomaly or typical whale behavior in PWS.
4) *Determine the diet and dietary shifts of humpback whales.* A shift in prey by whales can have profound effects on herring (i.e. in Southeast Alaska, when euphausiids become available pressure on herring by whales is greatly reduced).
5) *Estimate predation rates on herring by humpback whales.* This objective quantifies predation pressure on herring for PWS.
6) *Incorporate mortality rates into herring age structure models.* This is the management component of the study, to evaluate if predation by whales explains fluctuations in herring populations.

The field work for this proposal will center around three (~7 days) cruises each year during the fall and winter months for years 1-4 followed by a year of data synthesis (year 5), with the outlook of continuing this survey monitoring protocol for up to 20 years. Additional information on the seasonal abundance and distribution of humpback whales will be obtained using opportunistic surveys throughout the year by local residents and boat operators, as well as photo ID contributed by the killer whale project in the summers.

Project Integration

We expect strong collaboration between humpback whale, killer whale and seabird components of the pelagic monitoring projects. The proposed killer whale monitoring program will opportunistically collect humpback whale data during summers; likewise the observation of killer whales will be

documented during winter humpback whale cruises. On some surveys we will be able to provide a berth for a seabird observer.

**B. Procedural and Scientific Methods**

*Population estimates of humpback whales through the use of photographic mark- recapture models.*

We will use digital cameras with 80-200 mm telephoto lenses or fixed lenses to capture images of the ventral side of humpback whale flukes to identify individuals. All photographs will be quality coded and ranked as good, fair, poor, and insufficient quality to be used in models to estimate population size. Photographs deemed poor or of insufficient quality were excluded from the mark-recapture analysis to avoid potential bias from matching errors. Further, photographs of humpback whale calves will be excluded. The capture probability for a calf is complicated by their co-occurrence with their mothers (and is therefore not independent), and the probability of recapture in later years can be difficult as calf flukes tend to change more than adult flukes.

Time series of humpback whale abundance will be constructed using mark-recapture methods. The first photograph of a particular whale is treated as the "mark", and subsequent photographs of the same whale are "recaptures". Both closed and open population models will be examined.

*Monitor the seasonal trends of humpback whales in Prince William Sound relative to prey*. Although mark-recapture models provide an estimate of abundance, they do not describe seasonal trends. Consequently, we used the number of unique whales seen each month for establishing seasonal patterns and adjusted the pattern to account for the estimated number of whales present. The data used to establish the attendance patterns include calves and individuals identifiable in poor quality photographs and represent a lower bound to the daily attendance pattern for whales. Daily attendance was estimated by fitting linear models to the observed numbers.

*Estimate inter-annual trends in humpback whale abundance.*

Long term trends in abundance will be estimated by combining observations from this study and population estimates from Restoration Project: 100804, allowing us to explore the relationship between climate, prey availability, herring populations and humpback whales.

*Determine the diet and dietary shifts of humpback whales.*

When groups of whales are located and determined to be feeding, effort will made to determine what the whales were eating. Direct observations of prey being consumed, remains after feeding, and sonar mapping of the prey fields observed on a dual 50/200kHz frequency echosounder will be used to determine target prey of humpback whales. Prey distinctly visible on 50kHz was presumed to be fish. Prey visible only at 200kHz were presumed to be smaller and categorized as zooplankton. Confirmation of target prey will be accomplished using herring jigs, zooplankton tows, cast nets and skim nets (used to clean swimming pools) to collect surface fish near feeding whales. Scales and zooplankton were collected behind whales feeding at the surface with the skim net. Fecal samples are collected when possible. Certainty of identification of the target prey will be recorded as certain, probable or undetermined. Only cases were the identification was certain or probable were used to identify specific prey.

*Estimate predation rates on herring by humpback whales.*

The large size humpback whales prevent direct measurement of ingestion rates, therefore estimates of consumption are derived from the allometry between whale size and metabolic requirements. The model combines estimates of whale size, metabolic rates, abundance, and diet with estimates of the energy content of overwintering herring to predict consumption. We will estimated the potential biomass removed for each location and winter using four different modeling scenarios because of the uncertainty in whale metabolic costs and the numbers of whale present. The different scenarios represent the range of possible estimates. Dividing the total biomass consumed under a given scenario with estimates of herring abundance yields a measure of the intensity of humpback whale predation. This ratio, referred to here as predation intensity, is not meant to indicate the actual proportion of the biomass consumed by whales, but rather as an indicator of the scale of whale predation winter under each of the modeling scenarios.

*Incorporate mortality rates into herring age structure models.*
Information on whale abundance will then be fed into an age-structured model for Pacific herring in order to compare the relative magnitudes of disease, whales, and other factors on the mortality of herring. This will help EVOS TC better understand what factors are preventing the recovery of herring.

Project Logistics

For this project, John Moran (NOAA) will provide overall project management, logistics, photographic field captures, prey capture, and chemical analysis. Co-PI Jan Straley (UAS) will participate in photographic field captures, and lead the analysis of photographic IDs, , providing IDs and connection to photographic ID databases for all humpback whale photographs, quality assuring that permitting requirements are met, and collaborating with other whale researchers. Dr. Quinn (UAF) will lead the modeling efforts incorporating whale predation into the herring population models.

Humpback whale vessel survey schedule for Prince William Sound.

| **Month** | **FY12** | **FY13** | **FY 14** | **FY15** | **FY16** |
|---|---|---|---|---|---|
| Oct | 6 days | 7 days | 6 days | 6 days | Synthesis |
| Dec | 6 days | 7 days | 6 days | 6 days | Synthesis |
| Apr | 6 days | 6 days | 6 days | 6 days | Synthesis |
| **Total vessel days** | **18** | **18** | **18** | **18** | **0** |

**C. Data Analysis and Statistical Methods**

Data analysis is limited to estimating whale abundance and modeling their bioenergetic requirements. Whale abundance will be determined from photographic data. We anticipate that whales will not forage exclusively on a single prey item. The relative abundance of different prey types in their diet will be assumed to be equivalent to the relative abundance of species collected in our mid-water trawls. Trawls will be fished at the same depths whales are observed diving. The energetic content of a unit mass of prey in a particular patch will subsequently be estimated as the mean energy content of the prey in the patch, weighted by their relative abundance. Dividing this mass specific energy content into the energy requirement of a whale (described above) will provide an estimate of the total mass of the patch a whale requires. The contribution of herring to this total mass will be determined from their relative abundance in the sample and the average mass of an individual.

Modeling: Quinn et al. (2001) and Marty et al. (2003) developed an age-structured assessment model for Prince William Sound that included disease information. Thus the model can be used to evaluate the

impact of disease on population abundance, recruitment, and survival. ADF&G uses this model in its annual assessments of herring (S. Moffitt, ADF&G, pers. comm.).

The model contains information about the fisheries on PWS herring, which include purse-seine, gillnet, and pound fisheries in the spring (mainly for roe), and a food and bait fishery in the summer and fall. The model provides an estimation framework to integrate the various sources of information about Pacific herring in Prince William Sound from 1980 – 2006, including age compositions from the purse-seine fishery and spawning surveys, egg production estimates, mile-days of milt from aerial surveys, and hydroacoustic biomass estimates Marty et al. 2003, Hulson et al. 2006, Marty et al. 2006). These observations are compared to comparable model quantities in a least squares setting to obtain parameter estimates of recruitment, natural mortality, abundance, and biomass.

We propose to use this model as the basis of comparing the relative magnitudes of the various factors affecting PWS herring dynamics. Recruitment estimates at age 3 will be related to auxiliary variables related to disease, the environment, spawning stock, and predation. It is a simple matter to use the model as a simulation framework, in which alternative harvest and recruitment scenarios are developed. An example of a question to be addressed would be: If whales did not eat herring, would the population have rebounded more so than what really occurred?

Specifically the model will be used: (1) to determine if predation on adult PWS herring is significantly contributing to its failure to recover, (2) to compare the magnitude of this effect to other known factors such as disease and low recruitment, (3) to investigate whether low recruitment is a function of predation.

**D. Description of Study Area**

*Prince William Sound:* Results from EVOSTC project PJ090804 have identified humpback whale feeding aggregations whales in Sawmill Bay, Montague Strait, Elrington Passage, Prince of Wales Passage, and Port Gravina. Focusing on the waters of Sawmill Bay, where local researchers can be land based with small boats will continue to provide fine-scale temporal data, however to assess the impact of whales on herring, year three, will use larger vessels to survey all of PWS.

**E. Coordination and Collaboration with the Program**

This project will combine the skills and location advantage of researchers from Auke Bay Lab (Heintz, Moran), Univ of Alaska Southeast (Straley), Univ. of Alaska Fairbanks (Quinn). We will coordinate with the other PI's in the EVOS TC Long- term monitoring and herring projects.

**III. CV's/RESUMES –please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

***Objectives***

1) Population estimates of humpback whales through the use of photographic mark- recapture models. *To be met September 2015.*
2) Monitor the seasonal trends of humpback whales in Prince William Sound relative to prey. *To be met September 2015.*
3) Estimate inter-annual trends in humpback whale abundance. *To be met September 2015.*
4) Determine the diet and dietary shifts of humpback whales. *To be met September 2015.*
5) Estimate predation rates on herring by humpback whales. *To be met December 2015.*

6) Incorporate mortality rates into herring age structure models. *To be met January 2016.*

**B. Measurable Project Tasks (based on NOAA federal fiscal year)**

**FFY 14, 1st quarter (October 1, 2013-December 31, 2013)**
*October:* *6 day survey of PWS*
*December:* *6 day survey of PWS*

**FFY 14, 2nd quarter (January 1, 2014-March 31, 2014)**
*January:* *Annual Marine science Symposium*
*February:* *6 day survey of PWS*

**FFY 14, 3rd quarter (April 1, 2014-June 30, 2014)**
*Opportunistic surveys, analyze winter data.*

**FFY 14, 4th quarter (July 1, 2014-September 30, 2014)**
*Opportunistic surveys, analyze winter data.*

**FFY 15, 1st quarter (October 1, 2014-December 31, 2014)**
*October:* *6 day survey of PWS*
*December:* *6 day survey of PWS*

**FFY 15, 2nd quarter (January 1, 2015-March 31, 2015)**
*January:* *Annual Marine science Symposium*
*February:* *6 day survey of PWS*

**FFY 15, 3rd quarter (April 1, 2015-June 30, 2015)**
*Compile and analyze data.*

**FFY 15, 4th quarter (July 1, 2015-September 30, 2015)**
*Compile and analyze data.*

**FFY 16, 1st quarter (October 1, 2015-December 31, 2015)**
*Compile and analyze data. Begin writing final report.*

**FFY 16, 2nd quarter (January 1, 2016-March 31, 2016)**
*January:* *Annual Marine science Symposium.*
*Complete final report*

**FFY 16, 3rd quarter (April 1, 2016-June 30, 2016)**
*April 30* *Submit final report as a draft manuscript for publication to the Trustee Council Office.*

**V. BUDGET Long-term Monitoring: Pelagic Monitoring Component - Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound**

***Auke Bay Lab Budget Justification - $ 526K***

Personnel Salaries ($8K) – Overtime for Moran

Travel ($23,400) - Five round trips to the EVOS annual meetings. 24 round trips Juneau to Cordova for field work.

Contractual/Sample Analysis ($485.6K) - Includes 72 large vessel days in PWS, soft labor to collect and process samples, Contracts for UAS (Straley) and UAF (Quinn) awards are managed by NOAA..

Commodities ( $26K) - To prepare samples for shipping, freight, and miscellaneous supplies.

Equipment ($0) - No new equipment will be purchased with EVOSTC funds.

NOTE: We did not receive FY 12 funding until November of 2011. This delay in funding would have resulted in us missing most of the 2011/2012 winter field season setting us a year behind in the project; however, we were able to spend against other budgets with the assurance that the money would arrive. Further complicating matters, our field season straddles federal fiscal year and spend ceases during August and September to consolidate budgets. This requires us to secure contracts for the next winters field work by the end of July. Thus, some budget items, such as vessel charters and travel, will continue to be funded from the previous year's budget.

**FY14 PROGRAM PROJECT**
**PROPOSAL FORM**

**Project Title:** Long-term monitoring: Pelagic monitoring component - Monitoring long-term changes in forage fish distribution, abundance, and body condition in Prince William Sound.

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator(s):** John Piatt and Mayumi Arimitsu, U.S. Geological Survey, Alaska Science Center

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al.

In response to a lack of recovery of wildlife populations following the *Exxon Valdez* Oil Spill (EVOS), and evidence of natural background changes in forage fish abundance, there was a significant effort to document forage fish distribution, abundance, and variability in Prince William Sound (PWS) since the 1990's. We propose to adopt some of these earlier sampling techniques, and also incorporate new methods to monitor forage fish in Prince William Sound with fishing and acoustic surveys of forage fish, and to measure indices of forage fish condition.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $209.9 | $202.5 | $202.5 | $202.5 | $150.3 | $967.6 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $339 | $130 | $130 | $130 | $110 | $839 |

**Date: August 9, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Fluctuations in forage fish abundance can have dramatic ecosystem effects because much of the energy transferred from lower to higher trophic levels passes through a small number of key forage species. Forage fish typically produce a large number of offspring and have short lifespans, and these traits predispose populations towards large fluctuations in abundance, with associated impacts on predators. In response to a lack of recovery of wildlife populations following the *Exxon Valdez* Oil Spill (EVOS), and evidence of natural background changes in forage fish abundance, there was a significant effort to document forage fish distribution, abundance, and variability in Prince William Sound (PWS) in the 1990's. Since then, ongoing research has focused on commercially valuable Pacific herring, whereas less has been done to monitor other ecologically important forage species such as Pacific sand lance, capelin, eulachon and euphausiids (which we include under the generic term "forage species"). The lack of time series data on abundance and distribution of these forage species in PWS, and the spatial and temporal variability inherent to these populations makes it difficult to assess population status and trends of most forage species. We propose to initiate a program to monitor: 1) forage fish abundance and community composition; by conducting fishing and acoustic surveys of abundance and distribution that are cost effective and allow for long-term trend analyses; and, 2) indices of forage fish biology that are important in maintaining predator health, such as forage fish body size, condition, proximate composition and diet (inferred from stable isotope ratios).

### B. Summary of Project to Date (if applicable)

We are operating according to schedule as described in the original proposal.

## II. PROJECT DESIGN

### A. Objectives

We propose to gather new data on the distribution, relative abundance, and body condition of forage fish species in PWS, compare these data with some historical data from the 1990's and provide a baseline for future assessment of population trends. The specific objectives of this study are to:

1) Identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term monitoring of those indices.
2) After completing Objective 1, and in addition to any other indices we might identify, assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of PWS and at selected times of year.

3) Relate abundance and distribution of forage species to abiotic and biotic characteristics of the marine environment.

**B. Procedural and Scientific Methods**

For each objective listed in A. above, identify the specific methods that will be used to meet the objective. In describing the methodologies for collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methodologies considered, and explain why the proposed methods were chosen. In addition, projects that will involve the lethal collection of birds or mammals must comply with the Trustee Council's policy on collections, available at http://www.evostc.state.ak.us/Policies/other.cfm.

To address objective 1, we started by consulting fisheries scientist and statisticians familiar with past or current monitoring efforts (Lew Haldorsen, emeritus UAF; Scott Johnson, NMFS; John Thedinga, NMFS; Darcie Neff, NMFS; Ron Heinz, NMFS; JJ Vollenweider, NMFS; John Moran, NMFS; Steve Moffitt, ADF&G; Dick Beamish, retired Fisheries and Oceans Canada; Jeff Fujioka, retired NMFS; Terry Quinn, UAF; Jamal Moss, NMFS; Olav Ormseth, NMFS; Brenda Ballachey, USGS; Russ Hopcroft, UAF; Chris Zimmerman, USGS; Vanessa von Biela, USGS; Kris Monk, ADF&G; Scott Pegau, PWSSC, Evelyn Brown, Flying Fish Ltd.). There was generally broad agreement that monitoring should include a core program of hydroacoustic surveys combined with net-sampling of acoustic targets to identify school composition and obtain samples for analysis of fish condition. We developed a sampling protocol and began testing it during the 2012 field season. Based on results in 2012, we also tested the feasibility of incorporating aerial survey observations into our sampling plan in 2013, in order to more effectively find, quantify and collect forage fish in nearshore zones of the Sound. In FY14 we will continue to to incorporate aerial spotting surveys in July to aid in locating schools that can be subsequently sampled using traditional boat-based methods.

To address object 2, we are conducting hydroacoustic and trawl surveys in Prince William Sound during July 2012 – 2015. July is the optimum time to assess forage fish in the Sound because several target species occur inshore at that time. We are using a combination of aerial spotting surveys, hydroacoustics and various fishing techniques (i.e., midwater trawl, dip net, cast net, jig, gill net, beach seine, purse seine, video) to collect target species for age and body condition indices (i.e., age, length, weight), and to groundtruth hydroacoustic backscatter for species specific biomass estimates.

To address objective 3, we are collecting oceanographic information, zooplankton samples, and water samples for chlorophyll a and nutrient concentrations. These measures of marine habitat will facilitate a greater understanding of marine habitat use by target species.

**C. Data Analysis and Statistical Methods**

Abundance indices will be developed for each common forage species from coupled hydroacoustic-trawl surveys. Age distributions will be compared among regions and years using multinomial logit models. Size-at-age will be examined using von Bertalanffy growth curves and a two-way analysis of variance for each age with region and capture year as factors. Biomass estimates for target species will be calculated annually from ground-truthed hydroacoustic surveys by subarea using geostatistical models. We will calculate the echo integral over a given area (mean Nautical Area Scattering Coefficient, NASC, $m^2nm^{-2}$) using EchoView v 5.3 (Hobart, Tasmania, Australia). Acoustic properties of fish vary among species, and

target strengths for the species we capture will be drawn from the published literature. Geostatistical modeling of acoustic biomass by station will be done with the 'krige.bayes' routine in the geoR package. Abundance indices will be summarized using simple univariate statistics (after transformation where necessary), and changes among years and subareas tested with ANOVA. After a sufficient number of years it may be possible to detect significant trends with linear regression. To examine the issue of *why* populations may change, we will employ a variety of statistical approaches to examine overall patterns in distribution of fish or apex predators and correlate these patterns with bio-physical features. For example, we will use geostatistical analyses to help interpret spatial patterns of distribution, Principal Components Analysis (PCA) to identify gradients in physical properties, General Linear Models (GLM) and non-linear methods (e.g. GAMM, gradient boosted regression trees) to assess the relative contributions of different biophysical features in predicting the relative abundance of key forage fish and apex predators. Where appropriate, we will use Detrended Correspondence Analysis (DCA) or Non-metric multidimensional scaling (MDS) to characterize community structure and patterns of community response to physical gradients. Statistical analyses will be performed using tools available in R (R Core Development Team 2011).

**D. Description of Study Area**

We will work within Prince William Sound (bounding coordinates: 61.292, -148.74; 61.168, -146.057; 60.273, -145.677; 59.662, -148.238).

**E. Coordination and Collaboration with the Program**

We will make use of current and previous forage fish work in PWS— including that of ongoing herring assessments, the Sound Ecosystem Assessment (SEA) program, and the forage fish component of the Alaska Predator Ecosystem Experiment in PWS (APEX)— to help design our sampling and monitoring plan, and to make meaningful comparisons with past and current findings. We will also seek out and incorporate unpublished information for non-target species (e.g., eulachon, capelin) in bycatch data from NOAA RACE surveys, and work conducted at the Prince William Sound Science Center (e.g., Thorne *et al*., Bishop *et al*.), and University of Alaska (e.g. Iverson *et al*., Brown *et al*. currently Flying Fish Ltd., Norcross *et al*.), and ADF&G (Moffitt *et al*., Byerly *et al*.). We will coordinate our efforts with those of other PIs studying pelagic and nearshore components of the Sound, particularly those working on the current Herring Assessment (project 10100132, PI: Scott Pegau, PWSSC) and provide them with data we collect that may be useful in their analyses. All oceanographic data will be archived with AOOS. Herring and other requested samples will be made available to PIs involved in dedicated herring studies, and samples of other forage species will be saved and could be distributed opportunistically to PIs engaged in trophic studies using stable isotopes, fatty acids, etc.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

For each project objective listed above (II.A.), specify when critical project tasks will be completed. Project reviewers will use this information in conjunction with annual project reports to assess whether projects are meeting their objectives and are suitable for continued funding. Please format your information like the following example.

**Objective 1.** Identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term monitoring of those indices.

*To be met by March 2015*

**Objective 2**. Assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of PWS and at selected times of year.

*To be met by September 2016*

**Objective 3**. Relate abundance and distribution of forage species to abiotic and biotic characteristics of the marine environment.

*To be met by September 2016*

**B. Measurable Project Tasks**

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed. This information will be the basis for the quarterly project progress reports that are submitted to the Trustee Council Office. Please format your schedule like the following example.

**FY 14, 1st quarter (February 1 – May 31, 2014)**

*February, 2014* *Project funding available*

*Feb – May, 2014* *Update project outreach website, analyze and summarize data*

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

*June 2014:* *Upload 2013 data to workspace, update metadata*

*July-Aug, 2014:* *Field Sampling*

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

*September - November:* *2014 field data compilation, lab analyses*

*November:* *Annual PI meeting*

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**

*December 1:* *Hydroacoustic data analysis, report writing*

**V. BUDGET**

**Budget Form (Attached)**

| **FY14 PROGRAM PROJECT PROPOSAL FORM** |
|---|
| **Project Title:** Continuing the Legacy: Prince William Sound Marine Bird Population Trends. |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Kathy Kuletz, Migratory Bird Management, US Fish and Wildlife Service<br>1011 East Tudor Road, Anchorage, Alaska 99503 phone 907 786-3453, email Kathy_Kuletz@fws.gov<br>David Irons, Migratory Bird Management, US Fish and Wildlife Service,1011 East Tudor Road, Anchorage, Alaska 99503 phone 907 786-3376, email david_irons@fws.gov |

**Abstract:**

We propose to conduct small boat surveys to monitor abundance of marine birds in Prince William Sound, Alaska, during July 2012, 2014, and 2016. Eleven previous surveys have monitored population trends for marine birds and mammals in Prince William Sound after the *Exxon Valdez* oil spill. We will use data collected to examine trends from summer to determine whether populations in the oiled zone are increasing, decreasing, or stable. We will also examine overall population trends for the Sound. Continued monitoring of marine birds and synthesis of the data are needed to determine whether populations injured by the spill are recovering. Data collected from 1989 to 2010 indicated that pigeon guillemots (*Cepphus columba*) and marbled murrelets (*Brachyramphus marmoratus*)) are declining in the oiled areas of Prince William Sound. We have found high inter-annual variation in numbers of some bird species and therefore recommend continuing to conduct surveys every two years. These surveys are the only ongoing means to evaluate the recovery of most of these injured marine bird species. Surveys would also benefit the benthic monitoring and forage fish monitoring aspects of the Long-term Monitoring Project as well as the Herring Project.

**Estimated Budget:**
**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $206.3 | $24.2 | $211.1 | $24.2 | $215.7 | $681.4 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $56 | $22 | $56 | $22 | $56 | $212 |

**Date: 22 August 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

McKnight et al. (2008) examined whether marine bird and mammal species designated as injured by the *EVOS* Trustee Council had shown signs of recovery by 2007. Data collected from 1989 to 2007 in the oiled area indicated that common loons (*Gavia immer*) and cormorants (*Phalacrocorax spp.*) are increasing. Numbers of all other injured species are either not changing or are declining in the oiled area. Populations of harlequin ducks (*Histrionicus histrionicus*), black oystercatchers (*Haematopus bachmani*), Kittlitz's murrelets (*Brachyramphus brevirostris*), and common murres *(Uria aalgae*) are showing no trend in the oiled area; pigeon guillemots (*Cepphus columba*), and marbled murrelets (*Brachyramphus marmoratus*), are declining in the oiled areas of Prince William Sound in summer.

Pigeon Guillemots are the only bird on the EVOSTC injured species list that is "not recovering". In addition Kittlitz's murrelet is a candidate species under the Endangered Species Act and PWS is one of the few remaining hotspots for it. There are no other surveys done in PWS to get population estimates for marine birds.

Using small boat surveys, this project will collect additional information to monitor the distribution and abundance of marine birds and sea otters in Prince William Sound. These data will be combined with data collected in 1989-91 (Klosiewski and Laing 1994), 1993 (Agler et al. 1994a), 1994 (Agler et al. 1995a), 1996 (Agler and Kendall 1997), 1998 (Lance et al. 1999, Irons et al. 2000, Lance et al. 2001) and 2000 (Stephensen et al. 2001), 2004 (Sullivan et al.2005), 2005 (McKnight et al. 2006), and 2007 (McKnight et al. 2008) to examine trends in marine bird distribution and abundance. This project will benefit restoration of Prince William Sound by determining whether populations that declined due to the spill are recovering and by identifying which species are still of concern.

**B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities**

Please see pages 2-4 of the integrated proposal titled "Long-Term Monitoring of Marine Conditions and Injured Resources and Services," and submited by McCammon *et al*.

**B. Summary of Project to Date (if applicable)**

If the project was funded in previous years, please provide a summary of the goals met to date and what milestones are still outstanding. If there are milestones from the previous year's proposal that have not been met, provide a description of why they could not be met, how much funding remains for the project to complete the milestones and a timeline for their completion.

**II. PROJECT DESIGN**

**A. Objectives**

To determine population abundance, with 95% confidence limits, of marine bird populations in Prince William Sound during March and July 2012, 2014 and 2016 in both oiled and unoiled regions, as well as in Prince William Sound as a whole, in order to assess population trends in the years following the EVOS.

**B. Procedural and Scientific Methods**

Survey methodology and design will remain identical to that of past marine bird surveys conducted by the U. S. Fish and Wildlife Service in 1989, 1990, 1991, (Klosiewski and Laing 1994), 1993 (Agler et al. 1994a), 1994 (Agler et al. 1995a), 1996 (Agler and Kendall 1997), 1998 (Lance et al. 1999), 2000 (Stephensen et al. 2001), 2004 (Sullivan et al. 2005), 2005 (McKnight et al. 2006), and 2007 (McKnight et al. 2008). We will conduct three surveys: one during during July ("summer") 2012, 2014, and 2016. We will use three 7.7 m fiberglass boats traveling at speeds of 10-20 km/hr to survey transects over a 3-week period.

We will continue to use a stratified random sampling design containing three strata: shoreline, coastal-pelagic, and pelagic (Klosiewski and Laing 1994) (Fig. 1). The shoreline stratum will consist of waters within 200 m of land. Irons et al. (1988b) divided this stratum, by habitat, into 742 transects with a total area of 820.74 $km^2$. We will locate shoreline transects by geographic features, such as points of land, to facilitate orientation in the field and to separate the shoreline by habitat (Irons et al. 1988a,b). Shoreline transects will vary in size, ranging from small islands with <1 km of coastline to sections of the mainland with over 30 km of coastline. Mean transect length will be 5.55 km. During summer, we plan

to survey 212 shoreline transects. All transects were randomly chosen, and the same transects are used each survey (Klosiewski and Laing 1994).

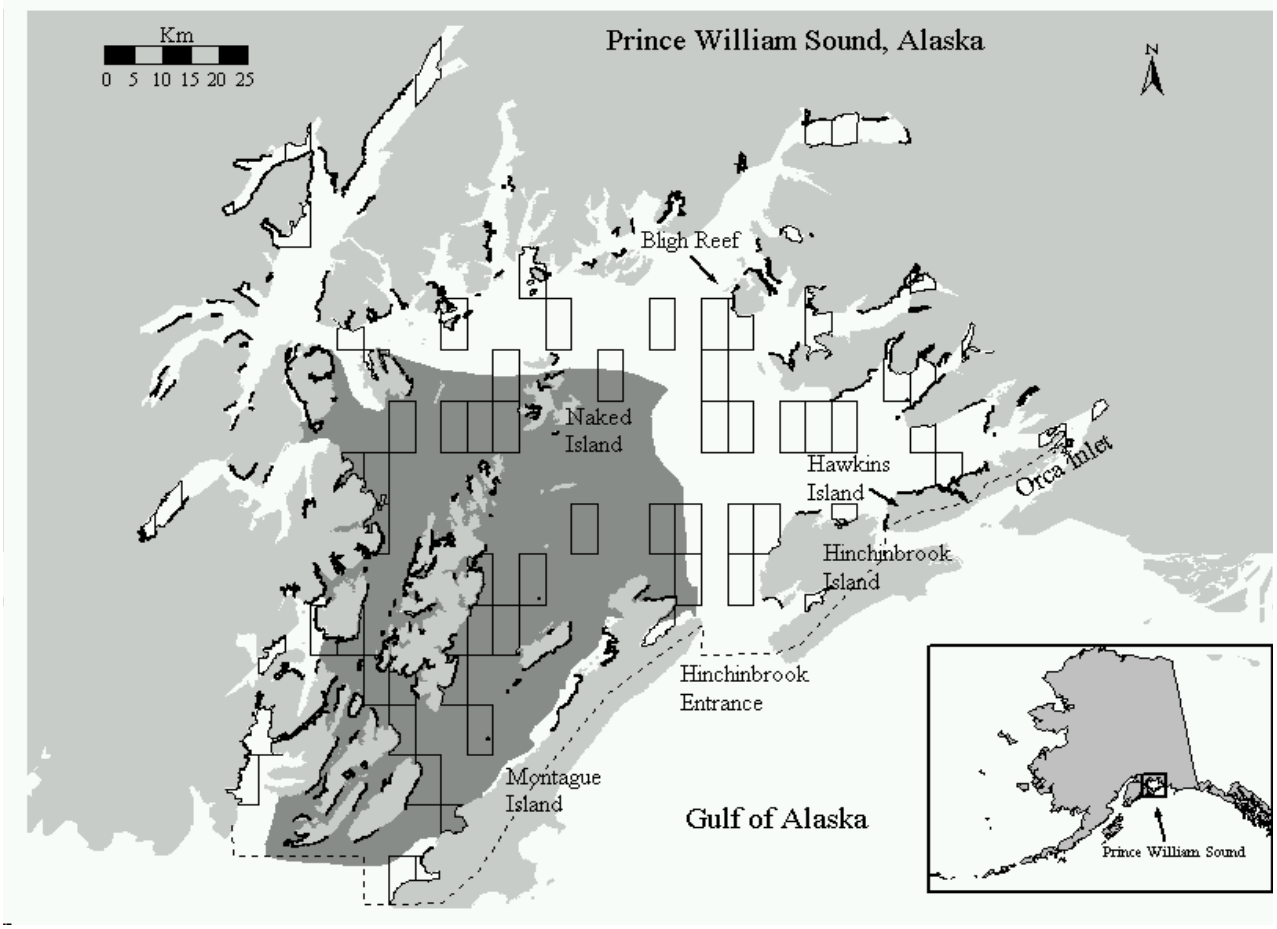


Figure 1. Locations of shoreline transects and pelagic transect blocks in Prince William Sound. Shading denotes the oiled region.

**Justification:**
Almost 30,000 marine bird (Piatt et al. 1990) and 900 sea otter (DeGange and Lensink 1990) carcasses were recovered following the *Exxon Valdez* oil spill. Based on modeling studies using carcass search effort and population data, an estimated 250,000 marine birds were killed in Prince William Sound and the northern Gulf of Alaska (Piatt and Ford 1996). Garrott et al. (1993) estimated that 2,800 sea otters also were killed. These estimates are probably low, because they only include direct mortality occurring in the first five months after the spill.

Twenty two years after the EVOS there are populations of Pigeon Guillemots, Kittlitz's Murrelets, and Marbled Murrelets are down by 50% to 90% compared to population numbers in 1989 after the initial mortality. All these species were affected by the spill, but are likely no longer being affected, however populations have never recovered. All three species rely on Pacific Herring during the summer breeding season and may be impacted by the herring crash of 1993.

There are no other studies monitoring population trends of these or any other marine bird species in PWS.

**Linkages:**
Pigeon Guillemots, Kittlitz's Murrelets, and Marbled Murrelets have continued to decline after the spill. All three species rely on Pacific Herring during the summer breeding season and may be impacted by the herring crash of 1993.

The EVOSTC has funded 11 surveys in 22 years to following population trends of marine birds in Prince William Sound. This is the best at-sea data set for marine bird populations in Alaska. This data set has been used to track recovery or lack of recovery for several injured species. It also provides the only information on the population trend of Kittlitz's murrelet, an ESA candidate species.

