1. Project Number:

14120114 and 14120120

2. Program Title: *See,* Reporting Policy at III (D) (2).

Gulf Watch Alaska

3. Program Lead Name(s): *See,* Reporting Policy at III (D) (3).

M. McCammon, K. Holderied, K. Hoffman

4. Time Period Covered by the Summary: *See,* Reporting Policy at III (D) (4).

February 1, 2015 to January 31, 2016

5. Date of Summary: *See,* Reporting Policy at III (D) (5).

March 1, 2016

6. Program Website (if applicable): *See,* Reporting Policy at III (D) (6).

www.gulfwatchalaska.org

7. Overview of Work Performed during the Reporting Period: *See,* Reporting Policy at III (D) (7).

PROGRAM INTRODUCTION

The overarching goal of the Gulf Watch Alaska (GWA) long-term monitoring program 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. This report describes work completed in year four of the first five-year period of the ecosystem monitoring program in the spill-affected region.

The long-term monitoring program has six main objectives:

1) Sustain and build upon existing time series of data collected in Prince William Sound, lower Cook Inlet and adjacent Gulf of Alaska coast.
2) Provide scientific data, data products and outreach to management agencies and a wide variety of users.
3) Develop improved monitoring for certain spill-affected species and ecosystems.
4) Develop science synthesis products to assist management actions, inform the public, and guide the evolution of monitoring priorities for the next 20 years.
5) Enhance connections between, and integration of, monitoring projects and within the GWA and Herring Research and Monitoring (HRM) programs.
6) Leverage partnerships with outside agencies and groups to integrate data from a broader monitoring effort than that funded by the Trustee Council.

The GWA program is composed of integrated program management, data management services, science synthesis, conceptual modeling, and outreach efforts (five projects), as well as the 15 ecosystem monitoring projects. Field sampling for most projects occurs each year, with the exception of the projects noted below. The program is structured into the following components, with the responsible entities for each project shown. For reader clarity, this report will follow this structure with heading titles adhering to the guidelines for contents in Section III. Annual Project Reports and Annual Status Summaries in EVOSTC Reporting Policy and reporting templates revised 1.13.2014.

Integrated program management, data management services, outreach, science synthesis and modeling

- Program coordination and logistics – Prince William Sound Science Center (PWSSC) and Alaska Ocean Observing System (AOOS)
- Outreach - AOOS
- Data management (and supplemental data management)–AOOS/Axiom Consulting
- Historical data management and synthesis – National Center for Ecological Assessment and Synthesis (NCEAS)
- Science coordination and synthesis – National Oceanic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory (KBL)
- Conceptual ecological modeling– Alaska Sea Life Center (ASLC)

Environmental drivers monitoring component

- Gulf of Alaska mooring (GAK1) monitoring – University of Alaska Fairbanks (UAF)
- Seward line monitoring – UAF
- Oceanographic conditions in Prince William Sound – PWSSC
- Oceanographic monitoring in Cook Inlet – University of Alaska Anchorage (UAA)-Kachemak Bay National Estuarine Research Reserve (KBNERR) and NOAA KBL
- Continuous plankton recorder –Sir Alister Hardy Foundation for Ocean Science (SAHFOS)

Pelagic monitoring component

- Ability to detect trends in nearshore marine birds – U.S. National Park Service (USNPS) Southwest Alaska inventory and monitoring Network (SWAN)
- Long-term killer whale monitoring – North Gulf Oceanic Society (NGOS)
- Humpback whale predation on herring – NOAA National Marine Fisheries Service (NMFS) Auke Bay Laboratory
- Forage fish distribution and abundance – U. S. Geological Survey (USGS) Alaska Science Center
- Prince William Sound marine bird surveys – U.S. Fish and Wildlife Service (USFWS)
- Seabird abundance in fall and winter –PWSSC

Benthic monitoring component

- Nearshore benthic systems in the Gulf of Alaska – USGS Alaska Science Center/ USNPS SWAN, Coastal Resources Associates
- Ecological Communities in Kachemak Bay – UAF

Lingering oil component

- EVOS oil exposure of harlequin ducks and sea otters, completed project – USGS Alaska Science Center
- Oil level and weathering tracking – NOAA/NMFS Auke Bay Laboratory

Summary of Work Completed

Progress toward objectives

Work within the GWA long-term ecosystem monitoring program during this year has focused on execution of the monitoring projects, coordinating and communicating findings from the monitoring work under the Pacific warm water anomaly, development of a special journal issue to be published jointly between the HRM and GWA programs, updating and adding to program outreach information and products, preparing proposals, discussing program changes for the FY2017-2021 Invitation, and preparation and presentation of materials for multiple science conferences. In addition, program principal investigators (PIs) planned and attended the annual meeting, held jointly with the HRM team, developed year 5 proposals, attended the EVOS Trustee Council (EVOSTC) and Public Advisory Committee meetings, and attended the 2016 Alaska Marine Science Symposium (AMSS). We continued to work collaboratively both within the GWA program and with HRM program investigators to integrate data for analyses and demonstrate linkages between various projects within and between both programs. Program investigators also continue to revise and improve the program website, develop new outreach tools such as virtual field trips and a program You Tube video page, and improve data access and develop data visualization tools. Program administration and management has proceeded as expected during this year.

Specific accomplishments related to the program objectives include:

Objective 1. Sustain and build upon existing time series in Prince William Sound, lower Cook Inlet and adjacent Gulf of Alaska coast.

- Successfully completed all planned field work for all projects this year. QA/QC. (For specific milestones accomplished by project, see Individual project reports provided separately.)

- Continued to add to data sets available on the GWA Ocean Workspace; completed metadata for all projects; and published data through the AOOS Gulf of Alaska data portal for both historic and ongoing work.

Objective 2. Provide scientific data, data products and outreach to management agencies and a wide variety of users.

- Continued to improve the program website (www.gulfwatchalaska.org), including adding a You Tube channel with available video, plus additional photos, presentations, and reports.
- Continued to improve tools for describing and publishing data to the AOOS Gulf of Alaska data portal, including completing one-on-one editing sessions with GWA PIs and data management staff members. Additionally, developed a prototype for data visualization using the humpback whale project data and the herring spawn information from ADFG to verify hypothetical relationships.
- Provided outreach workshops and seminars at public events in Cordova, Seward, and Homer.
- PIs gave multiple presentations and posters at scientific conferences (see individual project reports). Science Coordinator, Dr. Tammy Hoem Neher, presented GWA program summaries at the Kachemak Bay Science Conference, National American Fisheries Society Conference, National Coastal and Estuarine Research Federation conference, the Gulf of Mexico Research Initiative Oil Spills and Ecosystems Conference (in conjunction with Dr. Scott Pegau for HRM and Dr. Daniel Esler for the Lingering Oil component), and at AMSS.

Objective 3. Develop improved monitoring for certain species and ecosystems.

- Worked across projects, components, and programs to develop recommendations for cost efficient approaches for pelagic species monitoring (methods to be detailed in several project proposals for the next five year GWA program to be submitted in response to the FY 2017-2021 Invitation).

Objective 4. Develop science synthesis products to assist management actions, inform the public and guide the evolution of monitoring priorities for the next 20 years.

- We are currently working with Deep Sea Research II to provide a joint HRM and GWA program special issue; paper submission to begin in July 2016 with final issue completed spring 2017.

- Data management team worked to develop prototype of visualization of data for humpback whales, herring, and environmental drivers and demonstrated to GWA program members.

Objective 5. Enhance connections between and integration of monitoring projects and between the GWA and Herring Research and Monitoring (HRM) program.

- Worked closely with the HRM program lead to plan joint program annual meeting and develop joint special issue plan and time frame
- Facilitated collaborative monitoring activities including sharing of data, vessel time, and aerial survey time between GWA and HRM projects.

Objective 6. Leverage partnerships with outside agencies and groups to integrate data from a broader monitoring effort than that funded by the Trustee Council.

- Worked with NOAA National Centers for Coastal and Ocean Science (NCCOS) and Aleutian Pribilof Islands Association to collect and disseminate information for harmful algae monitoring results and testing.
- Continued partnerships with vessels of opportunity projects (Bishop, Batten, Kuletz).
- Worked with agency and North Pacific Research Board (NPRB) program scientists to share information and address parallel goals.
- Worked within the AOOS framework to incorporate information and modeling from the entire Gulf of Alaska region to the program data portal.
- Through NCEAS working group members, worked to compile and examine historic data for patterns and trends; shared information between programs and working groups.

Deliverable/Milestone	Status
Conduct project field data collection surveys	Completed.
Submit annual work plan for review	Completed September 1.
Conduct annual program meeting and periodic conference calls/ short meetings to coordinate administrative needs and provide forum for collaboration	Completed May, August, and November of 2015 and January 2016 at AMSS.
Present program information at AMSS	PIs presented 16 papers and 14 posters at nine national and international meetings, of which 5 papers and 13 posters were presented at AMSS
Complete annual report	Completed.

Noteworthy Issues and Findings within Program

One of the greatest advantages of the GWA program is that the monitoring occurs across trophic levels, ecosystems, across a broad spatial range, and integrates multiple disciplines to help us understand relationships and patterns. This becomes more apparent when comparing systems under stressors such as the northeast Pacific warm water anomaly that is currently being experienced across the Gulf of Alaska. Through the projects in the GWA program, we have observed:

Environmental Drivers: Substantial increases in water temperatures throughout the water column, up to three degrees Celsius more than the 15 year average in some places. In concert, we have observed decreases in surface salinity and increases in water column stratification.

Considering these environmental changes, we can predict some broad scale ecosystem effects, including:

- thermal stress in cold water adapted species;
- changes in plankton community composition and nutritive values;
- changes in magnitude and timing of plankton blooms.

Our observations support these predictions as we did, indeed, observe:

- changes in plankton community across the northcentral Gulf of Alaska, with increases in smaller, warm-water preferring zooplankton species and decreases in large, lipid dense copepods. We also saw changes in diatom community with increases in long-bodied organisms favored in low nutrient conditions and very low abundances of diatoms in 2014-2015 compared to previous years;
- increases in harmful algal blooms that resulted in shellfish closures.

We observed shifts in upper trophic level species distributions, and increases in illness and unusual mortality events both from within the program and within the communities where monitoring projects are based, these included:

- Shifts in distribution and behavior of humpback whales indicating a shift in herring prey;
- Unusual behavior in killer whales indicating abundance of adult or near adult salmon coho and Chinook salmon prey (not necessarily due to higher numbers but possibly due to migration pattern shifts into normal feeding areas);
- An absence of capelin and other sensitive forage fishes and life stages (i.e., no age-0 Pollock captured);
- Increases in sea-star wasting disease, documented throughout the Gulf of Alaska in 2015, whereas only one case had been reported in 2014;
- Multiple unusual mortality events in upper trophic levels, including several species of great whales, seabirds, and sea otters;
- Necropsies suggested that the mortalities could be due to multiple stresses, including metabolic stress, low prey, and impacts from algal toxins.

This information further emphasized the value of the long-term monitoring work in understanding the effects of the EVOS to injured resources in the context of ecological changes induced by climate, weather, and ecological drivers. The program continues as proposed, with minor changes made with approval of EVOSTC staff and Trustees. The following summarizes noteworthy issues and findings for each project.

PROGRAM COORDINATION AND LOGISTICS – HOFFMAN (PWSSC, 12120114-B)

PWSSC issued and managed sub-award contracts for all non-Trustee Agency GWA Year 4 projects. We remunerated sub-awardees based on demonstrated expenses, tracked spending, and initiated our annual audit in December 2015. We continued the contract with Marilyn Sigman (UAF) to support outreach programming and coordination. We provided outreach funding as directed by McCammon and the outreach steering committee. Semi-annual program reports (to NOAA) and the Year 5 EVOSTC work plans were submitted on time. We held quarterly PI meetings: two by phone; the other two were held in person at AMSS and at the annual PI meeting in Anchorage from November 16-18, 2015. PWSSC coordinated logistics and processed expenses for both of the aforementioned in-person meetings. The fall meeting was coordinated in collaboration with the EVOSTC-funded HRM program to enable cross-component and cross-program collaboration. We submitted all financial reporting requirements as required.

OUTREACH – MCCAMMON (AOOS, 12120114-B)
A GWA exhibit was installed at the Alaska SeaLife Center, using a design that will allow it to be made available as a traveling exhibit to other locations. The program's online presence was expanded through multiple modes. A virtual field trip featuring the science of each of the project components and the work of individual project scientists for middle school students is now online with instruction for middle school students. This virtual field trip features the four GWA program components, the results and the work and careers of a project scientist for each component, and lesson plans related to the scientific content and concepts. The virtual field trip and teaching resources are available online at: http://www.alaskasealife.org/gw_introduction.

Additionally, films about the response of community members to the spill and stewardship of their local environment have been produced in Tatitlek, Port Graham, and Seldovia. PWSSC conducted three interviews with GWA project scientists, which will be produced and air as *Field No*tes programs in May 2016. GWA Program PIs provided multiple presentations to stakeholder, community, and school groups. The outreach activities of the PIs are compiled in the Information and Data Transfer section below.

DATA MANAGEMENT – MCCAMMON/BOCHENEK (AOOS/AXIOM, 12120114-D)
The data management team (henceforth 'Axiom') continues to provide core data management support and services to GWA program. The focus continues to be on refining protocols for data and metadata transfer, data formatting and metadata requirements, improving search and discovery services, and salvage of historic data for both those data funded by the *EVOSTC* and ancillary historic data from other projects. Axiom has participated in regular GWA Program PI meetings, including the in-person meetings November 16-18, 2015 and the January 2016 meeting at AMSS, and is also coordinating activities between the HRM and GWA programs. To facilitate continued monitoring of data and metadata submission benchmarks, the Workspace metadata editor was expanded to include a data and metadata file tracking tool for project administrators. This tool eases data management by providing a transparent view of each project's data submissions, metadata record completeness, and data publication to the AOOS Gulf of Alaska data portal. The data management team will continue to use this tool to monitor the submission progress and maintain regular communications through email, phone, and in-person to assist with metadata authoring.

EVOS LTM DATA MANAGEMENT EXTENSION PROJECT – MCCAMMON/BOCHENEK (AOOS/Axiom, 15120114-D supplement)
The major focus of this project is to increase the data management support for both GWA and HRM programs by establishing a data coordinator position. During this past year, data coordinator Stacey Buckelew has targeted improving metadata quality and best practices. Ms. Buckelew worked to reorganize the HRM Program Ocean Workspace to create a cohesive organizational structure that parallels the GWA Program Ocean Workspace. Additionally, one-on-one meetings were scheduled with individual PIs from the GWA and HRM programs to provide guidance and support on data submission and metadata authoring. PIs received individual instruction in the use of the AOOS Workspace and exploration of data available in the AOOS Gulf of Alaska data portal. A metadata process was also established to ease the authoring process by PIs and to help standardize the metadata formats across programs.

HISTORICAL DATA MANAGEMENT AND SYNTHESIS – JONES (NCEAS, 12120120)
Data collection, collation, and assembly for synthesis continued and closely targeted questions and topics the working groups are studying. Some fisheries-independent data were collated, but other requests are still outstanding. Research topics are in different phases; however, data cleaning and preliminary analyses are on-going.

Historical data archiving: Initial efforts to archive historical GWA data returned 27% of known datasets; therefore, this project was re-invigorated in December 2015. Four student interns have been hired to assist in this effort, and in December we started a new process to prioritize and begin identify mechanisms to obtain important historical data sets. Couture has identified management team liaisons from each of the major agencies that still hold historical data, including ADFG, NOAA, UAF, USGS, and PWSSC. Discussions began at AMSS to include those managers in priority setting for data recovery, with the plan that the agency researchers will be more responsive when there is support for the activity from within their respective agencies.

A manuscript is in preparation documenting patterns in data recovery. Specifically, we are evaluating whether data type (e.g., oceanographic, fishery), collection agency (e.g., government, academic, non-governmental organization), and data age are correlated with likelihood of recovery.

Synthesis Working Groups: As planned in the previous year, both the Social-ecological Systems working group and the Portfolio Effects working group were convened in FY15, and each held two working group meetings at the National Center for Ecological Analysis and Synthesis in Santa Barbara, California to further their synthesis goals. The two postdocs associated with these groups (Blake and Ward) also started just before FY15, and their work is now synchronized and proceeding according to last year's revised plan. Both groups will hold two additional synthesis meetings in FY16, and complete submission of synthesis manuscripts this year. The budget for both the working groups and postdoc activities is being used in years 4 and 5 according to this revised plan.

Science Coordination and Synthesis – Holderied (NOAA KBL, 12120114-H)

This was a very busy year for coordinating monitoring information and presenting it to the public due to all of the information generated under the Pacific warm water anomaly. In addition, we worked with the HRM program team to plan a joint program special issue to which we will begin paper submission in July. We also held a joint program annual meeting with the HRM program and will continue to do so in 2016. We continued to work closely with the data management team to update the GWA website and data portal and helped facilitate use of online program resources by state and federal agency personnel as well as the general public. Finally, we presented GWA program information and monitoring highlights to scientific audiences, agency managers, and the public through science conference presentations, NOAA, ADFG and Bureau of Ocean Energy Management (BOEM) agency briefings, and public outreach events.

Conceptual Ecological Modeling – Hollmen (ASLC, 12120114-I)

During this past year, we published a novel framework for evaluating zooplankton-herring-whale trophic dynamics (Sethi & Hollmen 2015) and presented a poster describing mesoscale submodels at AMSS (Sztukowski, Sethi and Hollmen 2016). Additionally, we have constructed a Bayesian Belief Network model to explore scenarios of changes in nearshore prey base and impacts on higher tropic level consumers. This model framework is suitable for consideration of management approaches under different ecological conditions in the Gulf of Alaska nearshore system.

Finally, in response to emerging environmental conditions in the Gulf of Alaska ecosystem, we are incorporating current events and issues into structured models to forecast potential outcomes resulting from warmer ocean temperatures.

Gulf of Alaska Mooring (GAK1) Monitoring – Weingartner (UAF, 12120114-P)

The basic objectives of this project include sampling based on quasi-monthly conductivity-temperature-depth (CTD) casts at station GAK 1 (periods of sampling given in detailed project report) and the recovery and re-deployment of a string of 6 temperature-conductivity-pressure (TCP) recorders on a mooring at GAK 1. This mooring is recovered and re-deployed annually in March of each year. In addition, we have begun slowly been acquiring historical CTD data (via NODC) and CTD data from the Project ARGO floats from the northern Gulf of Alaska. The focus here is on determining if there are long-term temperature and salinity trends over the slope waters of the north Gulf. On an annual basis these waters flow onto the Gulf of Alaska shelf and occupy the deeper (>100m) portion of the shelf.

SEWARD LINE MONITORING – HOPCROFT (UAF, 12120114-J)

All sampling was completed as planned for this project. The spring 2015 cruise was conducted during one of the largest warm-water anomalies observed in the North Pacific during the past 50 years. Above average temperatures extend deep into the water column across the Seward line. Within the upper-100m, temperatures averaged 1.06°C above the long-term May mean making it the warmest May in the 19-year time-series. By September the intensity of the anomaly had declined and averaged 0.50° above the long-term mean.

OCEANOGRAPHIC CONDITIONS IN PRINCE WILLIAM SOUND – CAMPBELL (PWSSC, 12120114-E)

The six planned surveys of Prince William Sound were conducted during the reporting period and all 12 standard stations were occupied. All CTD data have been processed, and seasonally detrended anomalies of temperature and salinity at selected depths in central Prince William Sound are shown in the detailed project report. Temperatures in central Prince William have been above average since late 2013, as has been observed elsewhere in the Gulf of Alaska (see Hopcroft and Danielson/Weingartner reports). It appears that Prince William Sound exhibited the same "warm blob" anomaly seen throughout the Gulf of Alaska with approximately the same timing. Salinity anomalies in central Prince William Sound were less informative and more variable, but have for the most part tended towards fresh anomalies, presumably reflecting warmer than average summers throughout Alaska during the last two years.

OCEANOGRAPHIC MONITORING IN COOK INLET – DOROFF (UAA-KBRR) AND HOLDERIED (NOAA KBL, 12120114-G)

In 2015, we completed oceanographic surveys monthly in Kachemak Bay during all months along Transect 9 (across Kachemak Bay from Homer Spit, see detailed project report for figures). We also sampled marine plankton in all months except January. Under this project, we were funded for two lower Cook Inlet surveys and, through collaboration with BOEM and KBL, were able to leverage funding for a third survey this year. Within our study area there are 88 stations; 68 in lower Cook Inlet and 20 in Kachemak Bay. In 2015, we sampled a total of 273 stations with our CTD profiler and a subset of those were sampled for zooplankton (n=66 samples) and phytoplankton (n=68 samples). We had near complete sampling in February and April 2015, however, surveys in lower Cook Inlet were incomplete during November and December due to adverse winter conditions which prevented sampling along Transects 6 and 7; however, we completed Transect 3 (a high priority) and were able increase our sampling of outer Kachemak Bay. Details of our preliminary results can be found in the full project report.

CONTINUOUS PLANKTON RECORDER – BATTEN (SAHFOS, 12120114-A)

All of the continuous plankton recorder (CPR) transects were completed during this year. We did begin the sampling season earlier this year, in March, since conditions were unusually warm in early 2014 and we wanted to capture the start of the spring increase. The final sampling was therefore a little early, at the very end of August, instead of September. At this time, data are finalized for March to June samples, and still provisional for the July and August samples. The warm spring was clearly evident in data from the temperature logger attached to the CPR, with temperatures across the shelf generally higher than in previous years, particularly in May. This likely led to unusually high spring and summer zooplankton abundances, outside the range seen before from 2000 to 2013, which were biased (at least for copepods which are identified to species) towards smaller species.

We are also working on some collaborative publications with findings from this work. Annual anomalies of diatom abundance, as well as microzooplankton abundance, from the shelf CPR sampling (excluding Cook Inlet) were significantly correlated with measurements of first year growth in juvenile herring during the 10 year period of overlap of the time series. A manuscript is being prepared in collaboration with researchers from the HRM group, but the evidence suggests that indices of food quantity and quality from the CPR dataset help explain the interannual variability in juvenile herring growth.

Ability to Detect Trends in Nearshore Marine Birds – Coletti (USNPS SWAN, 12120114-F)
This project was completed using USNPS funding in 2014, with the findings reported in the program synthesis report. Funding was returned and this project is considered complete.

Long-term Killer Whale Monitoring – Matkin (NGOS, 12120114-M)
During this reporting period, we completed photoidentification for eight of the major resident pods including AB pod which has two new calves and now numbers 22 whales; all but one (AT6) of the AT1 transient individuals have been accounted for; and 23 Gulf of Alaska transients have been documented. There were 38 days of fieldwork during May and June. In addition, we completed collection of six biopsy samples across the early season period to examine changes in stable isotope levels over the season and over the years. Stable isotope levels appear to be dropping over decades, which indicates a trophic shift in the system or in the diet of the whales. We also collected 18 samples from sites of fish kills made by resident killer whales and observed and recorded predation of Gulf of Alaska transients on Dall's porpoise. Finally, we keep up with outreach of our project through our Facebook page with photos and updates from the associated field work. The page has generated up to 12,000 readers for some entries and regularly attracts a readership of over 2500 individuals per post.

Humpback Whale Predation on Herring – Moran (NOAA, NMFS Auke Bay Laboratory) and Straley (UAS, 12120114-N)
All work during 2015 proceeded as planned. During the reporting period we completed our scheduled April survey of Prince William Sound. In December of 2014 shoals of overwintering Pacific herring and their predators failed to return to Port Gravina. The 2015 spawning event also proved to be unusual; we did not locate large shoals herring typical of the area in spring and whales targeted small, fast moving herring schools.

Changes in feeding patterns in 2015: an increase in whales targeting bird feeding flocks in April
Typical whale behavior, when using feeding seabird flocks to target fish, involves fast swimming, shallow dives (without fluking), and frequent changes in direction. When a feeding flock forms (over one km away in some cases), the whales move quickly to the birds and engulf the fish school using a vertical or horizontal surface lunge. Whales often changed their direction of travel 90^0 when the flock forms, making it clear the whales detected the fish cued by the birds/fish. A noteworthy observation occurred on April 3, 2015 outside of Stockdale Harbor. Two whales, now named the "Bird Killers," engulfed and spit out eight glaucous winged gulls. In the wake of a lunge through the flocks, the dead and dying birds appeared to have lost their water proofing.

Forage Fish Distribution and Abundance – Piatt/Arimitsu (USGS Alaska Science Center, 12120114-O)
During this reporting period we conducted field work in June-July 2015. We completed the second year of the July aerial-acoustic survey that takes into account the advantages and limitations of previous forage fish work. We worked closely with a commercial herring spotting pilot and the HRM program. The sampling grid repeated in 2015 was based on 2010-2012 school density and was meant to simplify the aerial data collection and processing effort, increase certainty in aerial-derived species identification through on-the-

ground validation, and estimate biomass of schools in the water with hydroacoustics. This plan was submitted to the Ocean Workspace in June 2014 and was reviewed by the GWA Science Review Team.

We observed differences in marine habitat, forage fish and marine bird distribution between 2012-13 (cooler) and 2014-15 (warmer) years. Age-1 capelin made up a smaller proportion of trawl catches in warmer years compared to cooler years (see detailed project report for figures and more information). Our findings are consistent with the long-term dataset from Middleton Island that shows lower capelin proportion in diets in recent warm years. Capelin are a cold-water species that respond quickly to climate change and are known to use glaciated fjords as cold water refuge. All of the capelin we caught in 2015 were near glaciers in Columbia and Unakwik Bays.

Although the distribution of marine bird survey effort differed by year, transects conducted in conjunction with forage fish surveys throughout Prince William Sound suggested an unusually inshore distribution of common murres in 2015 compared to 2012-2013. The summer inshore distribution of common murres in 2015 was coincident with a mass mortality event later in the year and may have been an early warning sign. Unusually large numbers of subadult murres were observed on both summer surveys and in the winter die-off.

Prince William Sound Marine Bird Surveys – Irons/Kuletz/Kaler (USFWS Alaska Region, 12120114-K)
This project had no field work scheduled in 2015. Progress was made on data analysis, data transfer, updating metadata, and summarizing of project results and data from this project were presented at AMSS. Additionally, collaborative surveys were completed in response to reports of hundreds and thousands of dead common murre carcasses washing up along beaches in the western part of PWS and across the northern Gulf of Alaska. In January 2016, we conducted surveys focused on documenting common murre mortalities as part of a larger collaborative effort involving PWSSC, USGS, and GWA scientists.

Seabird Abundance in Fall and Winter – Bishop (PWSSC, 12120114-C)
During FY2015 (1 February 2015 – 31 January 2016), one observer (Anne Schaefer) with PWSSC performed 4 marine bird surveys in Prince William Sound, covering a total of 1016 km. The ships of opportunity used for the 2015 surveys included vessels surveying Pacific herring (HRM, PWSSC) and spot shrimp (ADFG). We also surveyed marine birds concurrently with the annual maintenance of the Ocean Tracking Network acoustic arrays that are stationed across the major entrances and southwest passages of Prince William Sound and serviced by the PWSSC. Previous years included surveys conducted concurrently with the GWA humpback whale project; however, neither fall nor winter whale surveys were conducted during this period.

Nearshore Benthic Systems in the Gulf of Alaska – Ballachey (USGS Alaska Science Center), Coletti (USNPS SWAN) and Dean (Coastal Resources Associates, 12120114-R)
Our field work for year 4 (the 2015 field season, with field work from April through July) was performed with no problems or concerns, with project components completed on schedule. We conducted 5 field trips, including one to Katmai National Park (KATM), one to Kenai Fjords National Park (KEFJ), two to western Prince William Sound (WPWS), and one to northern Prince William Sound (NPWS). At all areas, we re-sampled nearshore sites that were established in previous years. Work completed in all areas included monitoring of rocky intertidal sites, mussel sites, soft sediment sites, and eelgrass beds. At KATM, KEFJ, and WPWS, we also monitored black oystercatcher nests and collected sea otter forage data. We completed marine bird and mammal surveys in KATM and KEFJ, and sea otter carcass collections in WPWS, KATM and KEFJ. An aerial survey of sea otters in KATM was completed in July 2015. Additionally, we have continued to closely coordinate monitoring efforts with the GWA nearshore project in Kachemak Bay (K. Iken and B. Konar; GWA Nearshore Project 12120114-L).

Ecological Communities in Kachemak Bay – Iken/Konar (UAF, 12120114-L)
Work during this period included work up of field monitoring data collected during the May and June sampling period and comparisons with previous years' data. We found high variability among sites for rocky intertidal communities, but found that year 2015 showed unusual patterns, including lower kelp coverage, increases in seagrass coverage, and a high prevalence of sea star wasting disease that was not observed previously.

EVOS Oil Exposure of Harlequin Ducks and Sea Otters – Ballachey (USGS Alaska Science Center, 12120114-Q)
The field activities from this work were completed and published in 2014, and this project is considered complete:

Esler, Dan, Jim Bodkin, Brenda Ballachey, Dan Monson, Kim Kloecker, and George Esslinger. In review. Timelines and Mechanisms of Wildlife Recovery Following the *Exxon Valdez* Oil Spill. In Neher et al. editors. Quantifying temporal and spatial variability across the Northern Gulf of Alaska to understand mechanisms of change. Science Synthesis Report for the GWA Program. Submitted to the Exxon Valdez Oil Spill Trustee Council, December 1, 2014.

Oil Level and Weathering Tracking – Carls (NOAA/NMFS Auke Bay Laboratory, 12120114-S)
Field sampling was completed in 2015 to determine the quantity and weathering state of oil on nine Prince William Sound beaches. We proposed ten sites would be sampled but due to higher charter and fuel costs the survey was reduced by one day. Samples have been processed and quantified. A report is being drafted.

Preliminary results are:

- The total mass of oil varied from 0 to 3,600 kg per beach; no oil was discovered at Evans Island and one of the Eleanor Island beaches contained the most oil. Proportionate oiling ranged from 0 to 40% overall based on the number of oiled pits or 0 to 30% when based on oiled area.
- The amount of oiling was consistent with previous estimates; in general the proportion oiled remains the same. The percent oil discovered increased in one beach, declined in another and remained constant in the others. This variance is likely simply statistical noise; on average the amount of oil remaining is roughly the same.
- Polynuclear aromatic hydrocarbons (PAHs) were not discovered in passive samplers deployed on one beach in 2015; total PAH concentrations were low and modeling revealed no oil. Concentrations in field samples were about the same as in blanks. In sharp contrast, samplers deployed in 2002 in Herring Bay acquired orders of magnitude greater total PAH concentrations and they were petrogenic.

8. Information and Data Transfer: *See,* Reporting Policy at III (D) (8).

A) GWA PIs published information in peer-reviewed journals, reports, newspapers, and presented at nine national and international conferences during year 4 of the program (Table 2). PIs also participated in a variety of public outreach events and programs, including Discovery labs in Homer, and community lectures in Cordova (see McCammon and Hoffman Outreach and Community Involvement report for further detail). All of the monitoring projects have published 2014 data and are now in the process of publishing 2015 data to the program's AOOS Gulf of Alaska data portal.

GWA and HRM program PIs continue to collaborate for shared vessel time, equipment, and monitoring information. Humpback whale and marine bird abundance and diet data have been used to develop hypotheses about what may be limiting herring recovery. Data from the environmental drivers team have been used to develop hypotheses on recruitment limitations for herring. Cook Inlet oceanography data are being used by NOAA and UAF researchers to validate an ocean circulation model and by NOAA researchers to help identify triggers for paralytic shellfish poisoning events. We look forward to continuing to investigate ecological linkages to use in aiding management decisions as process study funding becomes available.

Table 2. Presentations and literature produced by GWA PIs through year four of the program.

Author(s) and Year	Title
Ballachey, B.E. and J.L. Bodkin. 2015	Challenges to sea otter recovery and conservation. Chapter 4 in Larson SE, Bodkin JL, VanBlaricom GR., Eds. Sea Otter Conservation. Academic Press, Boston. Pp 63-96.
Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and H.A. Coletti. 2015	Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.
Batten, Sonia. 2015	The effects of the anomalous warming on lower trophic levels in the NE Pacific, 2015. Annual PICES Meeting. https://pices.int/publications/presentations/PICES-2015/2015-S2/S2-1200-Batten.pdf.
Batten, Sonia.	The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling. Poster presentation. Pacific Anomalies workshop
Batten, Sonia. 2016	Batten, Sonia. The effects of the anomalous warming on lower trophic levels in the Gulf of Alaska from Continuous Plankton Recorder sampling. Oral presentation. AMSS
Bishop, Mary Anne, Kathy Kuletz, Jessica Stocking, and Anne Schaefer.	Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, AK. Poster presentation.
Bodkin, J.L. 2015.	Historic and Contemporary Status of Sea Otters in the North Pacific. Chapter 3 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 43-61.
Bowen, L., A. K. Miles, B. Ballachey, S. Waters and J. Bodkin.	Gene transcript profiling in sea otters post-*Exxon Valdez* oil spill: A tool for marine ecosystem health assessment. In review, *J. Mar. Sci. Eng.*
Campbell, Rob	Campbell, Rob. Effects of the 2013-2015 warm anomaly in Prince William Sound. Oral presentation. Pacific Anomalies workshop.
Campbell, Rob	Campbell, Robert. Surface layer and bloom dynamics in Prince William Sound. Oral presentation.
Carls MG, Holland L, Irvine GV, Mann DH, Lindeberg M. Submitted.	Biomarkers as tracers of *Exxon Valdez* oil.
Carls MG, Larry Holland, Corey Fugate, and Mandy Lindeberg. In prep.	Review of PAH and alkane retention in sediment oiled by the *Exxon Valdez*.
Carls MG, Larry Holland, Corey Fugate, and Mandy Lindeberg. In prep.	Biomarkers in *Exxon Valdez* oil from Prince William Sound, 2015.
Carls MG, Larsen ML, Holland LG. 2015.	Spilled oils: static mixtures or dynamic weathering and bioavailability? Plos One DOI:10.1371/journal.pone.0134448.
Coletti, H.A. and T.L. Wilson. 2015.	Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 12120114-F), National Park Service, Anchorage, Alaska.
Coletti, H.A., J.L. Bodkin, D.H. Monson, B.E. Ballachey and T.A. Dean. In review.	Engaging form and function to detect and infer cause of change in an Alaska marine ecosystem. Ecosphere.

Coletti, Heather, Dan Esler, Brenda Ballachey, James Bodkin, Thomas Dean, George Esslinger, Katrin Iken, Kimberly Kloecker, Brenda Konar, Mandy Lindeberg, Daniel Monson and Benjamin Weitzman.	Updates of key metrics from long-term monitoring of nearshore marine ecosystems in the Gulf of Alaska: Detecting change and understanding cause. Poster presentation.
Coletti, Heather, Grant Hilderbrand, Jim Pfeiffenberger, Carissa Turner, Brenda Ballachey, Liz Bowen, Kaiti Chritz, Katrina Counihan, Joy Erlerbach, Dan Esler, Tuula Hollman, Dave Gustine, Buck Mangipane, Benjamin Weitzman, Charlie Robbins and Tammy Wilson.	Changing Tides – The convergence of intertidal invertebrates, bears and people. Poster presentation.
Danielson, Seth, Sonia Batten, Robert Campbell, Angie Doroff, Kris Holderied, Russ Hopcroft, Rick Thoman and Tom Weingartner. 2016	Gulf of Alaska 2015 Anomalous Conditions Workshop: Oceanography. Large Whale Unusual Mortality Event workshop, AMSS, January 24.
Danielson, Seth, Tom Weingartner and Russell Hopcroft. 2016	1970 to 2015 thermal and haline anomalies on the Northern Gulf of Alaska Continental Shelf. Oral presentation, Pacific Anomalies workshop.
Doroff, AM, R.Campbell, C. McKinstry. 2016	Zooplankton Assemblages in Lower Cook Inlet and Kachemak Bay, 2012-2014. Poster presentation.
Esler, D., and B.E. Ballachey. 2015.	Long-term monitoring program - evaluating chronic exposure of harlequin ducks and sea otters to lingering Exxon Valdez oil in western Prince William Sound. Exxon Valdez Oil Spill Trustee Council Restoration Project Final Report (Project 14120114-Q), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.
Esler, Dan, Brenda Ballachey, Craig Matkin, Dan Cushing, Robb Kaler, James Bodkin, Dave Monson, George Esslinger, and Kimberly Kloecker. 2016.	Long-term data provide perspective on ecosystem recovery following the *Exxon Valdez* Oil Spill. Oil Spill and Ecosystems Conference, Tampa, February 2016.
Esler, Dan. 2015	Oil and wildlife don't mix: 25 years of lessons from the *Exxon Valdez* Oil Spill. Seminar at University of Quebec Rimouski, November 2015.
Fugate, Corey, Mandy Lindeberg, Mark Carls and Jacek Maselko,	Recent survey confirms persistence of lingering oil 26 years after the *Exxon Valdez* Oil Spill. Poster presentation.
Hoem Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. 2016	Gulf Watch Alaska in hot water! Ecological patterns in the Northern Gulf of Alaska under the Pacific 2014-2015 warm anomaly. Oral presentation.
Jan Straley and John Moran.	Bird killers of Prince William Sound: A foraging strategy used by humpback whales to detect schooling fish. Poster presentation.
Konar, B, K. Iken, H. Coletti, D. Monson, and B. Weitzman. In review.	Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuarine Coastal and Shelf Science.
Kris Holderied. 2015	Kris Holderied. Oceanographic and ecosystem response to the 2013-2015 Pacific warm anomaly in Kachemak Bay, Alaska. Oral presentation, Pacific Anomalies workshop.
Kuletz, Kathy. 2016	Seabird die-off events, 2014-2016: A summary of events. Large Whale Unusual Mortality Event workshop, AMSS, January 24.
Larson, S., J.L. Bodkin, and G.R. VanBlaricom. 2015.	Sea Otter Conservation. Academic Press, Boston. 447 p.
Lindeberg, Mandy	Seaweeds, Fishes, Monitoring & More! Public seminar, Prince William Sound Science Center community science seminar series, December 2015.