This component will provide the data on marine bird and mammal populations for the Benthic Nearshore Project.

Sea otters are counted on these surveys as well as marine birds.

**Major Logistics:**
A charter vessel for 7 days in July that sleeps nine. During July three 25' fiberglass boats will be used.

**C. Data Analysis and Statistical Methods**

As in previous surveys (Klosiewski and Laing 1994, Agler et al. 1994a,b,c, 1995a,b, Agler and Kendall 1997, Lance et al. 1999, Stephensen et al. 2001, Sullivan et al. 2005, McKnight et al. 2006, McKnight et al. 2008), we will use a ratio estimator (Cochran 1977) to estimate population abundance. Shoreline transects will be treated as a simple random sample; whereas the coastal-pelagic and pelagic transects will be analyzed as two-stage cluster samples of unequal size (Cochran 1977). To do this, we will estimate the density of birds counted on the combined transects for a block and multiply by the area of the sampled block to obtain a population estimate for each block; any land or shoreline area (within 200m of land) intersecting a block will be subtracted from the total area of that block. We then will add the estimates from all blocks surveyed and divide by the sum of the areas of all blocks surveyed. We will calculate the population estimate for a stratum by multiplying this estimate by the area of all blocks in the strata. Population estimates for each species and for all birds in Prince William Sound will be calculated by adding the estimates from the three strata, and we will calculate 95% confidence intervals for these estimates from the sum of the variances of each stratum (Klosiewski and Laing 1994).

*a) Trends in the oiled region*
We will perform a linear regression on log-tranformed population estimates over time (1989 – 2016) in the oiled region of Prince William Sound. Prior to calculating the $\log_{10}$ of each population estimate, we will add a constant of 0.167 to each estimate to avoid the undefined $\log_{10}$ of 0. In all analyses we will use a test size alpha = 0.10 to balance Type I and Type II errors. The reasons for this include: 1) variation is often high and sample sizes low (n = 11 survey years); and 2) monitoring studies are inherently different from experiments and the number of tests being run with a multi-species survey are many, therefore, controlling for the number of tests by lowering alpha levels (e.g. Bonferroni adjustment) might obscure trends of biological value.

Taxa with significant increasing trends in the oiled region will be considered “recovering,” while taxa with no trends or significant negative trends will be considered “not recovering.

*b) Comparing trends between oiled and unoiled regions*

We will use the regression technique detailed in (a) to perform regression analyses on population estimates (1989 – 2016) in the unoiled region. We will use a homogeneity of slopes test (Freud and Littell 1981) to compare population trends between the oiled and unoiled zones of Prince William Sound to examine whether species with population estimates of >500 individuals have changed over time. To do this, we must assume that marine bird and sea otter populations increase at the same rate in the oiled and unoiled zones of Prince William Sound. Significantly different slopes would indicate that population abundance of a species or species group changed at different rates.

Taxa showing no difference in trends between the oiled and unoiled regions will be considered “not recovering.” Taxa showing significantly greater trends in the oiled region compared with the unoiled region will be considered “recovering.” Taxa showing significantly greater trends in the unoiled region compared to the oiled region will be considered to be suffering “continuing and increasing effects.”

Overall, a species will be considered “recovering” if it meets the requirements for this category in either the regression analysis within the oiled region or the homogeneous slopes analysis.

To determine optimum survey frequency, we conducted a power analysis to estimate the probability of detecting trends in abundance using linear regression from a given number of samples (Taylor and Gerrodette 1993). We examined our power to detect trends when coefficient of variation (CV) of the population was 0.30 (greater than the mean CV from previous surveys for 73% of the injured species; Fig. 2) and when the CV = 0.13 (the mean summer CV for *Brachyramphus* murrelets, an injured species. Models of seabird population growth predict most species increase no more than 12% per year (Nur and Ainley 1992), so we used 10% for our comparisons. With CV=0.30 the probability of detecting an average annual change of 10% would be 92% with the 10 surveys completed to date (Fig. 2).

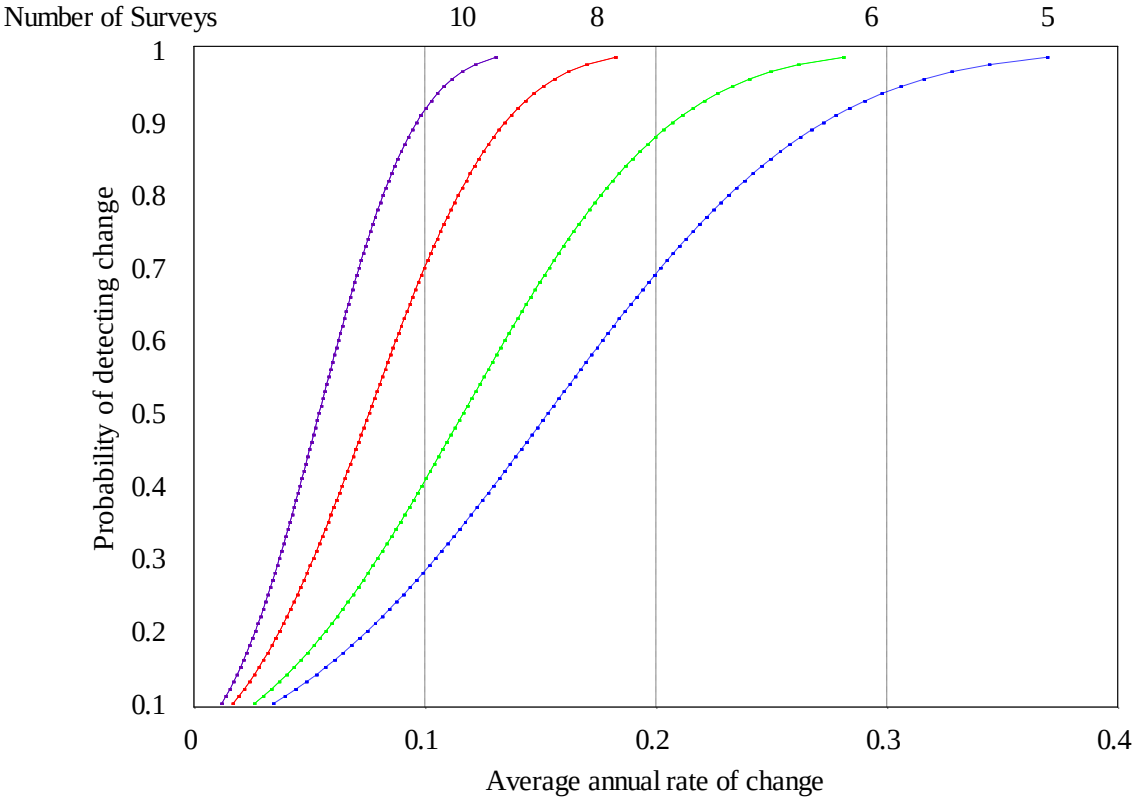


Figure 2. Estimated power based on numbers of surveys (5, 6, 8, and 10) conducted to detect a trend in marine bird populations in Prince William Sound when the CV = 0.30.

**D. Description of Study Area**

Our study area includes all waters within Prince William Sound and all land within 100 m of shore (Fig. 1). We exclude Orca Inlet, near Cordova, Alaska and the southern sides of Montague, Hinchinbrook, and Hawkins Islands (Klosiewski and Laing 1994).

**E. Coordination and Collaboration with Other Efforts**

*See above, Linkages.*

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.**

To determine population abundance, with 95% confidence limits, of marine bird populations in Prince William Sound during July 2014 in both oiled and unoiled regions, as well as in Prince William Sound as a whole, in order to assess population trends in the years following the EVOS. *To be met by April 2015.*

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**
*Hire project personnel*
*Prepare for Field Season*

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**
*Prepare for Field Season*
*Conduct field work*
*Submit annual report*

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**
*Data Analysis*

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**
*Report writing*
*Attend Annual PI Meeting*

**V. BUDGET**
**Budget Form (Attached)**
Please complete the budget form for each proposed year of the project.

| **FY14 PROGRAM PROJECT PROPOSAL FORM** |
|---|
| **Project Title:** Gulfwatch long-term monitoring pelagic component - Long-term monitoring of seabird abundance and habitat associations during late fall and winter in Prince William Sound. |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova<br>**Collaborators:** Kathy Kuletz, Ph.D. US Fish & Wildlife Service, Anchorage; John Moran, Auke Bay Lab, NOAA, Juneau; Michelle Buckhorn, Ph.D. & Richard Thorne, Ph.D. Prince William Sound Science Center. |

**Abstract:** This project is a component of the integrated Gulfwatch Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et.al. The vast majority of seabird monitoring in areas affected by the *Exxon Valdez* oil spill has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful. However, late fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels reduced, day length shorter and water temperatures colder. Of the seabirds that overwinter in PWS, nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered (marbled murrelet, Kittlitz's murrelet and pigeon guillemot). Here we propose to continue to monitor from 2012 through 2016 seabird abundance, species composition, and habitat associations using multiple surveys (up to 5 surveys per season) during late fall and winter. The data will improve our predictive models of seabird species abundance and distribution in relation to biological and physical environmental factors. In addition, by monitoring the top-down forcing by seabirds, a major source of herring predation, this project will complement the suite of *PWS HRM* studies, including improved mortality estimates for herring population models. This project is part of the pelagic component within the integrated *Gulfwatch LTM program* submitted by McCammon et. al. Our project uses as observing platforms the vessels associated with the *LTM Humpback Whale surveys* and *PWS HRM Juvenile Herring Abundance Index* as well as the *Extended Adult Herring Biomass Survey*s and integrates the seabird observations with those studies.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $51.7 | $78.6 | $80.9 | $83.4 | $86.3 | $380.9 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date:** August 31, 2013

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Seabirds spend most of the year widely dispersed. At higher latitudes, late fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels reduced, day length shorter and water temperatures colder. Consequently daily energy requirements increase (Fort *et al*. 2009) and birds have to forage for a large proportion of daylight hours (Daunt *et al*. 2006). Wind and sea state are known to affect surface-feeding seabirds in particular (Dunn 1973, Taylor 1983) but diving birds can also be impacted (Harris and Wanless 1996, Piatt and Van Pelt 1997, Frederiksen *et al*. 2008).

Of the seabirds that overwinter in Prince William Sound (PWS), nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered (marbled murrelet, Kittlitz's murrelet and pigeon guillemot. Nevertheless, the vast majority of seabird monitoring in areas affected by the Exxon Valdez oil spill has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful. Long-term monitoring of seabirds in PWS during winter is needed to understand how post-spill ecosystem recovery and changing physical and biological factors are affecting seabird abundance and species composition, as well as their distribution and habitat use.

Changes in the timing of biological events, geographic range and/or relative abundance of species, community structure, and system productivity can be indications of a changing ecosystem (Parmesan 2006). For example, a recent 10-year monitoring effort along the transition zone between the California Current and the Gulf of Alaska documented significant increases in seabird species diversity and relative abundance during the nonbreeding season that corresponded with a possible regime shift to cooler conditions (Sydeman et al. 2009).

In December 2004, we began monitoring seabird abundance and distribution in PWS during late fall and winter months. Initially our surveys were concurrent with hydroacoustic surveys for adult herring in northeast PWS. Beginning in March 2007, we expanded our winter survey efforts to other areas of PWS under EVOS Project 070814. Since then surveys have been conducted concurrent with either juvenile herring hydroacoustic surveys or with humpback whale surveys. Results from seven cruises conducted over two winters found consistent trends and species-distinct patterns in distribution. Habitat association modeling revealed that winter climate conditions may influence these distribution patterns (Dawson et al. *in review*). When we examined distribution at a fine- scale (1 km) using data from seabird transects with concurrent fish data, we found a positive association between presence of seabirds and predictable fish prey fields (Bishop et al. 2010). Furthermore, our consumption model of herring predation quantified the potential impacts of such prey association by seabirds during the winter. Our model shows that seabirds consume ~3-10% of the total adult herring biomass during each winter and underscores the importance of further examination of top-down forcing (Bishop et al., *in review*).

Post-spill ecosystem recovery and changing physical and biological factors all have the potential to affect PWS seabird populations. Here we propose to continue to monitor seabird abundance and habitat associations using multiple surveys during late fall and winter. While this proposal encompasses a five-year period, we would foresee this project continuing over a 20-year period in order for ecosystem changes to be detected.

**B. Summary of Project to Date.** Between October 2011 and July 2013, a seabird observer participated in eight cruises associated with three EVOS-funded projects: Gulfwatch *Humpback Whale systematic surveys* (n = 5), Herring and Research Monitoring *Juvenile Herring Abundance Index* (n = 1), and Herring and Research Monitoring *Expanded Adult Herring Surveys* (n = 1). Two cruises associated with the whale surveys were conducted pre-award (Oct 2011 and Dec 2011), but we believed an observer onboard was critical to maintaining our time series. Both herring projects have only had one cruise to date, and a seabird observer has participated in each of those cruises. In 2013, the late winter humpback whale survey was moved from February to April, and was dedicated to obtaining biopsy (genetic) samples within a small geographic area. A seabird observer was not placed on this cruise, because of the limited

opportunity to conduct transects. Preliminary data from the first six cruises was included in the February 1, 2012 – January 31, 2013 annual report, submitted in February 2013. We continue to use the same methodology on our cruises that we have used since November 2007. That includes a 300m transect width (150 m each side), and recording all observations into dLog software. Data analyses is ongoing. Data is stored in the form of a Microsoft access database. Metadata for the project is currently available. We continue on track to meet our milestones, all of which have completion dates in 2016.

**II. PROJECT DESIGN**

**A. Objectives**

This project is part of the pelagic component of the Long-term Monitoring of Marine Conditions and Injured Resources and Services. There are two primary research goals for the pelagic team: population monitoring of key species groups, and understanding the energy flow through the pelagic ecosystem with key measurements. Objectives of this study include:

1) Characterize the spatial and temporal distribution of seabirds in PWS during late fall and winter.
2) Relate seabird presence to prey fields identified during hydroacoustic surveys.
3) Identify critical biological and physical habitat characteristics for seabirds across PWS within and between winters.
4) Utilize increased temporal sampling resolution to improve our estimates of consumption of herring by seabirds during the winter.

The monitoring of top down forcing by seabirds and whales, the largest predators on herring, will complement the suite of *PWS Herring Research & Monitoring* studies, including insertion of key data into the population modeling of herring In addition, this project will provide information on the wintering ecology of several seabird species injured by the oil spill that can be used to help restore and/or conserve their populations.

**B. Procedural and Scientific Methods**

This study will be a continuation of systematic late fall and winter seabird surveys begun in 2007 by Bishop and Kuletz. Up to five surveys will be conducted between October and early April. Depending on the vessel of opportunity used, surveys will either be coupled with the or with surveys associated with the *PWS Herring Research and Monitoring* including *Juvenile Herring Abundance Index* in November and *Expanded Adult Herring Surveys* in late March/early April), as well as the *Gulfwatch LTM Humpback Whale systematic surveys* (October, December, and possibly a third whale survey).

All surveys will employ established U.S. Fish and Wildlife Service protocols that have been adapted for GPS-integrated data entry programs (USFWS 2007). One observer will record number and behavior of birds and marine mammals occurring along a strip transect width of 300 m (150 m both sides and ahead of the boat, in distance bins of 50m). Additionally, any noteworthy observations will be recorded out to 1 km either side. Observations will be recorded into a GPS-integrated laptop computer using the program Dlog (Ford Consulting, Inc., Portland OR). This GPS-integrated program provides location data at 20-sec intervals and for every entered observation program. In addition, sea conditions including sea

surface temperature (as indicated on the vessel's fish finder) and weather can be entered and tracked on site by the observer.

Seabird transects that are coupled with hydroacoustic fish surveys will occur in four to eight select bays in PWS. Seabird transects will also be conducted when the boat is in transit during daylight hours. Seabird surveys conducted onboard humpback whale surveys will follow specified routes from northeast to southwest PWS. At the end of first 5 years of the long-term monitoring (September 2016), this study will have data sets from broad-scale coverage of PWS ranging from 4 to 10 years.

**C. Data Analysis and Statistical Methods**

Density (birds • $km^{-2}$) of each seabird species will be calculated for each km of survey trackline. We will use all surveys conducted since 2007 to describe the seasonal patterns of abundance and distribution. Seabird observations will be mapped using ArcView GIS. Temporal variability in bird density will be addressed at inter- and intra-annual scales.

The November and late March/early April seabird transects will be conducted concomitant with hydroacoustic fish surveys. The November *Juvenile Herring Abundance Index* survey will take place in the four bays (Simpson, Eaglek, Zaikof, Whale) surveyed in the 1990's as part of the EVOS-sponsored Sound Ecosystem Assessment (SEA) program. Locations of the expanded adult herring surveys are not yet defined. Data on fish biomass (kg/m2) by depth will be available for each trackline. Composition of fish schools will be made available by the *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture,* a separate project that is part of the *PWS Herring Research & Monitoring* program. We will combine acoustic survey data on prey composition with a suite of additional independent variables shown to be relevant to seabird predation (eg., school density, school area, species composition and size structure, water depth, depth to school, depth below each school, and distance from shore [Kuletz 2005; Ostrand et al. 2004, 1998; Day and Nigro 2000]). We will use logistic regression to determine the role of these covariates on the presence of seabirds (Maniscalco et al. 1998; Manly et al. 1993). Model selection criteria (eg., AIC, GCV) will be chosen according to the most effective model framework (eg., GLM, GAM).

We will model seabird abundance and distribution in relation to biological and physical environmental factors. While the prey field data will be available from the *PWS Herring Research and Monitoring* cruises, seabird abundance surveys will cover both the herring and LTM humpback whale cruises. Seabird abundance data are typically zero-dominated therefore hurdle models will be applied whereby data are analysed initially as presence-absence, followed by a separate analysis of presence-only data (Boucher and Guillén, 2009, Zuur *et al*. 2009). Hence, the first analysis will determine which covariates are driving the presence and absence of birds, while the second analyses will focus on covariates driving the abundance of birds when they were present. GIS will be used to determine covariates such as distance to shore, water depth, distance to eelgrass beds, distance to kelp beds, and slope. Locations of coastal kelp and eelgrass beds will be obtained from the ShoreZone database (NOAA Fisheries 2009), and slope from the Alaska Ocean Observing System bathymetry grid. Other covariates including sea surface temperature, year, and month will also be examined. For the presence-absence data a binomial generalised additive mixed model (GAMM) will be used. For presence-only data we will use a GAMM. For a detailed description of the proposed statistical methods see Zuur *et al*. (*in press*).

Late fall and early winter plankton tows will be conducted in October and November each year in PWS as part of the *Gulfwatch LTM Long term monitoring of oceanographic conditions in Prince William Sound.* Surveys will be conducted in the four bays (Simpson, Eaglek, Zaikof, Whale) surveyed in the 1990's as part of the EVOS-sponsored Sound Ecosystem Assessment (SEA) program. In addition, plankton surveys will include the major entrances to PWS. We will examine zooplankton data to see if there are linkages to seabird hotspots observed during October, November and December cruises.

To describe the relationship between seabird densities and zooplankton biomass and herring biomass in PWS we will run linear regressions, using zooplankton and herring survey data provided from their respective projects. For each bird species, a best model for explaining variability in bird densities will be determined using a general linear model. A natural log or square root transformation of the dependent variable will be used when appropriate to improve the fit of the model to the data. The relationship between date, densities of each seabird species observed, and food abundance (zooplankton or herring biomass) will be evaluated by bay (the four SEA bays and the four additional bays), and in the case of herring biomass, by transect.

Current seabird survey data provide little information regarding the residence times of most seabird species in Prince William Sound from November through March. Our recent efforts to quantify herring consumption by seabirds utilizes the best available data about such residency and estimates seabird consumption based on a daily energy budget projected over each species winter residency period (Bishop et al., *in review).* The increased temporal resolution of sampling in the current proposal will enable us to include direct observations of seabird presence throughout the season to improve upon the current data. Refined data for each species will be used to update the residence time parameter in our current consumption model, thereby improving estimates of seabird consumption of herring during winter.

**D. Description of Study Area**

The pelagic component of the *Gulfwatch LTM* project, including this project and the *Humpback Whale Intensive Surveys* includes all of Prince William Sound. Seabird observations associated with the *PWS Herring Research & Monitoring Juvenile Herring Abundance Index* will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. The *PWS Herring Research & Monitoring Juvenile Herring Abundance Index* and the *Expanded Adult Herring Surveys* will include other bays based on the results from the synthesis and aerial surveys, respectively.

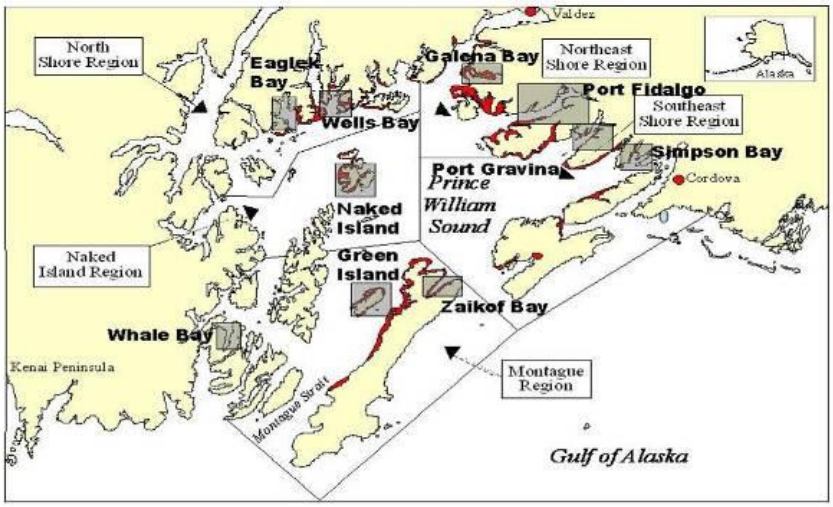


Figure 1. Study area, Prince William Sound. Hi-lighted in gray are the four SEA bays (Whale, Zaikof, Eaglek, and Simpson), as well as other bays historically important for juvenile herring.

**E. Coordination and Collaboration with the Program**

This project is a component of the integrated *Gulfwatch Long-term Monitoring of Marine Conditions and Injured Resources and Services* submitted by McCammon *et al*. Our proposed long-term monitoring program is composed of several components (Environmental Drivers, Pelagic and Benthic Monitoring), with a series of projects in each component lead by principal investigators from a number of institutions. The seabird project, headed by Dr. Mary Anne Bishop, is part of the pelagic monitoring component and shares research vessels associated with the *LTM Humpback Whale Systematic Surveys*, also part of the pelagic monitoring component. In addition, this seabird project is highly integrated with the *PWS Herring Research & Monitoring* program, and shares research vessels with the two projects in this program (see below).

This project builds on previous seabird data sets. Since 2004, winter seabird surveys have been performed on vessels conducting hydroacoustic surveys for adult herring (5 cruises, 2004-2006) and juvenile herring (10 cruises, Nov 2007 – Mar 2012). Cruises between Nov 2007 and Mar 2012 have been part of EVOS Projects 070814 and 10100132-H. In addition, seabird surveys were performed on vessels conducting Humpback Whale surveys (6 cruises, 2007-2009) as part of EVOS project 070804.

This long-term seabird monitoring project uses as observing platforms vessels associated with three different projects. Cruises begin in Cordova, and therefore the staff member would not need to travel. One seabird observer (PWSSC staff) will be onboard all cruises associated with the *Gulfwatch LTM Humpback Whale systematic surveys* (Oct, Dec, Feb, years 1-4). In addition, a seabird observer (PWSSC staff) will be onboard surveys associated with *PWS Herring Research and Monitoring.* Specifically the observer will be onboard *Juvenile Herring Abundance Index* surveys (Nov yrs 2-5) and the *Expanded Adult Herring Surveys* (late March/early Apr yrs 2-5). When not conducting daytime seabird surveys, observers assist the other projects, including helping to process the nighttime herring catch and helping identify humpback whales. Seabird observations from this project will be shared and integrated into the whale and herring surveys. In addition, information on herring, other fish and zooplankton prey fields

around whale foraging areas, juvenile herring schools and adult herring schools will be used for the seabird analyses.
Information from this project will feed into the *North Pacific Pelagic Seabird Database,* a database that is maintained by US Fish & Wildlife Service and USGS. This database is currently being integrated into a single database that will be available over the internet through an ARC/IMS.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Characterize the spatial and temporal abundance of seabirds in PWS during late fall and winter.
*Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016.*

**Objective 2**. Model species abundance and distribution in relation to biological and physical environmental factors
*Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016.*

**Objective 3**. Assess seabird habitat associations within and between winters
*Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program by August 2016.*

**Objective 4**. Relate species composition and distribution to prey fields.
*Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016.*

**Objective 5**. Identify critical marine habitats used by seabirds during late fall and winter
*Data analyses incorporating data collected through April 2016 will be completed by August 2016 and incorporated into Gulfwatch LTM program report by August 2016.*

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 –Apr 30, 2014)**

| | |
|---|---|
| Feb | Project funding available |
| Feb | Submit annual report |
| late Mar/early Apr | Field cruise: *LTM* seabird survey in conjunction with *PWS Herring* extended adult biomass cruise |
| late winter | Field cruise: *LTM* humpback whale cruise (if a whale survey, seabird survey will also occur) |
| Apr | Analyze data |

**FY 14, 2nd quarter (May 1, 2014- Jul 31, 2014)**

| | |
|---|---|
| May-Jul | Analyze data |
| Jul | Report writing (mid-year report, FY 2015 workplan) |

**FY 14, 3rd quarter (Aug 1, 2014- Oct 31, 2014)**

| | |
|---|---|
| Aug | Submit report, workplan |
| Aug-Oct | Analyze data |
| Oct | Field cruise: *LTM* humpback whale and seabird surveys |

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**

| | |
|---|---|
| Nov | Field cruise: *LTM* seabird survey in conjunction with *PWS Herring* juvenile abundance index |
| Nov | Annual PI meeting |
| Dec | Field cruise: *LT*M humpback whale and seabird surveys |
| Jan | Alaska Marine Science Symposium |
| Jan | Report writing |

**V. BUDGET (Attached)**

### Benthic Monitoring Component (lead – Ballachey)

**FY14 PROGRAM PROJECT**
**PROPOSAL FORM**

**Project Title: Gulf Watch Alaska: Long-Term Monitoring: Nearshore Benthic Ecosystems in the Gulf of Alaska**

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator(s):**
**Brenda Ballachey, James Bodkin, Daniel Esler, Kim Kloecker, Daniel Monson, Ben Weitzman**
USGS Alaska Science Center, 4210 University Drive, Anchorage, AK 99508
**Thomas Dean,** Coastal Resources Associates, Inc., 5190 El Arbol Drive, Carlsbad, CA 92008
**Heather Coletti, Michael Shephard ,** Southwest Alaska Inventory & Monitoring Network
National Park Service, 240 W. 5th Avenue, Anchorage, AK 99501
**Mandy Lindeberg,** NOAA/NMFS Auke Bay Laboratory, 11305 Glacier Hwy, Juneau, AK 99801
**Angela Doroff,** Kachemak Bay Research Reserve, 95 Sterling Highway, Suite 2, Homer, AK 99603

**Abstract:** We propose to continue the long-term nearshore marine monitoring program which has been ongoing in the GOA since 2006, supported by the National Park Service-Southwest Alaska Network and the US Geological Survey, and supported by the Gulf Watch Alaska project since 2012. The sampling design consists of three primary sampling locations in nearshore habitats in the central GOA region, including Prince William Sound (PWS), Kenai Fjords National Park (KEFJ), and Katmai National Park (KATM). Additionally, we will coordinate with nearshore sampling ongoing in Kachemak Bay as part of the Gulf Watch Alaska project. In western PWS, KEFJ and KATM, we plan to continue sampling at established sites on an annual basis through 2016. In eastern and northern PWS, we plan to continue sampling at established sites in alternate years, with eastern PWS scheduled for 2014. Monitoring includes measurements of water quality (temperature, salinity), intertidal invertebrates and algae, sea grasses, sea otters, black oystercatchers, and surveys of marine birds and mammals. The monitoring also includes measures of nearshore ecosystem productivity, predator-prey dynamics, and stable isotope and contaminant analyses.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $282.4 | $304.1 | $331.9 | $309.6 | $331.9 | $1,559.90 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $25.0 | $73.0 | $73.0 | $73.0 | $73.0 | $317.0 |

**Date: August 12, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

The nearshore is considered an important component of the Gulf of Alaska ecosystem, including the region affected by the *Exxon Valdez* oil spill (EVOS), because it provides:

- A variety of unique habitats for resident organisms (e.g. sea otters, harbor seals, shorebirds, seabirds, nearshore fishes, kelps, seagrasses, clams, mussels, and sea stars).
- Nursery grounds for marine animals from other habitats (e.g. crabs, salmon, herring, and seabirds).
- Feeding grounds for important consumers, including killer whales, harbor seals, sea otters, sea lions, sea ducks, shore birds and many fish and shellfish.
- A source of animals important to commercial and subsistence harvests (e.g. marine mammals, fishes, crabs, mussels, clams, chitons, and octopus).
- An important site of recreational activities including fishing, boating, camping, and nature viewing.
- A source of primary production for export to adjacent habitats (primarily by kelps, other seaweeds, and eelgrass).
- An important triple interface between air, land and sea that provides linkages for transfer of water, nutrients, and species between watersheds and offshore habitats.

Also, the nearshore is broadly recognized as highly susceptible and sensitive to both natural and human disturbances on a variety of temporal and spatial scales. For example, observed changes in nearshore systems have been attributed to such diverse causes as global climate change (e.g. Barry et al. 1995, Sagarin et al. 1999), oil spills (e.g. Dahlmann et al. 1994 Peterson et al. 2001, 2003), human disturbance and removals (e.g. Shiel and Taylor 1999, Murray et al. 1999), and influences of invasive species (e.g. Jamieson et al. 1998). Nearshore systems are especially good indicators of change because organisms in the nearshore are relatively sedentary, accessible, and manipulable (e.g. Dayton 1971, Sousa 1979, Peterson 1993, Lewis 1996). Also, in contrast to other marine habitats, there is a comparatively thorough understanding of mechanistic links between species and their physical environment (e.g. Connell 1972, Paine 1994, Estes and Duggins 1995) that facilitates understanding causes for change.

Perhaps most important with respect to the goals of the Gulf Watch Alaska Long-term Monitoring program, the nearshore is the one habitat within which it is most likely that we will be able to detect relatively localized sources of change, tease apart human-induced from natural changes, and provide

suggestions for policies to reduce human impacts. Because many of the organisms in the nearshore are sessile or have relatively limited home ranges, they can be geographically linked to sources of change with a reasonable degree of accuracy.

Finally, the nearshore is critically important because it was without doubt the habitat most impacted by the 1989 EVOS, and is known to be a persistent repository for oil that could be linked to continued injury to species that reside there (especially, sea otters and harlequin ducks; Peterson et al. 2003, Short et al. 2004, 2007). In addition, the majority of the species or services that have been listed by the EVOS Trustee Council as either "not recovered" or "status of recovery unknown" reside in or are associated with the nearshore. Thus, monitoring within the nearshore system provides the opportunity to continue to assess progress toward recovery, and to identify and possibly ameliorate other human induced disturbances.

Following several years of planning, a restoration and ecosystem monitoring plan for the nearshore marine ecosystems affected by the EVOS in the Gulf of Alaska (GOA) was completed (Dean and Bodkin 2006). Within this plan it was recognized that (1) restoration of resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the Gulf, and (2) causes of changes independent of the oil spill are likely to occur in the GOA during the 21$^{st}$ century, and are likely to result from a number of different agents (e.g. normal environmental drivers, global climate change, shoreline development and associated inputs of pollutants). Further, in order to effect restoration of injured resources it is essential to separate EVOS-related effects from other sources of change. 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 GOA. On the other hand, impacts from shoreline development will likely be more episodic and more local. Thus, one challenge of designing a monitoring program was to detect changes occurring over widely varying scales of space and time, and from various causes. To this end, a conceptual framework for monitoring in the nearshore was designed with the following elements:

1) Synoptic sampling of specified physical and biological parameters (e.g. temperature, salinity, and eelgrass cover) over the entire GOA.
2) 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 specified areas spread throughout the GOA; these are referred to as intensive sites. The focus is on species injured by the EVOS, in particular species not recovered or whose status relative to recovery is uncertain.
3) Sampling of a smaller suite of selected biological and physical parameters (e.g. the abundance and growth of intertidal organisms, and contaminant levels in mussels) at additional sites, 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 (e.g, stable isotope analyses of nearshore species).