Lindeberg, Mandy, Mayumi Arimitsu, Mary Anne Bishop, Dan Cushing, Robb Kaler, Kathy Kuletz, Craig Matkin, John Moran, John Piatt, and Jan Straley.	Response of top predators and prey to changes in the marine environment: Gulf of Alaska pelagic monitoring program. Poster presentation.
Marcotte, E. and M. Lytle. 2015.	Sea otter diet in Kachemak Bay 2015. In fulfillment of thesis research credits. University of Alaska, Kachemak Bay campus. (Results of research conducted by student interns mentored by Angela Doroff, Aug-Dec 2016.)
Monson, D.H. and L. Bowen. 2015.	Evaluating the Status of Individuals and Populations: Advantages of Multiple Approaches and Time Scales. Chapter 6 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 121-158.
Moran, John and Jan Straley.	Missing herring: Water temperature, relocation, or dinner? Poster presentation.
Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner.	Gulf Watch Alaska: Monitoring Ecological Patterns in the Northern Gulf of Alaska. Coastal Estuarine Research Federation conference, Portland, OR. Oral presentation.
Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner.	Gulf Watch Alaska: Monitoring Ecological Patterns in the Northern Gulf of Alaska. Kachemak Bay Science Conference. Oral presentation.
Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. 2016	Gulf Watch Alaska in hot water! Ecological patterns in the Northern Gulf of Alaska under the Pacific 2014-2015 warm anomaly. Gulf of Mexico Research Initiative Oil Spills and Ecosystems conference, Tampa, FL. Oral presentation.
Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. 2015	Gulf Watch Alaska: Monitoring Ecological Patterns in the Northern Gulf of Alaska. National American Fisheries Society Conference, Portland, OR. Poster presentation.
Olsen, Dan, Craig Matkin, and Russell Andrews.	Shifting hot spots: Seasonal and pod-specific habitat use by resident killer whales in the Northern Gulf of Alaska. Poster presentation.
Pister, Benjamin, Brenda Ballachey, Heather Coletti, Thomas Dean, Katrin Iken, Brenda. Konar, Mandy Lindeberg and Benjamin Weitzman.	Multi-agency efforts to monitor Sea Star Wasting Disease in Alaska: Results and recommendations for future efforts. Poster presentation.
Sethi, S.A. and T.E. Hollmén. 2015.	Conceptual models for marine and freshwater systems in Alaska: Flexible tools for research planning, prioritization, and communication. Arctic 68:422-434
Sztukowski, Lisa, Suresh Sethi and Tuula Hollmen.	Mesoscale ecosystem processes in the Gulf of Alaska. Poster presentation.
Taylor, Audrey, Mary Anne Bishop, Kristine Sowl, Anne Schaefer, and Luis Verissimo.	Black turnstone: Evidence for a population decline or shifting migration patterns? Poster presentation.
Traiger, Sarah, Brenda Konar, Angela Doroff, and L. McCaslin. 2016	Sea otters versus sea stars as major clam predators: Evidence from foraging pits and shell litter. Poster presentation. Best student poster award from the North Pacific Research Board.
Traiger, Sarah, Brenda Konar, Angela Doroff, and Lauren McCaslin. In review.	Sea otters versus sea stars as major clam predators: Evidence from foraging pits and shell litter. Marine ecology progress series.
Weitzman, B.P., and G.G. Esslinger. 2015.	Aerial Sea Otter Abundance Surveys – Prince William Sound, Alaska, Summer 2014. U.S. Geological Survey Administrative Report.

B) The GWA team currently does not formally collaborate with other EVOSTC-funded projects outside of the HRM program.

C) The GWA team works with staff from the NPRB, Alaska Sea Grant, AOOS, and Cook Inlet Regional Citizens Advisory Committee to find collaborative opportunities and partnerships through our outreach committee and agency PIs. We continue to participate in informal and formal meetings with agencies, non-governmental organizations (NGOs) and the public and invite members of Trustee agencies, other state and federal agencies, and NGOs to program meetings and workshops. We also collaborate with the members of our program Science Review Team, including Dr. Hal Batchelder (PICES), Dr. Leslie Holland-Bartels (USGS emeritus), Dr. Jeep Rice (NOAA, retired), Dr. Terrie Klinger (University of Washington), and Dr. Richard Brenner (ADFG). All Science Review Team members participate in program meetings and provide review of reports and the program FY2017-2021 proposals.

9. Coordination and Collaboration: *See,* Reporting Policy at III (D) (9).

The program investigators held two all-hands conference calls, and two in-person meetings during this reporting period to facilitate communication between team members and coordinate administrative activities. In addition, the management team held numerous conference calls with the Science Coordination Committee to ensure that administrative and science needs were met within the program components.

Program investigators continue the collaboration outside program members, including hosting members of the NCEAS working groups to present at the GWA program annual meeting. Drs. Richard Brenner and Terrie Klinger presented updates for both NCEAS working groups and Drs. Collette Ward and Rachael Blake presented their proposed post-doctoral projects at the annual program meeting (See Jones NCEAS project report for more details on working group and post-doc research topics). Members of the GWA program are also participating in both working groups. Please also see above sections for additional coordination and collaboration details.

Finally, program PIs continue to expand cross program collaborations with the HRM program. The annual program meetings were held jointly in November and team leads participated in both meetings during the AMSS in-person meetings in January 2016. In addition, GWA PIs shared vessel time (Bishop, Piatt/Arimitsu), plankton and nutrient data (Campbell/Batten) and aerial tracking information (Piatt/Arimitsu).

<u>Community Involvement/TEK and Resource Management Applications</u>
Several new outreach and community involvement tools were developed and used during this past year. The outreach and science teams updated the program website and data portal in May 2015 with annual updates planned for May 2016. Finally, the first of two virtual field trips was completed and is available on the ASLC webpage for teachers to use to introduce marine science in their classrooms as well as to be displayed at the Alaska Sea Life Center (http://www.alaskasealife.org/gw_introduction).

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (D) (10).

No comments were received for the Year 3 program annual report submitted in March 2015.

In response to comments for the year 5 work plans:

The Science Panel was pleased to see that the two programs are closely integrating. It is expected that cross program publications and further integration, both on a practical and on a scientific level, will occur in the next 5 year plan, as noted in the Panel's comments from September 2014.

The administrative program management component for the program is very high cost with no detail on the need for these expenditures.

Response:

We concur that cross-program integration has brought significant practical and scientific benefits to the overall program, and we look forward to continuing those efforts. In our year 5 work plan we have proposed a cross-program special issue journal publication as a final product from the first 5-year program and agree with continuing such efforts in the next 5-year plan. We also note that within and cross-program collaboration requires substantial effort, which is accomplished with our administrative program management and science coordination and synthesis projects.

We disagree with the comment that administrative program management costs are too high. The total proposed administrative project cost of the program for year 5 is $264K, which includes a flat fee of $200K in lieu of overhead for program administration by PWSSC and additionally covers outreach, PI meeting travel, Science Review Team coordination and travel and community involvement activities. As outlined in the year 5 work plan proposal and in the Year 3 annual report, PWSSC administration includes contracts and subcontract management (all non-Trustee agencies are contracted through PWSSC), budget tracking, annual and semi-annual report writing, PI meeting logistics, and an audit. We also point out that the 9% G&A for the project goes to NOAA, not PWSSC. The $200K administration costs are 8.6% of the total year 5 GWA program costs of $2.3 million before the 9% G&A, which is a discount on the PWSSC overhead rate of 30%, is less than G&A for Trustee Agencies, and is less than program administration and overhead costs. This low cost was possible due to joint coordination of program administration at PWSSC for both the GWA and HRM programs and leveraging of in-kind personnel time for program management from the AOOS and NOAA team leads, both of whom participate at no cost to the program.

Second, we recommend that the EVOSTC reconsider the recommendation to not fund the conceptual modeling project. Defunding a project in the last year of the funding cycle is difficult for both project and program management, due to integration between projects. The project PI, Dr. Tuula Hollmen, outlined a plan in the year 5 work plan to concentrate efforts in years 4 and 5 of the project, by full-time funding of a post-doc position which was filled during year 4. While the Science Panel expressed concerns about the conceptual modeling project's year 4 work plan, given the progress made in year 4 and lack of Science Panel comments for the project's year 3 annual report, the recommendation not to fund the project for year 5 is a surprise. Please see the attached response from Dr. Hollmen for more specific comments. We recommend that the project be funded for year 5. If it is funded, we can work with the Science Panel to further address their specific concerns. If the EVOSTC decides not to fund the project for the final year, we will need guidance regarding project close out and revision of the project proposal to determine what deliverables could be provided under a lower total project funding amount.

11. Budget: *See,* Reporting Policy at III (D) (11).

A few of the individual projects' actual cumulative spent deviated from the proposed spending budgets for a variety of reasons that ranged from organizational billing practice delays related to fiscal year offsets to changes in awarding of contracts. Please see the Comments section of each individual budget report form and Section 11 of each narrative report form for specific details. See the attached program workbook for specific figures.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$1,212.5	$1,440.7	$1,462.2	$1,433.6	$1,417.1	$6,966.0	$4,921.4
Travel	$123.7	$108.5	$247.5	$242.9	$121.8	$844.4	$371.6
Contractual	$708.0	$544.0	$659.8	$649.3	$474.1	$3,035.2	$2,020.2
Commodities	$150.6	$130.7	$154.5	$122.4	$127.0	$685.2	$573.5
Equipment	$304.4	$27.8	$27.8	$20.3	$21.5	$401.8	$345.5
Indirect Costs (*will vary by proposer*)	$165.6	$202.3	$194.8	$214.9	$160.0	$937.7	$598.6
SUBTOTAL	$2,664.7	$2,454.1	$2,746.7	$2,683.4	$2,321.5	$12,870.4	$8,830.8
General Administration (9% of subtotal)	239.8	220.9	247.2	241.5	208.9	1158.3	794.8
PROGRAM TOTAL	**$2,904.6**	**$2,674.9**	**$2,993.9**	**$2,925.0**	**$2,530.4**	**$14,028.8**	**$9,625.6**
Other Resources (In-Kind Funds)	**$1,886**	**$1,738**	**$1,823**	**$1,902**	**$1,636**	**$8,916**	

COMMENTS: All amounts are give in 1000 dollars.

FY12-16	**Program Title: 15120114 and 15120120 LTM - Long Term Monitoring** **Team Leader: Hoffman/McCammon/Holderied**	**SUMMARY**

Note: includes change of $24,987. between NCEAS and Axiom per Gulf Watch Management Team memo dated July 5, 2012

Note: includes addition of $102,100. Ballachey and Esler - Lingering Oil for Harlequin Duck for FY14

Note: includes addition of $247.8 for AOOS/Axiom data coordinator project in FY2015-2016

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114- O

2. Project Title: *See,* Reporting Policy at III (C) (2).

LTM Program – Monitoring long-term changes in forage fish distribution, abundance, and body condition in Prince William Sound

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Mayumi Arimitsu and John Piatt

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

As originally proposed, the objectives of this work were 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) assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in Prince William Sound during summer, and, 3) relate abundance and distribution of forage species to abiotic characteristics of the marine environment.

During this reporting period we conducted field work in June-July 2015. We completed the second year of the July aerial-acoustic survey that takes into account the advantages and limitations of previous forage fish work. We worked closely with a commercial herring spotting pilot and the herring research and monitoring program. The sampling grid repeated in 2015 was based on 2010-2012 school density (Figure 1) and was meant to simplify the aerial data collection and processing effort, increase certainty in aerial-derived species identification through on-the-ground validation, and estimate biomass of schools in the water by using hydroacoustics. This plan was submitted to the workspace in June 2014 and was reviewed by the Gulf Watch Alaska (GWA) science review team.

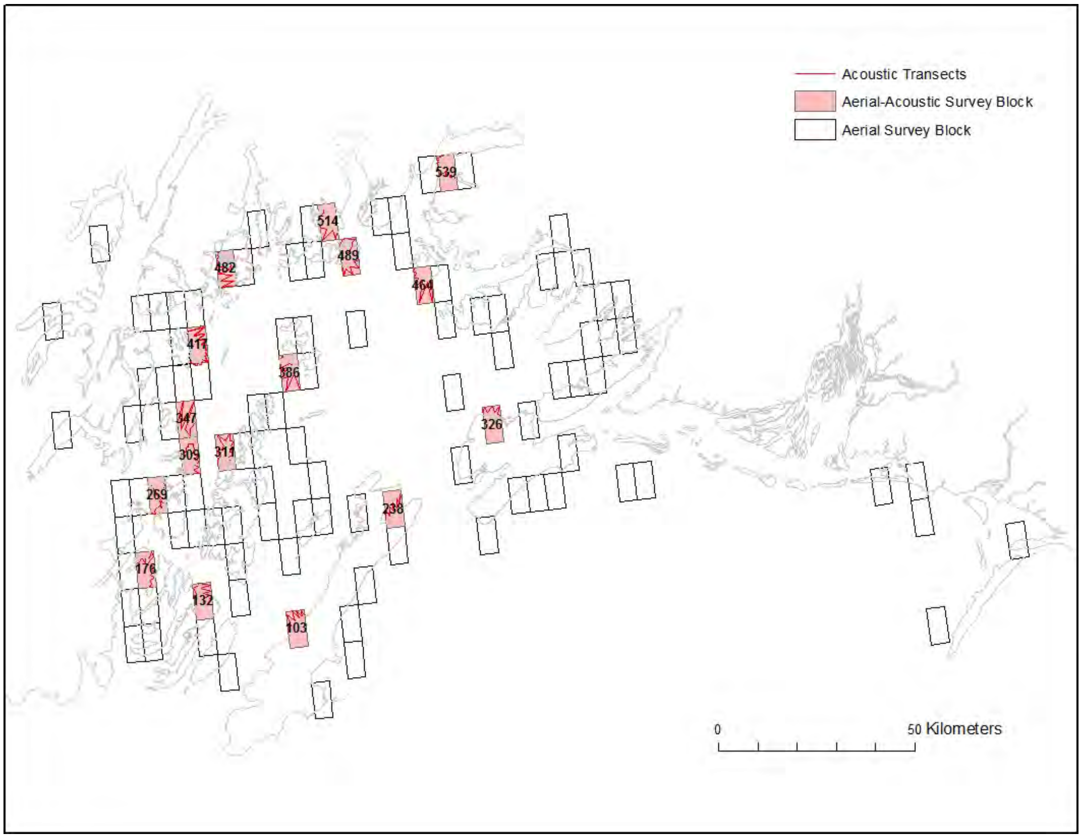


Figure 1. Aerial-acoustic survey conducted in July 2015. Fish schools were counted in aerial survey blocks (outlined in black) and hydroacoustic surveys were conducted in a random subset of blocks identified as persistent, high-density forage fish school areas from historical aerial surveys in Prince William Sound.

We provided survey equipment and technical support during the juvenile herring surveys in June 2015 (Figure 2). We also conducted the aerial-acoustic forage fish survey in July. Working closely with the Prince William Sound Science Center aerial survey team, we counted fish schools within low-high density sample boxes and ran hydroacoustic transects in 16 high density sample boxes located throughout Prince William Sound. We used several methods to verify species identification for aerial surveys and hydroacoustics including midwater trawl, cast nets, jigs, purse seines and underwater cameras.

We provided several written reports, presentations and interviews during this reporting period. In addition to project annual reports and work plans (February 2015, August 2015), we also highlighted this work in a lecture for the University of Alaska Fairbanks School of Fisheries and Ocean Sciences graduate seminar series (March 2015). We worked with the pelagic team and program leads to summarize recommendations for future work at the GWA principal investigators meeting in November. We uploaded available 2014 datasets to the Ocean Workspace and also updated the Morpho metadata. We co-authored a poster at the Alaska Marine Science Symposium on the GWA pelagic program.

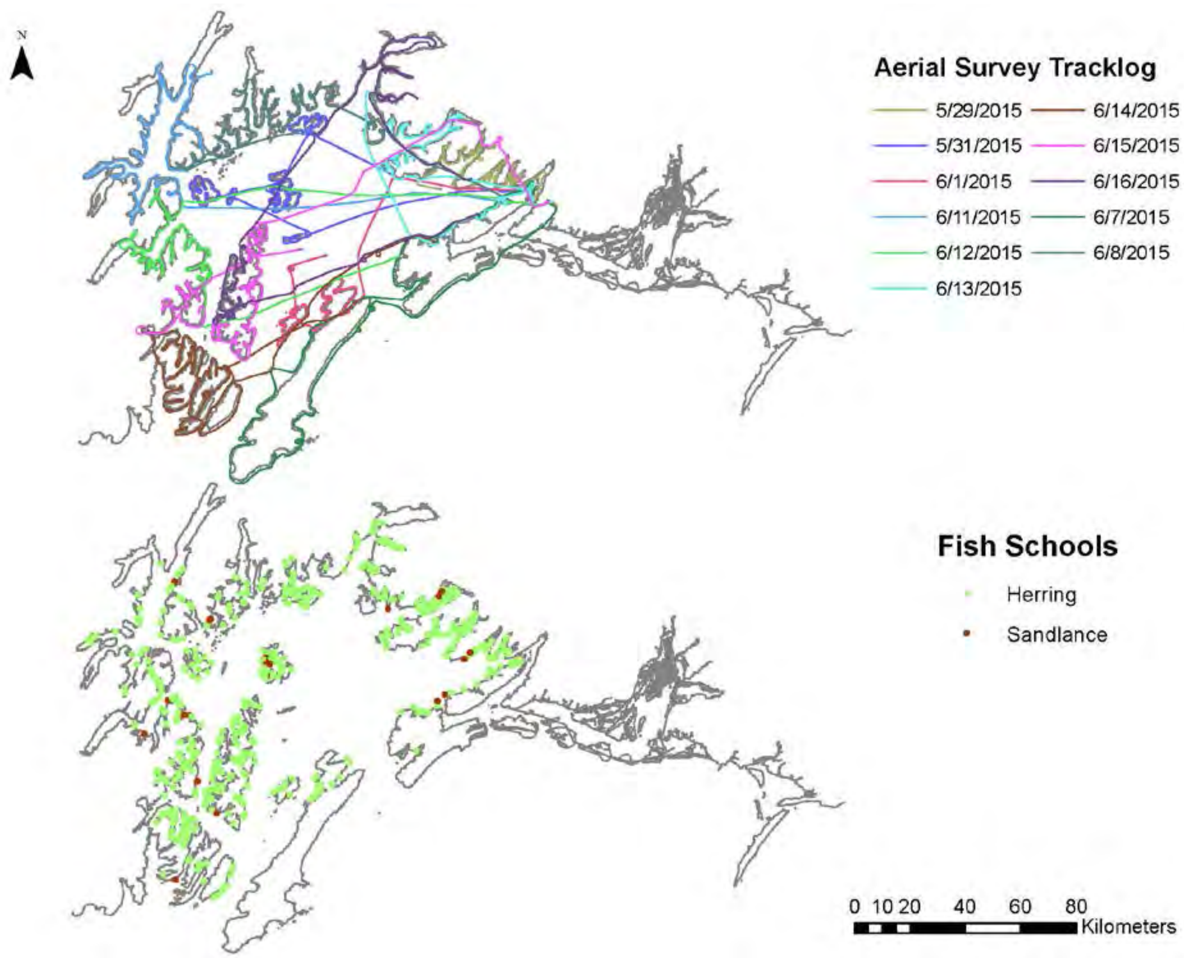
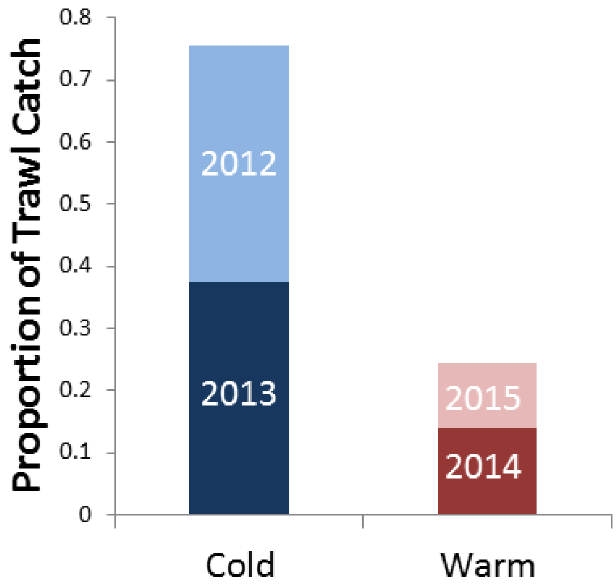


Figure 2. June 2015 aerial survey effort by date (top), and distribution of school observations by species (bottom). These surveys were conducted in collaboration with Scott Pegau (Herring Research and Monitoring Program, Prince William Sound Science Center).

We observed differences in marine habitat, forage fish and marine bird distribution between 2012-13 (cooler) and 2014-15 (warmer) years. Age-1 capelin made up a smaller proportion of trawl catches in warmer years compared to cooler years (Figure 3). Our findings are consistent with the long-term dataset from Middleton Island that shows lower capelin proportion in diets in recent warm years (Figure 3). Capelin is a cold-water species that responds quickly to climate change and are known to use glaciated fjords as cold water refuge. All of the capelin we caught in 2015 were near glaciers in Columbia and Unakwik bays.



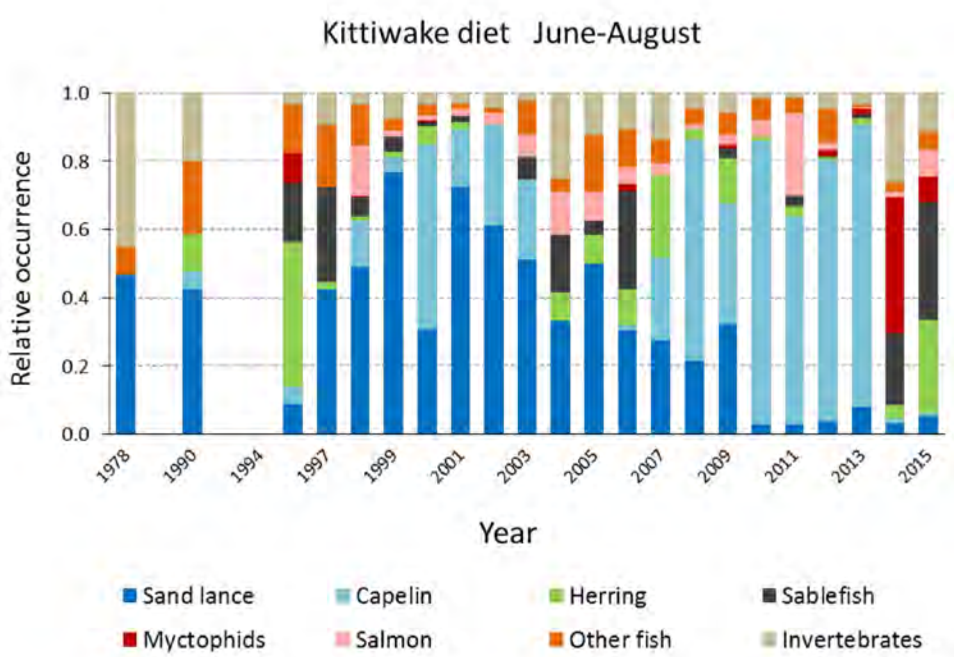
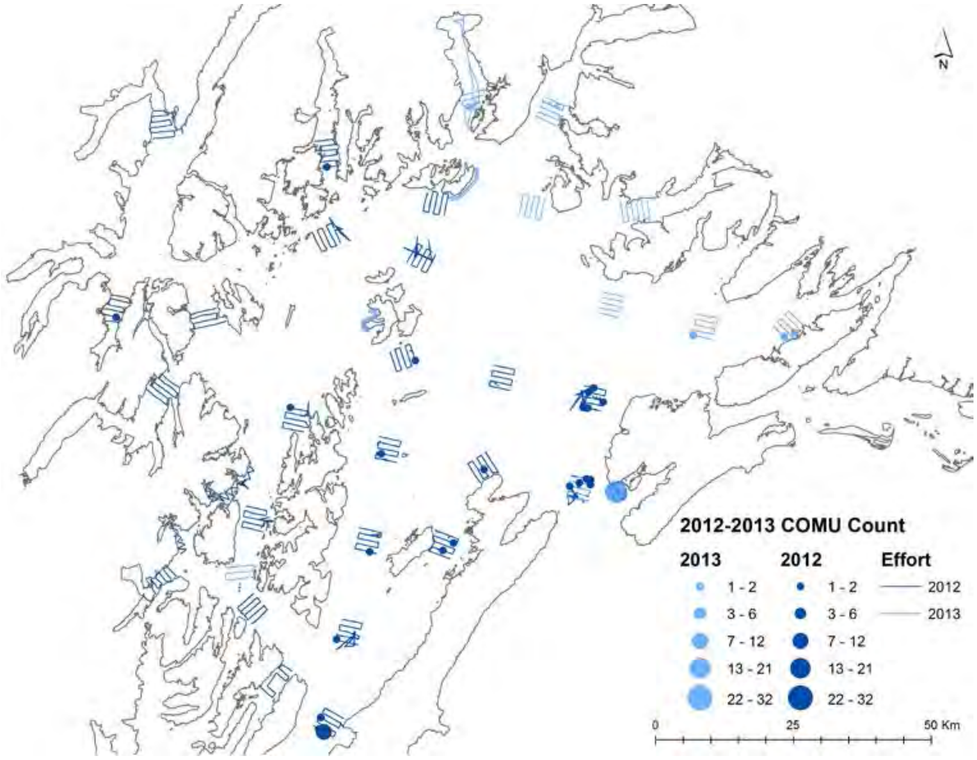


Figure 3. Proportion of age-1 capelin in trawl catches in cooler (2012-13) and warmer (2014-15) years of the GWA forage fish study in Prince William Sound (top). Relative occurrence of forage fish species in black-legged kittiwake diets at Middleton Island from 1978 – 2015 (bottom, long-term data courtesy of Scott Hatch (Institute for Seabird Research and Conservation).

Although the distribution of marine bird survey effort differed by year, transects conducted in conjunction with forage fish surveys throughout the Sound suggested an unusually inshore distribution of common murres in 2015 compared to 2012-2013 (Figure 4). The summer inshore distribution of common murres in 2015 was coincident with a mass mortality event later in the year and may have been an early warning sign. Unusually large numbers of subadult murres were observed on both summer surveys and in the winter die-off.



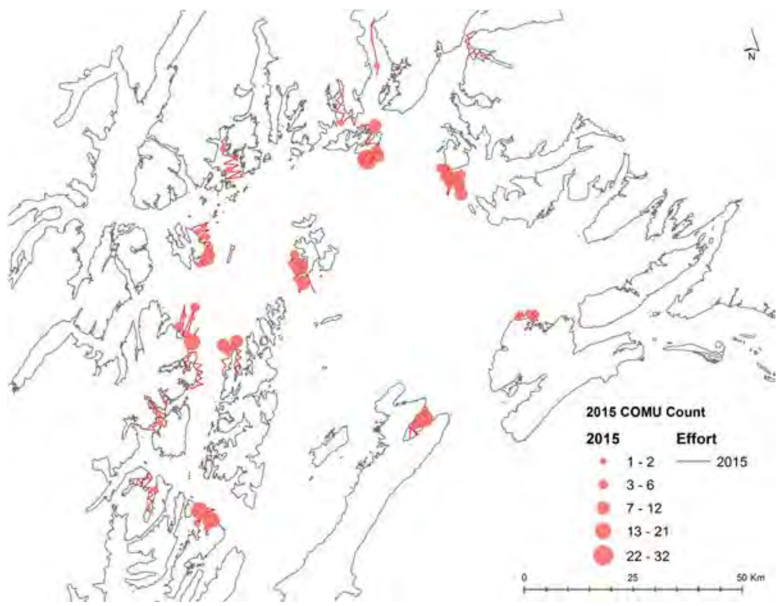


Figure 4. Common murre (COMU) distribution on marine bird transects conducted in conjunction with forage fish surveys in Prince William Sound in July 2012, 2013 and 2015. Transect layout (lines) differed among years due to changes in the forage fish survey design.

The July distribution of forage fish (all years, all methods) is shown in Figure 5. Walleye pollock and Pacific herring are more widely distributed in Prince William Sound compared to capelin, Pacific sand lance and eulachon.

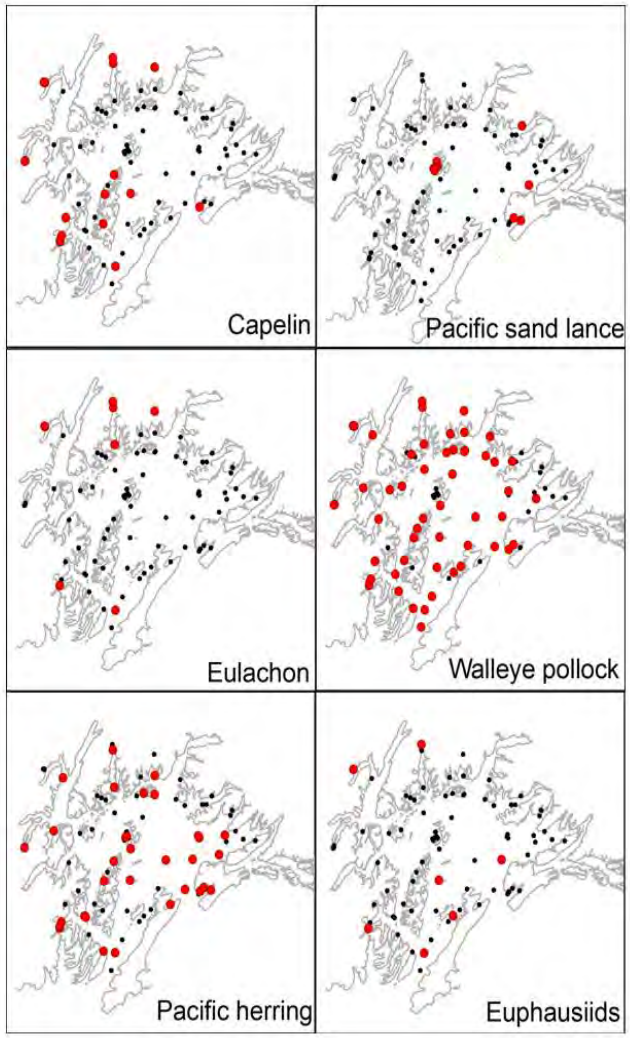


Figure 5. Distribution of forage fish (all methods and years) during July surveys in 2012-2015. Fishing effort (trawl, jig, beach seine, purse seine, dip net, cast net, and gill net) is shown as black circles, and presence is shown as red circles.

Deliverable/Milestone	Status
Submitted 2014 annual report	completed
2014 data with metadata uploaded to workspace	completed
Juvenile herring aerial survey support	completed
Forage fish aerial-acoustic survey	completed
Year 5 project plan	completed
GWA Synthesis	completed
November PI meeting and forage fish update in Anchorage	completed
Poster presentations at Alaska Marine Science Symposium	completed
Workspace data and metadata review with Axiom	Completed

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

We coordinated closely with Scott Pegau, Herring Research and Monitoring program coordinator, to conduct aerial surveys in summer 2015. We provided data recorders, cameras, and technical support for June age-1 herring and forage fish school survey, and July aerial-acoustic survey for forage fish (see Figure 2).

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

We uploaded data to the Ocean Workspace, and also had a data management meeting with Axiom on January 14, 2015.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

We uploaded the revised version of the study protocol to the Ocean Workspace. We responded to the helpful recommendations and comments from the reviewer by clarifying the text in the protocol.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Current expenditures of some line items deviated from the originally-proposed amount in cases where reporting accounts lagged behind actual expenses, because of inconsistencies between federal and Exxon Valdez Oil Spill Trustee Council fiscal year start dates, and because the US Geological Survey budget system categories (particularly commodities and equipment) differ from those shown. All expenditures are within keeping to our planned budget, despite the approved changes to survey design over the course of the study. We expect to use all proposed funds by the end of the project.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$123.1	$123.1	$123.1	$123.1	$119.8	$612.2	$546.9
Travel	$11.4	$10.5	$10.5	$10.5	$3.3	$46.2	$70.2
Contractual	$14.6	$28.9	$28.9	$28.9	$14.8	$115.9	$49.3
Commodities	$20.0	$20.0	$20.0	$20.0	$0.0	$80.0	$36.9
Equipment	$23.5	$3.3	$3.3	$3.3	$0.0	$33.4	$43.2
SUBTOTAL	$192.6	$185.7	$185.7	$185.7	$137.9	$887.7	$746.50
General Administration (9% of subtotal)	$17.3	$16.7	$16.7	$16.7	$12.4	$79.9	$67.2
PROJECT TOTAL	$209.9	$202.5	$202.5	$202.5	$150.3	$967.6	$846.39
Other Resources (in kind Funds)	$297.2	$297.2	$297.2	$297.2	$72.2	$1,260.8	1.188.64

Over life of the project, USGS will make a substantial contribution of salary (360.8K) for PIs (0.5 FTE GS-11, 0.2 FTE GS-15), half of the vessel costs for annual cruises (80K), and in each year all the field equipment required including sampling nets (9K; purse seine, beach seine, modified herring trawl, zooplankton nets), oceanography equipment (90K; CTD with rosette and external sensors, thermosalinograph), SIMRAD split beam dual frequency hydroacoustic equipment (141K), and small boats (10.5K).

FY12-16

Program Title: 15120114-O Forage Fish
Team Leader: John Piatt / M. Armitsu

FORM 4A
TRUSTEE AGENCY
SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-A

2. Project Title: *See,* Reporting Policy at III (C) (2).

Continuous Plankton Recorder Sampling

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Sonia Batten and Robin Brown

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

Information on the whole North Pacific continuous plankton recorder (CPR) survey available at: http://pices.int/projects/tcprsotnp/default.aspx

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Six transects were sampled in 2016 as planned, the dates and status of sample processing are given in the table below. The final section of the May transect had a mechanical failure, otherwise all samples were collected successfully. Owing to the ship dry-docking in early September the sampling season was shortened and the final 3 transects were sampled quite close together. Temperature data were also collected on all transects. Sample processing and quality control (QC) review is ongoing, with all samples to the end of June finalized.

<u>Impacts of the anomalous warming.</u>

Many examples of the impacts of the anomalous warming could be given, but the figures below show firstly the very warm temperatures measured in the surface waters of the shelf in spring 2015 (Figure 1). Temperatures along the first transect in April were almost 2°C higher than other years for which we have temperature logger data. By late summer waters were still warm, although 2014 may have been warmer at this time of year. There were clear changes in the plankton resulting from this warming. As well as a change in diatom community composition towards a higher proportion of pennate diatoms, there was a very high abundance of small copepods in spring (Figure 2). Small copepods were more numerous than in any other spring that we have sampled and their high numbers are thought to be a combination of the warmth advancing their seasonality to earlier in the year, and also favoring their productivity. They can have multiple generations in one season. In spring 2015 they made up over 90% of the zooplankton community, by numbers, which has never before been recorded in our data at this time of year. However, although numerous they are individually smaller than many other species usually present in the spring and do not store the energy-rich lipids that larger copepods accumulate to use for over-wintering. They are therefore a less energy-dense food for predators. We would expect to see changes in productivity of higher trophic levels resulting from these changes in the plankton

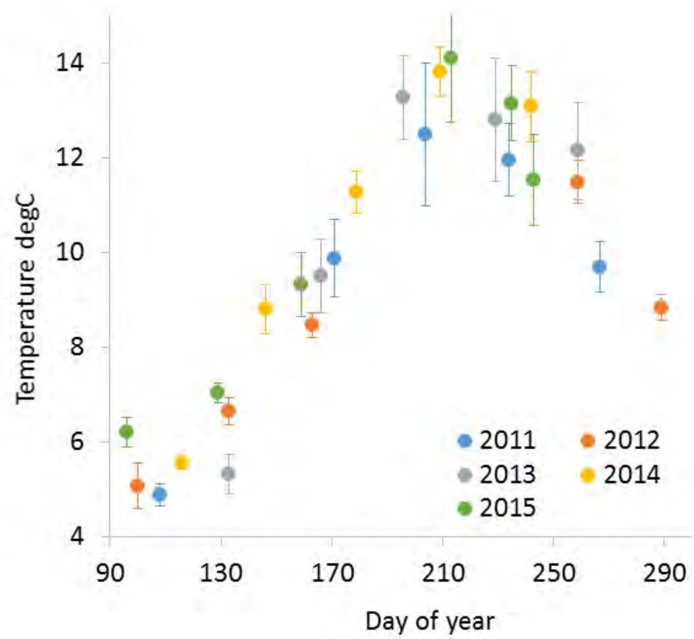


Figure 1. Mean (and standard deviation) near-surface temperature on the Alaskan shelf from loggers on the CPR for each transect sampled 2011-2015.

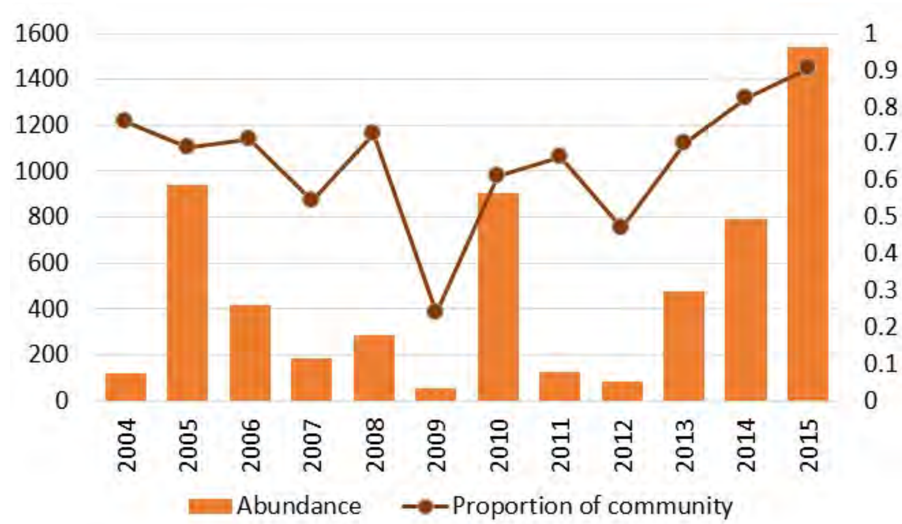


Figure 2. Mean spring (March to June) abundance (# per sample, left hand axis) of small copepods each year on the Alaskan shelf (bars) together with their contribution (as a proportion) to the total zooplankton population (line, right-hand axis).

Deliverable/Milestone	Status
Set up for start of field season, ship gear	Completed
Sample 6 transects, March to September	Completed: Transect 1: 4-6th April Transect 2: 7-9th May Transect 3: 6-8th June Transect 4: 30th July-1st Aug Transect 5: 20-23rd Aug Transect 6: 30th Aug-1st Sept
Process samples	All samples to June have been finalized and QC'd. Provisional data available for July-September samples.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

During 2015 we collaborated with researchers from the Herring Research and Monitoring Program to write up the study on plankton indices and first year herring growth. At the time of completing this report we have submitted a revised manuscript addressing minor review comments and we expect it to be accepted for publication in Fisheries Oceanography very soon. Details of the publication are given below.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

Publications

Batten, S.D., Moffitt, S., Pegau, W.S., and Campbell, R. Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fisheries Oceanography (in review).

Conference and workshop presentations and attendance during the reporting period

Dr. Batten gave an oral presentation at the 2015 Annual North Pacific Marine Science Organization (PICES) Meeting "The effects of the anomalous warming on lower trophic levels in the NE Pacific." Presentation is available here: https://pices.int/publications/presentations/PICES-2015/2015-S2/S2-1200-Batten.pdf.

Dr. Batten attended the 2nd Pacific Anomalies Workshop in January 2016 and presented a poster entitled "The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling."

Dr. Batten gave a talk at the January 2016 Alaska Marine Science Symposium entitled "The effects of the anomalous warming on the lower trophic levels."

Data and/or information products developed during the reporting period

Contribution to the National Oceanic and Atmospheric Administration (NOAA) Ecosystem Considerations report, http://access.afsc.noaa.gov/reem/ecoweb/index.cfm.

Data sets and associated metadata have been uploaded to the Gulf Watch Alaska program's data portal:

- Finalized 2014 plankton data (2015 will be uploaded later in 2016 when all 2015 data have been finalized).
- 2015 along-transect temperature data were uploaded.