The monitoring plan developed for the EVOSTC was revised and adopted by the National Park Service's Vital Signs Long-Term Monitoring Plan, Southwest Alaska Network (SWAN), and implemented in Katmai

NP (KATM) in 2006 and in Kenai Fjords NP (KEFJ) in 2007. In 2010, EVOS Project 10100750 funded the US Geological Survey to implement the long-term nearshore monitoring plan in western Prince William Sound (WPWS), providing for monitoring of the nearshore environment, sea otters, nearshore sea birds (including black oystercatchers), and intertidal kelps, seagrasses and invertebrates. In 2011, the EVOS Gulf Watch Alaska Project (12120114) was initiated to continue and expand the long-term nearshore monitoring, in combination with studies of pelagic systems and environmental drivers. The Gulf Watch Alaska Project is working in concert with the NPS-SWAN program and the USGS; the work described herein is a continuation of the nearshore benthic monitoring effort implemented over the past decade by those agencies.

**B. Summary of Project to Date (if applicable)**

To date, as part of the Gulf Watch Alaska project, we have conducted two full years of nearshore monitoring at KATM, KEFJ, and WPWS (intensive sites), and all goals of that sampling have been met. We have also established study sites in eastern PWS (EPWS, sampled in 2012) and northern PWS (NPWS, sampled in 2013) to be sampled biannually (extensive sites). We propose to continue a long-term restoration and ecosystem monitoring program these locations through 2014 (and longer depending on study continuation). We plan to continue the integration of SWAN and USGS programs with the Gulf Watch Alaska project.

**II. PROJECT DESIGN**

**A. Objectives**

***The overall objectives of the proposed research are:***

1. Long-term monitoring of a suite of nearshore benthic species at multiple locations across the Gulf of Alaska.
2. Continued restoration monitoring in the nearshore in order to evaluate the current status of injured resources in oiled areas.

To accomplish these objectives, we have a list of tasks, presented in Table 1.

**Table 1.** Components of the proposed nearshore benthic monitoring plan and five year schedule.

| COMPONENT | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **Western PWS, intertidal invertebrates and algae** | x | x | x | x | x |
| **Western PWS, kelps and sea grass** | x | x | x | x | x |
| **Western PWS, black oystercatchers** | x | x | x | x | x |
| **Western PWS, contaminants/water quality** | x | | | | |
| **Western PWS, sea otter carcass recovery** | x | x | x | x | x |
| **Western PWS, sea otter foraging** | x | x | x | x | x |

| | | | | | |
|---|---|---|---|---|---|
| **observations** | | | | | |
| **Eastern PWS, intertidal invertebrates and algae** | **x** | | **x** | | **x** |
| **Eastern PWS, kelps and sea grass** | **x** | | **x** | | **x** |
| **Eastern PWS, contaminants/water quality** | **x** | | | | |
| **Northern PWS, intertidal invertebrates and algae** | | **x** | | **x** | |
| **Northern PWS, kelps and sea grass** | | **x** | | **x** | |
| **Northern PWS, contaminants/water quality** | | **x** | | | |
| **Katmai NP, intertidal invertebrates and algae** | **x** | **x** | **x** | **x** | **x** |
| **Katmai NP, kelps and sea grass** | **x** | **x** | **x** | **x** | **x** |
| **Katmai NP, black oystercatchers** | **x** | **x** | **x** | **x** | **x** |
| **Katmai NP, sea otter carcass recovery** | **x** | **x** | **x** | **x** | **x** |
| **Katmai NP, sea otter foraging observations** | **x** | **x** | **x** | **x** | **x** |
| **Kenai NP, intertidal invertebrates and algae** | **x** | **x** | **x** | **x** | **x** |
| **Kenai NP, kelps and sea grass** | **x** | **x** | **x** | **x** | **x** |
| **Kenai NP, black oystercatchers** | **x** | **x** | **x** | **x** | **x** |
| **Kenai NP, sea otter carcass recovery** | **x** | **x** | **x** | **x** | **x** |
| **Kenai NP, sea otter foraging observations** | **x** | **x** | **x** | **x** | **x** |
| **PWS, sea otter aerial survey** | **x** | | **x** | | **x** |
| **Kenai NP, sea otter aerial survey** | | **x** | | **x** | |
| **Katmai NP, sea otter aerial survey** | **x** | | **x** | | **x** |
| **Kachemak Bay, sea otter aerial survey** | **x** | | **x** | | **x** |
| **PWS Nearshore marine bird survey (under Pelagic component)** | **x** | | **x** | | **x** |
| **Katmai nearshore marine bird survey** | **x** | **x** | **x** | **x** | **x** |
| **Kenai nearshore marine bird survey** | **x** | **x** | **x** | **x** | **x** |
| **Stable isotope analysis of selected nearshore species(4-5 areas/yr)** | **x** | **x** | **x** | **x** | **x** |
| **Tasks conducted under Project 11120114-L:** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Kachemak Bay, intertidal invertebrates and algae** | **x** | **x** | **x** | **x** | **x** |
| **Kachemak Bay, sea otter carcass recovery** | **x** | **x** | **x** | **x** | **x** |
| **Kachemak Bay, sea otter foraging observations** | **x** | **x** | **x** | **x** | **x** |

**B. Procedural and Scientific Methods**

Standard operating procedures (SOP's) for all data to be collected have been fully developed as part of the preparation and implementation of nearshore monitoring in KATM. KEFJ, and WPWS. The *Nearshore Restoration and Ecosystem Monitoring Program* (Dean and Bodkin 2006) and the *National Park Service SWAN Nearshore Monitoring Program* (Dean and Bodkin 2011) include protocols that provide justification, background, objectives, goals, an overview of the monitoring and sample design, the fundamental analytical approach, and description of operational requirements. The SOP's provide the details of each data collection procedure, their relations to one another, and how they can be integrated to provide understanding of causes of change that will be detected. Protocols are also available on the NPS project website: http://science.nature.nps.gov/im/units/swan/monitor/nearshore.cfm

(Note: Protocols for 1) sampling of mussel beds, 2) sampling of soft sediments, and 3) sampling of sea grass beds and in review and not yet available on the website but drafts are available from H. Coletti or B. Ballachey.)

Brief description of Tasks from Table 1 (refer to SOPs on Project Website for detail):

**1**. Collection of sea otter skulls for determination of age-at-death.

*Surveys will be conducted in western PWS in late April of each year to collect sea otter carcasses for determination of ages-at-death to be used in describing annual survival. In Katmai and Kenai, surveys for carcasses will be conducted opportunistically during the June/July field work. In Kachemak Bay, a coalition of the Center for Alaska Coastal Studies, the Homer Marine Mammal Stranding Network, and the USFWS have been and will continue to conduct systematic beach walks to recover sea otter and bird carcasses, and marine debris.*

**2**. Annual collection of sea otter diet data.

*Data will be obtained through direct observation of foraging sea otters using high powered spotting scopes and a stratified random sampling design.*

**3**. Aerial surveys of sea otter abundance.

*Estimates of sea otter abundance and distribution will be obtained through detection-corrected standardized aerial surveys using a stratified random sampling design.*

**4**. Sampling of intertidal invertebrates and algae.

*Estimates of the abundance intertidal algae and invertebrates, and sizes of invertebrates, will be obtained from annual sampling along permanent transects and quadrats (5 sites per block, including rocky, soft sediment, and mussel transects) using a stratified random sampling design. Sampling will include mussel collection for gene expression analyses, as a potential indicator of ecosystem health.*

**5**. Sampling of sea grasses.

*Estimates of sea grass abundance will be obtained through at sea surveys conducted in close proximity to each of the 5 sites per block.*

**6.** Diet and productivity of black oystercatchers.

*Black oystercatcher nests on transects associated with each of the intensive sites will be monitored annually in June/July for productivity, and shell litter will be collected to determine diet (prey items and sizes).*

**7.** Stable isotope analysis of selected nearshore species.

*Stable isotope analysis will be used to (1) trace the dominant sources of primary producer carbon that fuels nearshore marine food webs, and (2) characterize the trophic interactions between primary and secondary consumers within the nearshore. These data will provide a baseline of information that will be important in assessing now and in the future the role human activities and natural processes play in determining the structure and function of nearshore ecosystems in the GOA.*

### C. Data Analysis and Statistical Methods

Data analyses and statistical methods used to evaluate changes in the nearshore environment are detailed in Dean and Bodkin (2006) and Dean et al. (2008), and also presented in the SOPs as described above. In general we will examine trends in each metric over time within each location, differences among locations over time, and interactions between time and locations (i.e., the extent to which changes within each location track changes across locations over time) through regression and information-theoretic (IT) criteria (Burnham and Anderson 2002, 2004). Competing hypotheses (models) will be selected a priori and those models will be ranked based on their relative support (AIC values). These analyses will help to sort out effects of small scale sources of change (e.g., effects of oil in PWS or other location specific impacts such as logging activities) from larger scale sources of change (e.g., those due to climate change that are occurring over the entire GOA).

### D. Description of Study Area

The proposed work will be conducted in the Gulf of Alaska, in the area bounded by the following coordinates: -144.410, 61.480, NE corner; -145.600, 57.030, SE corner; -155.800, 57.300, SW corner; -156.030, 61.800, NW corner (decimal degrees, NAD 83 Albers).

### E. Coordination and Collaboration with the Program

A primary goal of the proposed nearshore monitoring effort is to evaluate the recovery status of resources in PWS that were injured by the EVOS. Our ability to assess the restoration of resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the Gulf. We will continue evaluation of EVOS injured resources and services (recreational, subsistence, and passive use), to determine when populations may be considered recovered, and where applicable, to foster recovery of those resources by identifying and recommending actions in response to factors limiting recovery. The NPS-SWAN program for nearshore monitoring along the KATM and KEFJ coasts was initiated in 2006, and has been collecting information similar to the data sets that have been used to assess recovery of injured resources in PWS (including monitoring implemented under EVOS Project 10100750), and under the Gulf Watch Alaska project, we have united the NPS-SWAN and USGS monitoring efforts. The addition of the study area in Kachemak Bay (Gulf Watch Alaska component 14120114-L), where monitoring has been ongoing for approximately a decade (although methods have varied from those used in PWS), will further enhance our ability to assess recovery. We will also integrate information gained on injured resources collected under project component 11120114-Q (lingering oil studies).

Sea otters are a focus species for restoration monitoring, as the population in western PWS was severely impacted by the EVOS, and in areas where shorelines were most heavily oiled, sea otters had not recovered to pre-spill abundance by 2009 (Bodkin et al. 2002, 2011, Monson et al. 2000, 2011). Data to be collected as part of the proposed monitoring will contribute to existing long-term data sets from PWS and other regions, including survey data on sea otter abundance since 1993, carcass data on sea otter ages at death since 1976, and sea otter foraging data since the mid-1970s.

As productivity in the nearshore is strongly influenced by physical oceanographic processes, it will be a priority to evaluate whether or not changes that may be noted in the nearshore systems are reflected in either oceanographic conditions or in synchronous changes in pelagic species and conditions that are being measured as part of Gulf Watch Alaska. The geographic scale of our study (GOA-wide) will provide greater ability to discern both potential linkages across these diverse components, as well as among the study areas within the nearshore, allowing us to evaluate relations and changes in the nearshore resources. We will incorporate data on annual and seasonal patterns measured in the Environmental Drivers component as well as data from the Pelagic study components. One component of the overall Gulf Watch Alaska project of particular importance to the nearshore is surveys of nearshore marine birds, which will be accomplished in PWS through the Marine Bird Population Trends monitoring component (representing a further long-term data set; see Irons et al. 2000) and at KEFJ and KATM by the NPS-SWAN program in collaboration with Gulf Watch Alaska.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Long-term monitoring of a suite of nearshore benthic species at multiple locations across the Gulf of Alaska. *To be met by September 2014, for the 2014 field season.*

**Objective 2**. Continued restoration monitoring in the nearshore in order to evaluate the current status of injured resources in oiled areas. *To be met by September 2014, for the 2014 field season.*

**B. Measurable Project Tasks**

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed. This information will be the basis for the quarterly project progress reports that are submitted to the Trustee Council Office. Please format your schedule like the following example.

**FY 14, 1st quarter (February 1 – May 31, 2014)**

| | |
|---|---|
| *February, 2014* | *Project funding available* |
| *April/May, 2014* | *Carcass surveys, PWS* |

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

| | |
|---|---|
| *June- July, 2014* | *Conduct field work, PWS, KATM, KEFJ* |
| *August, 2014* | *Upload 2013 datasets to GWA server* |

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

| | |
|---|---|
| *September-November, 2014* | *Data analyses, all project components* |
| *September-November, 2014* | *Stable isotope analyses of selected nearshore species* |
| *November 2014* | *Attend annual PI meeting, Anchorage* |

**FY 14, 4th quarter (December 1, 2015 – January 31, 2015)**

| | |
|---|---|
| *December 2014-January2015* | *Report preparation* |
| *January 2015* | *Attend Alaska Marine Science Symposium, Anchorage* |

**V. BUDGET**

**Budget Form attached**

**REFERENCES**


Barry J. P., Baxter C. H., Sagarin R. D., and Gilman S. E. 1995. Climate-related, long-term faunal changes in a California rocky intertidal community. Science 267(5198): 672-675.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, A.K. Fukuyama, S.C. Jewett, L.L. McDonald, D.H. Monson, C.E. O'Clair, and G.R. VanBlaricom. 2002. Sea otter population status and the process of recovery following the 1989 *Exxon Valdez* oil spill. Mar Ecol Prog Ser. 241:237-253.

Bodkin, J.L, Ballachey, B.E., and Esslinger, G.G., 2011, Trends in sea otter population abundance in western Prince William Sound, Alaska: progress toward recovery following the *Exxon Valdez* oil spill: U.S. Geological Survey Scientific Investigations Report 2001-5213, 14p.

Burnham, K.P. and D.R. Anderson. 2002. Model selection and multimodel inference. 2nd Ed. Springer-Verlag, New York.

Burnham, K.P. and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods in Research 33:261-304.

Connell, J. H. 1972. Community interactions on marine rocky intertidal shores. Annual Review of Ecology and Systematics 3: 169-92.Dahlmann, G., D. Timm, C. Averbeck, C. J. Camphuysen, H. Skov, and J. Durinck. 1994. Oiled seabirds: comparative investigations on oiled seabirds and oiled beaches in The Netherlands, Denmark and Germany (1990-93). Marine Pollution Bulletin 28(5): 305-310.

Dahlmann, G., D. Timm, Chr. Averbeck, C. Camphuysen, H. Skov, and J. Durinck. 1994. Oiled seabirds-comparative investigations on oiled seabirds and oiled beaches in Netherlands, Denmark and Germany (1990-1993). Mar. Poll. Bull. 28:205-310.

Dayton P. K. 1971. Competition, disturbance and community organization: the provision and subsequent utilization of space in a rocky intertidal community. Ecol Monogr 41(4): 351-89.

Dean, T. and J.L. Bodkin. 2006. Sampling Protocol for the Nearshore Restoration and Ecosystem Monitoring (N-REM) Program (Nearshore Restoration and Ecosystem Monitoring Research Project G-050750), US Geological Survey, Alaska Science Center, Anchorage, Alaska. Report submitted to the EVOS Trustee Council. 99 pg. plus appendices.

Dean, T. A., and J. L. Bodkin. 2011. Protocol narrative for marine nearshore ecosystem monitoring in the Southwest Alaska Network of National Parks. Natural Resource Report NPS/SWAN/NRR. National Park Service, Fort Collins, Colorado.

Dean, T.A., J.L. Bodkin, H.A. Coletti and K.A. Kloecker. 2008. Nearshore Data Management and Monitoring Project. Draft final report, Exxon Valdez Trustee Council Restoration Project 070750, Anchorage, Alaska, 99501, 56pp. April 2008.

Estes, J. A., and D. O. Duggins. 1995. Sea Otters and Kelp Forests in Alaska: Generality and Variation in a Community Ecological Paradigm. Ecological Monographs. 65. (1.): 75-100.

Irons, D.B., S.J. Kendall, W.P. Erickson, and L.L. McDonald. 2000. Nine years after the Exxon Valdez oil spill: effects on marine bird populations in Prince William sound, Alaska. Condor 102:723-737.

Jamieson, G. S., E. D. Grosholz, D. A. Armstrong , and R. W. Elner. 1998. Potential Ecological Implications from the Introduction of the European Green Crab, *Carcinus maenas* (Linneaus), to British Columbia, Canada, and Washington, USA. Journal of Natural History 32(10-11): 1587-1598.

Lewis, J. 1996. Coastal benthos and global warming: strategies and problems. Marine Pollution Bulletin 32(10): 698-700.

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. Proc. Natl. Acad. Sci. USA 97(12): 6562-6567.

Monson 2011

Murray, S. N., Denis T.G., J. S. Kido, and Smith J.R. 1999. Human visitation and the frequency and potential effects of collecting on rocky intertidal populations in southern California marine reserves.

*In* Calif. Coop. Ocean. Fish. Invest. Report, 40, 100–106.

Paine, R. T. 1994. Marine rocky shores and community ecology: an experimentalist's perspective. Ecology Institute: Oldendorf/Luhe, Germany. pp.152.

Peterson, C. H. 1993. Improvement of environmental impact by application of principles derived from manipulative ecology: Lessons from coastal marine case histories. Australian Journal of Ecology 18: 21-52.

Peterson, C. H. 2001. The "Exxon Valdez" oil spill in Alaska: acute, indirect and chronic effects on the ecosystem. Advances in Marine Biology 39: 1-103.

Peterson, C. H., S. D. Rice, J. W. Short, D. Esler, J. L. Bodkin, B. E. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302: 2082-2086.

Sagarin R.D., Barry J.P., Gilman S.E., and Baxter C.H. 1999. Climate related changes in an intertidal community over short and long time scales. Ecological Monographs 69(4): 465-490.

Schiel, D. R., and Taylor D.I. 1999. Effects of trampling on a rocky intertidal algal assemblage in southern New Zealand. J. Exp. Mar. Biol. & Ecol. 235(2): 213-235.

Short, J.W., M. R. Lindeberg, P. M. Harris, J. M. Maselko, J. J. Pela, and S. D. Rice. 2004. Estimate of oil persisting on the beaches of Prince William Sound 12 years after the *Exxon Valdez* oil spill. Environmental Science and Technology. 38(1):19-25.

Short JW, Irvine GV, Mann DH, Maselko JM and others (2007) Slightly weathered *Exxon Valdez* oil persists in Gulf of Alaska beach sediments after 16 years. Environ Sci Technol 41:1245-1250

Sousa, W. P. 1979. Experimental Investigations of Disturbance and Ecological Succession in a Rocky Intertidal Algal Community. Ecological Monographs. 49. (3.): 227-254

| **FY14 PROGRAM PROJECT<br>PROPOSAL FORM** |
|---|
| **Project Title:** Long-term monitoring: Benthic monitoring component - Long-term monitoring of Ecological Communities in Kachemak Bay: a comparison and control for Prince William Sound |
| **Project Period:** February 1, 2014 – January 31, 2015 |
| **Primary Investigator(s):** Brenda Konar and Katrin Iken (UAF)<br><br>Co-operating Investigator: Angie Doroff (KBNERR) |

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. As part of this component, we monitor rocky intertidal, seagrass and clam gravel beach systems as well as the sea otter abundance and diet in Kachemak Bay. This component is complementary to work being conducted under this program in Prince William Sound and Katmai.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $48.1 | $48.2 | $48.1 | $48.1 | $47.4 | $239.8 |

*(Funding requested must include 9% GA)*

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 30, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Justification

Many protocol similarities exist between the monitoring that is currently being done in Prince William Sound (EVOSTC Project 10100750) and that which is being done in Kachemak Bay. By continuing this monitoring in both areas, comparisons can be made between the two regions and Kachemak Bay may be able to be used as a control for Prince William Sound if another spill were to occur. Historical data exist in both areas, making future comparisons of trends even more valuable.

Project Concept

This project will evaluate ecological communities in Kachemak Bay. Following protocols established for Prince William Sound, we will monitor sea otter abundance, diet and carcasses, seabird carcasses, marine debris, abundance and distribution of rocky intertidal plants and invertebrates, abundance and size frequency of clams and mussels on gravel beaches, and selected environmental parameters in Kachemak Bay. All protocols have been established and are described for Prince William Sound. These same protocols as will be used in this study. These Kachemak Bay data will be compared with those being collected in Prince William Sound and may be able to act as a control if an oil spill were to occur in the Sound again. The data will also be comparable to data being collected in Kenai and Katmai National Parks (National Park Service SWAN Nearshore Monitoring Program) using the same methods as used in Prince William Sound.

### B. Summary of Project to Date (if applicable)

The project is ongoing since two years (2012, 2013). The second year (2013) of field sampling has just been completed and data are currently being entered from field notes, analyzed and formatted for database entry. Field sampling will be continued in 2014 and 2015 and data synthesized in 2016. It is expected that the project will continue for an additional 15 years after 2016.

**II. PROJECT DESIGN**

**A. Objectives**

7) Determine trends in sea otter abundance.
8) Determine the diet and dietary shifts of sea otters.
9) Determine trends in sea otter and seabird mortality.
10) Determine trends in marine debris.
11) Determine trends in the abundance and distribution of rocky intertidal plants and invertebrates
12) Determine trends in the abundance and size frequency of clams and mussels on gravel beaches.
13) Determine trends in selected environmental parameters and relate them to #1-6 above.

The field work for this proposal will completed annually for four years and followed by a year of data synthesis (year 5), with the outlook of continuing this pattern of monitoring for up to 20 years.

**B. Procedural and Scientific Methods**

Rocky intertidal sampling consists of visual estimates of percent cover of algae and sessile inverts in 10 replicates (1x1 $m^2$) along 50 m transects in the high, mid, low and -1 m intertidal strata. Mussels are collected along the mussel bed extent from 10 randomly distributed 25x25 cm2 quadrats and length of all mussels is measured. Length of at least 100 *Lottia persona* is measured at each rocky study sites. Seagrass is sampled with 10 replicates (50x50 $cm^2$) for seagrass shoot counts and percent cover of all vegetation and substrate. Clams are collected from ten randomly placed 0.125 $m^3$ excavations of the sediment and sieved over 1 $cm^2$ mesh. Temperature is measured at each rocky site using data loggers. Sea otter scat is being collected at a long-term site in Little Tutka Bay (Kachemak Bay) during the winter months. Each scat sample is sorted by prey type and assigned a percentage frequency method using a 1 – 6 ranking (1 = 1 – 5%; 2 = 5 – 25%; 3 = 25 – 50%; 4 = 50 – 75%; 5 = 75 – 95%; 6 = 95 – 100%). Visual foraging observations are conducted with a high-power telescope (Questar field model 50x). Methods follow previously established protocols for visually identifying prey and estimating prey size.

**C. Data Analysis and Statistical Methods**

Intertidal community data are analyzed using multivariate statistics, including hierarchical clustering, non-dimensional scaling and analysis of similarity. Size-frequency distributions are plotted for spatial and temporal comparisons. To summarize the categorical data on sea otter diet from scat samples, the median value for each category are used and then averaged by the monthly collection period.

**D. Description of Study Area**

Study sites are within Kachemak Bay, lower Cook Inlet.

**E. Coordination and Collaboration with the Program**

<u>Project Logistics</u>

For this project, Brenda Konar and Katrin Iken will provide overall project management. They also will oversee the rocky intertidal and gravel beach portion of this study. This will include working with student field assistants, conducting the field work (including some collections of environmental parameters) and completing analyses. Angie Doroff will complete the sea otter foraging observations component of this project and will oversee some of the environmental parameter collections. The

USFWS has tentatively committed to conducting sea otter abundance surveys (confirmation anticipated when 2011 federal budgets are determined). The Center for Alaska Coastal Studies, the Homer Marine Mammal Stranding Network, and the USFWS have been and will continue to conduct systematic beach walks to recover dead birds, sea otters, and marine debris.

Project Integration

We expect strong collaboration between all components of this project with the Prince William Sound, Katmai and Kenai components (all nearshore monitoring with similar data collection methods) and the Oceanographic component. Data sharing is integral to the success of this program. This project will be integrated with two University of Alaska field courses that are taught by Konar and Iken at the Kasitsna Bay Lab. Students will get valuable experience and training from participating in this project and the project will benefit from having these students.

**III. CV's/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Monitor intertidal communities in Kachemak Bay.
*To be done annually from 2012-2016.*

**Objective 2**. Monitor sea otter diet annually in Kachemak Bay.
*To be done annually from 2012-2016.*

**Objective 3**. Synthesize temporal (annual) patterns in intertidal communities and sea otter diet in Kachemak Bay.
*To be met by September 2016.*

**B. Measurable Project Tasks**

**FY 14, 1st quarter (February 1 – May 31, 2014)**

*February-April, 2014* — *Plan field sampling on intertidal communities, conduct monthly sea otter scat sampling*

*May-June 2014* — *Conduct field sampling on intertidal communities and sea otter diet*

**FY 14, 2nd quarter (June 1, 2014-August 30, 2014)**

*July 30:* *Enter data from field sampling, continue sea otter sampling*

*August 30:* *Preliminary data analysis, reporting (6-month report)*

**FY 14, 3rd quarter (September 1, 2014-November 30, 2014)**

*November 30:* *Additional data analysis, project presentation at annual PI meeting*

**FY 14, 4th quarter (December 1, 2014 – January 31, 2015)**

*January 31:* *Report writing, prepare presentation at scientific conference (Alaska Marine Science Symposium)*

**V. BUDGET**

**Budget Form (Attached)**

## Lingering Oil Monitoring Component (lead – Ballachey)

**FY14 PROGRAM PROJECT**
**PROPOSAL FORM**

**Project Title:** Long-term Monitoring: Lingering Oil - Evaluating Chronic Exposure of Harlequin Ducks to Lingering *Exxon Valdez* Oil - 14120114-Q

**Project Period:** February 1, 2014 – January 31, 2015

**Primary Investigator:** Daniel Esler, US Geological Survey, Anchorage, desler@usgs.gov

**Co-Investigator:** Brenda Ballachey, US Geological Survey, Anchorage, bballachey@usgs.gov

**Study Location:** Prince William Sound, Alaska

**Abstract:** This Lingering Oil project is associated with Gulf Watch Alaska, the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services funded by the EVOSTC. Harlequin duck populations in PWS were injured as a result of the *Exxon Valdez* oil spill, with evidence for both immediate acute mortality and longer term injury from chronic exposure to oil spilled in 1989. A series of EVOSTC projects have examined exposure of harlequin ducks to lingering oil as a factor constraining recovery, using the cytochrome P4501A biomarker, CYP1A. Harlequin ducks showed elevated CYP1A in oiled areas from 1998 through 2011 relative to unoiled areas, which was interpreted to indicate continued exposure to residual oil over that period. Data from March 2013 indicated that CYP1A induction was similar between oiled and unoiled areas, suggesting that exposure to lingering oil had ceased by that time, 24 years after the spill. As recommended in previous iterations of this body of work, we propose to re-sample harlequin duck CYP1A in March 2014 to confirm 2013 findings and substantiate our conclusion that exposure to lingering oil has abated. This work contributes to understanding of the timeline and process of recovery of injured species, as well as the nearshore ecosystem, generally.

**Estimated Budget: $121.3K**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $187.4 | | $111.3* | | | $298.7* |

*(Funding requested must include 9% GA)*

***This is a change from the full program proposal for the five years of the project approved by the Council.**

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | $10.0 | | | |

**Date:** August 8, 2013

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Sea duck populations in western PWS were injured as a result of the *Exxon Valdez* oil spill, with evidence for both immediate acute mortality and longer term injury from chronic exposure to oil spilled in 1989. A series of EVOSTC projects have addressed population demographic endpoints including abundance, habitat use, and survival rates (Rosenberg and Petrula 1998, Esler et al. 2002, McKnight et al. 2006, Esler and Iverson 2010, Iverson and Esler 2010) as well as sampling to monitor ongoing exposure to lingering EVO using the cytochrome P4501A (CYP1A) biomarker (Trust et al 2000, Esler et al. 2010, Esler et al. 2011).

As described below, a time series of CYP1A data has been collected describing exposure of harlequin ducks to lingering *Exxon Valdez* oil. The work proposed here requests continuation of this unprecedented evaluation of the timeline of population recovery and exposure following a catastrophic oil spill. This work is critical for confidently evaluating the duration and process of population recovery of a particularly vulnerable wildlife species.

**B. Summary of Project to Date**

As part of EVOSTC Restoration Project 070808, harlequin ducks were examined for lingering exposure to residual *Exxon Valdez* oil. This work demonstrated that harlequin ducks continued to show biomarker evidence of elevation of cytochrome P4501A in oiled areas through 2009, which was interpreted to indicate exposure to *Exxon Valdez* oil up to 20 years after the spill (Esler et al. 2010). More recent work (EVOSTC projects 11100808 and 12120114-Q) indicated that: (1) degree and incidence of elevated CYP1A in oiled areas was reduced in 2011 relative to previous years, and (2) in 2013, there was no evidence of elevated CYP1A in oiled areas. The 2013 sample was the first since the spill in which no difference between oiled and unoiled areas was evident, which in turn indicated that oil exposure had ceased by 24 years after the oil spill. Additional sampling proposed here for 2014 will evaluate the validity of the conclusion that harlequin ducks are no longer exposed to residual Exxon Valdez oil.

**II. PROJECT DESIGN**

**A. Objectives**

**Project Concept**

In this study, we propose to sample harlequin ducks in PWS for biomarker assays in March 2014 to evaluate recovery status by measuring the degree of continued exposure to lingering oil. As described above, this continues a time series of quantification of CYP1A induction that started in 1998. In this instance, the primary goal is to evaluate whether findings in 2013, indicating abatement of exposure to lingering *Exxon Valdez* oil, are supported, which would lend strong support to the conclusion that harlequin duck populations have recovered, based on the criteria for recovery of the species established by the EVOSTC.

**Objective 1.** Sample harlequin ducks in oiled and unoiled areas of PWS for CYP1A analyses to evaluate continuing exposure to lingering *Exxon Valdez* oil.

**B. Procedural and Scientific Methods**

Methods will replicate those from previous work (Trust et al. 2000, Esler et al. 2010) to facilitate time series comparisons. In brief, we will capture harlequin ducks in several areas that were oiled during the *Exxon Valdez* oil spill, including Bay of Isles, Herring Bay, Crafton Island, Lower Passage, and Green Island, as well as at nearby unoiled northwestern Montague Island. In each area, at least 20 harlequin ducks will have small (< 0.5g) liver biopsies taken while under general anesthesia. Biopsies will be frozen in liquid nitrogen immediately and will be maintained in a frozen state until laboratory analysis at UC Davis by collaborators Liz Bowen, Keith Miles, Jack Henderson, and Barry Wilson). CYP1A induction will be determined by measuring hepatic 7-ethoxyresorufin-*O*-deethylase (EROD) activity, which is a catalytic function principally of hydrocarbon-inducible CYP1A enzymes.

**C. Data Analysis and Statistical Methods**

For harlequin ducks, data analysis will follow that of Esler et al. (2010) and will evaluate average differences in EROD between oiled and unoiled areas, accounting for any effects of age, sex, or mass. Also, the incidence of elevated exposure, defined as two times the average EROD activity on unoiled areas, will be compared between oiled and unoiled areas. Finally, these data will be incorporated into time series evaluations to document the timeline of exposure to lingering *Exxon Valdez* oil.

**D. Description of Study Area**

This project will focus on harlequin ducks in western PWS. Captures will target birds in Bay of Isles, Herring Bay, Crafton Island, Lower Passage, and Green Island (all areas that were oiled in 1989), and at

nearby unoiled northwestern Montague Island to provide a reference sample. These sites are those that have been sampled over the entirety of the time series of harlequin duck CYP1A data.

**E. Coordination and Collaboration with Other Efforts**

This project is coordinated with the Gulf Watch Alaska long-term monitoring program funded by the EVOSTC. A primary goal of the monitoring effort is to evaluate the recovery status of resources in PWS that were injured by the EVOS, and measuring biochemical indices of exposure in harlequin ducks, a species recognized to have protracted recovery from the spill, directly supports that goal. This project will continue biomarker studies that were initiated in 1998 in western PWS, supported by the EVOSTC, and methods used will conform to those from earlier studies.

**III. CVs- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Harlequin duck sampling in oiled and unoiled areas of PWS, for CYP1A analyses, to evaluate continuing exposure to lingering oil of ducks captured in oiled areas. *To be met by March 31, 2014.*

**Measurable Project Tasks**

**FY 14, 1st quarter (February 1, 2014-April 30, 2014)**
*Plan for March captures*
*Arrange lab analysis of samples*
*Harlequin duck capture, PWS*
*Shipping of harlequin duck liver biopsies*

**FY 14, 2nd quarter (May 1, 2014-July 31, 2014)**
*Laboratory analyses of harlequin duck liver biopsies*
*Initiate analysis of laboratory data of EROD activity of harlequin ducks*

**FY 14, 3rd quarter (August 1, 2014-October 31, 2014)**
*Complete data analyses*
*Prepare report and submit to EVOSTC*

**FY 14, 4th quarter (November 1, 2015-January 31, 2015)**
*Attend meeting of LTM PI's, Anchorage*
*Attend Annual Marine Science Symposium, Anchorage*

**References:**

Esler, D., T. D. Bowman, K. Trust, B. E. Ballachey, T. A. Dean, S. C. Jewett, and C. E. O'Clair. 2002. Harlequin duck population recovery following the Exxon Valdez oil spill: progress, process, and constraints. Marine Ecology Progress Series 241: 271-286.

Esler, D., and S. A. Iverson. 2010. Female harlequin duck winter survival 11 to 14 years after the *Exxon Valdez* oil spill. Journal of Wildlife Management 74:471-478.

Esler, D., K. A. Trust, B. E. Ballachey, S. A. Iverson , T. L. Lewis, D. J. Rizzolo, D. M. Mulcahy, A. K. Miles, B. R. Woodin, J. J. Stegeman, J. D. Henderson, and B. W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the Exxon Valdez oil spill. Environmental Toxicology and Chemistry 29:1138-1145.

Esler, D., B. E. Ballachey, K. A. Trust, S. A. Iverson, J. A. Reed, A. K. Miles, J. D. Henderson, B. W. Wilson, B. R. Woodin, J. R. Stegeman, M. McAdie, and D. M. Mulcahy. 2011. Cytochrome P4501A biomarker indication of the timeline of chronic exposure of Barrow's goldeneye to residual *Exxon Valdez* oil. Marine Pollution Bulletin 62:609-614.

Iverson, S. A., and D. Esler. 2010. Harlequin duck population dynamics following the 1989 Exxon Valdez oil spill: assessing injury and projecting a timeline to recovery. Ecological Applications 20:1993-2006.

McKnight, A., K. M. Sullivan, D. B. Irons, S. W. Stephensen, and S. Howlin. 2006. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the *T/V Exxon Valdez* oil spill, 1989-2005. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Projects 040159/050751), U.S. Fish and Wildlife Service, Anchorage, Alaska.

Rosenberg D. H. and M. J. Petrula. 1998. Status of harlequin ducks in Prince William Sound, Alaska after the *Exxon Valdez* oil spill, 1995-1997. *Exxon Valdez* oil spill restoration project final report, No. 97427. Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage, Alaska.

Trust, K. A., D. Esler, B. R. Woodin, and J. J. Stegeman. 2000. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. Marine Pollution Bulletin 40: 397-403.

**V. BUDGET**
**Budget Form (Attached)**

| **FY14 PROGRAM PROJECT PROPOSAL FORM** |
|---|
| **Project Title:** Long-term Monitoring: Lingering Oil - Extending the Tracking of oil levels and weathering (PAH composition) in PWS through time. |
| **Project Period:** February 1, 2014 – January 31, 2017 |
| **Primary Investigator(s):** Mark Carls & Mandy Lindeberg, NOAA/NMSF Auke Bay Laboratories, 907-789-6019, mark.carls@noaa.gov |

**Abstract:** This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et al. This project fills three needs: understanding exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by measurement of geochemical biomarkers (triterpanes, hopanes, and steranes). The objectives are 1) to determine oil quantity and weathering in 12 PWS beaches 25 years post spill (with repeats every 5 years thereafter), 2) provide supplementary support analyses for other long-term monitoring collaborators, 3) maintain and expand the hydrocarbon database, and 4) produce annual, final, and published reports. The subset of PWS beaches to be monitored are those where sequestered oil is expected to linger for decades. At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s, (2) beach surveys that were continued up to 2004, and spatial modeling analysis that was initiated in 2008.

**Estimated Budget:**

**EVOSTC Funding Requested:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| $19.6 | $13.1 | $8.7* | $169.2* | $6.5 | $217.1 |

*(Funding requested must include 9% GA)* ***Funds originally requested for FY15 are now being requested in FY14 due to a shift in sampling dates, because the majority of the funds will be needed (in FY15). The FY14 request is equal to the value originally approved for FY15. This transposition of funding year requests results in no net effect on the total budget. See Part B, Summary of Project to Date for a detailed explanation.**

**Non-EVOSTC Funds to be used:**

| FY12 | FY13 | FY14 | FY15 | FY16 | TOTAL |
|---|---|---|---|---|---|
| | | | | | |

**Date: August 9, 2013**

## I. NEED FOR THE PROJECT

### A. Statement of Problem

Intertidal areas in western Prince William Sound were extensively coated with Exxon Valdez oil[1]; oil still remains in many beaches[2-3], presumably with declining impacts on intertidal invertebrates such as mussels[4-5], and also predators such as sea otters and harlequin ducks[6-9]. This project would revisit approximately 12 of the worst case sites to continue the long term data set that tracks oil quantity and weathering composition in the contaminated sediments, and establish long term oil monitoring sites that would be re-sampled every 5 years over the next 20 years.

This project fills three needs: understanding exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural

degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by triterpane, hopane, and sterane measurement. Understanding exposure doses is important to injured species, and this would complement biochemical biomarker evidence (cytochrome P4501A induction) of lingering exposure on sea otters and harlequin ducks (Ballachey; Esler). Understanding oil loss over time is important for understanding full recovery of the habitat; in Alaska, this time course is apparently longer than in lower latitude environments. This study would complement and extend previous work, and would complement the remediation studies by Boufadel in 2011-12 as well as the Irvine study outside of PWS in 2011-12. The study will retrospectively explore geochemical biomarkers (triterpanes, hopanes, and steranes) in Exxon Valdez oil samples collected over time for comparison with contemporary results (including the Boufadel study). To avoid confusion, please note that two very different topics are labeled 'biomarkers,' in the literature, the geochemical biomarkers previously noted and biochemical evidence of change in living animals, hence we use the term geochemical for the former and biochemical for the latter. We recognize, however, that these oil compounds were originally produced by plants.

**B. Summary of Project to Date (if applicable)**

- In general, hydrocarbon concentrations in Prince William Sound were low in 2012, ≤ 4 ng/g wet weight in mussel tissue (n=8) and ≤ 28 ng/g wet weight in sediment (n = 7; Payne et al)
- Some beaches remain heavily contaminated; hydrocarbon concentrations in bioremediation beaches (Boufadel et al) were high, $4.1 \times 10^4$ to $8.0 \times 10^6$ ng/g wet weight.
- Hydrocarbon composition in 2012 bioremediation samples was consistent with Exxon Valdez oil.
- New forensic modeling approaches with geochemical biomarkers provide definitive identification of stranded oil decades after stranding. Geochemical biomarkers have been measured in Exxon Valdez source oil and samples collected by Boufadel et al. Similar analysis of other source oils in PWS (Monterey crude oil, coal, Constantine Harbor) are not yet complete.
- Oil remains biologically available at some Gulf of Alaska locations (Irvine et al)
- The hydrocarbon database is undergoing a major overhaul, involving extensive data additions, record checking, and structure updates. This requires more than 1 person-year effort, well above the funded amount.
- Determination of oil quantity and weathering (composition) at 12 PWS beaches was scheduled for 2014; we suggest it be delayed until 2015 along with an appropriate shift in yearly funding.

**II. PROJECT DESIGN**

**Concept**

Continue monitoring a subset of beaches in Prince William Sound where sequestered oil is predicted to linger for long periods of time (decades). At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s[10], (2) beach surveys that were continued up to 2004[2], and spatial modeling analysis that was initiated in 2008[11]. Sampling techniques will allow extension of time series data (where they exist), detailed examination of hydrocarbons present (including PAHs, alkanes, and geochemical biomarkers), verification of hydrocarbon source, weathering state, and estimation of the amount of remaining oil at specific sites. In addition to sediment samples, mussel tissue will also be examined for hydrocarbon loads to determine if PAHs are biologically available without sediment disturbance (such as that created by foraging activities). A limited number of passive samplers may be deployed in pits dug for sampling purposes to demonstrate the potential for biological exposure if (or when) sediment is disturbed.

Chemical analyses will be upgraded to include geochemical biomarker data (terpanes, hopanes, and steranes); these compounds are the most recalcitrant compounds to biodegradation and weathering, and will yield a more complete picture of the biodegradation/weathering that has occurred over the last 25 plus years and the future 20 years. Geochemical biomarker data have not been collected in the past but are being incorporated in the remediation studies of 2011. We will analyze new samples, but also re-analyze samples collected in the past that are still stored and compliment the future sampling, plus Exxon Valdez source oil. In addition, geochemical biomarkers will be measured in a limited number of other known (stored) sources (Constantine Harbor, coal, and Monterey oil) for comparison and contrast with Exxon Valdez oil.

Lastly, to ensure integration between projects and with past monitoring, we will analyze a limited number of sediment samples collected from the intertidal monitoring project (e.g. from sea otter pits) and maintain the hydrocarbon database including new entries of all new sampling.

Future intentions: The periodic sampling (every 5 years) should be extended for three more cycles, ending on year 40 of the post spill era.

**A. Objectives**

1. Determine quantity and weathering state at 12 beaches in PWS, in 2015.
    a. Year 1 (2012). Begin Retrospective analysis of geochemical biomarkers in Exxon Valdez oil, weathered Exxon Valdez oil, and other potential source oils in Prince William Sound (Constantine Harbor, coal, and Monterey oil).
    b. Year 2 (2013). Continue geochemical biomarker retrospective analyses.
    c. Year 3 (2014). Determine specific subset of beaches to be sampled in 2015. Continue geochemical biomarker retrospective analyses. Draft a geochemical biomarker report (and paper).
    d. Year 4 (2015). Major field sample collection effort.
        i. Visit 10-12 beaches, collect sediment samples for PAH concentration and weathering profiles
        ii. Using random quadrats, measure the quantity of oil on specific beaches to estimate the quantity present.
        iii. Collect mussels near oil patches to determine bioavailability in tissues.
        iv. Place a limited number of passive samplers in disturbed areas to model oil bioavailability resultant from foraging activity assuming sufficient funding and interest among other Gulfwatch investigators. Pair these with samplers deployed without disturbance.
    e. Year 4, 5. Begin and end the chemical analyses of samples collected in primary field effort, using state of the art GCMS, with geochemical biomarkers included.
2. Supplemental support analyses: Support on-going intertidal projects with chemical analyses, such as determining PAH levels in sea otter pits or prey items. This will integrate with the sea otter and harlequin duck biochemical biomarker measurements in those studies. 10-20 samples per year depending on requests from other Gulfwatch investigators.
3. Database: Maintain and add new data to the hydrocarbon database.
    a. Add new information to hydrocarbon database. (This database contains data from all NRDA hydrocarbon samples from 1989 to present, including numerous data sets from investigators outside ABL.)

b. Prepare a complete FOIA package (100% of the chemical analyses have been FOIAed in the past, and these data will likely also be FOIAed.

4. Products: prepare annual and final reports as needed; supply collaborators with appropriate data (e.g. sea otter pit data to sea otter PI). Prepare synthesis manuscript summarizing environmental progress after 25 years.

**B. Procedural and Scientific Methods**

1 Chemical analyses: Standard operating procedures developed at the Auke Bay Laboratories for hydrocarbon analysis will be used for all sample analyses. These have resulted in numerous peer-reviewed publications.

2 Beaches will be randomly drawn from the identified group of oiled beaches (n = 12).

3 Beach segments will be up to 100 m long. Sampling by quadrat will be random across beaches, divided by upper, middle, and lower tide intervals; all based on past studies.

4 Beaches will be accessed by charter boat during spring or summer months during one cruise. Passive samplers will be deployed at the front end of the cruise and picked up at the back end.

<u>Project integration</u>

5 This project continues hydrocarbon analyses started prior to 1989 in Prince William Sound and recorded in a hydrocarbon database that encompasses multiple agencies, collection sites, and matrices. This database has been maintained by Auke Bay Laboratory (ABL) personnel since the time of the Exxon Valdez oil spill.

6 The major field sampling of 2014 will use methods developed in earlier studies and will conform to those methods for intercomparison over time.

7 This project will complement "effects" studies by including some sampling/analyses specifically targeted to those projects, and will complement the remediation studies of Boufadel (same analyses with geochemical biomarkers included), and will complement the tracking study by Irvine outside of PWS.

<u>Project Logistics:</u>

8 Major field effort in PWS in 2014 will be on a local charter, consisting of a field crew of up to 6 people. Federal personnel will lead the cruise effort, although some contract labor will likely be used for the labor intensive beach surveys. Laboratory logistics (chem labs, GCMS) will be at the Auke Bay Laboratories in Juneau Alaska. Senior staff will conduct the instrumental analyses, but processing effort will be by contractors.

**C. Data Analysis and Statistical Methods**

The basic statistical approach is regression analysis of time series data. Regression fits and slopes provide evidence for significant change (or not) and direction of change. To assess the usefulness of fitted regressions we compare the observed ANOVA F-ratio to the critical $F^{12}$. Knowledge of measured background levels provide an assessment of when a beach may be considered recovered (or at least indistinguishable from background levels). A third approach to understanding the data is source identification; we use several published PAH source models[13-15], have recently written a more robust version of one of these, and have developed biomarker source models as a result of Selendang Ayu studies. These models provide insight as to sample condition and independent assessment of whether or not samples match background conditions. We also map hydrocarbon distributions to understand geographic and temporal changes using ArcMap. Spatial variation at the beach level is addressed by replicate sampling and by random and composite sampling. Two examples of hydrocarbon time series are illustrated below to demonstrate these tools.

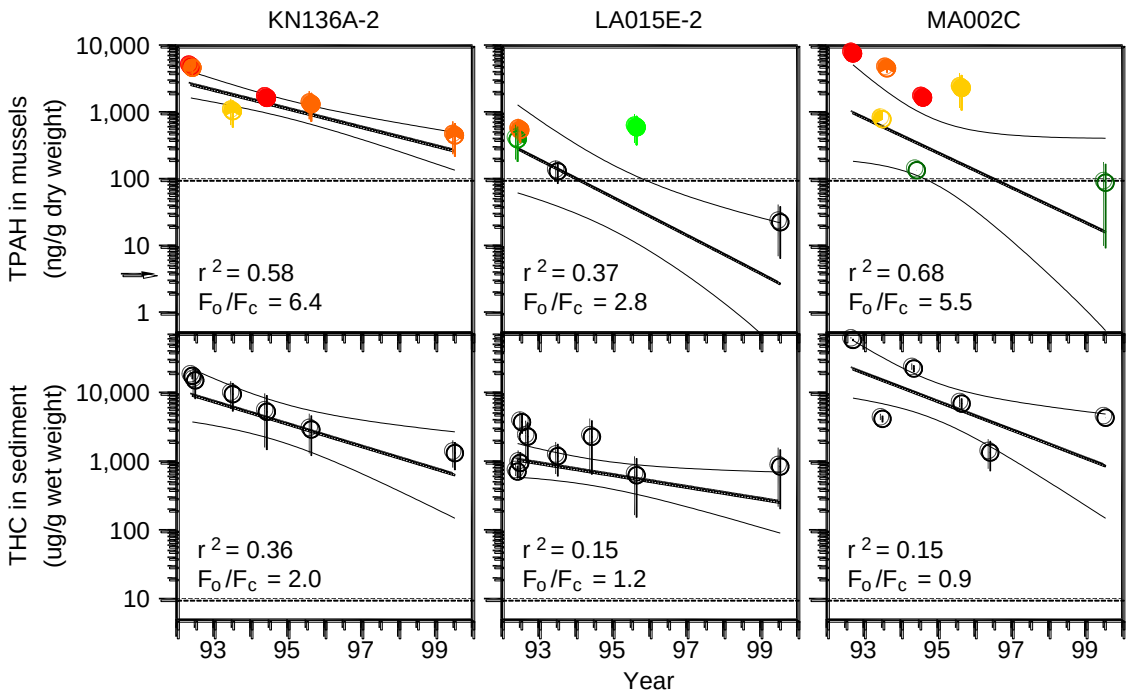


**Fig. 1**. Example mean (±SE) total polynuclear aromatic hydrocarbon (TPAH) concentrations in mussel tissue and total petroleum hydrocarbons (THC) in underlying sediment, 1992-1999, an extension of Carls et al. (2001). Exponential regressions are bounded by 95% confidence bands. Horizontal dashed lines indicate above-background concentrations. Arrows indicate the upper 95% confidence bound for TPAH in reference mussels (3.8 ng/g dry weight). See Fig. 2 for color and symbol fill keys; THC hydrocarbon source information cannot be determined from THC data.

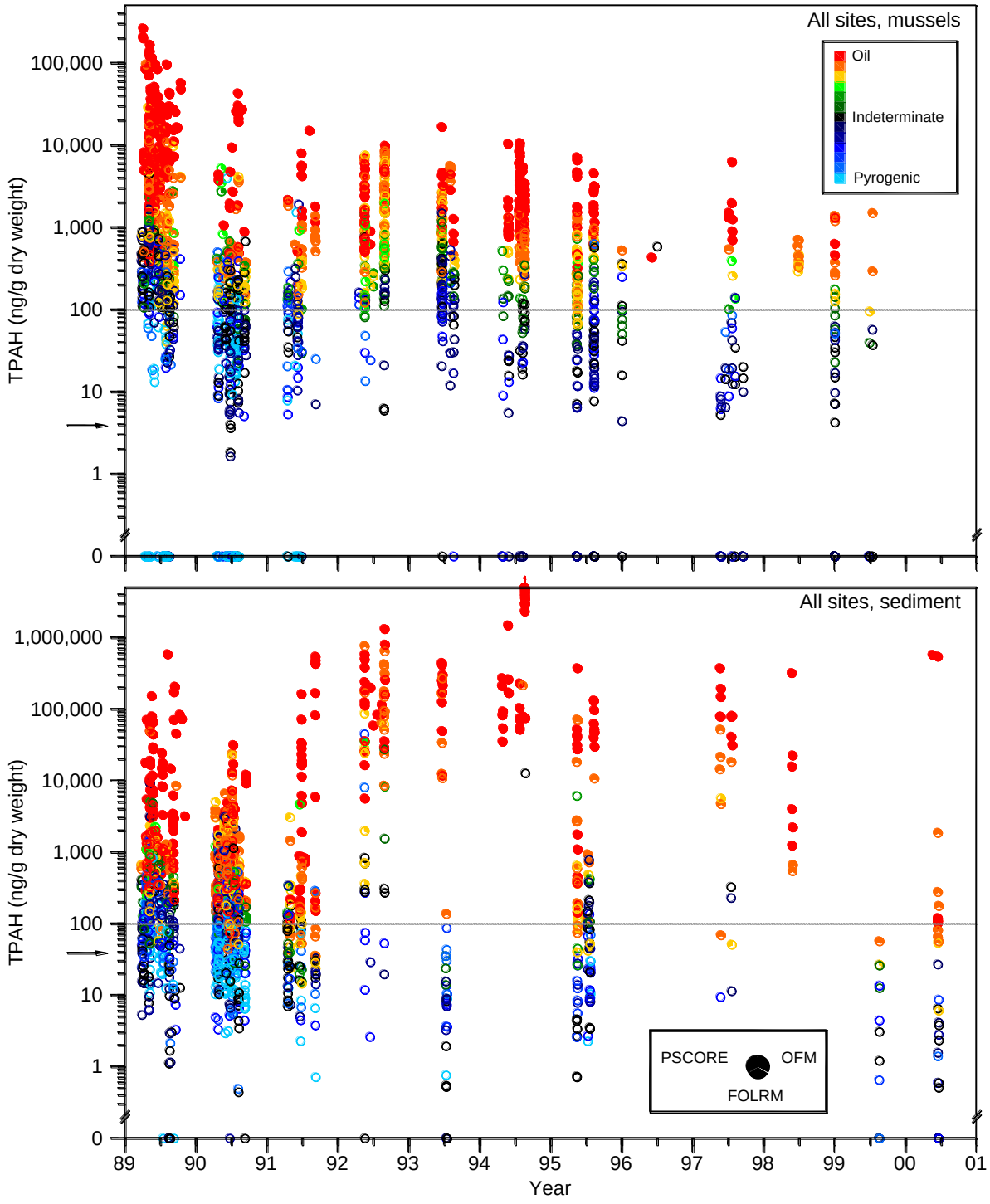


**Fig. 2**. Total PAH concentrations in mussels and sediment from all sites in Prince William Sound. Symbol fill indicates identification of *Exxon Valdez* oil by components of the consensus model; a non-parametric model (PSCORE; Carls 2006), an oil-fingerprint model (OFM; Bence and Burns 1995), and a first-order loss-rate model (FORLM; Short and Heintz 1997). Symbol colors are based consensus scores. Above-

background estimates are indicated with horizontal dashed lines; arrows indicate the upper 95% confidence bounds for TPAH in reference mussels and sediment.

**D. Description of Study Area**

The study area is western Prince William Sound (see following figure for an overview); specific locations will be chosen based on previous research. The subset of beaches monitored will be those where sequestered oil is predicted to linger for long periods of time (decades). At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s[10], (2) beach surveys that were continued up to 2004[2], and spatial modeling analysis that was initiated in 2008[11].

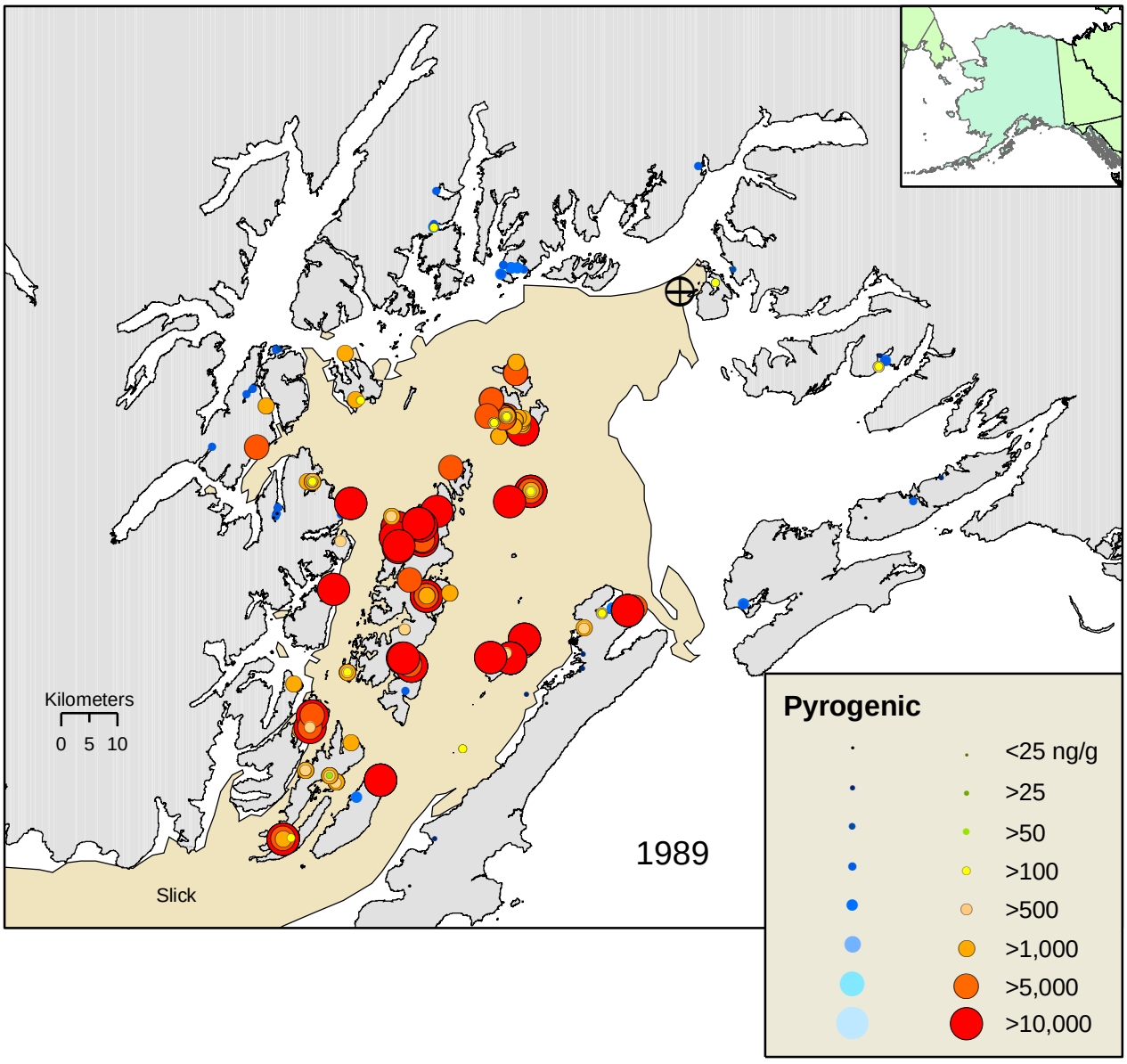

**Fig. 3.** Composition and concentration of PAHs in mussels in Prince William Sound after the Exxon Valdez oil spill. Orange - red symbols are petrogenic.

**E. Coordination and Collaboration with the Program**

This project provides a chemical frame of reference for other studies in PWS and the Gulf of Alaska, including 1) an understanding of exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by triterpane, hopane, and sterane measurement. Understanding exposure doses is important to injured species, and this complements biochemical biomarker evidence (cytochrome P4501A induction) of lingering exposure on sea otters and harlequin ducks (Ballachey; Esler). Understanding oil loss over time is important for understanding full recovery of the habitat; in Alaska, this time course is apparently longer than in lower latitude environments. This study complements and extends previous work, and complements the remediation studies by Boufadel in 2011-12 and the Irvine study outside of PWS in 2011-12.

**III. CVs/RESUMES- please see appendix 2**

**IV. SCHEDULE**

**A. Project Milestones**

**Objective 1.** Determine oil quantity and weathering in 12 PWS beaches 25 years post spill.
*To be met by September 2016. (Field work completed in 2014, measurements completed in 2016, analyses and manuscript completed in 2016)*

**Objective 2**. Supplemental support analyses.
*To be met yearly as information is requested by other long-term monitoring collaborators*

**Objective 3**. Maintain and add new data to the hydrocarbon database
*Primary database update to be met by October 2013. Additions to the data base to be met yearly.*

**Objective 4**. Prepare annual and final reports
*To be met annually. A synthesis manuscript is expected in 2016.*

**B. Measurable Project Tasks**

**FFY 14, 1st quarter (Feb 1, 2014-Apr 30, 2014)**

| | |
|---|---|
| *February* | *Design 2015 field study* |

**FFY 14, 2nd quarter (May 1, 2014-Jul 31, 2014)**

| | |
|---|---|
| *June* | *Draft biomarker report* |

**FFY 14, 3rd quarter (Aug 1, 2014-Oct 31, 2014)**

*September*

**FFY 14, 4th quarter (Nov 1, 2013-Jan 31, 2014)**

| | |
|---|---|
| *December* | *Complete biomarker paper* |
| *January* | *Annual Marine Science Symposium, meetings* |

**V. BUDGET**
**Budget Form (Attached)**

# Gulf Watch Alaska Appendix 2. CVs of Principal Investigators

**A. Program Management and Science Coordination/ Synthesis**
Molly McCammon – Alaska Ocean Observing System (Team Lead)
Katrina Hoffman – Prince William Sound Science Center (Administrative Lead)
Kris Holderied – NOAA Kasitsna Bay Laboratory (Science Lead and Env. Drivers)
Tuula Hollmen – Alaska Sea Life Center
Shane St Clair – Alaska Ocean Observing System (Data Management Lead)

**B. Environmental Drivers Monitoring Component**
Tom Weingartner – University of Alaska Fairbanks (Component Lead)
Sonia Batten – Sir Alister Hardy Foundation for Ocean Science
Rob Campbell – Prince William Sound Science Center
Angela Doroff – ADF&G Kachemak Bay Research Reserve
Russell Hopcroft – University of Alaska Fairbanks

**C. Pelagic Monitoring Component**
Mary Ann Bishop – Prince William Sound Science Center
David Irons – USFWS Alaska Region
Kathy Kuletz- USFWS Alaska Region
Craig Matkin – North Gulf Oceanic Society
John Moran – NOAA/NMFS Auke Bay Laboratory
John Piatt – USGS Alaska Science Center
Mandy Lindeberg- NOAA NMFS Auke Bay Laboratory

**D. Benthic Monitoring Component**
Brenda Ballachey – USGS Alaska Science Center (Component Lead)
Heather Coletti – National Park Service, SW Alaska Inventory & Monitoring Network
Thomas Dean, Coastal Resources Associates, Inc
Brenda Konar – University of Alaska Fairbanks
Katrin Iken – University of Alaska Fairbanks

**E. Lingering Oil**
Brenda Ballachey USGS Alaska Science Center (Component Lead)
Dan Esler- USGS Alaska Science Center
Mark Carls- NOAA NMFS Auke Bay Laboratory

**Molly (Mary Elizabeth) McCammon**
mccammon@aoos.org
Work Telephone: (907) 644-6703 **or** Mobile Telephone: (907) 227-7634
1007 West Third Avenue, Suite 100, Anchorage, Alaska 99501

**PROFESSIONAL EXPERIENCE**

**July 2003 – Present**

**Alaska Ocean Observing System (AOOS).** Executive Director.

***Responsibilities***
- Develop the Alaska regional component of the national Integrated Ocean Observation System (IOOS).
- Represent Alaska interests in National Federation of Regional Associations (NFRA) and further development of national IOOS.
- Work with Alaska members to establish an integrated system of ocean observations for Alaska to meet the needs of a wide variety of users, including mariners and fishermen, scientists, resource managers, search and rescue and coastal security operations, and educators.

**July 2009 – Present**
**Lead PI for COSEE Alaska,** funded by NSF**.**

***Responsibilities***
- Oversee senior management team developing statewide program to increase broader impacts of ocean scientists in Alaska Arctic, with a focus on climate change.
- Increase interactions between ocean scientists and informal and formal education audiences and providers.

**1993 - 2003**
***Exxon Valdez*** **Oil Spill Trustee Council**. Executive Director.

***Responsibilities***
- Implement policies and direction of six-member, joint federal-state Trustee Council which is required to have unanimity for all decisions.
- Administer programs funded by $900 million trust fund established by settlement of government claims against Exxon Corporation following 1989 oil spill, including annual work plans ranging in size from $6 million - $25 million a year.

***Major Accomplishments***
- Developed oil spill restoration program that is now viewed as an international model.
- Guided planning and successful review by National Academy of Sciences of ground-breaking long-term environmental monitoring program (Gulf Ecosystem Monitoring – GEM).
- Negotiated and implemented one of largest habitat acquisition programs in the nation and sustained it over nearly a decade of scrutiny by public officials and others.

**Recent Professional Activities**
- 2005 – present, national chair, National Federation of Regional Associations (NFRA) of Coastal and Ocean Observing; 2003- present, Alaska representative to NFRA.
- 2006 – present, co-chair, ocean observing sub-panel of national Ocean Research and Resources Advisory Panel; past ORRAP member 2006-2009.
- 2008 – present, member, National Academy of Sciences Polar Research Board.
- 2004 - present, Board member representing city of Anchorage and past President, Cook Inlet Regional Citizens' Advisory Council.
- 2004 – present, Alaska Sea Grant Program, Advisory Group member.
- 2005 – present, Fellow, Cooperative Institute for Arctic Research, University of Alaska Fairbanks.
- 2004 – 2006, member, National Research Council Committee to Establish an Arctic Observing

Network.
- 2003 - 2010, Board member, Prince William Sound Science Center.

**Past Experience 1984 – 1993**
Ten years experience in Alaska public policy, specializing in natural resources, fisheries, and Alaska Native issues, working for Alaska Governor Bill Sheffield, the Alaska Department of Fish and Game, Chief of Staff for Senate Finance Chairman John Binkley, and Senate Fisheries Committee aide.