10. Response to EVOSTC Review, Recommendations and Comments: See, Reporting Policy at III (C) (10).

N/A

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$0.0	$31.8	$32.7	$33.8	$35.0	$133.3	$98.3
Travel	$0.0	$1.0	$1.0	$1.0	$1.1	$4.1	$3.0
Contractual	$0.0	$7.2	$7.4	$7.5	$7.9	$30.0	$22.1
Commodities	$0.0	$4.5	$4.7	$4.8	$4.8	$18.8	$14.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (will vary by proposer)	$0.0	$16.8	$17.3	$17.8	$18.3	$70.2	$51.9
SUBTOTAL	$0.0	$61.3	$63.1	$64.9	$67.1	$256.4	$189.3
General Administration (9% of subtotal)	$0.0	$5.5	$5.7	$5.8	$6.0	$23.1	$17.04
PROJECT TOTAL	$0.0	$66.8	$68.8	$70.7	$73.1	$279.5	$206.33
Other Resources (in kind Funds)	$0.0	$94.7	$148.0	$180.8	$169.0	$592.5	$242.70

COMMENTS:The North Pacific CPR survey is supported by a Consortium managed by the North Pacific Marine Science Organisation, of which the EVOS TC is a member. Costs included here are 40% of the full costs of acquiring data along the north-south transect. The remining funds come from the consortium which currently includes the NPRB ($30,000 in FY2014), Canadian Dept Fisheries and Oceans ($25,000 in FY 2014) and SAHFOS ($39,700 in FY2014).

FY12-16

Program Title:15120114-A CPR
Team Leader: S. Batten

FORM 3A
NON-TRUSTEE AGENCY
SUMMARY

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-C

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term monitoring of seabird abundance and habitat associations during late fall and winter in Prince William Sound

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Mary Anne Bishop, Ph.D., Prince William Sound Science Center

Report prepared by: Anne Schaefer

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015 – January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

February 12, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

http://www.gulfwatchalaska.org/

http://pwssc.org/research/birds-2/seabirds/

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

The objectives of this project are to:

1) Characterize the spatial and temporal distribution of seabirds in Prince William Sound (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) Use increased temporal sampling resolution to improve our estimates of herring consumption by seabirds during the winter.

For this FY15 report we provide preliminary results that address objectives 1, 3 and 4. Objective 2 will be addressed as hydroacoustic survey data become available from the juvenile herring surveys.

2015 Field Work and Preliminary Analyses

During FY2015 (1 February 2015 – 31 January 2016), one observer (Anne Schaefer) with the Prince William Sound Science Center (PWSSC) performed 4 marine bird surveys in Prince William Sound (PWS), covering a total of 1016 km (Table 1; Figure 1). The ships of opportunity used for the 2015 surveys included vessels surveying Pacific herring (Exxon Valdez Oil Spill [EVOS] Herring Research and Monitoring, PWSSC) and spot shrimp (Alaska Department of Fish and Game [ADF&G]). We also surveyed marine birds concurrently with the annual maintenance of the Ocean Tracking Network (OTN) acoustic arrays that are stationed across the major entrances and southwest passages of PWS and serviced by the PWSSC. Previous years included surveys conducted concurrently with the Gulf Watch Alaska (GWA) Humpback whale project; however, neither fall nor winter whale surveys were conducted during this period.

All surveys followed established U.S. Fish and Wildlife Service (USFWS) protocols (USFWS 2007). Briefly, the observer recorded the number and behavior of all marine birds and mammals within a 300 m fixed-width strip (150 m on either side of the vessel) into a GPS-integrated data entry program (dLOG). The observer identified species to the lowest taxonomic unit possible. For each three km segment of the surveyed trackline, we calculated bird density (birds/km^2) for 11 species or species groups (Table 2).

Table 1. Cruises completed during FY2015. No milestones were scheduled to be completed for FY2015.

Month/Collaborator		Km surveyed	Observer	Status
February (A)	PWSSC	205	A. Schaefer	Completed, February 12–17, 2015
February (B)	PWSSC	108	A. Schaefer	Completed, February 23–24, 2015
October	ADF&G	371	A. Schaefer	Completed, October 12–23, 2015
November	PWSSC	332	A. Schaefer	Completed, November 6–15, 2015
January	PWSSC	400	A. Schaefer	Completed, January 6–8, 2016

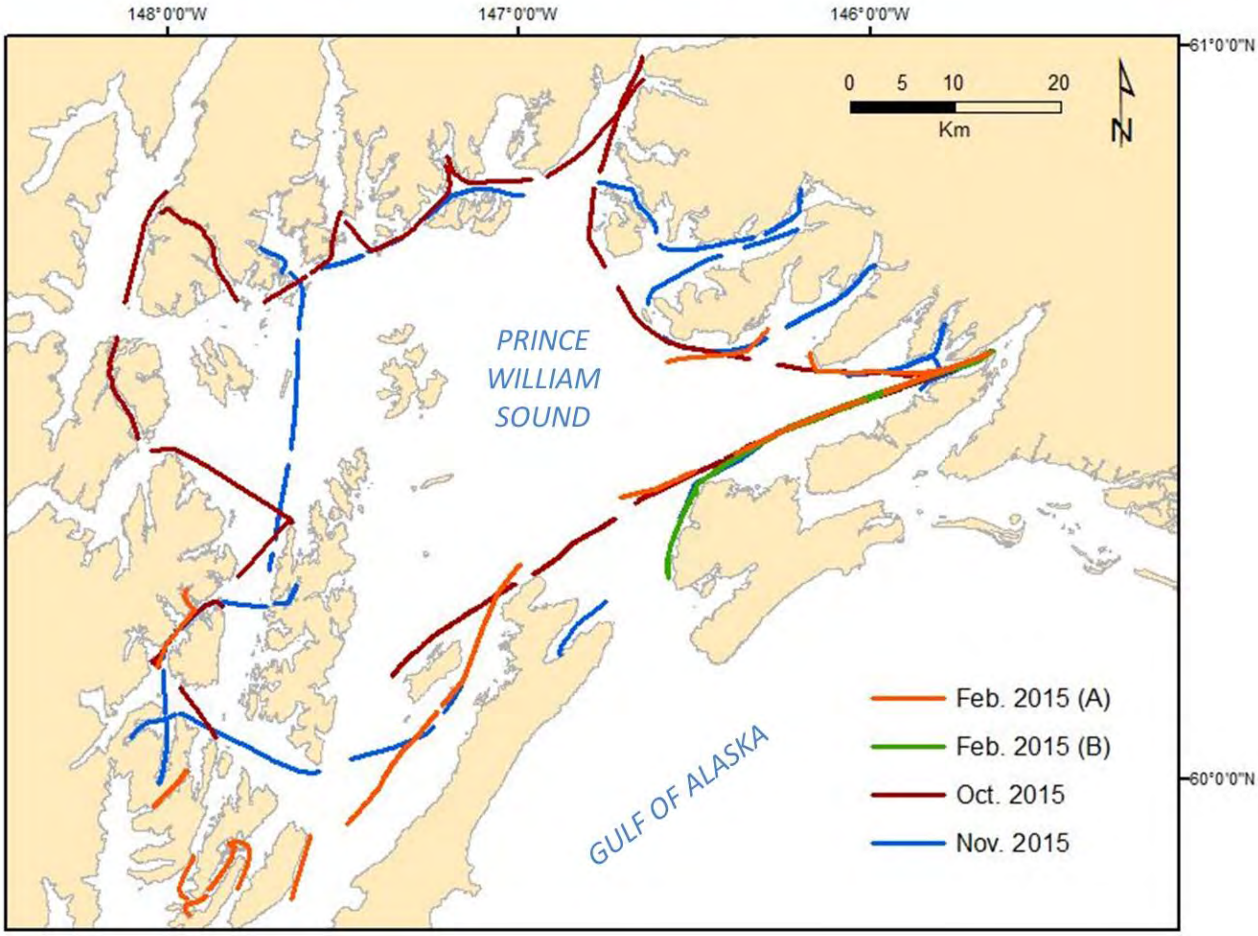


Figure 1. Spatial coverage of the four cruises completed in Prince William Sound, AK during FY2015.

Common Murre Die-off

Beginning in March 2015, observations of dead murres floating in the water or washed up on beaches began to be reported to wildlife officials along the Gulf of Alaska. The die-off continued through the summer and then spiked in December 2015 and early January 2016, after a period of severe storms and high winds. Examination of carcasses sent to the U.S. Geological Survey (USGS) National Wildlife Health Center determined starvation to be the cause of death.

Immediately preceding the die-off event, we recorded a dramatic increase in the number of common murres using the southwest passages of PWS (February 2015 surveys; Figures 2 & 3, Table 2). Common murres are typically the most abundant marine birds in PWS by late winter (March; Dawson et al. 2015, Bishop and Kuletz 2013). The early movement of murres into PWS may have signaled a change in food availability in the Gulf of Alaska due to unusually warm water temperatures. Sea temperatures in the Gulf of Alaska have increased 0.5-1.5 degrees Celsius since 2013, with temperature anomalies in PWS 2-4 degrees Celsius warmer than average (Campbell 2016). Murre densities in PWS were also higher this past October and November (2015; Figure 3, Table 2), right before the spike in reported mortalities, as compared to previous surveys during this time period.

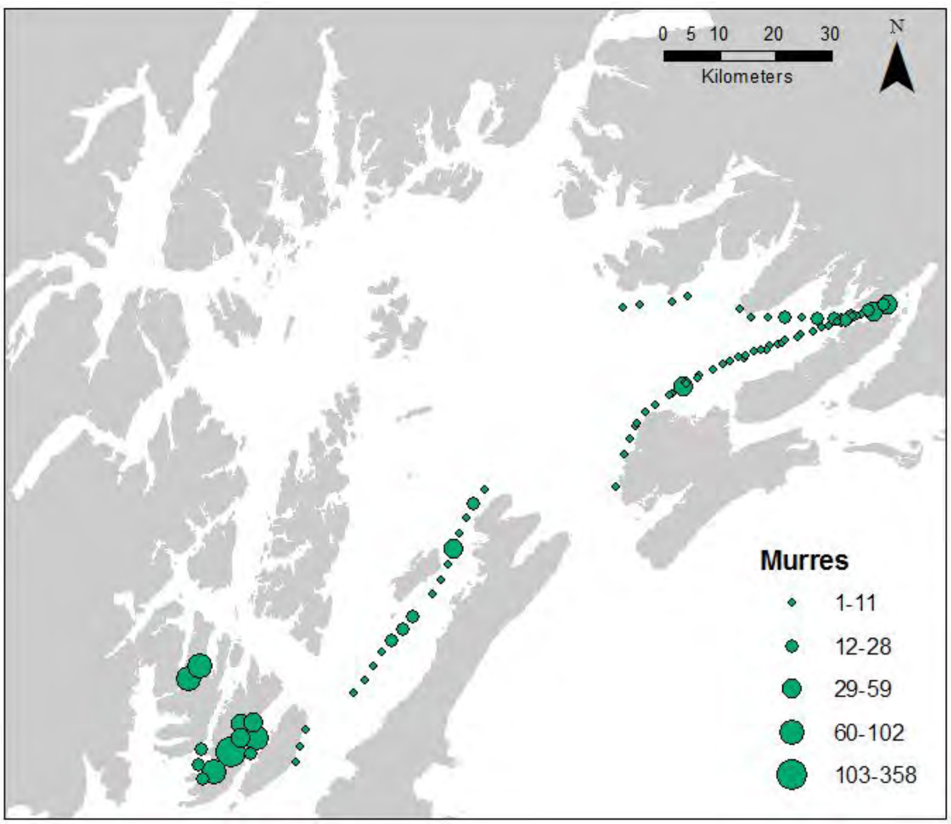


Figure 2: The highest densities of common murres to date were observed in the southwest passages of Prince William Sound during February 2015, immediately prior to the die-off beginning in March 2015.

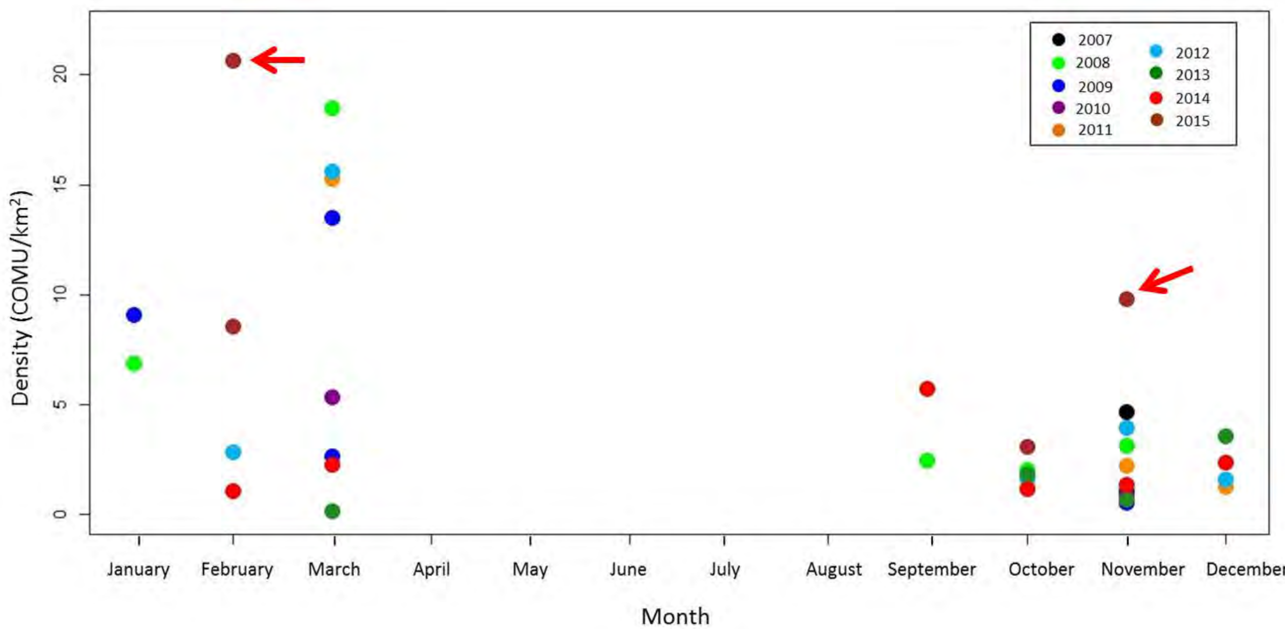


Figure 3: Common murre (COMU) densities by month and year in Prince William Sound, 2007-2015. Dramatic increases in the number of common murre observed during 2015 within Prince William Sound immediately preceded the beginning (March 2015) and the peak (December 2015 and January 2016) of the murre die-off occurring along the Gulf of Alaska (red arrows).

In response to reports of hundreds and thousands of dead common murre carcasses washing up along beaches in the western part of PWS, in January 2016 we conducted an additional survey focused on documenting common murre mortalities as part of a larger collaborative effort involving USFWS, USGS, and GWA scientists. Our survey occurred over a three-day period (January 6-8, 2016) from the R/V New Wave in conjunction with the GWA Long Term Monitoring Oceanographic Conditions in Prince William Sound project (R. Campbell, PWSSC). We counted floating common murre carcasses while traveling between ocean sampling locations (pelagic transects) and carcasses washed up along the shoreline (beach transects). The total sampling effort was approximately 400 km: 378 km pelagic transects, and 22 km of boat-based beach surveys (Figure 4).

Overall, we counted 392 dead murres: 316 on beaches and 76 while traveling (Figure 4). We also collected 6 carcasses for submission to the USGS National Wildlife Health Center in Madison, Wisconsin. While we did not observe high densities of dead murres compared to other reports, our results indicate that the spatial extent of the die-off in PWS was quite large. We observed dead murres on 21% of the 122, 3-km segments of surveyed pelagic transects (Figure 4). These transects covered a wide range of habitat types, including open water, narrow passages, and bays. Further, dead murres were recorded on 7 of the 16 boat-based beach scans.

The larger collaborative response effort by USGS, USFWS, PWSSC, and GWA scientists resulted in 184 km of beach surveys and 451 km of ocean surveyed for dead birds (these numbers include the survey effort by PWSSC described above) from January 1-10, 2016. Approximately 10 km of beaches were walked, with the rest surveyed from boats. On

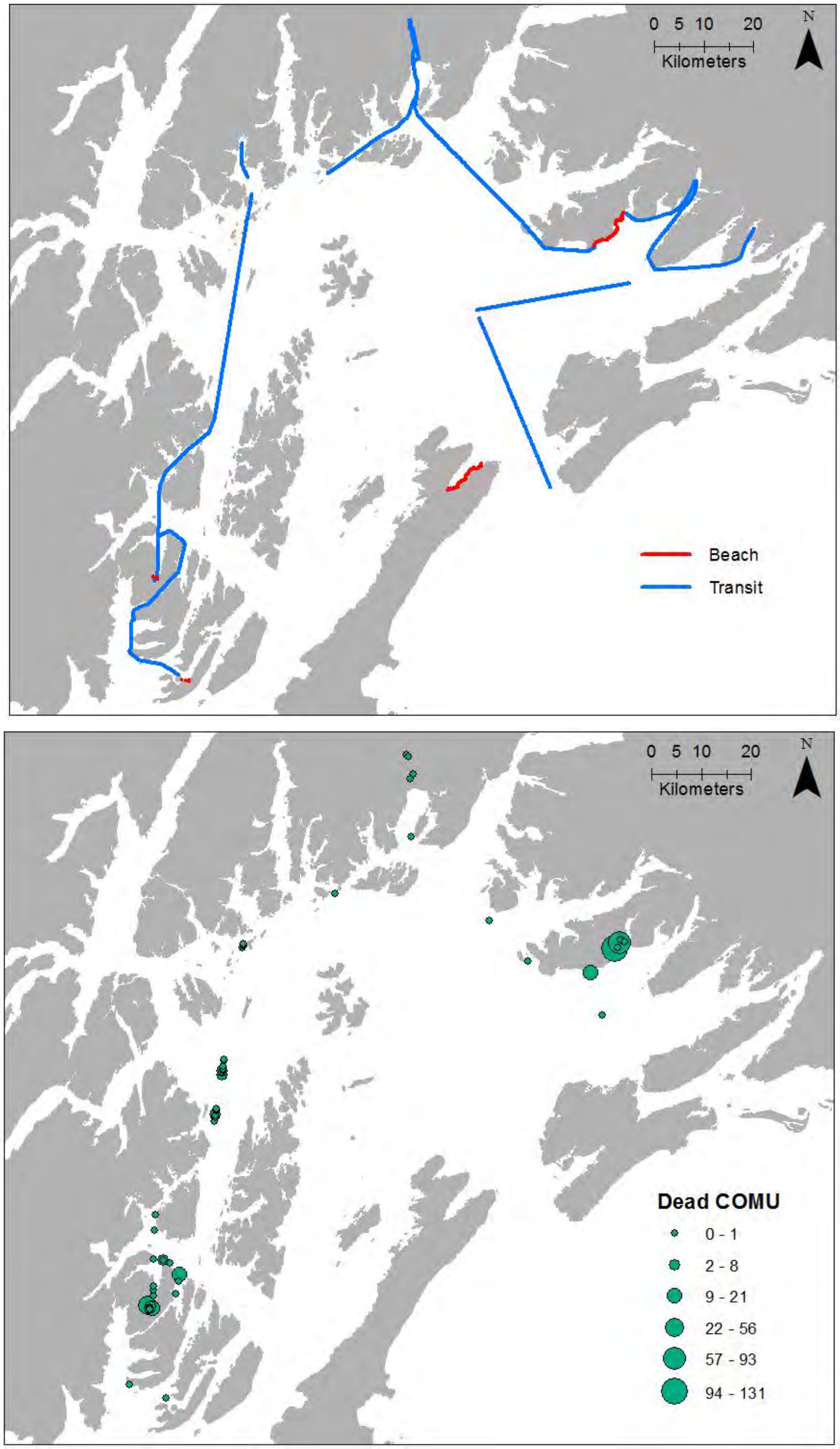


Figure 4: On effort beach (red) and transit (blue) transects (top panel) surveyed for common murre (COMU) carcasses (bottom panel) conducted by Prince William Sound Science Center, January 6-8, 2016.

the beaches 17,293 dead murres were counted (estimated as 21,759 with detectability correction), with the highest densities of carcasses recorded in the northwest region of PWS. At sea, 854 dead murres were counted, resulting in an average density of 3.7 dead birds/km^2, or 33,500 total dead murres when extrapolated to the rest of PWS. However, sampling was not random or systematic, so this extrapolated estimate is biased. Field necropsies of 60 carcasses recovered from PWS revealed that birds were severely underweight compared to average breeding murres in the Gulf of Alaska (n = 219 birds, May-August, 1988-2000). Further, the majority of carcasses displayed strongly emaciated pectoral muscles, zero subcutaneous fat, and stomachs were completely empty. Based on the collaborative surveys, the estimated total murre mortality to date has likely been in the hundreds of thousands (J. Piatt, USGS, pers. comm.).

<u>Comparison of 2014/2015 and 2015/2016 winters.</u> Although this reporting period only covers surveys completed in FY2015, we present data summaries for the 2014/15 winter (n = 6) and the 2015/16 winter (up to November 2015, n = 2), with emphasis placed on the FY2015 surveys (n=4).

During the FY2015 surveys we observed 29 avian species over 1,016 km of survey effort, with an average density of 17.14 ± 31.84 (SD) birds/km^2. When analyzed by winter, during the 2014/15 winter, 33 species were observed over 1,678 km of surveyed tracklines, with an average density of 13.93 ± 39.40 (SD) marine birds/ km^2. Birds were observed in the greatest densities during the first, 12-17 February 2015 survey. To date for the 2015/16 winter, we have observed 25 species in 703 km of survey effort. Average density for the two cruises (October and November) was 13.87 ± 20.55 (SD) marine birds/ km^2 with the highest density recorded during November. These densities are higher than those observed during the same time period during the previous winter (October and November 2014; Table 2).

We observed distinct temporal patterns in species occurrence over both winters, emphasizing the importance of not characterizing the nonbreeding season as a single time period when describing marine bird communities (Figure 5, Table 2). As in previous years, common murre was the most numerous species observed during the winter marine bird surveys, with density peaking in February 2015 during the first OTN maintenance survey. Across both winters, murres were distributed throughout PWS with the largest congregations occurring in the southwestern and northeastern portions of the Sound (Figures 2, 6, & 7).

The highest densities of *Brachyramphus* murrelets were observed in February (first OTN survey, 2014/15 winter) and November (2015/16 winter). The lowest densities of *Brachyramphus* murrelets were recorded in September (2014) and October (2015) when murrelets emigrate from PWS to complete their pre-basic molt. Similar to murres, murrelets were clustered primarily in the northeastern and southwestern regions of PWS (Figures 6 & 7). Black-legged kittiwakes were broadly distributed throughout PWS in both winters (Figures 6 & 7) with densities peaking in September during winter 2014/15. Interestingly, in 2015 there were still high densities of kittiwakes observed in PWS into mid-November. Typically, kittiwakes disperse to overwintering areas outside of PWS immediately after the breeding season (McKnight et al. 2011). During winter 2014/15, loons were recorded primarily in the northeastern and southwestern parts of PWS (Figures 6 & 7), with densities peaking in November 2014. So far for winter 2015/16, loons were sparsely distributed throughout the Sound, with the highest density observed in November.

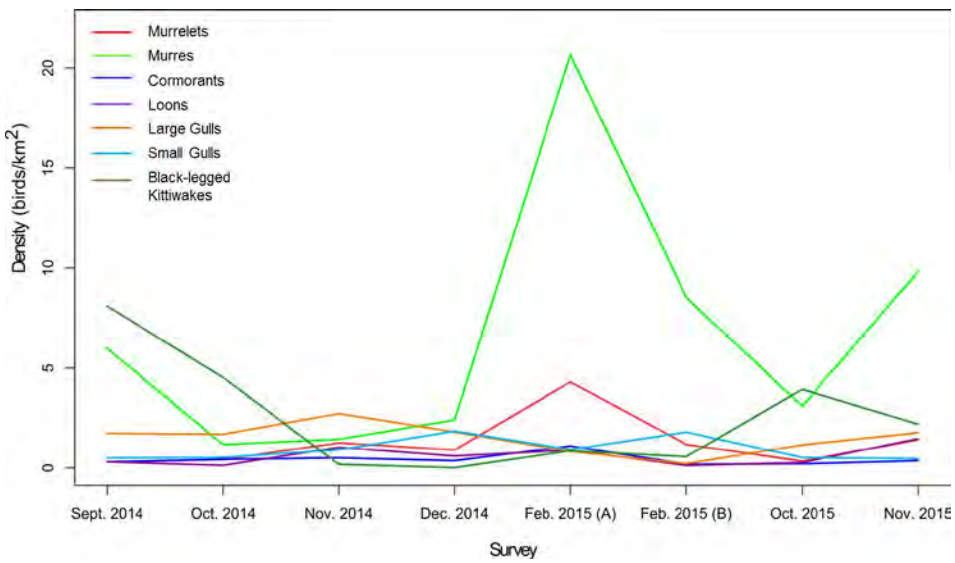


Figure 5. Observed densities of the most abundant species groups during winters 2014/15 and 2015/16 in Prince William Sound. The four surveys during 2015 were completed during this reporting period. Note the large spike of common murres in February 2015, coinciding with the die-off that began in the Gulf of Alaska during March 2015.

Table 2. Density (birds/km^2 $\pm$ SE) of main species groups observed within the 300 m transect strip during winters 2014/15 (top) and 2015/16 (bottom). Highest density values for each species group by winter are indicated in bold.

Species or Species Group	**2014**				**2015**	
	September	**October**	**November**	**December**	**February (A)**	**February (B)**
Murrelets	0.29 (0.10)	0.41 (0.11)	1.26 (0.34)	0.90 (0.18)	**4.30 (0.97)**	1.17 (0.34)
Murres	5.97 (1.96)	1.17 (0.48)	1.43 (0.36)	2.40 (0.66)	**20.65 (6.25)**	8.53 (2.17)
Cormorants	0.29 (0.08)	0.43 (0.25)	0.50 (0.18)	0.36 (0.09)	**1.10 (0.42)**	0.18 (0.09)
Loons	0.29 (0.11)	0.12 (0.04)	**1.03 (0.37)**	0.59 (0.22)	0.89 (0.42)	0.12 (0.07)
Mergansers	0 (0)	0.10 (0.05)	0.05 (0.03)	**0.11 (0.10)**	0 (0)	0 (0)
Large Gulls	1.73 (0.53)	1.69 (0.34)	**2.72 (0.53)**	1.80 (0.35)	0.83 (0.23)	0.21 (0.10)
Small Gulls	0.50 (0.42)	0.52 (0.17)	0.91 (0.30)	**1.84 (0.59)**	0.92 (0.34)	1.79 (1.41)
Black-legged Kittiwakes	**8.09 (4.71)**	4.52 (1.81)	0.18 (0.09)	0.01 (0.01)	0.86 (0.38)	0.56 (0.14)
Scoters	0.08 (0.07)	0.12 (0.06)	0.16 (0.09)	0.08 (0.04)	**0.51 (0.46)**	0.06 (0.06)
Grebes	0.08 (0.06)	0.09 (0.05)	**0.11 (0.06)**	0.06 (0.04)	0 (0)	0 (0)
Long-tailed Ducks	0 (0)	0 (0)	0 (0)	0.05 (0.03)	**0.62 (0.48)**	0 (0)
Harlequin Ducks	0.02 (0.02)	0.07 (0.03)	0.03 (0.03)	0.01 (0.01)	**0.25 (0.21)**	0 (0)
Inshore Ducks	0 (0)	**0.49 (0.39)**	0.20 (0.16)	0.02 (0.02)	0 (0)	0 (0)
Total	17.35 (5.71)	9.75 (2.14)	8.58 (1.39)	8.25 (1.29)	30.94 (7.24)	12.62 (2.56)

Species or Species Group	**2015**	
	October	**November**
Murrelets	0.33 (0.14)	**1.42 (0.34)**
Murres	3.08 (0.45)	**9.82 (1.51)**
Cormorants	0.20 (0.06)	**0.36 (0.08)**
Loons	0.26 (0.13)	**1.47 (0.88)**
Mergansers	**0.11 (0.08)**	0.07 (0.07)
Large Gulls	1.15 (0.24)	**1.76 (0.44)**
Small Gulls	**0.52 (0.20)**	0.46 (0.09)
Black-legged Kittiwakes	**3.93 (0.64)**	2.19 (0.77)
Scoters	**0.10 (0.07)**	0.04 (0.03)
Grebes	0.03 (0.02)	**0.04 (0.03)**
Long-tailed Ducks	0 (0)	**0.03 (0.03)**
Harlequin Ducks	**0.07 (0.05)**	0.04 (0.02)
Inshore Ducks	**0.63 (0.34)**	0.15 (0.09)
Total	10.44 (1.23)	17.87 (2.60)

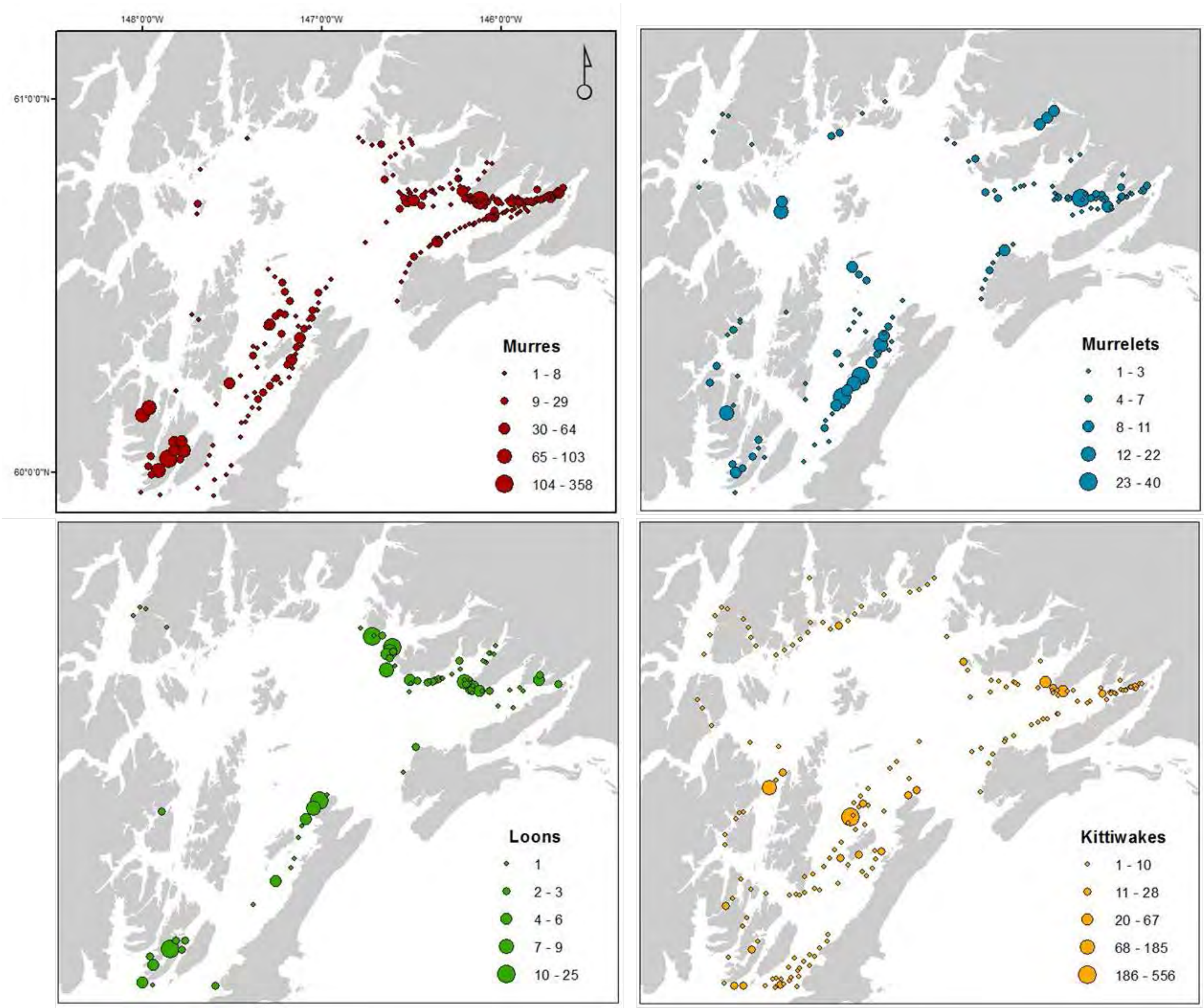


Figure 6. Distribution of common murre, *Brachyramphus* murrelets (Kittlitz's and marbled murrelets), loons (common loon, Pacific loon, red-necked loon, and yellow-billed loon) and black-legged kittiwakes recorded during winter 2014/15 surveys (*n* = 6) in Prince William Sound. Note that scales for each figure legend vary by species.

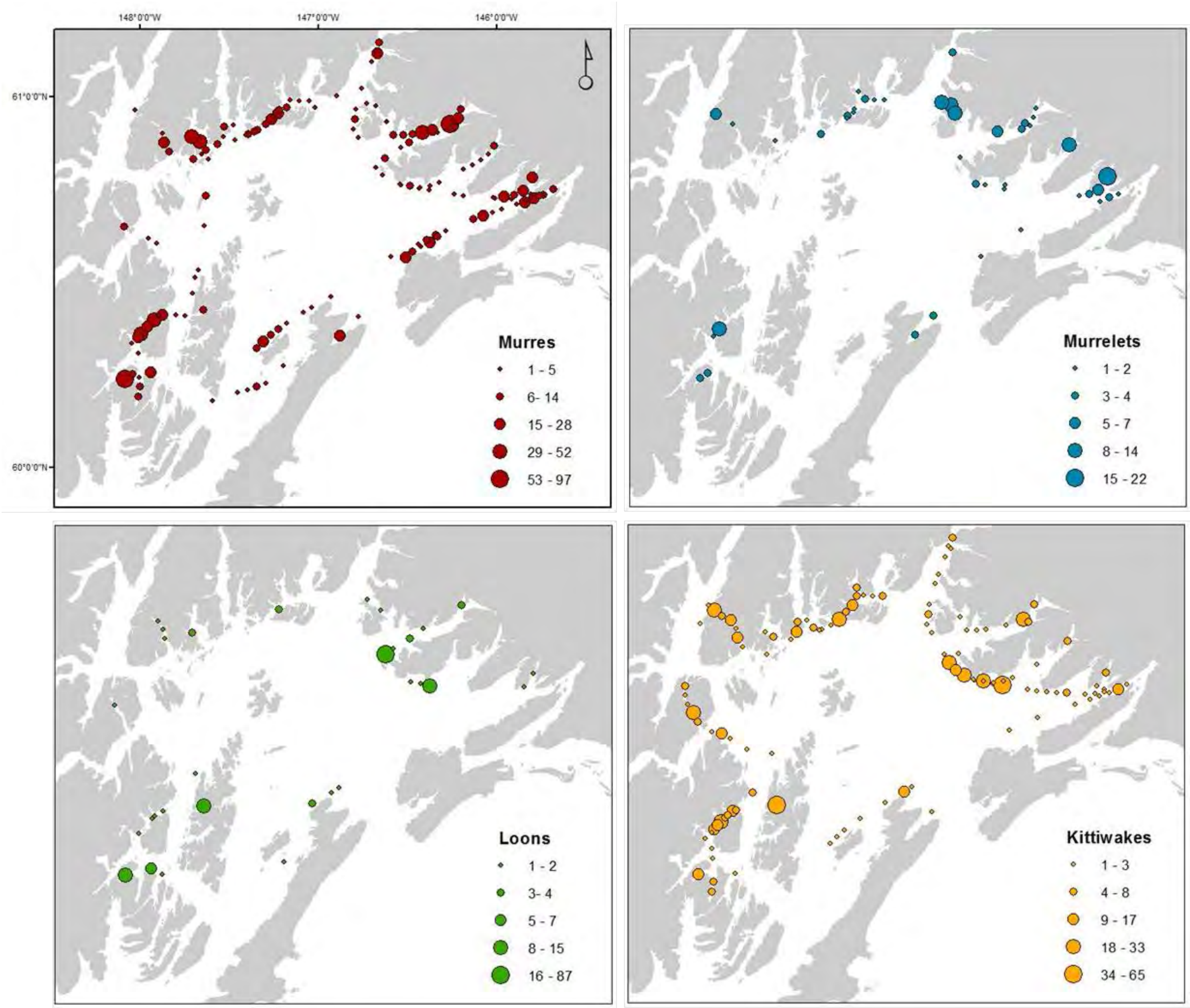


Figure 7. Distribution of common murre, *Brachyramphus* murrelets (Kittlitz's and marbled murrelets), loons (common loon, Pacific loon, red-necked loon, and yellow-billed loon) and black-legged kittiwakes recorded during October & November 2015 surveys ($n = 2$) in Prince William Sound. Note that scales for each figure legend vary by species.

Modeling by Quanticipate Consulting

We continue to work with Dr. Ali Arab of Quanticipate Consulting modeling habitat associations using zero-inflated Poisson (ZIP) models. These types of models incorporate zeros that we suspect are due to lack of detection of birds that were present. Exploratory data analyses have been completed, and we are now extending the current analyses to spatial and spatio-temporal analyses. Using the first seven winters of data, we developed a spatial Poisson hurdle model to explore geographic variation in marbled murrelets while accounting for zero inflation.

For future analyses, we will expand our data set to cover nine winters (2007/2008 – 2015/2016 winters). Our plan is to submit a manuscript detailing our findings for submission as part of the joint long-term programs' special issue of Deep Sea Research II.

Future Work

In 2016 marine bird observations will be conducted in February (Ocean Tracking Network maintenance cruise), October (Alaska Department of Fish & Game spot shrimp cruise), and November (EVOS Herring Research & Monitoring). We are still awaiting confirmation on GWA whale cruises for FY2016.

In addition to our modeling efforts with Quanticipate Consulating, beginning in spring 2016 we will begin an analysis to evaluate associations between Pacific herring and marine birds during winter. Pacific Herring (*Clupea pallasii*) was identified as a resource injured by the 1989 Exxon Valdez Oil Spill. Concurrent with the decline in Pacific herring abundance, several marine birds wintering in PWS have demonstrated a reduced capacity to recover post-oil spill, a phenomena that may be related to reduced forage fish availability. Despite the dynamic association between marine birds and forage fish, few studies have addressed seabird-herring relationships during winter months and the potential for effects on population recovery.

For this study we will use seabird observation data collected concurrently with hydroacoustic herring surveys in PWS during November and March cruises (2008-2012). Analysis of these data will allow us to:

- Characterize the abundance and distribution of seabird predators in relation to prey abundance and distribution and habitat characteristics;
- Identify habitats and characteristics of seabird-associated and seabird-non-associated fish schools;
- For seabird-associated schools, characterize the key habitats and fish school features influencing the abundance of marine birds selecting the schools.

We will prepare a manuscript detailing our findings for submission as part of the special issue of Deep Sea Research II.

Milestones/Deliverables

No milestones were scheduled to be completed in FY2015. Below is an update on our progress.

Deliverable/Milestone	Status
Characterize the spatial and temporal abundance of seabirds in PWS during late fall and winter.	Conducted marine bird surveys from vessels of opportunity in February, October, and November for a 1016 km of survey effort. Patterns of distribution and abundance are summarized in this report.
Model species abundance and distribution within and across winters in relation to biological and physical environmental factors.	We continue to work with Dr. Ali Arab of Quanticipate Consulting to model these relationships. Using the first seven winters of data, we developed a model to explore geographic variation in marbled murrelets. We are now extending the analyses to include nine winters and other species groups.
Relate species composition and distribution to prey fields.	Hydroacoustic data are currently being processed and analyses will begin in spring 2016. We will prepare a manuscript detailing our findings for submission as part of the special issue of Deep Sea Research II.
Identify critical marine habitats used by seabirds during late fall and winter.	Analyses using nine winters of survey data from vessels of opportunity are on-going.
Submit year 5 work plan	Year 5 work plan was prepared and provided to Trustee Council staff. Plan was approved during the November 2015 EVOSTC meeting.
Submit annual project report	This document constitutes report submission.