**Past Experience 1973 – 1984**
Reporter/writer for various news media and organizations.

**Other**
- *1975 – 1984*. Homesteaded in the western Brooks Range. Co-owner and operator, recreational guiding service.

**Education**
B.A. in Journalism, University of California, Berkeley, 1973. Phi Beta Kappa.

**CV — Robert Bochenek**

**Position and Address**
Information Architect
Axiom Consulting and Design, 523 W. 8th Ave, Anchorage, AK 99501, USA
**Professional Preparation**
University of Michigan, Aerospace Engineering, B.S.E., 2001
**Appointments**

| | |
|---|---|
| 2010 – Present | Technical Lead, Alaska Ocean Observing System, Anchorage, AK |
| 2006 – Present | Information Architect, Axiom Consulting and Design, Anchorage, AK |
| 2003 – 2006 | Data Systems Manager, Exxon Valdez Oil Spill Trustee Council (EVOSTC), Anchorage AK, 99504 |
| 2001 – 2002 | Analyst Programmer, Alaska Department of Fish & Game, Anchorage, AK |

**Publications**
None
**Synergistic Activities**

| | |
|---|---|
| 2012 – Present | Funded under the NOAA High Performance Computing program for exploratory research in applying HPC concepts to serving and visualizing gridded multidimensional models and observational data sets |
| 2011 – Present | Member of the IOOS Sensor Observation Service standardization Committee |
| 2010 – Present | Member of the Alaska Data integration Working Group (ADIWG) focused on developing frameworks for interchange of scientific information across Alaskan Agencies. |
| 2009 - Present | Development of the Prince William Sound Data Portal, A tool for scientists, educators and the public to visualize four dimensional fisheries data |

**Collaborators and Co-Editors**

| | |
|---|---|
| Broderson, Dayne | Geographic Information Network of Alaska (GINA), Fairbanks, AK |
| Howard, Katherine | Alaska Department of Fish and Game, Anchorage, AK |
| Jones, Matt | National Center for Ecological Analysis and Synthesis, Santa Barbara, CA |
| Krueger, Charles | Great lakes Fishery Council, Ann Arbor, MI |
| Moffit, Steve | Alaska Department of Fish and Game, Anchorage, AK |
| Moss, Jamal | Alaska Fisheries Science Center, Juneau, AK |
| Mueter, Franz | University of Alaska, Juneau, AK |
| Mundy, Phillip | Alaska Fisheries Science Center, Juneau, AK |
| Pegau, Scott | Oil Spill Recovery Institute, Cordova, AK |
| Saupe, Susan | Cook Inlet Citizen's Advisory Council, Anchorage, AK |
| Smith, Stan | United states geological Survey, Anchorage, AK |
| Snowden, Derrick | Integrated Ocean Observing System, Silver Springs, MD |
| Svoboda, Michael | Environment Canada, Whitehorse, Canada |
| Wiese, Francis | North pacific Research Board, Anchorage, AK |

**CV — Shane R. StClair**

**Position and Address**

Senior Software Engineer

Axiom Consulting and Design, 523 W. 8th Ave, Anchorage, AK 99501, USA

**Professional Preparation**

University of Alaska Anchorage, Biological Sciences, B.S., 2002

**Appointments**

| | |
|---|---|
| 2008 – Present | Senior Software Engineer, Axiom Consulting and Design, Anchorage, AK |
| 2006 – 2008 | Analyst Programmer, Exxon Valdez Oil Spill Trustee Council, Anchorage, AK |
| 2002 – 2006 | Research Analyst, Alaska Department of Fish & Game, Anchorage, AK |

**Publications**


Brannian, L. K., K. R. Kamletz, H. A. Krenz, S. StClair, and C. Lawn. 2006. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2006. Alaska Department of Fish and Game, Special Publication No. 06-21, Anchorage.

Hamner, H. H., S. St Clair, and H. Moore. 2004. An inventory of age, sex and length data for Norton Sound, Kotzebue, and Kuskokwim chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-06, Anchorage.

Estensen J. L., S. St Clair. 2003. Pacific herring stocks and fisheries in the Arctic-Yukon-Kuskokwim region of the Bering Sea, Alaska, 2003 and outlook for 2004. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-37, Anchorage.

Hamner H., S. Karpovich, S. StClair. 2003. Development Of A Shared AYK Salmon Database. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-23, Anchorage.

Hamner, H. H., S. Karpovich, S. St. Clair. 2003. Norton Sound salmon information database file inventory and problem review. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-01, Anchorage.


**Synergistic Activities**

| | |
|---|---|
| 2011 - Present | Member of the IOOS Sensor Observation Service standardization committee |
| 2011 - Present | Developer of IOOS customizations of 52North SOS software and significant contributor to main codebase |
| 2011 - Present | Maintainer of GeoServer (open source geospatial data server) Excel WFS output plugin |
| 2010 - Present | Maintainer of Redmine/ChiliProject (open source project management software) Recaptcha anti-spam plugin |
| 2009 - Present | Contributor to several widely used open source projects including jTDS, OpenScales, Maven Shade, GeoTools |
| 2009 - 2012 | Developed spatially enabled online data management application for Alaska Dept. of Fish & Game aerial surveys and transferred software to client systems and programmers |
| 2008 - Present | Developer for global seabird abundance, population health, and diet database in conjunction with USFWS, World Seabird Union, Pacific Seabird Group, and others |

**Collaborators**

| | |
|---|---|
| Aime, Andrea | GeoSolutions, Reggiolo, Italy |
| Bridger, Eric | Gulf of Maine Research Institute, Portland, ME |
| Chaouchi, Mohamed | Center for Operational Oceanographic Products and Services, Silver Spring, MD |
| Deoliveira, Justin | OpenGeo, New York, NY |
| Dickinson, Ian | Epimorphics, Bristol, UK |
| Garcia, Mike | National Data Buoy Center, John C. Stennis Space Center, MS |
| Hollmann, Carsten | 52North Initiative for Geospatial Open Source Software, Muenster, Germany |
| Irons, David | U.S. Fish and WIldlife Service, Anchorage, AK |
| Jones, Kathleen | Alaska Department of Fish and Game, Juneau, AK |
| Kaler, Robb | U.S. Fish and WIldlife Service, Anchorage, AK |
| Kellon, Cathy | Ecotrust, Portland, OR |
| Kimball, Heath | Alaska Department of Fish and Game, Anchorage, AK |
| Mayorga, Emilio | Northwest Association of Networked Ocean Observing Systems, Seattle, WA |
| Moffit, Steve | Alaska Department of Fish and Game, Cordova, AK |
| Snowden, Derrick | Integrated Ocean Observing System, Silver Springs, MD |
| Walton, Kelly | Alaska Natural Heritage Program, Anchorage, AK |
| Welch, Tim | Ecotrust, Portland, OR |
| Wilcox, Kyle | Applied Science Associates, South Kingstown, RI |

**MATTHEW B. JONES** E-mail: jones@nceas.ucsb.edu

**PROFESSIONAL PREPARATION**

| | | | |
|---|---|---|---|
| DARTMOUTH COLLEGE | Biology | B.A. | 1989 |
| UNIVERSITY OF FLORIDA | Zoology | M.S. | 1994 |

## APPOINTMENTS

2007 - present **Director of Informatics Research and Development** NCEAS, UCSB
2000 - 2006 **Informatics Projects Lead (CNT IV)** NCEAS, UCSB
1996 - 2000 **Database and Information Specialist (CNT III)** NCEAS, UCSB
1994 - 1996 **Programmer Analyst II** Psychology, UCSB

## RELEVANT PRODUCTS


Reichman, O.J., Matthew B. Jones, and Mark P. Schildhauer. 2011. Challenges and Opportunities of Open Data in Ecology. Science 11 February 2011: 703-705. doi:10.1126/science.1197962

Jones M.B., M Schildhauer, OJ Reichman, and S Bowers. 2006. The new bioinformatics: integrating ecological data from the gene to the biosphere. Annual Review of Ecology, Evolution, and Systematics.

Jones, M.B., C. Berkley, J. Bojilova, M. Schildhauer. 2001. Managing Scientific Metadata. IEEE Internet Computing 5 (5): 59-68.

Madin J. S., Bowers S., Schildhauer M., and Jones M. B. 2008. Advancing ecological research with ontologies. Trends in Ecology and Evolution 23 (3): 159-168. doi:10.1016/j.tree.2007.11.007

Leinfelder B, Tao J, Costa D, Jones MB, Servilla M, O'Brien M, Burt, C. 2010. A metadata-driven approach to loading and querying heterogeneous scientific data. Ecological Informatics 5: 3–8. doi:10.1016/j.ecoinf.2009.08.006


## OTHER SIGNIFICANT PRODUCTS


Barseghian D, Altintas I, Jones MB, Crawl D, Potter N, Gallagher J, Cornillon P, Schildhauer M, Borer ET, Seabloom EW, Hosseini PR. 2010. Workflows and extensions to the Kepler scientific workflow system to support environmental sensor data access and analysis. Ecological Informatics 5: 3–8.

Berkley C, Bowers S, Jones MB, Madin JS, Schildhauer M. (2009) Improving Data Discovery in Metadata Repositories through Semantic Search. Proceedings of iSEEK'09. IEEE Computer Society.

Berkley, C., S. Bowers, M. B. Jones, B. Ludaescher, M. Schildhauer, J. Tao. 2005. Incorporating Semantics in Scientific Workflow Authoring. Proc of the 17th International Conference on Scientific and Statistical Database Management. IEEE Computer Society.

Ludäscher B, Altintas I, Berkley C, Higgins D, Jaeger-Frank E, Jones M, Lee E, Tao J, Zhao Y. 2006. Scientific Workflow Management and the Kepler System. Special Issue: Workflow in Grid Systems. Concurrency and Computation: Practice & Experience 18(10): 1039-1065.

Pennington D, D Higgins, AT Peterson, MB Jones, B Ludaescher, S Bowers. 2006. Ecological Niche Modeling Using the Kepler Workflow System. Workflows for eScience: Scientific Workflows for Grids, Chapter 8, Springer.

**SYNERGISTIC ACTIVITIES**

1. Editorial Board, International Society for Ecological Informatics 2006-present
2. Informatics, Working Groups, including: Chair, NEON Data Services Working Group (2010-2011); Chair, GBIF Metadata Implementation Framework Task Group (2009); GBIF Task Group on Observational Data (2008); Convener, Observations Task Group, TDWG (2008); NEON Information Technology and Communications Committee Member; Biological Data Working Group Member, Federal Geographic Data Committee (1996-1999)
3. Science Advisory Board, Tropical Ecology Assessment & Monitoring Network, Conservation International (2006-present)
4. Scientific Program Committees, including Intelligent Systems for Environ. Engineering and EcoInformatics Knowledge (2009), International Society for Ecological Informatics (2006, 2008, 2010, 2012), Environmental Information Management (2008, 2011), Semantic Scientific Knowledge Integration (2008),, e-Science (2007), Data Integration in the Life Sciences (2005), Scientific and Statistical Database Management Conference (SSDBM 2011)

**COLLABORATORS AND OTHER AFFILIATIONS**

**Collaborators and Co-Editors**

Altintas I (SDSC), Ames D (ISU), Berkley C (UC Santa Barbara), Bermudez L (SURA), Blanchette C (UCSB), Borer E (OSU), Bowers S (UC Davis), Bochenek R (Axiom), Bunker D (Columbia), Caron B (New Media Studios), Cobb J (ORNL), Collins S (UNM), Cook R (ORNL), Cornillon P (URI), Costa D (UNM), Crawl D (UCSD), Critchlow T (LLNL), Cruse P (CDL), Deelman E (ISI), DeRoure D (U of Southampton), Ebert-May, D (Michigan State U), Estrin D (UCLA), Frame M (USGS), Fox P (RPI), Gaines S (UCSB), Gallagher J (OPeNDAP), Goble C (Univ Manchester), Graham E (UCLA), Gries C (U. Wisconsin), Hampton S (UCSB), Hosseini P (Princeton), Hutchison V (USGS), Jones C (UCSB), Katz S (AIBS), Kelling S (Cornell U), Klasky S (ORNL), Lapp H (NESCent), Lee E (UC Berkeley), Ludaescher B (UC Davis), Madin J (UC Santa Barbara), Mattman C (USC), McManus M (Univ. Hawaii), McPhillips T (UC Davis), Meyer C (ESIP), Michener W (Univ. of New Mexico), Naeem S (Columbia), O'Brien M (UCSB), Peet R (U North Carolina), Pennington D (UNM), Podhorszki N (ORNL), Potter N (OPeNDAP), Reichman, OJ (UCSB), Scherle R (NESCent), Schildhauer M (UC Santa Barbara), Seabloom E (OSU), Servilla M (UNM), Silva C (U Utah), Smith K (NESCent), Tao J (UC Santa Barbara), Taylor I (Cardiff U), Vanderbilt K (UNM), Vieglais D (U Kansas), Vouk M (NCSU), Wang J (SDSC), Wilson B (ORNL), Zhao Y (UC Berkeley)

**Graduate and Postdoctoral Advisors:** Levey, Doug (University of Florida, NSF)

**Thesis Advisor and Postgraduate-Scholar Sponsor:** None

**Kristine (Kris) Holderied**
National Oceanic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory
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WORK EXPERIENCE

NOAA, National Ocean Service, National Centers for Coastal Ocean Science,
Kasitsna Bay Laboratory. Homer, AK 09/2005- present
Director/Supervisory Physical Oceanographer: NOAA Director for the Kasitsna Bay Laboratory, a subarctic coastal marine ecosystem laboratory run in partnership with the University of Alaska Fairbanks (UAF). Develop and implement science and operations plans for the lab. Provide on-site coordination for facility construction activities. Coordinate research and education activities with regional partners, including local, state, and federal agencies, Alaska Native organizations, universities, public schools and non-profit education and conservation groups.

NOAA, National Ocean Service, National Centers for Coastal Ocean Science,
Center for Coastal Monitoring and Assessment. Silver Spring, MD 06/2000-09/2005
Physical Scientist: Developed innovative technical solutions to address internal NOAA and external customer needs for remote sensing products and services in U.S. coastal regions. Used satellite data to map benthic habitats in support of NOAA's Coral Reef Program and developed applications of satellite-derived information to address issues with harmful algal blooms, estuarine and coastal eutrophication and climate change. Served as technical representative on remote sensing, habitat mapping and water quality sensor development contracts.

Old Dominion University, Center for Coastal Physical Oceanography. Norfolk, VA 11/1996-06/2000
Graduate Research Assistant: Planned and conducted observational studies of density and circulation in the Chesapeake Bay, Inland Sea of southern Chile, and Gulf of California, Mexico.

U.S. Army Corps of Engineers, Norfolk District. Norfolk, VA 01/1992-11/1996
Oceanographer: Project manager for environmental compliance projects, a navigation study, and a three-year water quality sampling program. Led development and technical management of multi-year, multi-million dollar delivery order contracts for Army training area management and general environmental compliance support for Federal facilities across the U.S.

GE Government Services. Norfolk, VA 11/1991-01/1992
Systems Engineer (acoustics): Developed a training course in ocean acoustics.

U.S. Navy active duty - Rota, Spain; Cambridge, MA; Norfolk, VA; Bay St Louis, MS 05/1984-09/1991
Naval Officer (Oceanographer): Provided meteorological, acoustic and tactical environmental forecasts to naval and merchant marine ships and aircraft in the North Atlantic Ocean and Mediterranean, Red and Black Seas. Provided local meteorological forecasts for Rota, Spain and Norfolk, VA. Managed divisions of up to 12 people, with responsibility for personnel supervision, training and administration.

EDUCATION

MIT-WHOI, M.S. 1988, Physical Oceanography, Cambridge MA. (Satellite scatterometer wind study)
U.S. Naval Academy, B.S. 1984, Oceanography, Annapolis MD. Valedictorian.

RECENT PUBLICATIONS

- Valle-Levinson, A., K. Holderied, C. Li, and R. J. Chant. 2007. Subtidal flow structure at the turning region of a wide outflow plume. J. Geophys. Res. 112. C04004,

doi:10.1029/2006JC003746.
- Stumpf, R., S. Dunham, L. Ojanen, A. Richardson, T. Wynne, K. Holderied. 2005. Characterization and Monitoring of Temperature, Chlorophyll, and Light Availability Patterns in National Marine Sanctuary Waters: Final Report. NOAA NCCOS Technical Memorandum 13. Silver Spring, MD. 56 pp.
- National Oceanic and Atmospheric Administration. 2003. Atlas of the Shallow-Water Benthic
  Habitats of the Northwestern Hawaiian Islands (Draft). 160 pp.
- Stumpf, R.P., K. Holderied, and M. Sinclair. 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. *Limnology and Oceanography*, v. 48(1, part 2), pp. 547-556.
- Caceres, M., A. Valle-Levinson, H.H. Sepulveda, and K. Holderied. 2002. Transverse variability of flow and density in a Chilean fjord. Continental Shelf Research, v. 22(11-13), pp. 1683-1698.

**CV- Tammy D. Hoem Neher**

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EDUCATION

UNIVERSITY OF ALASKA FAIRBANKS

| | | |
|---|---|---|
| Ph.D. Fisheries | 69 Semester credits (G.P.A. 3.81) | 2012 |

BOISE STATE UNIVERSITY, IDAHO

| | | |
|---|---|---|
| M.S. Biology | 45 Semester credits (G.P.A. 3.52) | 2001 |

BOISE STATE UNIVERSITY, IDAHO

| | | |
|---|---|---|
| B.S. Environmental Health | 175 Semester credits (G.P.A. 3.05) | 1998 |

PUBLICATIONS

(Authorship in bold, former name: Salow)

PEER-REVIEWED, FULL-LENGTH JOURNAL ARTICLES

Monnot, L. A., J. B. Dunham, **T. D. Hoem**, P. Koetsier. 2008. Influences of body size and environmental factors on autumn downsteam migration of bull trout in the Boise River, Idaho. North American Journal of Fisheries Management 28: 231-240

**Hoem Neher, T. D.**, A. E. Rosenberger, C. E. Zimmerman, C. M. Walker, and S. J. Baird. *In press.* Estuarine environments as rearing habitats for juvenile coho salmon in contrasting south-central Alaska watersheds. Submitted to Transactions of the American Fishery Society. December 2012.

**Hoem Neher, T**. D., A. E. Rosenberger, C. E. Zimmerman, C. M. Walker, and S. J. Baird. *In review.* Use of Glacier River-fed Estuary Channels by Juvenile Coho Salmon: Transitional or Rearing Habitats? Submitted to Environmental Biology of Fishes, February 2013.

RELEVANT EMPLOYMENT HISTORY

SCIENCE COORDINATOR, 3/2013 to current. NOAA Kasitsna Bay Laboratory. 2181 Kachemak Dr. Homer, Alaska, 99603.

Coordinate with team leaders, principal investigators, adminstrative team, and EVOSTC staff on overall long term monitoring program planning, reporting and evaluation for a large scale ecosystem monitoring program within the Gulf of Alaska. Plan agenda and facilitate annual investigator meeting, coordinate with administrative team. Develop and maintain ongoing field work schedule for posting on LTM program website. Coordinate with the herring program lead on

program implementation and joint information needs. Coordinate with groups outside the LTM program (NPRB GOAIERP, NPS, GINA, LCCs etc.) on joint synthesis of information.

GRADUATE TEACHING AND RESEARCH ASSISTANT, 1/2008 to 12/2012. University of Alaska Fairbanks, P.O. Box 757220, Fairbanks, Alaska, 99775.
Have written several successful proposals in response to funding solicitations for our salmon estuary work and have presented oral and scientific poster summaries of work annually for the Kachemak Bay Community Council and at several scientific conferences. Completed research project planning including development of proposals, sampling plans, and obtaining all required permits and compliance documents for sampling. Completed three years of sample collection, including pilot study, data and sample analysis. Worked as the field crew lead for interagency sampling teams consisting of University, State, and Federal staff and interns as well as volunteers Provided peer review for submissions to scientific journals. Assisted with undergraduate biology and Ichthyology courses, including setting up and teaching laboratory sessions, assigning and grading homework and quizzes, giving guest lectures and coordinating with the course instructors.

FISHERY BIOLOGIST, GS-12-02**,** 11/2001 to 12/2006. Bureau of Reclamation, Snake River Area Office West, 230 Collins Road, Boise, Idaho 83702
Worked with an interagency team to determine population size, habitat use patterns and periods of occupancy and trends in abundance for bull trout within the Boise River Basin. Used research and other literature to complete effects analyses for the Biological Assessments for bull trout related to the U.S. Bureau of Reclamation's operations of the Boise River projects and the Arrowrock Dam valve replacement project.
Participated as a team member in the ESA Section 7 consultations and was a coauthor on the Biological Assessments for the U.S. Bureau of Reclamation's Operations of the Boise and Payette River projects and the Arrowrock Dam valve replacement project. Developed plans and field programs, including conducting the field activities, to monitor entrainment of bull trout through dams, evaluate population size and determine trends in population size related to environmental conditions. This work included extensive use of radio and acoustic telemetry equipment and tracking time. Developed the monitoring and implementation plans for the Biological Opinions issued for Arrowrock Dam valve replacement project and the U.S. Bureau of Reclamation Operations in the Upper Snake River projects for bull trout. Participated as a team member and coauthor of the fisheries sections of the Environmental Impact Statement for the Arrowrock Dam valve replacement project under the National Environmental Policy Act

**Tuula Hollmén, D.V.M., Ph.D.**
Research Associate Professor of Marine Science (University of Alaska Fairbanks)
Science Director (Alaska SeaLife Center)
Alaska SeaLife Center and University of Alaska Fairbanks
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**EDUCATION**
Ph.D. University of Helsinki, Helsinki, Finland (2002)
D.V.M. University of Helsinki, Helsinki, Finland (1992)

**PROFESSIONAL INTERESTS**

Physiological ecology, marine ornithology, conservation biology, decision support for conservation/resource management planning

**PROFESSIONAL EXPERIENCE**

**Administrative**

Science Director, Alaska SeaLife Center (2010-)
Eider Program Manager, Alaska SeaLife Center (2002-)

**Research**

Research Associate Professor of Marine Science (University of Alaska Fairbanks) (2005-)
Research Assistant Professor of Marine Science (University of Alaska Fairbanks) (2002-2005)
Visiting Scientist, U.S. Geological Survey, National Wildlife Health Center,WI (1997-2002)
Assistant Professor, University of Helsinki, Department of Basic Veterinary Sciences, Finland (1992-1996)
Visiting Scientist, National Biological Survey, Pacific Islands Science Center, HI (1994)

**Current Professional Committee Service**

Spectacled and Steller's eider recovery team, member
Steller's eider reintroduction committee, chair
North Pacific Research Board Science Panel, member

**SELECTED RECENT PUBLICATIONS** *(*Graduate student)*


Hollmén, T.E., DebRoy, C., Flint, P.L., Safine, D.E., Schamber, J., Riddle, A., Trust, K. 2010. Molecular typing of Escherichia coli strains associated with threatened sea ducks and near-shore marine habitats of southwest Alaska. Environmental Microbiology Reports, in press.

Federer, R.N.*, Hollmén, T.E., Esler, D., Wooller, M.J., Wang, S.W. 2010. Stable carbon and nitrogen isotope discrimination factors from diet to blood plasma, cellular blood, feathers, and adipose tissue fatty acids in spectacled eiders (*Somateria fischeri*). Canadian Journal of Zoology 88:866-874.

Latty, C.J.*, Hollmén, T.E., Petersen, M.R., Powell, A.N., Andrews, R.A. 2010. Abdominally implanted transmitters with percutaneous antennas affect the dive performance of common eiders. Condor 112:314-322.

Oppel S., Federer R.*, Powell A., and T. Hollmén. Effects of lipid extraction on stable isotope ratios in avian egg yolk – is arithmetic correction an alternative? Auk 127:72-78.

Wang, S.W., Hollmén, T.E., and S.J. Iverson. 2009, Validating quantitative fatty acid signature analysis to estimate diets of spectacled and Steller's eiders (Somateria fischeri and Polysticta stelleri). Journal of Comparative Physiology B 180:125-139.

Nilsson, P.*, Hollmén, T., Atkinson, S., Mashburn, K., Tuomi, P., Esler, D., Mulcahy, D,. and D. Rizzolo. 2008. Effects of ACTH, capture, and short term confinement on glucocorticoid concentrations in harlequin ducks (*Histrionicus histrionicus*). Comparative Biochemistry and Physiology 149:275-283.


**THOMAS J. WEINGARTNER**

**EDUCATION**

Ph.D. Physical Oceanography, 1990, North Carolina State University

M.S. Physical Oceanography, 1980, University of Alaska
B.S. Biology, 1974, Cornell University

**SYNERGISTIC ACTIVITIES**

**National**

**National Research Council, Member, "Emerging Research Questions in the Arctic"**

**Workshop Organizer, Physical Oceanography Studies Needs for the Alaskan Beaufort Sea(sponsored by MMS)**

**Past Member, GLOBEC Northeast Pacific Executive Committee, 2000 - 2003**

**Past Member, Science Steering Committee, NSF - Arctic System Science-Ocean Atmosphere Ice Interaction (OAII) Shelf-Basin Interaction Project (2/98 - 2/03).**

**Past Member, Science Steering Committee, NSF - ARCSS-OAII Shelf-Basin Interactions (1995 -2002)**

**Past Member, UNOLS Fleet Improvement Committee (1994 – 1998)**

**State of Alaska**

**Member, Science Advisory Council, Alaska Sea Life Center,**

**Member, Science Advisory Committee, Shell-North Slope Borough Baseline Studies Program, Barrow, Alaska (2011-2015).**

**Member, Science Advisory Committee, Synthesis Of Arctic Research, BOEM-NOAA Committee (2012-2015)**

**University of Alaska**

**Chair IMS Ship Committee (1994 – present)**

**Chair (Academic Coordinator), Graduate Program in Marine Science and Limnology, SFOS (2005-07)**

**Chair, Unit (Oceanography) Promotion and Tenure Committee (2010, 2012)**

**AWARDS**

**Emil Usibelli Distinguished Research Award at University of Alaska, Fairbanks**

**PROFESSIONAL EXPERIENCE**

Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 6/07 – present

Associate Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 6/99 – 6/07

Assistant Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 11/93 - 1999

Research Associate; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 9/91 - 10/93

Postdoctoral Student; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 7/88 - 8/91

Graduate Research Assistant; Department of Marine, Earth and Atmospheric Sciences, North Carolina State U.; Raleigh, North Carolina; and Department of Marine Science, U. of South Florida; St. Petersburg, Florida; 8/84 - 10/88

**ADDITIONAL APPOINTMENTS**

Affiliate 1pher, Applied Physics Laboratory, University of Washington, (2000 – present)
Affiliate Professor,College Natural Science and Mathematics, U. Alaska.

**FIVE REFEREED PUBLICATIONS RELEVANT TO THE PROPOSED WORK**

1) Janout, M. A., **T. Weingartner**, P. Stabeno. 2013. Air-sea and oceanic heat flux contributions to the heat budget of the northern Gulf of Alaska shelf. 2013. *Journal of Geophysical Research*, VOL. 118, doi:10.1002/jgrc.20095
2) Janout, M.A, **T. J. Weingartner**, T. Royer, and S. Danielson, 2010. On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, Journal of Geophysical Research, 115, C05023, doi:10.1029/2009JC005774
3) **Williams, W. J., T. J. Weingartner, A. J. Hermann, 2010. Idealized 2-dimensional modeling of a coastal buoyancy front, or river front, under downwelling-favourable wind-forcing with application to the Alaska Coastal Current, *Journal of Physical Oceanography,* 40: 279-294.**
4) **Weingartner**, T.J., The Physical Environment of the Gulf of Alaska (Section 2.2, p 12 – 47), IN: Long-Term Ecological Change in the Northern Gulf of Alaska, edited by R. B. Spies, Elsevier B.V., Amsterdam, 589 p., 2007.
5) **Weingartner, T.J.,** S. Danielson, and T. C. Royer. 2005. Freshwater Variability and Predictability in the Alaska Coastal Current *Deep-Sea Research*, 52: 169 – 192.

**FIVE OTHER SIGNIFICANT PUBLICATIONS**

1) Day, R. H., **T. J. Weingartner**, *R. R. Hopcroft,* L. A. M. Aerts, *A. L. Blanchard,* ***A. E. Gall*****,** B. J. Gallaway, D. E. Hannay, *B. A. Holladay, J. T. Mathis, B. L. Norcross*, and S. S. Wisdom. 2013. The offshore northeastern Chukchi Sea: a complex high-latitude system. Continental Shelf Research (in press) http://dx.doi.org/10.1016/j.csr.2013.02.002
2) **Weingartner, T.,** ***E. Dobbins***, *S. Danielson*, ***R. Potter, H. Statscewich, and P. Winsor.*** 2013 Hydrographic variability over the northeastern Chukchi Sea shelf in summer-fall 2008–2010, *Continental Shelf Research*. (in press) http://dx.doi.org/10.1016/j.csr.2013.03.012.
3) *Danielson, S.*, **T. Weingartner**, K. Aagaard, J. Zhang, R. Woodgate, Circulation on the central Bering Sea shelf (in press, *Journal of Geophysical Research*)
4) *Kasper, J. L*. and **T. J. Weingartner**, 2012. Modeling winter circulation under landfast ice: The interaction of winds with landfast ice. *Journal of Geophysical Research*, 117, C04006, doi:10.1029/2011JC007649.
5) *Danielson, S.*, E. Curchitser, ***K. Hedstrom,*** **T. Weingartner**, and P. Stabeno, 2011. On ocean and sea ice modes of variability in the Bering Sea, *Journal of Geophysical Research*, 116, C12034, doi:10.1029/2011JC007389.

**COLLABORATORS (OTHER THAN STUDENTS BOLD AND ITALICIZED OR UAF COLLEAGUES (ITALICIZED IN PRECEDING REFERENCES)**

Knut Aagaard (U. Washington), E. Curchitser (Rutgers U.), Robert H. Day (ABR Inc.), Ronald Lindsay (U. Washington), Phyllis Stabeno (NOAA-PMEL), Robert S. Pickart (Woods Hole Oceanographic), Rebecca Woodgate (U. Washington).

**Robert William Campbell**
Prince William Sound Science Center
P.O. Box 705, Cordova, AK, 99574
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(907)424-5800

EDUCATION

**Doctor of Philosophy, University of Victoria, School of Earth and Ocean Sciences (1999-2003)**

Thesis: "Overwintering ecology of Neocalanus plumchrus"

**Master of Science, Biology, Dalhousie University (1996-1998)**

Thesis: "Reproduction of Calanus finmarchicus in the western North Atlantic: fecundity and hatching success"

**Bachelor of Science (Hons), Biology, University of Toronto (1991-1996)**

Thesis: "Simulation and bioenergetic modeling of Walleye (Stizostedion v. vitreum) populations"

APPOINTMENTS

2007 – present Oceanographer, Prince William Sound Science Center

2010 – present Affiliate faculty, University of Alaska Anchorage

2004-2006 Post-doctoral researcher, University of Hamburg, Germany

PUBLICATIONS

Mackas, D., Galbraith, M., Faust, D., Masson, D., Young, K., Shaw, W., Romaine, S., Trudel, M., Dower, J., Campbell, R., Sastri, A., Bornhold Pechter, E.A., Pakhomov, E. and R. El-Sabaawi. In Press. Zooplankton time series from the Strait of Georgia: Results from year-round sampling at deep water locations, 1990–2010. Progress in Oceanography. Accepted 06/2013.

Diekmann, A.B.S., Holste, L., St. John, M., Peck, M and R.W. Campbell. 2009.Variation in diatom biochemical composition during a simulated bloom and its effect on copepod reproduction. J. Plankton Res. 31:1391-1405

Campbell, R.W. 2008. Overwintering habitat of Calanus finmarchicus in the North Atlantic inferred from autonomous profiling floats. Deep Sea Res. 55:630-645.

Campbell, R.W and J.F. Dower. 2008. Life history and depth distribution of Neocalanus plumchrus in the Strait of Georgia. J. Plankton Res. 30:7-20.

Kattner, G., Hagen, W., Lee, R.F., Campbell, R.W., Deibel, D., Falk-Petersen, S., Graeve, M., Hansen, B.W., Hirche, H.J., Jonasdottir, S.H., Madsen, M.L., Mayzaud, P., Müller-Navarra, D., Nichols, P., Paffenhöffer, G.A., Pond, D., Saito, H., Stübing, D., and P. Virtue. 2007. Perspectives on zooplankton lipids. Can. J. Fish. Aquat. Sci. 64:1628-1639.

Campbell, R.W., Boutillier, P. and J.F. Dower. 2004. Ecophysiology of overwintering in the copepod Neocalanus plumchrus: Changes in lipid and protein contents over a seasonal cycle. Mar. Ecol. Prog. Ser. 280:211-226.