References

Bishop, M.A. and K.J. Kuletz. 2013. Seasonal and Interannual Trends in Seabird Predation on Juvenile Herring. *Exxon Valdez* Oil Spill Restoration Project Final Report (Project 10100132-H), Prince William Sound Science Center, Cordova, Alaska.

Campbell, R. 2016. Surface layer and bloom dynamics observed with the Prince William Sound autonomous profiler. Presentation for 2016 Ocean Sciences Meeting, New Orleans, LA.

Dawson, N., M.A. Bishop, K. Kuletz and A. Zuur. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. *Northwest Science* 89:111–128.

McKnight, A., D. B. Irons, A. J. Allyn, K. M. Sullivan, R. M. Suryan. 2011. Winter dispersal and activity patterns of post-breeding black-legged kittiwakes *Rissa tridactyla* from Prince William Sound, Alaska. Marine Ecology Progress Series 442: 241–253.

USFWS. 2007. North Pacific pelagic seabird observer program observer's manual, inshore/small vessel version, November 2007. U.S. Fish and Wildlife Service, Migratory Bird Management Nongame Program, Anchorage, Alaska. Unpublished protocol manual, 25 pp.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

Coordination and collaboration is critical to this project as all our surveys require placing an observer on vessel charters associated with other projects. During FY2015 we placed an observer on EVOS PWS Herring Research & Monitoring program (November), as well as the Alaska Department of Fish and Game spot shrimp survey (October) and Ocean Tracking Network annual maintenance cruise (February) (Table 1). We also collaborated with the GulfWatch Alaska zooplankton survey for PWS in order to conduct the January 2016 murre survey.

When not conducting daytime marine bird surveys, the bird observer assists the other projects when possible. During the past year, assistance has included helping set and pick shrimp pots and process their contents, helping process the catches from plankton trawls, fish trawls, and gill nets, and collecting and processing stratified water samples.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

Publications:

Bishop, M.A., J. Watson, K. Kuletz, and T. Morgan. 2015. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography* 24(1):1–13.

Dawson, N., M.A. Bishop, K. Kuletz and A. Zuur. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. *Northwest Science* 89:111–128.

Popular Press:

Bishop, M.A. 2016. Seabird die-off in Prince William Sound. *The Cordova Times*, January 8, Page 1.

Schaefer, A. L. 2015. Fish, birds, whales- they're all connected! *Delta Sound Connections* (circulation ~15,000). This annual newspaper published about the natural history of PWS and the Copper River Delta is distributed each May to airports and tourist areas in southcentral Alaska.

Posters:

Bishop, M.A., K. Kuletz, J. Stocking, and A. Schaefer. 2016. Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, Alaska. Alaska Marine Science Symposium, Anchorage, AK.

Lindeberg, M., M. Arimitsu, M.A. Bishop, D. Cushing, R. Kaler, K. Kuletz, et al. 2016. Population trends of Top Predators and Prey in PWS. Alaska Marine Science Symposium, Anchorage, AK.

Presentations:

Kuletz, K.J., H. Renner, R. Kaler, J. Parrish, B. Bodenstein, J. Piatt, and M.A. Bishop**.** 2016**.** Seabird Die-off events, 2014-2016. Workshop on Unusual Mortality Events. Alaska Marine Science Symposium, Anchorage, AK.

Meetings

Bishop participated in the Herring Research Monitoring/Gulf Watch Alaska synthesis meeting during February 2015 in Anchorage. Bishop also participated in the Gulf Watch Alaska meeting for Principal Investigators in November 2015 in Anchorage and attended the Gulf Watch Alaska meeting during January 2016 at Alaska Marine Science Symposium via teleconference. Bishop also attended the quarterly teleconference meetings of Gulf Watch Alaska principal investigators.

Schaefer attended the Gulf Watch Alaska meeting and presented the poster "Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, Alaska" in January 2016 at Alaska Marine Science Symposium.

Data:

Datasets and associated metadata through November 2015 have been uploaded to the Gulf Watch Alaska portal.

Data from the January 2016 murre survey were made available to collaborators at the USGS and USFWS.

In January 2016 we met with Stacey Buckelew of Axiom Consulting to discuss project metadata and address changes or additions that were needed.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

No issues were raised by the most recent EVOSTC review.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

The contract cost of Dr. Ali Arab of Quanticipate Consulting for conducting the habitat association analyses is coming out of money originally designated for personnel since it was not initially budgeted. Travel to the annual PI meeting in November 2015 for Bishop and to AMSS 2016 for Schaefer was charged to the project, although it was not initially budgeted.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$46.0	$70.0	$72.0	$74.3	$77.3	$339.6	$240.1
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$5.4
Contractual	$1.4	$2.1	$2.1	$2.1	$1.8	$9.5	$20.3
Commodities	$0.0	$0.0	$0.1	$0.1	$0.1	$0.3	$3.3
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (will vary by proposer)	waived	waived	waived	waived	waived	waived	
SUBTOTAL	$47.4	$72.1	$74.2	$76.5	$79.2	$349.4	$269.0
General Administration (9% of subtotal)	$4.3	$6.5	$6.7	$6.9	$7.1	$31.5	$24.2
PROJECT TOTAL	$51.7	$78.6	$80.9	$83.4	$86.3	$380.9	$293.2
Other Resources (In kind Funds)	$10.5	$45.5	$63.5	$63.5	$63.5	$246.5	$183.0

$246.50

FY12-16

Project Title:15120114-C Long-term monitoring of seabird abundance & habitat associations during late fall & winter in PWS
Project PI: M.A. Bishop

FORM 3A
NON-TRUSTEE AGENCY
SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-D

2. Project Title: *See,* Reporting Policy at III (C) (2).

Gulf Watch Alaska Program - Data Management

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Rob Bochenek

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

Gulf Watch website: www.gulfwatchalaska.org

AOOS Workspace Gulf Watch group: https://workspace.aoos.org/group/5186/projects

AOOS Gulf of Alaska Data Portal, Gulf Watch published project data: http://portal.aoos.org/gulf-of-alaska.php#module-search?1g=5040a46e-25db-11e1-94b9-0019b9dae22b&page=1&tagId=91&q=

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

The data management team (henceforth 'Axiom') continues to provide core data management support and services to Gulf Watch Alaska (GWA), an *Exxon Valdez* Oil Spill Trustee Council (EVOSTC)-funded long-term monitoring (LTM) program. The focus continues to be on refining protocols for data and metadata transfer, data formatting and metadata requirements, improving search and discovery services, and salvage of historic data for both those data funded by the EVOSTC and ancillary historic data from other projects.

Axiom has participated in regular GWA Program principal investigator (PI) meetings, including the in-person meetings in November 2015 and January 2016, and is coordinating activities between the Herring Research and Monitoring (HRM) and GWA programs. Based on feedback acquired from the EVOSTC Science Panel and staff, Axiom recruited and hired the data coordinator, Ms. Stacey Buckelew, who began work on the project in June 1, 2015. Axiom continues to work with the Program Management Team to follow up on recommendations developed through the January 29-30, 2014 Data Review Workshop. Further, one-on-one meetings have been held with each of the GWA and HRM PIs and/or data managers to help meet data submission benchmarks, improve metadata quality, and homogenize the use of data management best practices across LTM program PIs.

The Alaska Ocean Observing System (AOOS)'s Ocean Research Workspace, rolled out to PIs in Year 1, continues to be used as the internal staging area for PI data and work products. The

Workspace contains individual PI user and group profiles in which data can be submitted and shared among project collaborators. To assist PIs in proficiently and efficiently using the Workspace, Axiom staff continues to provide training via webinars and support through email and in-person meetings. GWA Program PIs continue to use the system to organize and consolidate their project level data. Software engineers at Axiom provide support for the Workspace, resolve bugs and implement new functionality in response to user feedback.

Data from the GWA Program is a key component of the AOOS Gulf of Alaska Data Portal. The portal showcases GWA data once it becomes public alongside other environmental data sets.

Table 1 provides an overview of the status of achieving objectives. A more detailed summary of work toward objectives follows.

Table 1. Project Milestone Status

Objective/Deliverable/Milestone	**Status**
Objective 1: Provide data management oversight and services, including data structure optimization, metadata generation & data transfer. Audit data and restructure and reorganize for public access.	Ongoing ● All 2012, 2013, and 2014 data posted on Workspace.
Objective 2: Consolidate, standardize, and provide access to study area data sets that are critical for retrospective analysis, synthesis, and model development.	Ongoing ● Axiom data analysts continued to add additional data layers to the Gulf of Alaska Data Portal
Objective 3: Develop tools for user groups to access, analyze, and visualize information produced by the GWA effort.	Ongoing ● Portal search was rebuilt. ● Data manifest view of GWA assets was developed and added to the portal to provide simple, inventory view of the outputs of the EVOSTC LTM effort ● Four-dimensional (4D) visualization system developed for three dimensional (3D) time series, currently in pre-beta testing ● Applicable GWA data sets continue to be converted to network common data form (netCDF) for early 4D demo and long-term preservation and archiving
Objective 4: Integrate all data & metadata into AOOS data system and Gulf of Alaska Data Portal for long term storage and public use.	Ongoing ● Axiom is in the early research and scoping stages of making AOOS data portal a DataONE node. ● With other funding, AOOS/Axiom is developing protocols for semi-automating archiving to federal National Center for Environmental Information archive.

Objective 1

The primary results produced by this project include the acquisition and documentation of GWA PI-produced data sets and the aggregation of ancillary environmental data sets for integration into the AOOS Gulf of Alaska Data Portal. As such, the increased use of the Workspace by PIs is represented in the figures below (Figures 1-3).

All 2014 data are now posted on the Workspace, per the Program Management data sharing protocols, with 2014 data from 12 of 16 projects made publicly available through the AOOS Gulf of Alaska Data Portal. Further, Axiom continues to improve the Ocean Workspace in response to feedback from the PIs and other users.

The Ocean Workspace is used by GWA Program Managers, PIs, and project team members to facilitate many of the logistical, curatorial, and preservation-oriented aspects of data collection and management. Improvements to the Workspace, while not explicitly funded as a part of the GWA Data Management project, have and will continue to be made based on feedback from users. In 2015, the Workspace metadata editor was expanded to include a data and metadata file tracking tool for project administrators. This tool eases data management by providing a transparent view of each project's data submissions, metadata record completeness, and data publication to the Portal.

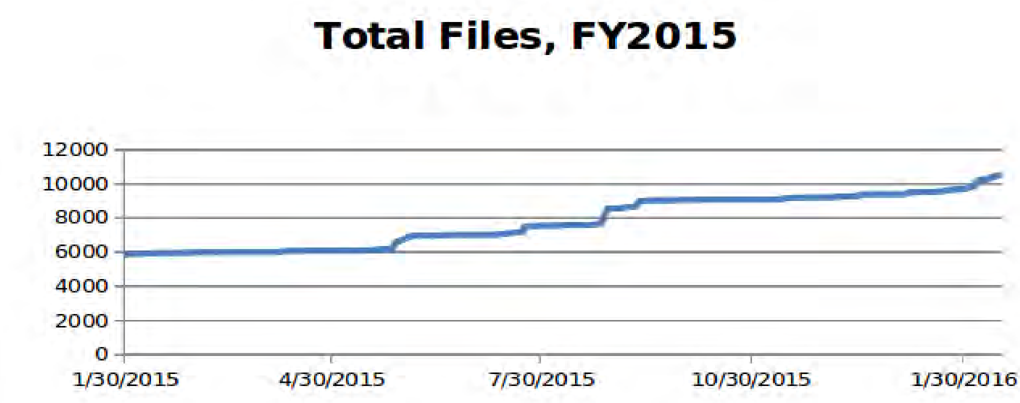


Figure 1. The number of files uploaded by GWA team members in FY 2015.

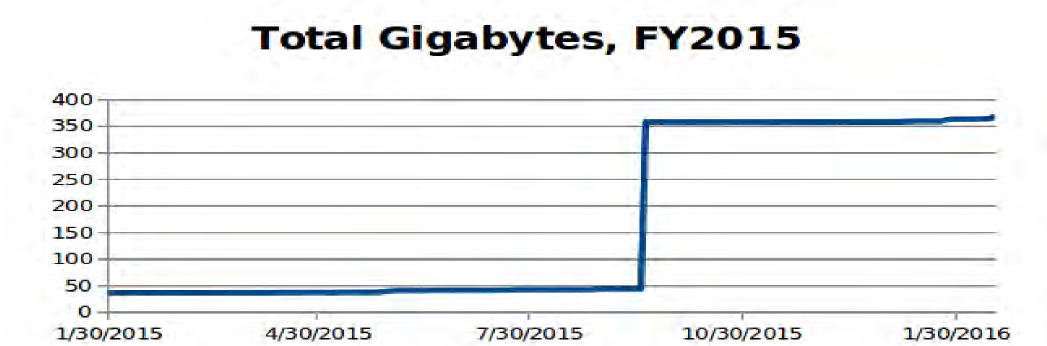


Figure 2. The amount of total storage in gigabytes used by GWA team members in FY 2015.

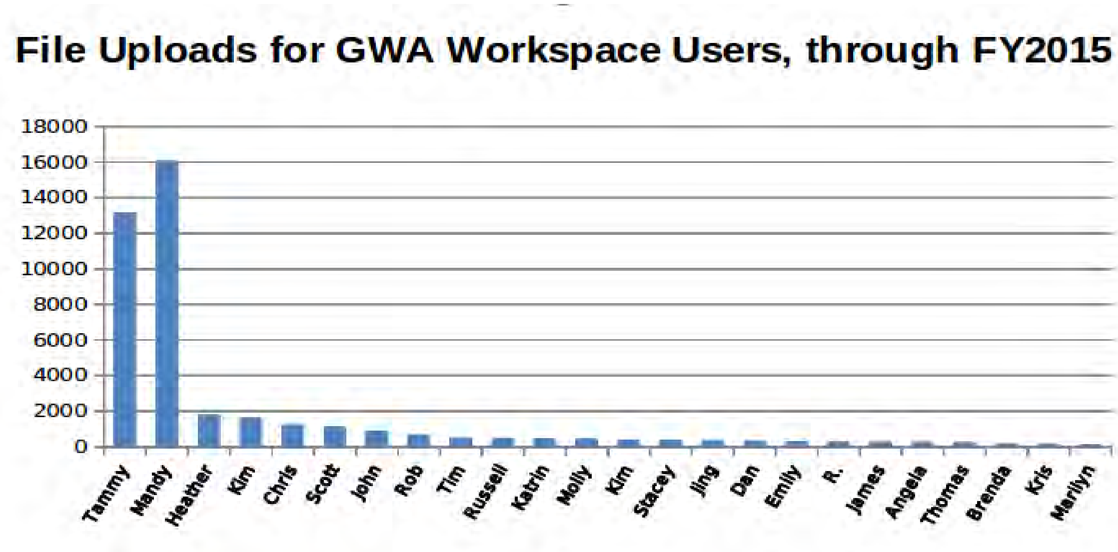


Figure 3. The distributions of file upload effort across individual GWA users through FY2015.

The Ocean Workspace

The Ocean Workspace is a web-based data management application built specifically for storing and sharing data among members of scientific communities. GWA PIs and their teams use the Workspace as an internal staging area prior to public release of data through the AOOS Gulf of Alaska Data Portal. In addition to the GWA program, 36 other distinct regional, national, and private research efforts currently use the Workspace, which has more than 480 active individuals sharing more than 800,000 digital files across more than 1300 distinct projects. The Workspace provides users with an intuitive, web-based interface that allows scientists to create projects, which may represent scientific studies or particular focuses of research within a larger effort. Within each project, users create topical groupings of data using folders and upload data and contextual resources (e.g., documents, images and any other type of digital resource) to their project by simply dragging and dropping files from their desktop into their web-browser. International Standard Organization (ISO) 19115-2 compliant metadata can be generated for both projects and individual files. Users of the Workspace are organized into campaigns, and everyone within a campaign can view the projects, folders and files accessible to that campaign. This allows preliminary results and interpretations to be shared by geographically or scientifically diverse individuals working together on a project or program before the data is shared with the public. It also gives program managers, research coordinators and others a transparent and front-row view of how users have structured and described projects and how their programs are progressing through time. The Workspace has the following capabilities:

> *Secure group, user, and project profiles* — Users of the Workspace have a password protected user profile that is associated with one or more disciplinary groups or research programs. The interface allows users to navigate between groups in which they are involved through a simple drop down control. Transfer of data and information occur over Secure Socket Layer (SSL) encryption for all interactions with the Workspace. The Workspace supports authentication through Google accounts, so if users are already logged into their Google account (e.g., Gmail, Google Docs, etc.), they can use the Workspace without creating a separate username and password.

Metadata authoring — Because the Workspace is a cloud-based service, researchers can move between computers during the metadata generation process in addition to allowing team members and administrators to simultaneously review and edit metadata in real time.

Metadata elements currently available to researchers in the Workspace are common to the Federal Geographic Data Committee (FGDC) designed Content Standard for Digital Geospatial Metadata (CSDGM) and the ISO 19115 standards for geospatial metadata, extended with the biological profiles of those standards. Axiom also developed an integrated FGDC biological profile extension editor that allows users to search the ~625,000 taxonomic entities of the Integrated Taxonomic Information System (ITIS) and rapidly generate taxonomic metadata.

To support the multidisciplinary approach of many projects in the GWA program, PIs can author metadata records at both a project and individual file level. File level allows the PI to provide metadata fields that define the attributes of the data file in a standards-compliant format. Figures 4 and 5 demonstrate the metadata interface.

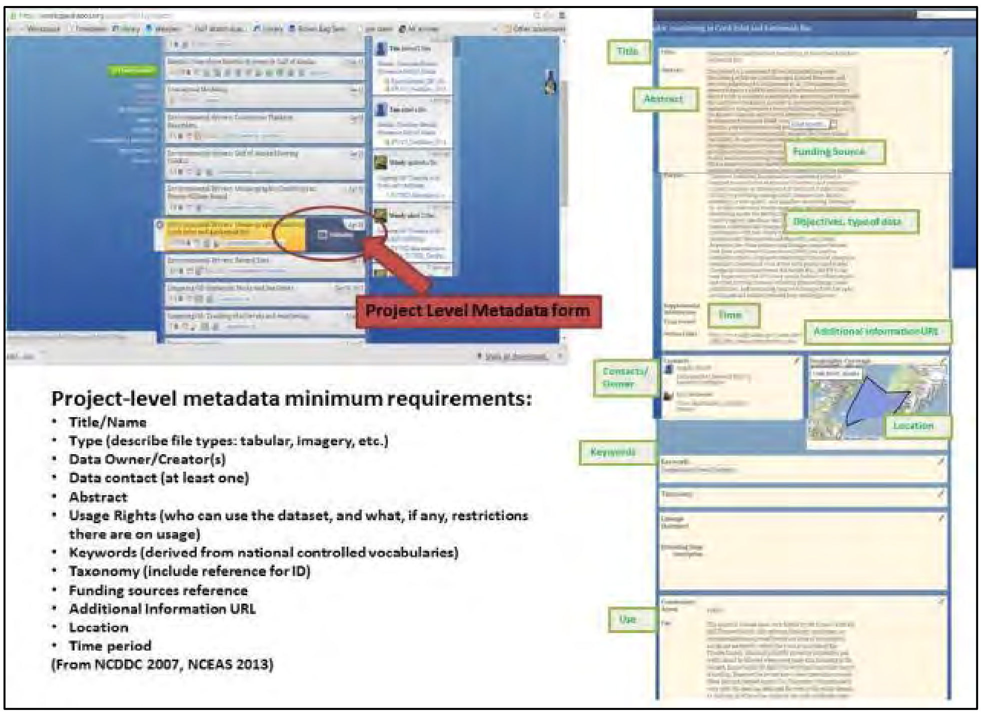


Figure 4. A screenshot of the Workspace project-level metadata interface. The interface allows the authoring of standards-compliant metadata content, including basic descriptive and citation metadata fields, description of the project's geographic extent, keywords, taxonomic information and data constraints. The suggested minimum metadata content for usefully descriptive metadata is included as a reference.