Campbell, R.W. and J.F. Dower. 2003. The role of lipids in the regulation of buoyancy by zooplankton. Mar. Ecol. Prog. Ser. 263:93-99.

Irigoien, X., Harris, R.P., Verheye, H.M., Joly, P., Runge, J.A., Starr, M. Pond, D., Campbell, R.W., Shreeve, R., Ward, P., Smith, A.N., Dam, H.G., Napp, J., Peterson, W., Tirelli, V., Koski, M., Smith, T., Harbour, D., Strom, S. and R. Davidson. 2002. Copepod Hatching Success Rate in Marine Ecosystems With with High Diatom Concentrations - the Paradox of Diatom-Copepod Interactions Revisited. Nature. 419:387-389.

RECENT COLLABORATORS

E. Acheampong (U. Hamburg); J. Churnside (NOAA); J. Crusius (USGS); D. Causey (UAA); D. Deibel (Memorial University of Newfoundland); T. Dellapenna (TAMU); Diekmann (U. Hamburg); L. Feinburg (OSU); S. Gay (PWSSC); S. Gassó (NASA GSFC); G. Gust (Technical University of Hamburg); R. Heintz (NOAA); P. Hershberger (USGS); G. Kineke (BC); T. Kline (PWSSC); S. Kuehl (VIMS); L. McFadden (PWSSC); C. Moy (USGS); S. Pegau (OSRI); F. Sewall (UAS); A. Schroth (UVM); A. Thomas (U. Maine); J. Welker (UAA); J. Vollenwieder (NOAA).

**Kristine (Kris) Holderied**
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WORK EXPERIENCE

NOAA, National Ocean Service, National Centers for Coastal Ocean Science,
Kasitsna Bay Laboratory. Homer, AK 09/2005- present
Director/Supervisory Physical Oceanographer: NOAA Director for the Kasitsna Bay Laboratory, a subarctic coastal marine ecosystem laboratory run in partnership with the University of Alaska Fairbanks (UAF). Develop and implement science and operations plans for the lab. Provide on-site coordination for facility construction activities. Coordinate research and education activities with regional partners, including local, state, and federal agencies, Alaska Native organizations, universities, public schools and non-profit education and conservation groups.

NOAA, National Ocean Service, National Centers for Coastal Ocean Science,
Center for Coastal Monitoring and Assessment. Silver Spring, MD 06/2000-09/2005
Physical Scientist: Developed innovative technical solutions to address internal NOAA and external customer needs for remote sensing products and services in U.S. coastal regions. Used satellite data to map benthic habitats in support of NOAA's Coral Reef Program and developed applications of satellite-derived information to address issues with harmful algal blooms, estuarine and coastal eutrophication and climate change. Served as technical representative on remote sensing, habitat mapping and water quality sensor development contracts.

Old Dominion University, Center for Coastal Physical Oceanography. Norfolk, VA 11/1996-06/2000
Graduate Research Assistant: Planned and conducted observational studies of density and circulation in the Chesapeake Bay, Inland Sea of southern Chile, and Gulf of California, Mexico.

U.S. Army Corps of Engineers, Norfolk District. Norfolk, VA 01/1992-11/1996
Oceanographer: Project manager for environmental compliance projects, a navigation

study, and a three-year water quality sampling program. Led development and technical management of multi-year, multi-million dollar delivery order contracts for Army training area management and general environmental compliance support for Federal facilities across the U.S.

GE Government Services. Norfolk, VA 11/1991-01/1992
Systems Engineer (acoustics): Developed a training course in ocean acoustics.

U.S. Navy active duty - Rota, Spain; Cambridge, MA; Norfolk, VA; Bay St Louis, MS 05/1984-09/1991
Naval Officer (Oceanographer): Provided meteorological, acoustic and tactical environmental forecasts to naval and merchant marine ships and aircraft in the North Atlantic Ocean and Mediterranean, Red and Black Seas. Provided local meteorological forecasts for Rota, Spain and Norfolk, VA. Managed divisions of up to 12 people, with responsibility for personnel supervision, training and administration.

EDUCATION

MIT-WHOI, M.S. 1988, Physical Oceanography, Cambridge MA. (Satellite scatterometer wind study)
U.S. Naval Academy, B.S. 1984, Oceanography, Annapolis MD. Valedictorian.

RECENT PUBLICATIONS


- Valle-Levinson, A., K. Holderied, C. Li, and R. J. Chant. 2007. Subtidal flow structure at the turning region of a wide outflow plume., J. Geophys. Res. 112. C04004, doi:10.1029/2006JC003746.
- Stumpf, R., S. Dunham, L. Ojanen, A. Richardson, T. Wynne, K. Holderied. 2005. Characterization and Monitoring of Temperature, Chlorophyll, and Light Availability Patterns in National Marine Sanctuary Waters: Final Report. NOAA NCCOS Technical Memorandum 13. Silver Spring, MD. 56 pp.
- National Oceanic and Atmospheric Administration. 2003. Atlas of the Shallow-Water Benthic
  Habitats of the Northwestern Hawaiian Islands (Draft). 160 pp.
- Stumpf, R.P., K. Holderied, and M. Sinclair. 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. *Limnology and Oceanography*, v. 48(1, part 2), pp. 547-556.
- Caceres, M., A. Valle-Levinson, H.H. Sepulveda, and K. Holderied. 2002. Transverse variability of flow and density in a Chilean fjord. Continental Shelf Research, v. 22(11-13), pp. 1683-1698.



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**Education**:
***Master of Science Degree*** - Wildlife Ecology
University of Wisconsin, Madison.

***Bachelor of Science Degree*** - Biology
University of Minnesota, Minneapolis.

**Current Employment**:
Research Coordinator (2008-present), Kachemak Bay Research Reserve, 95 Sterling Hwy Suite 2 Homer, AK 99603,

The Kachemak Bay Research Reserve (KBRR) is housed within National Estuarine Research

Reserve System (NERRS/NOAA) and the Alaska Department of Fish and Game. During my tenure at KBRR, I provided vision and direction for the development of the following biological programs for the Reserve, 1) long-term monitoring of abiotic trends (water quality, weather, vertical land-level change) and biotic trends (emergent salt marsh vegetation and associated biota, plankton and harmful algal blooms, and marine invasive species), and 2) directed/short-term research on juvenile salmon rearing and smolting habitat, hard-shell clam life history studies, sea otter survival and movement patterns, sea bird diet studies, and impacts on ocean acidification to larval Tanner crabs. I oversee the research program at the Reserve and supervise a team of four researchers and two graduate students, attend annual NERRS meetings to set standardized monitoring programs and funding for research, I served on the Coastal Training Program oversight committee, and on the NERRS Climate Change Adaptation Panel. I am the principal investigator on a grant to work with Homer and Kenai Peninsula Borough coastal zone managers to assess regional land and sea-level changes through intensive monitoring and modeling. I have been actively involved in research program development (written a 5-yr research plan), grant writing, communication of research results, and building upon and forming new partnerships with communities, Universities, State, and Federal agencies.

**Recent Employment:**
Wildlife Biologist (1992-2008), U.S. Fish and Wildlife Service, Marine Mammals Management 1011 E Tudor Road, Anchorage AK 99503

During my 16-yr tenure, I worked on directing and development of the following biological programs for sea otters 1) bio-monitoring program, 2) population abundance and distribution surveys, and 3) studies of individual health by monitoring, contaminate exposure, disease agents, and body condition. For all programs, I was responsible for planning, budget management, study design, implementation, analysis, and report writing. Data from these studies have been used in population stock assessment reports and in publications. I have conducted extensive sea otter/marine bird surveys in the near-shore coastal habitat in Alaska including Aleutian and Kodiak archipelagos, Alaska Peninsula, and the Gulf of Alaska and Yakutat Bay. I worked to standardize sampling methods (tissue collection techniques) and survey methods which were applied to Native co-management projects, international collaborations, and cooperative work within our National Wildlife Refuges. I am the International Union for Conservation of Nature and Natural Resources (IUCN) species representative for sea otters to the International Otter Specialist Group. In this role, I directed and facilitated the development of formal goals for the management and conservation throughout the species' range and organized the Area V, U.S./Russia Sea Otter Working Group meetings in Alaska and in California. I have authored or co-authored 11 scientific papers in peer reviewed journals and since 1992, authored 11 peer reviewed reports.

I coordinated the public outreach for the Sea Otter Conservation Plan with the State of Alaska, Marine Mammal Commission, scientists, Alaska Native people, conservation groups, and the general public. I prepared a three-year planning document, "A Co-management Vision for the Sustainable Use of Sea Otter, Polar Bear, and Walrus", to guide marine mammal co-management work with Fish and Wildlife Service and coastal Alaska Native groups. I participated in a one-year lateral assignment (Special Assistant to the Marine Mammals Management Supervisor) and two rotational assignments (Refuges Planning Department and Migratory Bird Management) during my tenure.

**Select Publications**:
Doroff, A.M. and J. L. Bodkin. 1994. Sea Otter Foraging Behavior and Hydrocarbon Levels in Prey Following in the *Exxon Valdez* Oil Spill in Prince William Sound, Alaska. *In*: Marine Mammals and Oiling. ed. T. R. Loughlin. Academic Press.

Doroff, A. M., J. A. Estes, M. T. Tinker, D. M. Burn, and J. A. Evans. 2003. Sea Otter Population Declines in the Aleutian Archipelago. Journal of Mammalogy 84:55-64.

Ballachey B. E., J. L. Bodkin, S. Howlin, A. M. Doroff, and A. H. Rebar. 2003. Correlates to Survival of Juvenile Sea Otters in Prince William Sound, Alaska. Canadian Journal of Zoology 1494-1510.

Burn, D. M., A. M. Doroff, M. T. Tinker. 2003. Carrying Capacity and Pre-decline Abundance of Sea Otters (*Enhydra lutris kenyoni*) in the Aleutian Islands. Northwest Naturalist 84:145-148

Burn, D.M. and A.M. Doroff. 2005. Decline in sea otter (Enhydra lutris) populations along the Alaska Peninsula, 1986-2001. Fishery Bulletin 103:270-279.

Estes, J.A., M.T. Tinker, A.M. Doroff, and D.M. Burn. 2005. Continuing sea otter population declines in the Aleutian archipelago. Marine Mammal Science. 21:169-172.

Goldstein T, J.A.K. Mazet, V.A. Gill, A. M. Doroff, K. A. Burek, and J.A. Hammond. 2009. Phocine distemper virus in northern sea otters in the Pacific Ocean, Alaska, USA. Emerging infectious diseases. 15:925-927.

**Recent Grants:**

U.S Army Corp of Engineers 2007-2008: Principal Investigator (85K)

U.S Fish and Wildlife Service 2007-2010: Principal Investigator (655.7K)

State Wildlife Grants 2008-2009: Project Manager (145K)

University of New Hampshire, Science Collaborative 2010-2013: Principal Investigator (915K)

**Heather A. Coletti**
Marine Ecologist
National Park Service
240 W 5th Avenue, Anchorage, Alaska 99501, USA
Phone: 907-644-3687
E-mail: Heather_Coletti@nps.gov

**Areas of Expertise**
General ecology of nearshore marine ecosystems
Sea otter ecology
GIS (Geographical Information Systems) for designing surveys of various types as well as for more complex spatial analysis of data to determine habitat use and potential species densities

**Education**
**University of New Hampshire, Durham, New Hampshire – M.S., 2006**
Major: Natural Resources: Environmental Conservation
**University of Rhode Island, Kingston, Rhode Island - B.S., 1997**
Major: Zoology

**Professional Experience (2001 to present)**
**Marine Ecologist,** 2008 - present
National Park Service, Anchorage, AK
**General Biologist,** January 2002 to July 2008
U.S. Geological Survey – Alaska Science Center, Anchorage, AK
**Biological Technician,** October 2001 to January 2002
US Fish and Wildlife Service, Anchorage, AK
**General Biologist,** May 2001 to October 2001
U.S. Geological Survey – Alaska Science Center, Anchorage, AK

**Collaborations**
USGS, USFWS**,** NPS

**Affiliations**
Society for Marine Mammalogy

**Selected Publications**
Coletti, H., J. Bodkin, T. Dean, and K. Kloecker. 2010. Nearshore Marine Vital Signs Monitoring in the Southwest Alaska Network of National Parks. Natural Resource Technical Report.

Coletti, H., J. Bodkin, T. Dean, and K. Kloecker. 2009. Nearshore Marine Vital Signs Monitoring in the Southwest Alaska Network of National Parks. Natural Resource Technical Report.

Coletti, H. 2006. Correlating sea otter density and behavior to habitat attributes in Prince William Sound, Alaska: A model for prediction. MS Thesis, University of New Hampshire, Durham, NH. pp. 99.

Bodkin, J. L., T. A. Dean, H. A. Coletti, and K. A. Kloecker. 2008. Nearshore Marine Monitoring in the Southwest Alaska Network of National Parks. National Park Service. Anchorage, AK. 176 pg. In Review.

Bodkin, J. L., T. A. Dean, and H. A. Coletti. 2007. Nearshore Marine Monitoring in the Southwest Alaska Network of National Parks. National Park Service. Anchorage, AK. 102 pg.

Bodkin, J. L., B. E. Ballachey, G. G. Esslinger, K. A. Kloecker, D. H. Monson, and H. A. Coletti. 2007. Perspectives of an invading predator: Sea otters in Glacier Bay. Pp.133-136 in J. F. Piatt and S. M. Gende (eds.), Proceedings of the Fourth Glacier Bay Science Symposium. U.S. Geological Survey Scientific Investigations Report 2007-5047, 246 p.

Bodkin, J. L., B. E. Ballachey, K. A. Kloecker, G. G. Esslinger, D. H. Monson, and H. A. Coletti. 2005. Sea otter studies in Glacier Bay National Park and Preserve. 2004 Annual Report. USGS Alaska Science Center, Anchorage, AK.

Bodkin, J. L., B. E. Ballachey, K. A. Kloecker, G. G. Esslinger, D. H. Monson, H. A. Coletti, and J. A. Estes. 2004. Sea otter studies in Glacier Bay National Park and Preserve. 2003 Annual Report. USGS Alaska Science Center, Anchorage, AK.

Bodkin, J. L., K. A. Kloecker, G. G. Esslinger, D. H. Monson, H. A. Coletti, and J. Doherty. 2003. Sea otter studies in Glacier Bay National Park and Preserve. 2002 Annual Report. USGS Alaska Science Center, Anchorage, AK.

Bodkin, J. L., K. A. Kloecker, H. A. Coletti, G. G. Esslinger, D. H. Monson, and B. E. Ballachey. 2002. Marine Predator Surveys in Glacier Bay National Park and Preserve. Annual Report to USNPS. USGS Alaska Science, Anchorage, AK.

Bodkin, J. L., K. A. Kloecker, H. A. Coletti, G. G. Esslinger, D. H. Monson, and B. E. Ballachey. 2001. Marine Predator Surveys in Glacier Bay National Park and Preserve. Annual Report to USNPS. USGS Alaska Science, Anchorage, AK.

CRAIG O. MATKIN, B.A., M.S.

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www.whalesalaska.org

EDUCATION

B.A. in Biology, University of California, Santa Cruz (1974)
M.S. in Zoology, University of Alaska Fairbanks (1980)

PROFESSIONAL EXPERIENCE

Executive Director, North Gulf Oceanic Society, Homer, Alaska, (1982-present)

Supervise and conduct research on cetaceans, primarily killer whales and humpback whales, oversee stranding network and educational operations, operate and outfit research vessels. Maintain collaborations with numerous institutions and oversee fiscal operations of NGOS.

Adjunct faculty, University of Alaska, Kenai Peninsula College, Kachemak Bay Campus, Homer, Alaska (1999-present)

Teaching of marine mammal classes and guest lectures on marine topics. Participation in elder hostel program.

Commercial Fisherman, Gulf of Alaska, Alaska (1977-1997)

Outfitting and operation of commercial fishing vessels harvesting, salmon, herring and various species of crab. Participation on boards of various fishing organizations.

RELATED EXPERIENCE

Mr. Matkin has conducted research on marine mammals in southern Alaska since 1977. He completed work on harbor seals and Steller sea lions and their interactions with fisheries in 1977-79 leading to an M.S. degree. He initiated photo-identification work of killer whales and humpback whales in Prince William Sound in 1977. Since 1982 he has worked as executive director of the North Gulf Oceanic Society, acted as principal investigator on numerous contracts from the National Marine Mammal Laboratory, National Marine Fisheries Service; the U.S. Fish and Wildlife Service; Sea Grant Marine Advisory Program; Alaska Council on Science and Technology, U.S. Marine Mammal Commission; Hubbs Sea World Research Institute, the *Exxon Valdez* Trustee Council, the North Pacific Universities Marine Mammal Research Consortium and the Alaska Sea Life Center. He has directed the NGOS long-term photo-identification project examining killer whale population dynamics in Alaska since 1984. He has conducted population/distribution/genetics research on humpback whales from southeast Alaska to the Aleutian Islands and western Alaska, most recently as part of the SPLASH program. He has specialized in biopsy sampling of various cetaceans including killer whales, humpback whales, fin whales and sperm whales. Using the biopsy sampling technique he has investigated population genetics and environmental contaminant levels in killer whales and humpback whales, and most recently, feeding habits using stable isotopes and lipid/fatty acids. With collaborators he has developed small telemetry packages for remote attachment to killer whales and other cetaceans and applied ARGOS satellite sytems to tracking killer whales. He directed work for the past 20 years (1989-present) contracted by the *Exxon Valdez* Oil Spill Trustee Council and National Marine Fisheries Service assessing the long-term impacts of the *Exxon Valdez* Oil Spill on killer whales. He currently supervises a killer whale research program that extends from southeastern Alaska to the Eastern Aleutians. He has participated in marine mammal stranding work since 1986 as a designated agent of the National Marine Fisheries Service, providing field response and reports. Recently he has reviewed the status of the Cook Inlet beluga whale and provided recommendations to the National Marine Fisheries Service and he is the scientific reviewer for the Eagle River Flats beluga studies

MEMBERSHIPS

Alaska Scientific Review Group (Advising the National Marine Fisheries Service on marine mammal stock issues)

Society for Marine Mammalogy (Active group of Marine Mammal Scientists)

SELECTED RECENT PUBLICATIONS

Saulitis, E.L., C.O. Matkin, L. Barrett-Lennard, K. Heise and G. Ellis. 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) populations in Prince William Sound, Alaska Marine Mammal Science, 16(1)94-109.

Scheel, D. C.O. Matkin, E Saulitis. 2001. Distribution of killer whale pods in Prince William Sound, Alaska over a thirteen year period 1984-96. Marine Mammal Science.17(3)

Ylitalo, G.M., C.O. Matkin, J. Buzitis, M. M. Krahn, L. L. Jones, T. Rowles, and J. Stein. 2001. Influence of Life-History Parameters on Organochlorine Concentrations in Free-Ranging Killer Whales (*Orcinus orca*) from Prince William Sound, Alaska. The Science of the Total Environment 281:183-203.

Matkin, C O., L. Barrett-Lennard, G. Ellis. 2002. Killer Whales and Predation on Steller sea lions. In Demaster, D. and Atkinson. S. Steller Sea Lion Decline: Is it Food II. University of Alaska, Sea Grant College Program AK-SG-02-02

Heise, K., L. G. Barrett-Lennard, E. L. Saulitis, C. O. Matkin and D. Bain. 2003. Examining the evidence for killer whale predation on Steller sea lions in British Columbia and Alaska. Aquatic Mammals 29:325-334.

**John R. Moran**
Tel: (907) 789-6014
Email: John.Moran@noaa.gov

EDUCATION
University of Alaska Fairbanks, M.S. in Fisheries, August 2003.
University of New Hampshire, B.A. in Zoology, minor in Marine Biology, May 1989.

PROFESSIONAL EXPERIENCE
Research Fisheries Biologist, *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory*, *Juneau AK. August 2006-present*
Research Associate, *University of Alaska Southeast, Juneau, AK.* September 2003- August 2006
Research Assistant, *University of Alaska Fairbanks, Juneau, AK*. January 2002-May 2003
Weir Crew Leader, *SWCA, Salt Lake City, UT.* September 2001-November 2001
Graduate Intern, *Alaska Department of Fish and Game, Juneau, AK.* April 2000-April 2001
Teaching Assistant, *University of Alaska Fairbanks, Juneau, AK.* September 1999-December 2000
Biological Technician (Fisheries), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK*. April 1998-August 1999
Biological Science Technician (Wildlife), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK*
Fisheries Technician/Tagger/Diver, *Prince William Sound Aquaculture, Cordova, AK.* February 1992-April 1993

SELECT PUBLICATIONS (primary author):

John R. Moran and Rowena D. Flinn. Opportunistic Foraging on Seal Blood by Snow Buntings. (submitted to Canadian Field-Naturalist).

John R. Moran, Janice M. Straley, Terrence J. Quinn II, Stanley D. Rice, and Suzanne F. Teerlink. Late-season abundance and seasonal trends of humpback whales in Prince William Sound, Lynn Canal and Sitka Sound, Alaska. ( In prep. for Marine Ecology Progress Series).

John R. Moran, Kevin Boswell, and Janice M. Straley. Opportunistic in situ length measurements of humpback whales (Megaptera novaeaglia) and Steller sea lions (Eumetopais jubatus) using dual frequency identifying sonar (DIDSON). (In prep. for Marine Mammal Science).

Moran, J.R., M. Adkison, and B. Kelly. Counting seals: Estimating the unseen fraction using a photographic capture-recapture and covariate model. (In prep. for Canadian Journal of Zoology).

Moran, J.R. 2003. Counting seals: Estimating the unseen fraction using a covariate and capture-recapture model. M.S. Thesis, University of Alaska Fairbanks.

RECENT COLLABORATORS:
Mary Anne Bishop, Prince William Sound Science Center, Cordova, AK
Janice Straley, University of Alaska Southeast, Sitka AK.
Brendan Kelly, University of Alaska Southeast, Juneau, AK
Mervi Kunnasranta, University of Joensuu, Joensuu, Finland
Peter Boveng, Polar Ecosystem Program, NMML, NMFS, Seattle, WA
Lois Harwood, Department of Fisheries and Oceans Canada, Yellowknife, NT, Canada
Tom Smith, EMC EcoMarine Corporation,Quebec, Canada
Rex Snyder, Nanuuq Commission, Anchorage, AK

John F. Piatt
4210 University Dr., Anchorage AK 99801
360-774-0516, jpiatt@usgs.gov
Research Biologist (GS-15), Marine Ecology Project Leader, Alaska Science Center, U.S. Geological Survey, 4210 University Drive, Anchorage, Alaska, U.S.A. 99508.
Current mailing address: USGS Marrowstone Marine Station, 616 Marrowstone Point Road, Nordland WA 98358-9633 1o Work ph: (360) 774-0516; Fax (360) 385-7207
E-mail: john_piatt@usgs.gov Web:
http://www.absc.usgs.gov/research/seabird_foragefish/index.html

**ACADEMICS**:

Affiliate Professor, School of Aquatic and Fisheries Sciences, University of Washington, Seattle.

Affiliate Professor, Department of Fisheries and Wildlife, Oregon State University, Corvallis.

Ph.D., Marine Biology, 1987, Department of Biology, Memorial University of Newfoundland, St. John's, Canada. Thesis: Behavioural Ecology of Common Murre and Atlantic Puffin Predation on Capelin: Implications for Population Biology.
B.Sc. (Hons.) Biochemistry, 1977, Memorial University of Newfoundland, St. John's, Canada.

RELEVANT RESEARCH EXPERIENCE

Endangered Species Studies (2001-2013). Principal Investigator for studies on rare and threatened seabirds in Alaska, including Kittlitz's Murrelet, Marbled Murrelet and Short-tailed Albatross. Studies include detailed

investigations of marine ecology, forage fish and habitat use, radio and satellite telemetry, physiology, surveys for distribution and abundance in Alaska, etc.

North Pacific Pelagic Seabird Database (2002-2013). Principal Investigator responsible for the compilation of a quarter million transects that document the distribution of seabirds at sea in the North Pacific Ocean. Writing book entitled "Marine Ecology of Seabirds in the North Pacific".

Glacier Bay Marine Ecosystem Studies (1999-2008). Principle Investigator for studies on oceanography, zooplankton, forage fish (using hydroacoustics, seines, trawls) and marine predators (seabirds, marine mammals) in Glacier Bay National Park (including 4 year inventory of all fish species in the park, study of Humpback Whale foraging behavior, and investigations of murrelet ecology).

Functional Response of Seabirds to their Prey in Cook Inlet (1995-2001). Principal Investigator of integrated study of oceanography, forage fish (seining, trawling, hydroacoustics), and seabirds (diets, stress, energetics, breeding, foraging behavior, genetics, annual survival) around three seabird colonies in lower Cook Inlet.

Tufted and Horned Puffin population and feeding ecology at 15 colonies in the Aleutians and along the Alaska Peninsula (1990-2000; chick diets and growth, adult diets, seabird distribution at sea, surveys for prey).

Participated in 39 research cruises in 1977-2011 to study oceanography, plankton, forage fish and seabirds in the North Atlantic, Labrador Sea, eastern Canadian Arctic, North Central Pacific, Gulf of Alaska, Aleutians, Bering Sea and Chukchi Sea.

**OTHER ACTIVITIES**

Contributing Editor, Marine Ecology Progress Series (2007- current)

Associate Editor, *The Auk* (2006 – current)

Science Panel, North Pacific Research Board, Anchorage, Alaska (2005-2011)

Past or Current advisor and/or graduate committee member for: A. Agness *U. Washington*; S. Speckman, *U. Washington*.; M. Romano, *Oregon State U.*; M. Robards, *Memorial U. Newfoundland*; T. Van Pelt, *U. Glasgow*; M. Litzow, *U. California, Santa Cruz*; A. Kitaysky, *U. Washington*; Ann Harding, *Sheffield U.;* K. Kuletz*, U. Victoria,* S. Zador*, U. Washington,* M. Renner*, U. Washington,* Mayumi Arimitsu, *U. Alaska, Fairbanks*, J. Lawonn, *Oregon State U.*, J. Cragg, *U. Victoria*.

**SELECTED PUBLICATIONS**:

Cury, P.M., I.L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R.J.M. Crawford, R.W. Furness, J.A. Mills, E. Murphy, H. Osterblom, M. Paleczny, J.F. Piatt, J.P. Roux, L. Shannon, W.J. Sydeman. 2011.

Global seabird responses to forage fish depletion – one-third for the birds. **Science** 334:1073-1076.

Arimitsu, M.L, J.F. Piatt, E.N. Madison, J.S. Conaway, N. Hillgruber. 2011. Oceanographic gradients and seabird prey community dynamics in a glacial fjord. **Fisheries Oceanography** 21:148-169.

Piatt, J.F., A.M.A. Harding, M. Shultz, S.G. Speckman, T. I. van Pelt, G.S. Drew, A.B. Kettle. 2007. Seabirds as indicators of marine food supplies: Cairns revisited. **Marine Ecology Progress Series** 352: 221-234.

Harding, A.M.A., Piatt, J.F., Schmutz, J.A., Shultz, M.T., Van Pelt, T.I., Kettle, A.B., and Speckman, S.G. 2007. Prey density and the behavioral flexibility of a marine predator: the Common Murre (*Uria aalge*). **Ecology** 88: 2024-2033.

Piatt, J.F., and A.M.A. Harding. 2007. Population Ecology of Seabirds in Cook Inlet. Pp. 335-352 *in*: Robert Spies (ed.), **Long-term Ecological Change in the Northern Gulf of Alaska**. Elsevier, Amsterdam.

Speckman, S., J.F. Piatt, C. Minte-Vera and J. Parrish. 2005. Parallel structure among environmental gradients and three trophic levels in a subarctic estuary. **Progress in Oceanography** 66: 25-65.

COLLABORATORS

During the past four years, I have collaborated with the following on proposals and papers (including only the Principal Investigators of projects or papers): Jim Bodkin (USGS), Ian Boyd (Univ. St. Andrews, UK), G. Vernon Byrd (USFWS), Philippe Cury (Ctr. Tropical Fish. Res., France), Anthony DeGange (USGS), Vicki Friesen (Queen's Univ., Canada), Bob Furness (Univ. Glasgow, UK), Shelley Hall (NPS), Ann Harding (Alaska Pacific Univ.), George Hunt (Univ. Washington), David Irons (USFWS), Michelle Kissling (USFWS), Alexander Kitaysky (Univ. Alaska, Fairbanks), Kathy Kuletz (USFWS), Ellen Lance (USFWS), Bill Montevecchi (Memorial Univ., Canada), Julia Parrish (Univ. Washington), Bill Pyle (USFWS), Martin Renner (U. Wash.), Dan Roby (Oregon State Univ.), Suzann Speckman (USFWS), William Sydeman (Farallon Institute).

**Mayumi Arimitsu**
USGS-Alaska Science Center
250 Egan Dr., Juneau AK 99801
Tel: 907-364-1593, FAX: 907-364-1540,
email: marimitsu@usgs.gov

**EDUCATION**

| | |
|---|---|
| University of California, Santa Cruz CA | B.Sc. (1998) Biology |
| University of Alaska Fairbanks, Juneau AK | M.Sc. (2009) Fisheries |
| University of Alaska Fairbanks, Juneau AK | PhD student (current) Fisheries |

**TECHNICAL TRAINING**

National Association of Underwater Instructors, Scientific Diving Certification, 1996
UC Extension, Endangered Species Conservation Program, Chile, 1997

Secondary Education Credential Program, Humboldt State University, 2000
American Fisheries Society, Advanced GIS Techniques for Fisheries Biologists, 2004
ESRI, Spatial Statistics ArcGIS 9.0 workshop, 2005
BIOSONICS, Hydroacoustic Tools for Fish and Habitat Assessment, 2005
Anthony Starfield, Principles of Modeling for Conservation Planning and Analysis, 2007
Oz Garton, Wildlife and Fisheries Survey Design and Analysis, 2008
R programming for fisheries statistics, University of Alaska Fairbanks, 2007
Spatial Statistics and Stable Isotope Methods, University of Alaska Fairbanks, 2012

**PROFESSIONAL GROUP AFFILIATIONS**

American Fisheries Society
Wildlife Society
Pacific Seabird Group

**PROFESSIONAL EXPERIENCE**

Research Ecologist, USGS Alaska Science Center 2007 - Present

I lead the forage fish and oceanography components of the multidisciplinary Marine Ecology Project. This research program focuses on marine ecosystems of Alaska and the North Pacific and seeks to elucidate ecological relationships between seabirds, forage fish, and their marine habitats. Current research includes the use of hydroacoustic/trawl surveys, marine bird surveys, and oceanographic surveys in glacial-marine ecosystems.

Fishery Biologist, USGS Alaska Science Center 2005 - 2007

Co-PI during a large-scale forage fish and oceanography study that sampled 1500 km along the Alaska Peninsula and Aleutian Archipelago. I was responsible for proposals (North Pacific Research Board Project 630), budgets, collaborations, staff, and contracts. I also oversaw fishing and oceanography data collection efforts, data analysis and reporting.

Fishery Biologist, USGS Alaska Science Center 2002 - 2004

Lead biologist during two inventory and monitoring projects in Alaska's national parks. I conducted a marine and estuarine fish inventory in Glacier Bay, Sitka, Kolndike Gold, and Wrangell St. Elias National Parks, and was in charge of fishing operations, data analysis, interpretation, and reporting. I also led a ground-nesting marine bird inventory in Glacier Bay, and was responsible for all aspects of the work, including permitting, staffing, data collection, analysis and reporting.

Biotech, USGS Alaska Science Center 1998 - 2001

Field biologist in support of USGS research in Kachemak Bay, Glacier Bay, and Aleutian Islands, Alaska. I worked on several projects related to understanding seabird abundance, survival, nesting and foraging ecology, and movement. I operated and maintained remote field camps, conducted fish surveys with SCUBA and net sampling, used radio telemetry to track seabirds, and captured colonial-nesting birds for blood hormone analysis.

**OTHER ACTIVITIES**

Interdisciplinary workshop on glacier change, speaker 2013

Forage Fish in Marine Ecosystems, AFS National meeting, symposium organizer 2011

Juneau Douglas High School Science Fair, student mentor 2010

Forage fish identification, Alaska Marine Science Symposium, workshop leader 2009

Kittlitz's Murrelet Satellite Tag Deployment, collaborator 2009 - present

Kittlitz's Murrelet Technical Committee, steering committee member 2008 – present

Forage population special session, Pacific Seabird Group meeting, co-chair 2008

Tidal currents relative to glacial features study, collaborator 2007

USGS long-term oceanographic monitoring program, manager 2005 – 2008

Seabird, Marine Mammal, Oceanography Coordinated Investigation (SMMOCI), 2005 – 2006

lead fishery biologist in charge of trawl operations Pribilof Islands, Aleutians

**FIVE RECENT PUBLICATIONS**

**Arimitsu, M.L.,** J.F. Piatt, E.N. Madison, J.S. Conaway, and N. Hillgruber. *In Press*. Oceanographic gradients and seabird prey community dynamics in glacial fjords. Accepted in Fisheries Oceanography.

**Arimitsu, M.L.,** J.F. Piatt, M.D. Romano, and T. Van Pelt. 2011. Status and distribution of the Kittlitz's Murrelet in Kenai Fjords, Alaska. Marine Ornithology 39: 13-22

**Arimitsu, M.L.,** J.F. Piatt, M.A. Litzow, A.A. Abookire, M.D. Romano, and M.D. Robards. 2008. Distribution and spawning dynamics of capelin (*Mallotus villosus*) in Glacier Bay, Alaska: A cold water refugium. Fisheries Oceanography 17:137-146.

***Arimitsu, M.L.,** and J.F. Piatt. 2008. Forage fish and their habitats in the Gulf of Alaska and Aleutian Islands: Pilot study to evaluate opportunistic use of the U.S. Fish and Wildlife refuge support vessel for long-term studies. Final Report to NPRB, Project 630. U.S. Geological Survey, Alaska Science Center. 42 pp.

**Arimitsu, M.L.,** J.F. Piatt, M.D. Romano, and D.C. Douglas. 2007. Distribution of pelagic forage fishes in relation to the oceanography of Glacier Bay. Pages 96-100 in J.F. Piatt and S.M. Gende, editors, Proceedings of the Fourth Glacier Bay Science Symposium, 2004. U.S. Geological Survey, Open-File Report 2007-5047. 239 pp.

**AWARDS**

Best Student Poster Presentation, North Pacific Research Board, January 2009
Best Student Oral Presentation, North Pacific Research Board, January 2010

**RECENT COLLABORATIONS**

Alisa Abookire (previously USGS), Jeff Conaway (USGS Water Resources), David Douglas (USGS), Lisa Eisner (NOAA), Nicola Hillgruber (MSc. Thesis advisor, University of Alaska Fairbanks), Eran Hood (PhD committee member, University of Alaska Southeast), Michelle Kissling (USFWS), Mike Litzow (previously USGS), Erica Madison (USGS), Franz Mueter (PhD Thesis advisor, University of

Alaska Fairbanks), Martin Robards (previously USGS), Marc Romano (USFWS, previously USGS), Tom Wiengartner (MSc. Committee member, University of Alaska Fairbanks), Tom Van Pelt (NPRB, previously USGS)

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U.S. Fish and Wildlife Service
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Anchorage, Alaska 99503
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(907) 786-3376

EDUCATION

| | |
|---|---|
| B. S. Environmental Resource Management 1976 | *Pennsylvania State University* |
| M. S. Wildlife Ecology 1982 | *Oregon State University* |
| Ph. D. Biology 1992 | *University of California, Irvine* |

RECENT PROFESSIONAL EXPERIENCE

| | |
|---|---|
| 1999-2011 | Alaska Seabird Coordinator, Migratory Bird Management, U.S. Fish and Wildlife Service |
| 1993-1998 | Marine Bird Monitoring Coordinator, Migratory Bird Management, U.S. Fish and Wildlife Service |
| 1984-1992 | Biologist, Migratory Bird Management, U.S. Fish and Wildlife Service |

COMMITTEES

Chair, World Seabird Conference, International Steering Committee
Alaska Region Representative, North American Colonial Waterbird Conservation Plan
Chair, Alaska Seabird Working Group
Chair, Circumpolar Seabird Group
Seabird Coordinator, Circumpolar Arctic Flora and Fauna (CAFF), Circumpolar Biodiversity Monitoring Network.
Chair, Pacific Seabird Group – 2003-2005

Related Publications

Golet, G. H., J. A. Schmutz, D. B. Irons, and J. A. Estes. 2004. Mechanistic determinants of reproductive costs in a long-lived seabird: a multiyear experimental study of the black-legged kittiwake. *Ecological Monographs* 74:353-372.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. Ballachey, D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. *Science* 302:2082-2086.

Ainley, D.G., R. G. Ford, E. D. Brown, R. M. Suryan, and D. B. Irons. 2003. Prey resources, competition, and geographic structure of kittiwake colonies in Prince William Sound, Alaska. *Ecology* 84: 709-723.

Lance B. K., D. B. Irons, S. J. Kendall, L. L. McDonald. 2001. An evaluation on marine bird population trends following the Exxon Valdez oil spill, Prince William Sound, Alaska. *Marine Pollution Bulletin* 42:298-309.

Irons, D. B., S. J. Kendall, W. P. Erickson, L. L. McDonald, and B. K. Lance. 2000. Chronic effects of the *Exxon Valdez* oil spill on summer marine birds in Prince William Sound, Alaska. *Condor* 102:723-737.

Other Publications

Irons, D.B., T. Anker-Nilssen, A. J. Gaston, G. V. Byrd, K. Falk, G. Gilchrist, M. Hario, M. Hjernquist, Y. V. Krasnov, A. Mosbech, B. Olsen, A. Petersen, J. B. Reid, G. J. Robertson, H. Strøm, & K. D. Wohl. 2008. Fluctuations in circumpolar seabird populations linked to climate oscillations. *Global Change Biology* 14:145-1463.

Golet, G. H., and D. B. Irons. 1999. Raising young reduces body condition and fat stores in Black-legged Kittiwakes. *Oecologia* 120:530-538.

Irons, D. B. 1998. Foraging area fidelity of individual seabirds in relation to tidal cycles and flock feeding. *Ecology* 70:647-655.

Golet, G. H., D. B. Irons, and J. A. Estes. 1998. Survival costs of chick rearing in Black-legged Kittiwakes. *Journal of Animal Ecology* 67:827-841.

Irons, D. B., R. G. Anthony, and J. A. Estes. 1986. Foraging strategies of glaucous-winged gulls in a rocky intertidal community. *Ecology* 67:1460-74.

COLLABORATORS

Ainley, David, H.T. Harvey and Associates
Anker-Nilssen, Tycho, NINA, Norway
Brown, Evelyn, UAF
Byrd, Vernon, USFWS
Decker, Mary Beth, Yale U
Drew, Gary, USGS
Dragoo, Don, USFWS
Erickson, Wally, West Inc.
Ford, Glenn, R.G. Ford Consulting
Golet, Greg, TNC
Jodice, Pat, Clemson U.
Kendall, Steve, USFWS
Kuletz, Kathy, USFWS
Lance, Brian, NMFS
McDonald, Lyman, West Inc.
Ostrand, Bill, USFWS
Piatt, John, USGS
Roby, Dan, OSU
Schmutz, Joel USGS
Stephensen, Shawn, USFWS
Suryan, Rob, OSU
Turco, Kathy, self employed

**Dr. Kathy J. Kuletz**

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Anchorage, Alaska 99503
Phone : 907-786-3453 Email: Kathy_Kuletz@fws.gov

Academic Training

| | |
|---|---|
| Ph.D. Biology, 2005 | Univ. of Victoria, British Columbia |
| M. S. Ecology & Evolutionary Biology, 1983 | University of California, Irvine |
| B. S. Wildlife Ecology, 1974 | California State Polytechnic, San Luis Obispo, with Honors |

Recent Professional Experience

2005-present Pelagic Observer Program Coordinator, Migratory Bird Management, USFWS

1998-2005 Alaska Seabird Specialist, Migratory Bird Management, USFWS
1989-1997 Principal Investigator, *Exxon Valdez* studies on marine birds, USFWS

*Related Professional Experience*
PI for Seabirds in Bering Sea Integrated Research Program (BSIERP), with NPRB grant
PI for North Pacific Pelagic Seabird Observer Program, with NPRB grant
Co-PI for 'Seabirds as Predators on Juvenile Herring', funded by EVOS in 2006-2009.
PI and Co-PI for EVOS projects on murrelets and pigeon guillemots, 1989 - 1999
PI for project on decadal changes in seabirds in Kachemak Bay (ADFG/SWG grant), 2004-2007.

*Committees*
Science & Statistical Committee of North Pacific Fisheries Management Council (2007-present)
NOAA/NPFMC Groundfish Fisheries Plan Team (2000 – 2006)
North Pacific Albatross Working Group
EVOS Prince William Sound Herring Working Group
Marbled Murrelet Technical Committee, Kittlitz's Murrelet Technical Committee (PSG)
*Professional Societies*
Pacific Seabird Group (Secretary, 1998-1999)
American Ornithologists' Union
Society of Conservation Biologists
The Wildlife Society
*Honors, Awards, and Fellowships*
Exceptional Service Award, *Exxon Valdez* Oil Spill, U.S. Fish and Wildlife Service, 1989
Regents Fellowship, University of California, Irvine, 1980, 1981
King Platt Memorial Award, University of Victoria, 1998 & 1999
*Related Publications*

Golet, G. H., K. J. Kuletz, D. D. Roby, and D. B. Irons. 2000. Adult prey choice affects chick growth and reproductive success in pigeon guillemots. Auk 117(1):82-91.

Kuletz, K.J., D. Irons, J.F. Piatt, B. Agler, and D.C. Duffy. 1997. Long-term changes in diets and populations of piscivorous birds and mammals in Prince William Sound, Alaska. Pages 703-706 *In:* B.R. Baxter (ed.), Proceedings of the Symposium on the Role of Forage Fish in the Marine Ecosystem. Alaska Sea Grant College Program AK-SG-97-01.

Kuletz, K. J., and S. J. Kendall. 1998. A productivity index for marbled murrelets in Alaska based on surveys at sea. Journal of Wildlife Management 62(2):446-460.

Kuletz, K.J., E. A. Labunski, M. Renner, D.B. Irons. The North Pacific Pelagic Seabird Observer Program. North Pacific Research Board Final Report, Project No. 637.

Kuletz, K. J., S.W. Stephensen, D.B. Irons, E.A. Labunski, & K.M. Brenneman. 2003. Changes in distribution and abundance of Kittlitz's murrelets *Brachyramphus brevirostris* relative to glacial recession in Prince William Sound, Alaska. Marine Ornithology 31:133-140.

Other Publications

Golet, G. H., P. E. Seiser, 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 '*Exxon Valdez*' oil spill on pigeon guillemots in Prince William Sound, Alaska. Marine Ecology Progress Series. Vol 241: 287-304.

Kuletz, K. J. 1996. Marbled murrelet abundance and breeding activity at Naked Island, Prince William Sound, and Kachemak Bay, Alaska, before and after the *Exxon Valdez* oil spill. Pages 770-784 *in* S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, editors. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

Kuletz, K.J. 2005. Foraging behaviour and productivity of a non-colonial seabird, the Marbled Murrelet (*Brachyramphus marmoratus*) relative to prey and habitat. Ph.D. Dissertation. University of Victoria, Victoria, British Columbia.

Kuletz, K.J. E.A. Labunski, S.G. Speckman. 2008. Abundance, distribution, and decadal trends of Kittlitz's and marbled murrelets and other marine species in Kachemak Bay, Alaska. Final Report (Project No. 14) by U.S. Fish and Wildlife Service for Alaska Dept. Of Fish and Game, State Nongame Wildlife Grant, Anchorage, Alaska.

Piatt, J.F., Kuletz, K.J., Burger, A.E., Hatch, S.A., Friesen, V.L., Birt, T.P., Arimitsu, M.L., Drew, G.S., Harding, A.M.A., Bixler, K.S. 2007. Status review of the marbled murrelet (*Brachyramphus marmoratus*) in Alaska and British Columbia. Open-file report, 2006-1387. Alaska Science Center, U.S.G.S., Anchorage, Alaska. 258p.

Recent Collaborators

Mary Anne Bishop (Prince William Sound Science Center); Vernon Byrd (U.S. Fish and Wildlife Service); George L. Hunt, Jr. (University of Washington); David Irons (U.S. Fish and Wildlife Service); Alexander Kataysky (Univ. of Alaska, Fairbanks); John Piatt (U.S. Geological Survey, Alaska Science Center); Dan Roby (Oregon State University); Mike Sigler (Alaska Fisheries Science Center, NOAA); Andrew Trites (University of British Columbia).

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EDUCATION

Ph.D. Department of Wildlife and Range Sciences, University of Florida, Gainesville, 1988.

M.S. Wildlife and Fisheries Sciences, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, 1984.

B.B.A. School of Business, University of Wisconsin, Madison, 1974.

**RECENT PROFESSIONAL EXPERIENCE**

Research Ecologist, Prince William Sound Science Center, Cordova, Alaska, Jun 1999-present

Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1990-1994 and 1997- May1999

Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska, 1994-1997

Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1992-1993.

SELECTED SCIENTIFIC PUBLICATIONS (5 of 53)

***Bishop, M.A.,** J.T. Watson, K. Kuletz, T. Morgan. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography*. (accepted pending revisions*)*.

**Bishop, M.A.**, B.F. Reynolds, S.P. Powers. 2010. An *in situ*, individual-based approach to quantify connectivity of marine fish: ontogenetic movements and residency of lingcod. *PLoS ONE* 5(12): e14267

**Bishop, M.A.**, N. Warnock, and J. Takekawa. 2004. Differential spring migration of male and female Western Sandpipers at interior and coastal stopover sites. *Ardea* 92: 185-196.

***Bishop, M.A.** and S.P. Green. 2001. Predation on Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. *Fisheries Oceanography* 10 (1): 149-158.

*Dawson, N.M., **M.A. Bishop**, K.J. Kuletz, A.F. Zuur.. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. *Arctic (accepted pending revisions)*.

PROFESSIONAL COLLABORATIONS

M. Buckhorn (PWSSC), K. Carpenter (CRWP), N. Dawson (PWSSC), J. Eiler (NOAA), R. Heintz (NOAA), N. Hill (MIT), E.N. Ieno (Highland Statistics), K. Kuletz (USFWS), A. Lang (Memorial Univ.), F. Li (Intl. Crane Foundation), J. Moran (NOAA), T. Morgan (PWSSC), E. Nol (Trent Univ.), W.S. Pegau (OSRI), S. Powers (U. S. Alabama), B. Reynolds (PWSSC), G. Robertson (CA), D. Roby (OSU), J. Runstadler (MIT), A Saveliev (Highland Statistics), S. Senner (Audubon), Y. Suzuki (OSU), A. Taylor (UAA), R. Thorne (PWSSC), D. Tsamchu (Tibet Plateau Institute of Biology, PR China), J. Vollenweider (NOAA), J. Watson (PWSSC), M. Wille (Memorial Univ.), Z. Zuur (Highland Statistics)

**BRENDA E. BALLACHEY**
Research Physiologist, Sea Otter Project/Coastal Ecosystem Team

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## Education

Oregon State University, Corvallis, Oregon - Ph.D., 1985
Colorado State University, Fort Collins, Colorado - M.S., 1980
Colorado State University, Fort Collins, Colorado - B.S. with distinction, 1974

## Professional Experience

**Research Physiologist,** Alaska Biological Science Center, USGS, Anchorage, AK,
July 1990 to present (formerly National Biological Service; Fish & Wildlife Service)
**General Biologist,** Alaska Fish and Wildlife Research Center, USFWS, Anchorage, AK,
November 1989 to July 1990
**Staff Officer,** Board on Agriculture, National Research Council (NRC), Washington, DC, USA,
March 1987 to November 1989

## Current Activities

Research Physiologist with the Alaska sea otter research project and the coastal ecosystems team of the Alaska Science Center, USGS. Supervise and manage activities associated with research projects internal to the Alaska Science Center; collaborate with several agencies, academic and private institutions on cooperative, multi-disciplinary projects. In addition to sea otters, research program includes nearshore marine monitoring, benthic habitat classification, biological and physical oceanography, seabirds and other marine mammals, marine invertebrates, and marine fishes. A major focus of research for the past two decades has been identification and understanding of long-term population and ecosystem level effects of petroleum contaminants in the nearshore marine environment, addressing species and ecosystems of high interest to the U.S. Department of the Interior. This work now continues in the form of the Gulf Watch Alaska project, a long-term monitoring project funded by the EVOS Trustee Council.

## Recent Publications

**Ballachey**, B.E., J.L. Bodkin and D.H. Monson. 2013. Quantifying long-term risks to sea otters from the 1989 'Exxon Valdez' oil spill: Reply to Harwell & Gentile (2013). Marine Ecology Progress Series 488: in press.

**Ballachey**, B.E., J.L. Bodkin, S. Howlin, A.M. Doroff and A.H. Rebar. 2003. Survival of juvenile sea otters in Prince William Sound, Alaska, 1992-93. Cdn. Jnl. Zoology

Bodkin, J.L. and B.E. **Ballachey**. 2010. Modeling the effects of mortality on sea otter populations. Scientific Investigations Report 2010-5096. U.S. Geological Survey. 12 p.

Bodkin, J.L B.E. **Ballachey**, H.A. Coletti, G. G.Esslinger, K.A. Kloecker, S.D. Rice, J. A. Reed, and D. H. Monson. 2012. Long-term effects of the *Exxon Valdez* oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447:273-287.

Bodkin, J.L., B.E. **Ballachey**, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. 2002. Recovery of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Mar. Ecol. Prog. Ser. 241:237-253.

Bodkin, J.L., **Ballachey**, B.E., and Esslinger, G.G. 2011. Trends in sea otter population abundance in western Prince William Sound, Alaska: Progress toward recovery following the 1989 *Exxon Valdez* oil spill. U.S. Geological Survey Scientific Investigations Report 2011–5182, 14 p.

Bowen, L. A.K. Miles, M. Murray, M. Haulena, J. Tuttle, W. Van Bonn, L. Adams, J.L. Bodkin, B.E. **Ballachey**, M. T. Tinker, R. Keister, and J.L. Stott. 2012. Gene Transcription in Sea Otters (*Enhydra lutris*); Development of a diagnostic tool for sea otter and ecosystem health. Molecular Ecology Resources12: 67-74

Esler, D., K.A. Trust, B.E. **Ballachey**, S.A. Iverson, T.L. Lewis, D.J. Rizzolo, D.M. Mulcahy, A.K. Miles, B.R. Woodin, J.J. Stegeman, J.D. Henderson, and B.W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the *Exxon Valdez* oil spill. Environ Toxicol Chem 29(5):1138-1145.

Miles , A.K., L Bowen, B E. **Ballachey**, J.L. Bodkin, M. Murray, J.A. Estes, R.A. Keister and J.L. Stott. 2012. Gene transcription in sea otters (*Enhydra lutris*) two decades post *Exxon Valdez*. Marine Ecology Progress Series 451:201-212.

Monson, D.H., D.F. Doak, B.E. **Ballachey** and J.L. Bodkin. 2011. Could residual oil from the *Exxon Valdez* spill create a long-term population "sink" for sea otters in Alaska? Ecological Applications. 21(8)2917–2932.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. **Ballachey**, and D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086.

**Recent Collaborators**

Bodkin, James, USGS ASC; Bowen, Lizbeth, UC Davis, CA; Coletti, Heather, NPS, Anchorage; Esslinger, George, USGS ASC; Dean, Thomas, Coastal Resources Associates, San Diego; Doroff, Angela, AK Dept of Fish and Game, Homer; Esler, Dan, Simon Fraser University, Victoria, BC; Estes, James, University of California, Santa Cruz; Holdried, Kris, NOAA Kasitsna Bay Lab; Hoffman, Katrina, PWSSC, Cordova; Howlin, Shay, West Ecosystems Technology, Cheyenne, WY; Kloecker, Kim, USGS ASC; Irons, David, USFWS, Anchorage; Larson, Shawn, Seattle Aquarium; Lipscomb, T., DVM. Diplomate ACVP; Lindeberg, Mandy, NOAA Auk Bay Lab; Matkin, Craig, North Gulf Oceanographic Society; McCammon, Molly, AOOS, Anchorage; Michel, Jackie, Research Planning; Miles, A. Keith, USGS WERC; Mohr, F. Chuck, UC Davis; Murray, Mike, Monterey Bay Aquarium; Newsome, Seth, University of Wyoming; Nixon, Zach, Research Planning; Rice, Jeep, NOAA Auk Bay Lab; Staedler, Michelle, Monterey Bay Aquarium, Saupe, Sue, CIRCAC; Speckman, Suzann, USFWS; Tinker, Tim, USGS & University of California, Santa Cruz; Von Biela, Vanessa, USGS ASC; Weitzman, Ben, USGS WERC. (Note: full listing of Gulf Watch Alaska PI's not given here; available upon request).

**Thomas A. Dean, Ph. D.**

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**Education**

| | |
|---|---|
| University of Delaware, Ph.D., Biology | 1977 |
| East Carolina University, M.A., Biology | 1973 |
| Gettysburg College, B.A., Biology | 1970 |

**Professional Experience**

| | |
|---|---|
| President, Coastal Resources Associates, Inc. | 1988 to Present |
| Associate Research Biologist, University of California, Santa Barbara | 1978 to 1987 |
| Senior Staff Ecologist, E.H. Richardson Associates | 1976 to 1978 |

**Representative projects**

Principal Investigator – Development and Implementation of marine nearshore monitoring in National Parks of the Southwest Alaska Network. National Park Service - Anchorage

Principal Investigator – Monitoring in the nearshore Gulf of Alaska as part of the Gulf Ecosystem Monitoring Project: A process for making reasoned decisions. *Exxon Valdez* Oil Spill Trustee Council

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

Project Director – The San Clemente artificial reef project: Transplantation of giant kelp onto experimental reefs for the purposes of kelp enhancement. Southern California Edison Co.

**Selected Publications**

Bowyer, R.T., G.M. Blundell, M. Ben-David, S.C. Jewett, T.A. Dean, L.A. Duffy. 2003. Effects of the *Exxon Valdez* oil spill on river otters: injury and recovery of a sentinel species. Wildl Monog 67:1-53.

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. Mar Ecol Prog Ser 241:255-270

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 217:17-24

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. Mar Ecol Prog Ser 241:237-253

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. Mar Ecol Prog Ser 241:287-304

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. Mar Ecol Prog Ser 241: 271-286

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. Mar Environ Res 54:21-48.

Dean, T.A., S.C. Jewett. 2001. Habitat specific recovery of shallow subtidal communities following the *Exxon Valdez* oil spill. Ecol Appl 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., 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
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
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

**Selected Organizations and Advisory Positions**

Past Member and past chair - Exxon Valdez Trustee Council science advisory panel
Advisor to the State of California Water Resources Control Board. Assessment and protocol selection for marine toxicity tests.
Advisor to the State of California Water Resources Board. Scientific Review Committee for the Marine Bioassay Project.
Reviewer for Ecological Applications, Marine Ecology Progress Series, Marine Biology, Botanica Marina, and other scientific journals.

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**Current position:** Marine Ecologist, National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring (I&M)Program.

**Education:** Master of Science, Natural Resources: Environmental Conservation (University of New Hampshire, Durham, New Hampshire). Bachelor of Science, Zoology (University of Rhode Island, Kingston, RI).

**Current activities related to the proposed project:** Monitoring resources that are explicitly linked to the marine nearshore along regions within the Gulf of Alaska through the NPS SWAN I&M program and Gulf Watch Alaska.

**Selected Publications**

Bodkin, J., B. Ballachey, H. Coletti, G. Esslinger, K. Kloecker, S. Rice, J. Reed and D.

Monson. 2012. Long-term effects of the Exxon Valdez oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. *Marine Ecology Progress Series*.

Coletti, H. A. J. L. Bodkin and G. G. Esslinger. 2011. Distribution and density of marine birds and mammals along the Kenai Fjords National Park coastline - March 2010: Southwest Alaska Network Inventory and Monitoring Program. Natural Resource Technical Report NPS/SWAN/NRTR—2011/451. National Park Service, Fort Collins, Colorado.

Coletti, H. A., J. L. Bodkin, and G. G. Esslinger. 2011. Sea otter abundance in Kenai Fjords national Park: results from the 2010 aerial survey: Southwest Alaska Inventory and Monitoring. Natural Resource Technical Report NPS/SWAN/NRTR—2011/417. National Park Service, Fort Collins, Colorado.

Coletti, H. A., J. L. Bodkin, T. A. Dean, and K. A. Kloecker. 2011. Nearshore marine vital signs monitoring in the Southwest Alaska Network of National Parks: 2010. Natural Resource Technical Report NPS/SWAN/NRTR—2011/497. National Park Service, Fort Collins, Colorado.

Coletti, H. 2006. Correlating sea otter density and behavior to habitat attributes in Prince William Sound, Alaska: A model for prediction. MS Thesis, University of New Hampshire, Durham, NH. pp. 99.

Bodkin, J. L., B. E. Ballachey, G. G. Esslinger, K. A. Kloecker, D. H. Monson, and H. A. Coletti. 2007. Perspectives of an invading predator: Sea otters in Glacier Bay. Pp.133-136 in J. F. Piatt and S. M. Gende (eds.), Proceedings of the Fourth Glacier Bay Science Symposium. U.S. Geological Survey Scientific Investigations Report 2007-5047, 246 p.

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**Education:**
2000 Ph.D. Wildlife Science. Oregon State University, Corvallis, Oregon, USA.
1988 M.Sc. Wildlife Ecology. Texas A&M University, College Station, Texas, USA.
1985 B.Sc. Biology/Outdoor Education. Northland College, Ashland, Wisconsin, USA.

**Professional Experience:**

**August 2013 – present** Project Leader and Research Wildlife Biologist, Nearshore Marine Research Group, Alaska Science Center, U.S. Geological Survey, Anchorage, Alaska

**February 2001 – May 2013** University Research Associate and Adjunct Professor, Centre for Wildlife Ecology, Department of Biological Sciences, Simon Fraser University, British Columbia

**March 1993 - February 2001** Research Wildlife Biologist, Alaska Biological Science Center, Biological Resources Division, U.S. Geological Survey, Anchorage, Alaska

**Relevant Publications:**


**Esler, D.**, B. E. Ballachey, K. A. Trust, S. A. Iverson, J. A. Reed, A. K. Miles, J. D. Henderson, B. W. Wilson, B. R. Woodin, J. R. Stegeman, M. McAdie, and D. M. Mulcahy. 2011. Cytochrome P4501A biomarker indication of the timeline of chronic exposure of Barrow's goldeneye to residual *Exxon Valdez* oil. Marine Pollution Bulletin 62:609-614.

Mulcahy, D. M., and **D. Esler**. 2010. Survival of captive and free-ranging harlequin ducks (*Histrionicus histrionicus*) following surgical liver biopsy. Journal of Wildlife Diseases 46:1325-1329.

**Esler, D.**, K. A. Trust, B. E. Ballachey, S. A. Iverson , T. L. Lewis, D. J. Rizzolo, D. M. Mulcahy, A. K. Miles, B. R. Woodin, J. J. Stegeman, J. D. Henderson, and B. W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the Exxon Valdez oil spill. Environmental Toxicology and Chemistry 29:1138-1145.

Ricca, M. A., A. K. Miles, B. E. Ballachey, J. L. Bodkin, **D. Esler**, and K. A. Trust. 2010. PCB exposure in sea otters and harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. Marine Pollution Bulletin 60:861-872.

Iverson, S. A., and **D. Esler**. 2010. Harlequin duck population dynamics following the 1989 Exxon Valdez oil spill: assessing injury and projecting a timeline to recovery. Ecological Applications 20:1993-2006.

**Esler, D**., and S. A. Iverson. 2010. Female harlequin duck winter survival 11 to 14 years after the *Exxon Valdez* oil spill. Journal of Wildlife Management 74:471-478.

Iverson, S. A., and **D. Esler**. 2006. Site fidelity and the demographic implications of winter movements by a migratory bird, the harlequin duck. Journal of Avian Biology 37:219-228.

Peterson, C. H., S. D. Rice, J. W. Short, **D. Esler**, J. L. Bodkin, B. A. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302:2082-2086.

**Esler, D.**, T. D. Bowman, K. Trust, B. E. Ballachey, T. A. Dean, S. C. Jewett, and C. E. O'Clair. 2002. Harlequin duck population recovery following the Exxon Valdez oil spill: progress, process, and constraints. Marine Ecology Progress Series 241:271-286.

**Esler, D.**, J. A. Schmutz, R. L. Jarvis, and D. M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the Exxon Valdez oil spill. Journal of Wildlife Management 64:839-847.


**Recent Collaborators:**

Laura Agüero, Centro Nacional Patagónico, Puerto Madryn, Argentina
Eric Anderson, British Columbia Institute of Technology, Burnaby, BC
Brenda Ballachey, Alaska Science Center, U.S. Geological Survey, Anchorage, AK

Jeanine Bond, Ducks Unlimited Canada, Surrey, BC
Pablo Garcia Borboraglu, Centro Nacional Patagónico, Puerto Madryn, Argentina
Tim Bowman, U.S. Fish and Wildlife Service, Anchorage, AK
Sean Boyd, Environment Canada, Delta, BC
Matt Burns, Nai Kun Wind Energy Development, Ltd, Vancouver, BC
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Susan De La Cruz, Western Ecological Research Center, U.S. Geological Survey, Vallejo, CA
Joe Evenson, Washington Department of Fish and Wildlife, Olympia, WA
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Jason Schamber, Alaska Department of Fish and Game, Anchorage, AK
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**DANIEL H. MONSON**

Research Wildlife Biologist

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## Education

2009 – PhD, University of California Santa Cruz, Santa Cruz, CA. (Ecology and Evolutionary Biology)

1995 - MS, University of California Santa Cruz, Santa Cruz, CA. (Marine Biology)

1983 - BA, Luther College, Decorah, Iowa (Biology)

## Current Activities

Currently I am the scientific lead within the Alaska Science Center'sCoastal Marine Ecosystem Team, and manage anearshore long-term monitoring program funded through the EVOS trustee counsel. This project utilizes sea otters as an indicator apex predator, and incorporates data on benthic habitat classification, biological and physical oceanography, seabirds and other marine mammals, marine invertebrates, and marine fishes in a multi-disciplinary research effort to monitor change in the nearshore coastal ecosystems of the North Pacific. I am responsible for synthesizing data collected during the development phase of this monitoring program, working with other project PI's to insure the project is productive, and keeping the project focused while integrating short-term value-added research components that address questions arising from the emerging monitoring data sets.

## Selected Publications

Bodkin, J. L., B. E. Ballachey, H. A. Coletti, G. G. Esslinger, K. A. Kloecker, S. D. Rice, J. A. Reed, and D. H. Monson. 2012. Long-term effects of the *Exxon Valdez* oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447: 273-287.

Monson, D. H., D.F. Doak, B.E. Ballachey, and J.L. Bodkin. 2011. Could residual oil from the *Exxon Valdez* spill create a long-term population "sink" for sea otters in Alaska? Ecological Applications 21:2917-2932.

Newsome, S.D., M.T. Tinker, D. Monson, O.T. Oftedal, K. Ralls, M.M. Staedler, M.L. Fogel, and J.A. Estes. 2009. Using stable isotopes to investigate individual diet specialization in California sea otters (*Enhydra lutris nereis*). Ecology 90:961-974.

Newsome, S.D., M.A. Etnier, D.H. Monson, and M.L. Fogel. 2009. Retrospective characterization of ontogenetic shifts in killer whale diets via δ13C and δ15N analysis of teeth. Marine Ecology Progress Series. 374:229-242.

Doak, D.F., J.A. Estes, B.S. Halpern, U. Jacob, D.R. Lindberg, J. Lovvorn, D.H. Monson, M.T. Tinker, T.M. Williams, J.T. Wootton, I. Carroll, M. Emmerson, F. Micheli, and M. Novak. 2008. Understanding and Predicting Ecological Dynamics: Are Major Surprises Inevitable? Ecology 89:952-961.

Bodkin, J.L., D.H. Monson, and G.G. Esslinger. 2007. Population status and activity budgets derived from time-depth recorders in a diving mammal. J. Wildlife Management 71(6):2034-2044.

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

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 of the National Academy of Sciences. 97:6562-6567.

**KATRIN IKEN**

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Phone: (907) 474—5192 E-mail: iken@ims.uaf.edu

PROFESSIONAL PREPARATION:

| | |
|---|---|
| B.A. | University of Düsseldorf, Germany (1987) |
| M.S. | University of Bayreuth, Germany (1991) |
| Ph.D. | Alfred Wegener Institute for Polar and Marine Research, Germany (1995) |

APPOINTMENTS:

| | |
|---|---|
| 2007-present | Associate Professor School of Fisheries and Ocean Sciences, University of Alaska Fairbanks |
| 2002 – 2007 | Assistant Professor, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks |
| 1999 – 2001 | Postdoctoral Research Fellow, University of Alabama at Birmingham |
| 1996 – 1999 | Postdoctoral Research Fellow, Alfred Wegener Institute of Polar and Marine Research |
| 1992 – 1995 | Research Assistant (Graduate Student), Alfred Wegener Institute |
| 1987 – 1991 | Teaching Assistant, University of Bayreuth |

SYNERGISTIC ACTIVITIES:

Development of Curricular Materials (classes not previously offered at UAF)
Antarctic Marine Biology, Marine Chemical Ecology, Macroalgae, Marine Biology & Ecology Field Class, Proposal Writing, Marine Invertebrates Summer Class

Workshop Organizer
Arctic Ocean Diversity Workshop (new Census of Marine Life initiative 2003); Editor for Proceedings Volume from this workshop; PRIMER-e workshop

Web Site Contributions
Contributions to Census of Marine Life NaGISA (Natural Geography In Shore Areas) Program; OBIS (Ocean Biogeographic Database) website on marine biodiversity

Community Outreach
Development of extra-curricular activities for K-12 and community groups, including Alaska Native communities, on marine biology and ecology, including field research

Service to scientific community
Reviewer for peer-reviewed journals (e.g., Polar Biology, Limnology & Oceanography, Progress in Oceanography, Marine Biology, Journal of Experimental Marine Biology and Ecology, etc)
Reviewer for funding agencies (e.g., NSF, NOAA, Sea Grant, NPRB, EVOS, NERC, AAD)
Guest editor Special Issue in Deep-Sea Research II – in press

10 SELECTED PUBLICATIONS (of 55 total):


Iken K, Konar B, Benedetti-Cecchi L, Cruz Motta JJ, Knowlton A, Pohle G, Mead A, Miloslavich P, Wong M, Trott T, Mieszkowska N, Riosmena-Rodriguez R, Airoldi L, Kimani E, Shirayama Y, Fraschetti S, Ortiz-Touzet M, Silva A. 2010. Large-scale spatial distribution patterns of echinoderms in nearshore rocky habitats. *PLoS ONE* 5:e13845.Bluhm, B.A., Iken, K., Mincks, S., Sirenko, B., Holladay, B. (*In press*). Epibenthic community structure in the Chukchi Sea. *Aquatic Research*

Konar B, Iken K, Cruz-Motta JJ, Benedetti-Cecchi L, Knowlton A, Pohle G, Miloslavich P, Edwards M, Trott T, Kimani E, Riosmena-Rodriguez R, Wong M, Jenkins S, Mead A, Silva A, Sousa Pinto I, Shirayama Y. (2010) Global Patterns of Macroalgal Diversity and Biomass in Rocky Nearshore Environments. *PLoS One* 5(10): e13195

Iken K, Bluhm BA, Dunton KH (2009) Benthic food web structure under differing water mass properties in the southern Chukchi Sea. *Deep-Sea Research II* doi:10.1016/j.dsr2.2009.08.007

Iken K, Amsler CD, Amsler MO, McClintock JB, Baker BJ (2009) Field studies on deterrent roles of phlorotannins in Antarctic brown algae. *Botanica Marina* 52: 547-557

Wulff A, Iken K, Quartino ML, Al-Handal A, Wiencke C, Clayton MN (2009) Biodiversity, Biogeography and Zonation of benthic micro- and macroalgae in the Arctic and Antarctic. *Botanica Marina* 52: 491-507

Konar B, Iken K, Edwards M (2009) Depth-stratified community zonation patterns on Gulf of Alaska rocky shores. *Marine Ecology* 30: 63-73

Konar B, Iken K (2009) Influence of taxonomic resolution and morphological functional groups in multivariate analyses of macroalgal assemblages. *Phycologia* 48: 24-31.

Chenelot HA, Iken K, Konar B, Edwards M (2007) Spatial and Temporal Distribution of Echinoderms in Rocky Nearshore Areas of Alaska. In: Rigby P.R. and Shirayama Y. (eds) Selected Papers of the NaGISA World Congress 2006, Publications of the Seto Marine Biological Laboratory, Special Publication Series Vol. VIII. pp 11-28

Iken K (1999). Feeding ecology of the Antarctic herbivorous gastropod *Laevilacunaria antarctica* Martens. *Journal of Experimental Marine Biology and Ecology, 236 (1)*, 133-148.

Iken K, Barrera-Oro ER, Quartino ML, Casaux RJ, Brey T (1997). Grazing in the Antarctic fish

*Notothenia coriiceps*: Evidence for selective feeding on macroalgae. *Antarctic Science, 9 (4),* 386-391.

COLLABORATORS OVER PAST 48 MONTHS

Dr. Charles Amsler (UAB), Dr. Bill Baker (USF), Dr. Bodil Bluhm (UAF), Dr. JJ Cruz-Motta (USB, Venezuela), Dr. Ken Dunton (U Texas), Dr. Matthew Edwards (UCSD), Dr. Nora Foster (UAF), Dr. Rolf Gradinger (UAF), Dr. Russ Hopcroft (UAF), Dr. Max Hoberg (UAF), Dr. Brenda Konar (UAF), Dr. Jim McClintock (UAB), Dr. Patricia Miloslavic (USB, Venezuela), Dr. Gerhard Pohle (HMSC, Canada), Dr. Rafael Riosmena-Rodriguez (UABCS, Mexico), Dr. Yoshihisa Shirayama (Kyoto University, Japan), Dr. Boris Sirenko (ZIN, Russia), Dr. Jonny Stark (AAD, Australia), Dr. Terry Whitledge (UAF), Dr. Christian Wiencke (AWI, Germany)

GRADUATE ADVISORS

MS degree: Dr. Konrad Dettner

PhD degree: Dr. Wolf Arntz (co-advisor), Dr. Tom Brey (co-advisor), Dr. Gunter Kirst (member)

THESIS SPONSOR

Present chair: Tania Spurkland (PhD), Jared Weems (MS), Jamie McKellar (MS), Raphaelle Descoteaux (MS, co-chair), Amy Rath (MS)
Past chair: Heike Lippert (PhD, co-chair), Angela Dubois (MS), Carrie Parris (MS), Megan Murphy (MS), Melissa Deimann (co-chaired MS),
Present committee member: Katharine Miller (PhD), Brenna McConnell (MS), Martin Schuster (MS), Matt Sexson (PhD), Shiway Wang (PhD), Laura Oxtoby (PhD)
Past committee member: Casey Debenham (MS), Reid Brewer (MS), Hector Douglas (PhD), Nick Harman (MS), Jennifer Bump (MS), Melanie Wenzel (MS), Renee Raudonis (MS)

**Brenda Konar**
Professor
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**Academic Preparation**

| | | |
|---|---|---|
| San Jose State University, San Jose, CA | Zoology | B.A. 1986 |
| Moss Landing Marine Laboratories, CA | Marine Sciences | M.S. 1991 |
| University of California, Santa Cruz | Biology | Ph.D. 1998 |

**Appointments**

2009- PRESENT: Professor, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks (UAF).
2004-2009: Associate Professor, School of Fisheries and Ocean Sciences, UAF.
2006-PRESENT: Science Director, Kasitsna Bay Laboratory. UAF.
2004-2006: Interim Lab Director, Kasitsna Bay Laboratory. UAF.
2000 to 2004: Assistant Professor, School of Fisheries and Ocean Sciences, UAF.
1999 to 2000: Research Assistant Professor, School of Fisheries and Ocean Sciences, UAF.
1999 to PRESENT: Staff Scientist for the West Coast and Polar Regions National Undersea Research Center.

**Current Activities**

*Education & Outreach:*

Arctic: Biodiversity in the Arctic Workshop. 10-14 April 2003. Fairbanks Alaska. Workshop Organizer.

Proceedings: Iken K and B Konar (eds.) 2003. Proceedings of the Arctic Biodiversity Workshop: New Census of Marine Life Initiative. Alaska Sea Grant College Program, University of Alaska Fairbanks, M-26, Fairbanks. 162pp.

Cold Water Diving: Current chair of the University of Alaska's Diving Control Board and board member of the national American Academy of Underwater Sciences. Also instructor of Cold Water Diving and Scientific Diving at the University of Alaska Fairbanks

Field sampling: Invited speaker at the Through-ice Sampling Workshop. 7 November 2007. Fairbanks Alaska. Sponsored by the Minerals Management Service.

Statistical: Co-organizer for the Primer-e Statistical Package Workshop. 27 August-1 September 2007. Fairbanks Alaska.

*Development of Curricular Materials:*

Field Topics in Marine Biology, Kelp Forest Ecology, and several seminars including Macroalgae, Controversies in Science, and Professional Development

*Committee examples:*

International: Natural Geography Inshore Areas (NaGISA) Steering Committee (current co-PI)
National: National Research Council Study Committee for the North Pacific Research Board (past)
State: Kachemak Bay National Research Reserve Advisory Council (current)
University-wide: Faculty Senate (current)
Department-wide: Marine Biology Tenure & Promotion committee (past chair)

*Examples of Outreach:*

K-12 presentations at 15 different schools, Alaska native community presentations at 10 different communities in Alaska, multiple media interactions

*Reviewer History:*

Multiple papers and proposals for various peer-reviewed journals and funding agencies

**Ten Relevant Publications**


Daly B and B Konar. In Press. Temporal trends in nearshore juvenile and adult crab populations in different habitats. Crustaceana.

Konar, B, K Iken and M Edwards. 2009. Depth-stratified community zonation patterns on Gulf of Alaska rocky shores. Marine Ecology 30:63-73.

Konar B and K Iken. 2009. Influence of taxonomic resolution and morphological functional groups in multivariate analyses of macroalgal populations. Phycologia 48:24-31.

Daly B and B Konar. 2008. Effects of macroalgal structural complexity on nearshore larval and post-larval crab composition. Marine Biology 153:1055-1064.

Coyle K.O., B.A. Bluhm, B. Konar, A.L. Blanchard and R.C. Highsmith. 2007. Amphipod prey of gray whales in the northern Bering Sea: comparison of biomass and distribution between the 1980s and 2002 - 2003. Deep Sea Research II 54: 2906-2918.

Hamilton, J. and B. Konar. 2007. The influence of kelp variability and substrate complexity on northern nearshore fish abundance. Fishery Bulletin 105:189-196.

Konar, B. 2007. Recolonization of a high latitude hard-bottom nearshore community. Polar Biology 30:663-667.

Konar B and K Iken. 2005. Competitive dominance among sessile marine organisms in a high arctic boulder community. Polar Biology 29:61-64.

Konar B, R Riosmena-Rodriguez and K Iken. 2006. Rhodolith bed: a newly discovered habitat in the North Pacific. Botanica Marina 49:355-359.

Konar, B and Estes, JA. 2003. The stability of boundary regions between kelp beds and deforested areas. Ecology 84: 174-185.

**Collaborators in the last 48 months**

Dr. Lisandro Benedetti-Cecchi (University of Pisa, Italy)
Dr. Lee Cooper (University of Tennessee)
Dr. Juan J. Cruz (Simon Bolivar University, Venezuela)
Dr. Ken Dunton (University of Texas)
Dr. Matt Edwards (San Diego State University)
Dr. James Estes (University of California Santa Cruz)
Dr. Jackie Grebmeier (University of Tennessee)
Dr. Katrin Iken (University of Alaska Fairbanks)
Dr. Tohru Iseto (Seto Marine Biological Lab, Kyoto University, Japan)
Dr. Edward Kimani (Kenya Marine and Fisheries Research Institute, Mombassa)
Dr. Ann Knowlton (University of Alaska Fairbanks)
Dr. Patricia Miloslavich (Simon Bolivar University, Venezuela)
Dr. Gerhard Pohle (The Huntsman Marine Science Centre, Canada)
Dr. Yoshihisa Shirayama (Seto Marine Biological Lab, Kyoto University, Japan)
Dr. John Trefry (Florida Institute of Technology)

**Thesis Sponsor**

Present Chair: Martin Schulster (MS), Alexandra Ravelo (MS), Steven Savard (MS), Nathan Stewart (PhD), Terril Efird (MS), Amy Tippery (MS)
Past Chair: Melissa Deiman (MS), Brooke McFarland (MS), Tracie Merrill (MS), Joel Markis (MS), Benjamin Daly (MS), Casey Debenham (MS), Heather Patterson (MS), Judith Hamilton (MS), Heloise Chenelot (MS), Catherine Hegwer (MS), Reid Brewer (MS)
Present committee member: Tania Spurkland (PhD), Benjamin Daly (PhD)
Past committee member: Seanbob Kelly (MS), Arny L Blanchard (PhD), Angela Dubois (MS), Christine Frazier (MS). Eloise Brown (MS), Ann L Knowlton (PhD).

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**Education:**

2000 Ph.D. Wildlife Science. Oregon State University, Corvallis, Oregon, USA.
1988 M.Sc. Wildlife Ecology. Texas A&M University, College Station, Texas, USA.
1985 B.Sc. Biology/Outdoor Education. Northland College, Ashland, Wisconsin, USA.

**Professional Experience:**

**August 2013 – present** Project Leader and Research Wildlife Biologist, Nearshore Marine Research Group, Alaska Science Center, U.S. Geological Survey, Anchorage, Alaska

**February 2001 – May 2013** University Research Associate and Adjunct Professor, Centre for Wildlife Ecology, Department of Biological Sciences, Simon Fraser University, British Columbia

**March 1993 - February 2001** Research Wildlife Biologist, Alaska Biological Science Center, Biological Resources Division, U.S. Geological Survey, Anchorage, Alaska

**Relevant Publications:**


**Esler, D.**, B. E. Ballachey, K. A. Trust, S. A. Iverson, J. A. Reed, A. K. Miles, J. D. Henderson, B. W. Wilson, B. R. Woodin, J. R. Stegeman, M. McAdie, and D. M. Mulcahy. 2011. Cytochrome P4501A biomarker indication of the timeline of chronic exposure of Barrow's goldeneye to residual *Exxon Valdez* oil. Marine Pollution Bulletin 62:609-614.

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Ricca, M. A., A. K. Miles, B. E. Ballachey, J. L. Bodkin, **D. Esler**, and K. A. Trust. 2010. PCB exposure in sea otters and harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. Marine Pollution Bulletin 60:861-872.

Iverson, S. A., and **D. Esler**. 2010. Harlequin duck population dynamics following the 1989 Exxon Valdez oil spill: assessing injury and projecting a timeline to recovery. Ecological Applications 20:1993-2006.

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Iverson, S. A., and **D. Esler**. 2006. Site fidelity and the demographic implications of winter movements by a migratory bird, the harlequin duck. Journal of Avian Biology 37:219-228.

Peterson, C. H., S. D. Rice, J. W. Short, **D. Esler**, J. L. Bodkin, B. A. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302:2082-2086.

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**Esler, D.**, J. A. Schmutz, R. L. Jarvis, and D. M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the Exxon Valdez oil spill. Journal of Wildlife Management 64:839-847.


**Recent Collaborators:**

Laura Agüero, Centro Nacional Patagónico, Puerto Madryn, Argentina
Eric Anderson, British Columbia Institute of Technology, Burnaby, BC
Brenda Ballachey, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
Jeanine Bond, Ducks Unlimited Canada, Surrey, BC
Pablo Garcia Borboraglu, Centro Nacional Patagónico, Puerto Madryn, Argentina
Tim Bowman, U.S. Fish and Wildlife Service, Anchorage, AK
Sean Boyd, Environment Canada, Delta, BC
Matt Burns, Nai Kun Wind Energy Development, Ltd, Vancouver, BC
Rob Butler, Bird Studies Canada, Delta, BC

Susan De La Cruz, Western Ecological Research Center, U.S. Geological Survey, Vallejo, CA
Joe Evenson, Washington Department of Fish and Wildlife, Olympia, WA
Tuula Hollmén, Alaska SeaLife Center, Seward, AK
Jerry Hupp, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
Sam Iverson, Environment Canada and Carleton University, Ottawa, ON
Tyler Lewis, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
Malcolm McAdie, Ministry of the Environment, Nanaimo, BC
Keith Miles, Western Ecological Research Center, U.S. Geological Survey, Davis, CA
Dan Mulcahy, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
Dave Nyeswander, Washington Department of Fish and Wildlife, Olympia, WA
Mark Ricca, Western Ecological Research Center, U.S. Geological Survey, Davis, CA
Dan Rizzolo, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
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Jason Schamber, Alaska Department of Fish and Game, Anchorage, AK
Joel Schmutz, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
John Takekawa, Western Ecological Research Center, U.S. Geological Survey, Vallejo, CA
Jonathan Thompson, Ducks Unlimited Canada, Edmonton, AB
David Ward, Alaska Science Center, U.S. Geological Survey, Anchorage, AK
Tony Williams, Simon Fraser University, Burnaby, BC
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**BRENDA E. BALLACHEY**
Research Physiologist, Sea Otter Project/Coastal Ecosystem Team
U.S. Geological Survey, Alaska Science Center
4210 University Drive, Anchorage, Alaska 99508
Phone: (907)748-4347
Email: bballachey@usgs.gov

**Education**

Oregon State University, Corvallis, Oregon - Ph.D., 1985
Colorado State University, Fort Collins, Colorado - M.S., 1980
Colorado State University, Fort Collins, Colorado - B.S. with distinction, 1974

**Professional Experience**

**Research Physiologist,** Alaska Biological Science Center, USGS, Anchorage, AK,
July 1990 to present (formerly National Biological Service; Fish & Wildlife Service)
**General Biologist,** Alaska Fish and Wildlife Research Center, USFWS, Anchorage, AK,
November 1989 to July 1990
**Staff Officer,** Board on Agriculture, National Research Council (NRC), Washington, DC, USA,
March 1987 to November 1989

**Current Activities**

Research Physiologist with the Alaska sea otter research project and the coastal ecosystems team of the Alaska Science Center, USGS. Supervise and manage activities associated with research projects internal to the Alaska Science Center; collaborate with several agencies, academic and private institutions on cooperative, multi-disciplinary projects. In addition to sea otters, research program includes nearshore marine monitoring, benthic habitat classification, biological and physical

oceanography, seabirds and other marine mammals, marine invertebrates, and marine fishes. A major focus of research for the past two decades has been identification and understanding of long-term population and ecosystem level effects of petroleum contaminants in the nearshore marine environment, addressing species and ecosystems of high interest to the U.S. Department of the Interior. This work now continues in the form of the Gulf Watch Alaska project, a long-term monitoring project funded by the EVOS Trustee Council.

**Recent Publications**


**Ballachey**, B.E., J.L. Bodkin and D.H. Monson. 2013. Quantifying long-term risks to sea otters from the 1989 'Exxon Valdez' oil spill: Reply to Harwell & Gentile (2013). Marine Ecology Progress Series 488: in press.

**Ballachey**, B.E., J.L. Bodkin, S. Howlin, A.M. Doroff and A.H. Rebar. 2003. Survival of juvenile sea otters in Prince William Sound, Alaska, 1992-93. Cdn. Jnl. Zoology

Bodkin, J.L. and B.E. **Ballachey**. 2010. Modeling the effects of mortality on sea otter populations. Scientific Investigations Report 2010-5096. U.S. Geological Survey. 12 p.

Bodkin, J.L B.E. **Ballachey**, H.A. Coletti, G. G.Esslinger, K.A. Kloecker, S.D. Rice, J. A. Reed, and D. H. Monson. 2012. Long-term effects of the *Exxon Valdez* oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447:273-287.

Bodkin, J.L., B.E. **Ballachey**, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. 2002. Recovery of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Mar. Ecol. Prog. Ser. 241:237-253.

Bodkin, J.L., **Ballachey**, B.E., and Esslinger, G.G. 2011. Trends in sea otter population abundance in western Prince William Sound, Alaska: Progress toward recovery following the 1989 *Exxon Valdez* oil spill. U.S. Geological Survey Scientific Investigations Report 2011–5182, 14 p.

Bowen, L. A.K. Miles, M. Murray, M. Haulena, J. Tuttle, W. Van Bonn, L. Adams, J.L. Bodkin, B.E. **Ballachey**, M. T. Tinker, R. Keister, and J.L. Stott. 2012. Gene Transcription in Sea Otters (*Enhydra lutris*); Development of a diagnostic tool for sea otter and ecosystem health. Molecular Ecology Resources12: 67-74

Esler, D., K.A. Trust, B.E. **Ballachey**, S.A. Iverson, T.L. Lewis, D.J. Rizzolo, D.M. Mulcahy, A.K. Miles, B.R. Woodin, J.J. Stegeman, J.D. Henderson, and B.W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the *Exxon Valdez* oil spill. Environ Toxicol Chem 29(5):1138-1145.

Miles , A.K., L Bowen, B E. **Ballachey**, J.L. Bodkin, M. Murray, J.A. Estes, R.A. Keister and J.L. Stott. 2012. Gene transcription in sea otters (*Enhydra lutris*) two decades post *Exxon Valdez*. Marine Ecology Progress Series 451:201-212.

Monson, D.H., D.F. Doak, B.E. **Ballachey** and J.L. Bodkin. 2011. Could residual oil from the *Exxon Valdez* spill create a long-term population "sink" for sea otters in Alaska? Ecological Applications. 21(8)2917–2932.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. **Ballachey**, and D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086.

**Recent Collaborators**

Bodkin, James, USGS ASC; Bowen, Lizbeth, UC Davis, CA; Coletti, Heather, NPS, Anchorage; Esslinger, George, USGS ASC; Dean, Thomas, Coastal Resources Associates, San Diego; Doroff, Angela, AK Dept of Fish and Game, Homer; Esler, Dan, Simon Fraser University, Victoria, BC; Estes, James, University of California, Santa Cruz; Holdried, Kris, NOAA Kasitsna Bay Lab; Hoffman, Katrina, PWSSC, Cordova; Howlin, Shay, West Ecosystems Technology, Cheyenne, WY; Kloecker, Kim, USGS ASC; Irons, David, USFWS, Anchorage; Larson, Shawn, Seattle Aquarium; Lipscomb, T., DVM. Diplomate ACVP; Lindeberg, Mandy, NOAA Auk Bay Lab; Matkin, Craig, North Gulf Oceanographic Society; McCammon, Molly, AOOS, Anchorage; Michel, Jackie, Research Planning; Miles, A. Keith, USGS WERC; Mohr, F. Chuck, UC Davis; Murray, Mike, Monterey Bay Aquarium; Newsome, Seth, University of Wyoming; Nixon, Zach, Research Planning; Rice, Jeep, NOAA Auk Bay Lab; Staedler, Michelle, Monterey Bay Aquarium, Saupe, Sue, CIRCAC; Speckman, Suzann, USFWS; Tinker, Tim, USGS & University of California, Santa Cruz; Von Biela, Vanessa, USGS ASC; Weitzman, Ben, USGS WERC. (Note: full listing of Gulf Watch Alaska PI's not given here; available upon request).

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**Education**

M.Sc., 1978, biological oceanography, Dalhousie University, Halifax, Nova Scotia.
B.A., 1975, biology; Magna cum laude, Gustavus Adolphus College, St. Peter, Minnesota.
Additional coursework (30 semester hours), University of Alaska Southeast (statistics, genetics, fish, and misc)

**Professional Experience**

Supervisory Chemist, 2009 – present, Auke Bay Laboratory. Fisheries Biologist, 1979-2009, Auke Bay Laboratory

Principal Investigator for *Exxon Valdez* Oil Spill Trustee Council

- Embryo toxicity: pink salmon, Pacific herring, zebrafish
- Herring Synthesis
- Pink salmon habitat
- Mussel and sediment contamination
- Hydrocarbon chemistry: sampling, interpretation, modeling

Biological Review Teams

- Pacific herring, Lynn Canal, Alaska (chairman)

- Status of Pacific herring in Puget Sound, Washington

Habitat and Ecological Processes Team

**Recent publications**


Jung J-H, Hicken CE, Boyd D, Anulacion BF, Carls MG, Shim WJ, Incardona JP. 2013. Geologically distinct crude oils cause a common cardiotoxicity syndrome in developing zebrafish. Chemosphere 91:1146-1155.

Nahrgang J, Camus L, Carls MG, Gonzalez P, Jonsson M, Taban IC, Bechmann RK, Christiansen JS, Hop H. 2010. Biomarker responses in polar cod (Boreogadus saida) exposed to the water soluble fraction of crude oil. Aquatic Toxicology 97:234-242.

Carls MG, Thedinga J.F. 2010. Exposure of pink salmon embryos to dissolved polynuclear aromatic hydrocarbons delays development, prolonging vulnerability to mechanical damage. Marine Ecology Research 69:318-325

Carls MG, Meador JP. 2010. A perspective on the toxicity of petrogenic PAHs to developing fish embryos related to environmental chemistry. Human and Ecological Risk Assessment 15:1084-1098.

Carls MG, Holland L, Larsen M, Collier TK, Scholz NL, Incardona JP. 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic Toxicology 88:121-127.

Carls MG, Rice SD. 2007. Fish embryo sensitivity and PAH toxicity. In: Anyakora C (ed), "Environmental impact of polynuclear aromatic hydrocarbons," Research Signpost, Kerala, India, pp. 159-190.

Carls, M.G. 2006. Nonparametric identification of petrogenic and pyrogenic hydrocarbons in aquatic ecosystems. Environ Sci Technol. 40:4233-4239.

Carls MG, Heintz RA, Marty GD, Rice SD. 2005. Cytochrome P4501A induction in oil-exposed pink salmon *Oncorhynchus gorbuscha* embryos predicts reduced survival potential. Mar Ecol Prog Ser. 301:253-265.

Carls, M.G., S.D. Rice, G.D. Marty, and D.K. Naydan. 2004. Pink salmon spawning habitat is recovering a decade after the *Exxon Valdez* oil spill. Trans Am Fish Soc 133:834-844.

Carls MG, LG Holland, JW Short, RA Heintz, SD Rice. 2004. Monitoring polynuclear aromatic hydrocarbons in aqueous environments with passive … devices. Environ Toxicol Chem 23:1416-1424.

Carls MG., PM Harris, SD Rice. 2004. Restoration of Oiled Mussel Beds… Mar. Environ. Res. 57:359-376.

Carls MG, Thomas RE, Rice SD. 2003. Mechanism for transport of oil-contaminated water into pink salmon redds. Mar. Ecol. Prog. Ser. 248:245-255.

Carls MG, GD Marty, JE Hose. 2002. Synthesis of the toxicological impacts of the *Exxon Valdez* oil spill on Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska, U.S.A. Can. J. Fish. Aquat. Sci. 59:1-20.


**Collaborators** (excluding ABL staff):

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1990- present: Mandy has been involved in oil spill research and nearshore habitat studies throughout Alaska's coastline. Her research includes oil spill studies on intertidal invertebrates, fish, seaweeds, and long-term persistence of oil in Prince William Sound. Mandy is now part of the Gulf Watch Alaska Program serving as Pelagic Component Lead and co-Principle Investigator for the Benthic component. She has been participating in the Alaska *ShoreZone* habitat mapping project and essential fish habitat projects of nearshore forage fish throughout the state. Her expertise lies with coastal ecology and specializes in the taxonomy and ecology of seaweeds. All of these studies have enabled her to develop a unique knowledge of Alaskan coastal habitats.

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**Publications:**

Johnson, S. W., A. D. Neff, J. F. Thedinga, M. R. Lindeberg, and J. M. Maselko. 2012. Atlas of nearshore fishes of Alaska: A synthesis of marine surveys from 1998 to 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-239, 261 p.

Lindeberg, M.R. and S.C. Lindstrom. 2010. Field Guide to Seaweeds of Alaska. Alaska Sea Grant College Program, University of Alaska Fairbanks, 192 p.

Johnson, S.W., J. F. Thedinga, A. D. Neff, P. M. Harris, M. R. Lindeberg, J. M. Maselko, and S. D. Rice. 2010. Fish assemblages in nearshore habitats of Prince William Sound, Alaska. Northwest Science 84:266-280.

Stickle, W. B., M. Lindeberg, Rice, S.D. 2010. Seasonal freezing adaptations of the mid-intertidal gastropod Nucella lima from southeast Alaska. Journal of Experimental Marine Biology and Ecology395(1-2): 106-111.

Kawai, H., T. Hanyuda, M.R. Lindeberg, and S.C. Lindstrom. 2008. Morphology and molectular phylogeny of *Aureophycus aleuticus* gen. et sp. Nov. (Laminariales, Phaeophyceae) from the Aleutian Islands. J. of Phycol. 44:1013-1021.

Springman, K. R., J. W. Short, M. R. Lindeberg, J. M. Maselko, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part 1 – Induction of CYP1A in rainbow trout from contaminants in Prince William Sound, Alaska. Mar. Environ. Res. 66:477-486.

Short, J. W., K. R. Springman, M. R. Lindeberg, L. G. Holland, M. L. Larsen, C. A. Sloan, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part II – A comparison of lingering Exxon Valdez oil with other potential sources of CYP1A inducers in Prince William Sound, Alaska. Mar. Environ. Res. 66:487-498.

Springman, K. R., J. W. Short, M. Lindeberg, and S. D. Rice. 2008. Evaluation of bioavailable hydrocarbon sources and their induction potential in Prince William Sound, Alaska. Mar. Environ. Res. 66:218-220.

Thedinga, J. F., S. W. Johnson, A. D. Neff, and M. Lindeberg. 2008. Fish assemblages in shallow nearshore habitats of the Bering Sea. Transactions of the American Fisheries Society. 137:1157-1164.

Short J.W.., G. V. Irvine, D. H. Mann, J. M. Maselko, J. J. Pella, M. R. Lindeberg, J. R. Payne, W. B. Driskell, and S. D. Rice. 2007. Slightly weathered Exxon Valdez oil persists in Gulf of Alaska beach sediments after 16 years. Environ. Sci. Technol. 41:1245-1250.

Thomas, R.E., M. R. Lindeberg, Patricia M. Harris, and Stanley D. Rice. 2007. Induction of DNA Strand Breaks in the Mussel (*Mytilus trossulus*) and Clam (*Protothaca staminea*) Following Chronic Field Exposure to Polycyclic Aromatic Hydrocarbons from the Exxon Valdez Spill. Marine Pollution Bulletin. 54: 726-732.

Short, J.W., J.M. Maselko, M.R. Lindeberg, P.M Harris, and S.D. Rice. 2006. Vertical distribution and probability of encourntering intertidal *Exxon Valdez* oil on shorelines of three embayments within Prince William Sound, Alaska. Environ. Sci. and Technol. Vol. 40, 3723-3729.

Payne, J.R., W.B. Driskell, M.R. Lindeberg, W. Fournier, M.L. Larsen, J.W. Short, S.D. Rice, and D. Janka. Dissolved- and particulate-phase hydrocarbons in interstitial water from Prince William Sound intertidal beaches containing buried oil thirteen years after the Exxon Valdez Oil Spill. 2005 International Oil Spill Conference, American Petroleum Institute.

Short, Jeffrey W., M. R. Lindeberg, Patricia M. Harris, J. Maselko, Jerome J. Pella, and S.D. Rice. 2004. An estimate of oil persisting on beaches of Prince William Sound, 12 years after the *Exxon Valdez* oil spill. Environ. Sci. and Technol. Vol 38: 19-25.

Short, Jeffrey W., M. R. Lindeberg, Patricia M. Harris, Jacek Maselko, and Stanley D. Rice. 2002. Vertical oil distribution within the intertidal zone 12 years after the *Exxon Valdez* oil spill in Prince William Sound, Alaska. Pp. 57-72 In: Proceedings of the Twenty-fifth Arctic and Marine Oilspill Program (AMOP) Technical Seminar. Environment Canada, Ottawa, Ontario.

Charles E. O'Clair, M. R. Lindeberg, and Joshua Millstein. 2001. "Mesoscale differences in mussel, Mytilus trossulus, population structure in Prince William Sound, Alaska in relation to oiling history and predation intensity." Journal of Experimental Marine Biology and Ecology. 262:155-176.

Highsmith, Raymond C., Rucker, T.L., Stekoll, M.S., Saupe, S.M., Lindeberg, M.R., Jenne, R.N., Erickson, W.P. 1996. Impact of the *Exxon Valdez* Oil Spill on Intertidal Biota. American Fisheries Society Symposium 18:212-237.