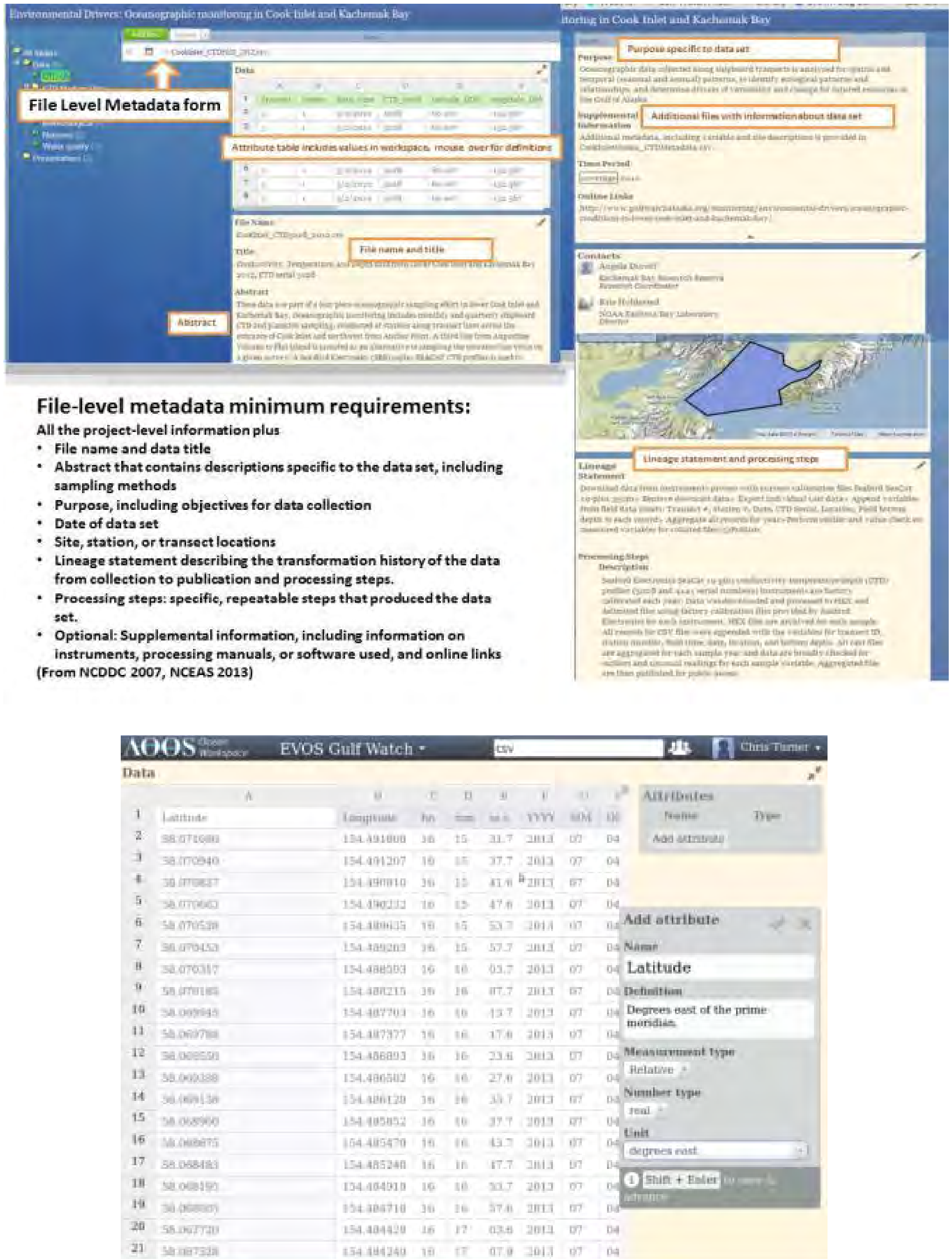


Figure 5. Screenshots of the Workspace interface for file-level metadata. The interface allows the authoring of standards-compliant metadata content, including basic descriptive and citation metadata fields, description of the project's geographic extent, keywords, taxonomic information, data constraints, and descriptive information about the attributes of the data set. The suggested minimum metadata content for usefully descriptive metadata is included as a reference. Additionally, included in the lower figure is a screenshot of the interface for editing attributes in tabular data files.

Advanced and secure file management — A core functionality of the Workspace is the ability to securely manage and share project-level digital resources in real-time with version control among researchers and study teams. Users of the Workspace are provided with tools that allow them to bulk upload files, organize those documents into folders or collections, create, contextualize, and sort projects with predefined and user-created tags, and control read and write permissions on files within projects. The Workspace also has the ability to track file versions: if a user re-uploads a file of the same name, the most current version of the file is displayed, but access is provided to past versions as well (Figure 6).

Figure 6. Screenshots of project and file management in the Workspace. The first screenshot shows a list of projects to which the example user has access rights. The second screenshot displays the interface a researcher would use to organize independent files into folders, and the way two versions of the same file are tracked by the Workspace.

Objective 2.

The AOOS Gulf of Alaska Data Portal consolidates and standardizes relevant study area datasets to provide GWA PIs with access to a large, diverse set of valuable information for retrospective analysis, synthesis, and model development. This information can be accessed alongside GWA program data that have been shared publicly through the AOOS Gulf of Alaska Data Portal, where data are available for use by managers and scientists with EVOSTC agencies. AOOS data management has worked with several data consumers within U.S. Geological Survey (USGS), National Park Service, Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Administration (NOAA) in accessing and using data contained within this data portal. The Ocean Workspace is also being used by the North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program. Historic data acquired through that program are also being provided to GWA PIs. By leveraging the work done by other research, modeling, and monitoring efforts in the Gulf of Alaska, the GWA program contributes to a deeper understanding of the Gulf of Alaska ecosystem. In 2015, Axiom data analysts continued to add additional data layers to the Gulf of Alaska portal to provide PIs access to more diverse environmental information.

Objectives 3 and 4.

In 2015, Axiom maintained and expanded upon the AOOS Gulf of Alaska Data Portal. The data portal integrates data and project information produced by GWA researchers with more than 300 additional geographic information system (GIS), numerical modeling and remote sensing data resources specifically for the Gulf of Alaska region. The team leveraged the AOOS portal, which was developed using other funding and had these additional features: an improved integrated search catalog which allows users to search by category or keyword, ability to preview data before downloading files, and advanced visualization tools. Once the program's monitoring data have been ingested into the Ocean Workspace, quality controlled, and approved as final, they are then ingested into the Gulf of Alaska Data Portal for full public access. In this reporting period, a new search feature was added to the portal to enhance data discovery by the user. When searching data in the catalog, the user can now opt to search for content using a manifest view. This tabular list of data allows more information to be viewed on the page at one time, and it will expedite access time for users seeking specific datasets.

During 2015, new features were added to the AOOS data system, the benefits of which are shared by the GWA program and the other research groups supported by or working with AOOS. These improvements are presented below based on work completed in 2015 and work underway (initiated in previous years and under development and work initiated in 2015).

During this reporting period, Axiom also met with National Center for Ecological Analysis and Synthesis (NCEAS) investigator Matt Jones to coordinate future activities, including the integration of historical datasets into the Ocean Workspace for publication through the DataOne node. Work is underway and target completion date is the end of 2016.

Using other funding secured by AOOS, the Axiom team is working with NOAA's National Centers for Environmental Information to streamline archiving of AOOS data into the federal archives.

Table 2 outlines the process by which GWA and HRM program data are entered, reviewed and made public.

Table 2. Gulf Watch Alaska and Herring Research and Monitoring programs: Data life cycle.

	PIs	**Program Mgmt Team**	**AXIOM**	**NCEAS**	**EVOSTC & Trustee agencies**
Data collection & any telemetry	PI/agency responsibility; established sampling protocols for each component.	Review & maintain sampling Standard Operating Procedures (SOPs). Coordinate, with Science Coordinating Committee, consistency in sampling across the program.	Store current SOPs within Ocean Research Workspace.		Fund data collection projects and programs. Establish basic requirements quality data, well documented, publicly accessible, archived.
QA/QC	PI responsibility based on agency or entity requirements. Documentation of instrument calibration & data QA/QC procedures to be included in sampling SOPs & project metadata.	Review QA/QC documentation before accepting data. Limited QA/QC performed on metadata to ensure it has required information (e.g.,	Working with GWA program science coordinator, specific datasets are aggregated together and reviewed for problems to prepare for	For historical data, limited QA/QC (e.g., columns, domain, units) is performed and provided in metadata documentation to ensure it has required	Establish clear requirements for program and coordinate on agency data standards.

	PIs	Program Mgmt Team	AXIOM	NCEAS	EVOSTC & Trustee agencies
		date, time, location, etc.) and data fields are appropriately documented (e.g., units in column headers).	synthesis efforts. Mostly rely upon PI for QA/QC.	information. If original PIs are unavailable then any issues are simply noted in metadata.	
Metadata	PI responsibility to provide metadata according to agency and team standards.	Works with PIs & data team to develop requirements. Assists PIs & reviews project level and file level metadata files.	Metadata can be created through the Workspace on the project level or file level using the ISO suite of protocols with taxonomic extensions (ITIS). Other metadata formats can be incorporated as well.	For historical data projects, NCEAS researches data and provides metadata as available to reconstruct the data set. Metadata are extracted from reports, papers, and other available materials. Metadata are provided in EML format using tools developed at NCEAS (web entry, and Morpho entry).	Coordinate on agency metadata requirements and standards.
Internal data access and staging	Post data on Ocean Research Workspace as soon as possible, but no later than 1 year after collection.	Keeps records of data availability. Assists PIs in posting data on Ocean Research Workspace. Coordinates with Axiom/AOOS and NCEAS on user requirements for Workspace.	Provide Workspace as internal staging area for use by team. Work w/team to develop additional functionality for team use. Workspace is highly leveraged tool that is password protected.	Use Redmine ticket system to track the lengthy process of finding, acquiring, and processing historical data. As data are processed, they are inserted as private objects into the GoA Member Node, and then made public as the documentation is completed.	
Data security			Data are archived on AOOS server in Anchorage & at mirror sites in Portland, OR and Providence, RI.	Historical data are archived on the NCEAS GoA Member Node, replicated to DataONE, and a copy is made on the AOOS data servers. DataONE checks validity of content through rolling audit.	Provide any agency specific requirements for archiving data.

	PIs	Program Mgmt Team	AXIOM	NCEAS	EVOSTC & Trustee agencies
Data analysis, synthesis & visualiza-tion	Produce data analyses, synthesis documents and data visualizations from project data.	Coordinates with PIs, AOOS, Axiom and NCEAS to produce synthesis and visualization products and reports.	Provides team with full access to all data for potential applications. Provide team access to all ancillary AOOS data & tools. Provide time series animations & syntheses on request from science team & outreach team.	Historical data are made publicly available via the GoA Member Node, and can be accessed from the web, analytical environments like R, and workflow systems like Kepler and VisTrails.	
Data discovery (search function)	Ensures that data are complete, QA/QCd & have complete metadata records.	Determines when data & metadata are ready to be published to public AOOS portal.	Incorporates data & metadata into AOOS GoA data search catalog w/additional GWA & historical EVOSTC tags. Setting up process for connecting to DataONE.	Historical data are listed on the AOOS GoA data portal, and are searchable on the DataONE portal as well as the NCEAS archive, KnB.	
Public data delivery	Reviews published data on data portal for accuracy.	Reviews published data on data portal for accuracy. Keeps track of program data delivery status.	When data meet all above requirements, publish data & metadata into the AOOS Gulf of Alaska portal for broader public access & use.	Historical data and metadata can be downloaded from AOOS GoA Data Portal, the GoA DataONE member node, and DataONE replica servers.	Public data access is required.
Long-term archive			AOOS data system is being used for long-term storage. With other funding, now developing methods for automated delivery to national archives (e.g., NODC) and to DataONE nodes.	Provide linkages to DataONE to replicate data across diverse institutions to protect against funding and policy failures. Historical data have 3 replicas nationally, working with Axiom on replication processes for current data streams.	Long-term archiving required by trustee agencies.

Work Completed

Axiom software engineers redesigned the display in the Gulf of Alaska Data Portal for metadata created in the Ocean Workspace and imported into the portal. Upon initial release of the portal, project metadata created in the Workspace was visible as a hypertext markup language (HTML) webpage and file-level metadata from the Workspace was available in the portal as raw, unstyled JavaScript object notation (JSON) documents. In the time since the launch of the portal, the metadata editors in the Ocean Workspace have been harmonized to provide the same interface and fields for project and file metadata, and have expanded to provide new metadata fields. This year, Axiom's interface designer created a new stylesheet to display both the project and file level metadata from the Workspace in a much more human-readable form. The design of the metadata pages in the portal underwent several design iterations based on user feedback before settling into their current form (Figure 7).

Axiom software architects and engineers have worked throughout 2015 to improve the Gulf of Alaska Data Portal's data catalog user interface and portal visualization capabilities. Improvements completed in 2015 include rebuilding the search tool to improve the precision and relevancy of search results, and to allow search results to be added to the mapping portal from the portal search bar. Additional improvements include indexing the spatial and temporal metadata associated with a dataset to allow searches to be constrained both spatially and temporally. These upgrades to the data system were motivated by feedback received from GWA program managers as well as external sources. Improvements to the catalog search tool have expanded the range of material indexed for search to include file-level metadata and the text content of files imported into the Gulf of Alaska Data Portal from the Workspace. Indexing spatial and temporal metadata will allow users to limit the results of their searches to show only the data in the area selected during the time span indicated. Portal users are able to set these limits by drawing a polygon on a map, inputting a spatial bounding box, and/or using a time slider to set a time range.

Data visualization is limited by the underlying data structures used by the data collectors. Axiom and AOOS continue to work on a next-generation data portal based on a 4-dimensional (4D) data model enabled by the network common data form (netCDF) data format. Significant progress has been made on this system, which will be released in late 2016. At the November 2015 GWA PI meeting, Axiom demonstrated this system with 4D visualizations of GWA data from the physical oceanography data generated by the Seward Line and GAK1 mooring projects and converted into netCDF files by Axiom data analysts. NetCDF is a well-documented, open, and self-describing format that was designed with the needs of long-term preservation in mind. Once these conversions are complete, the datasets can be more robustly visualized along standardized parameters while being ready for archiving in a long term preservation environment. From the GWA program, Axiom analysts have worked with GWA program managers to convert three seasons of conductivity, temperature, and depth (CTD) data into netCDF files that will be used to create rich, 4D visualizations once the conversion is complete.

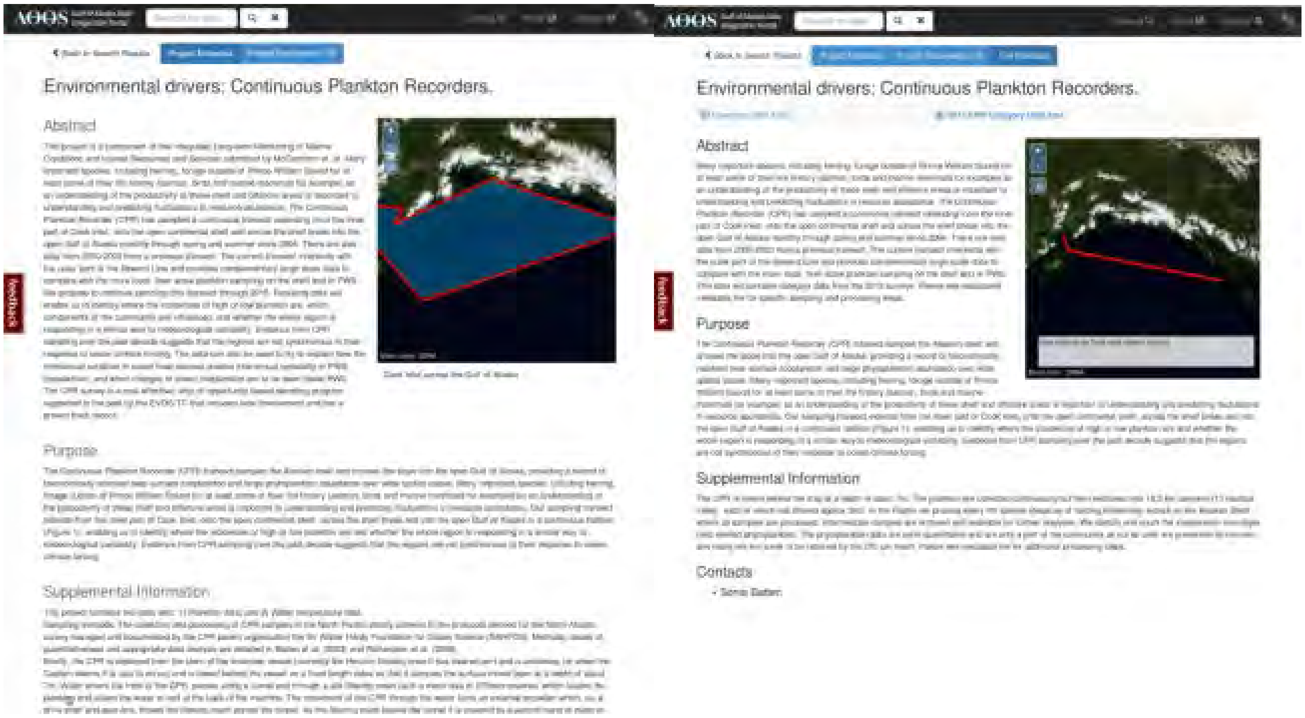


Figure 7. Screenshots of metadata imported from the Ocean Workspace into the public Gulf of Alaska Data Portal. On the left: project metadata for the Continuous Plankton Recorder (CPR) project; on the right: metadata for a single data file within the CPR project.

Work Underway

In addition to continually revising the display of project and file metadata in the portal, in FY2015 Axiom staff began work on an improved version of the metadata editor. This new editor will provide the fields and flexibility necessary to more robustly describe projects, the datasets they generate, and relationships between projects and resources. This new web-based editor will initially create xml records for ISO 19115 metadata, with the ability to create ISO 19115-1 and EML records developed after release. This new editor will be released in early Spring 2016.

To integrate data into the Gulf of Alaska portal and enhance its use by GWA PIs and the public, data visualizations were completed for several EVOSTC LTM datasets. The goal of visualizations is to provide a clear and efficient visual communication of data by making complex or long-term information more accessible, understandable and usable. Additionally, the complex, stackable visualizations Axiom develops for the Gulf of Alaska portal can be used by researchers and managers to easily understand data on its own in the context of other related or environmental datasets.

In this reporting period, observations made of humpback whales during surveys conducted from 2006 to 2014 were visualized in the Gulf of Alaska portal. The location, time, and notes about the observation (e.g., photos taken or individual whale identification) were mapped in the portal (Figure 8). Using a time slider or seasonal filter, the change in humpback whale distributions over time can be explored. To aid the user in generating summary statistics about these observations, a polygon tool has been integrated. With the tool, a user can draw a polygon around a spatial area to generate a summary chart of the number of animals observed over time within that area (Figure 9). To summarize data over large spatial extents, a hexed heat map is generated when the user zooms out. The heat map displays the areas where humpback whales have been most frequently observed (Figure 10). Using a time slider or seasonal filter to the heat map, the change in humpback whale distribution can also be explored.

Additional data can be co-visualized with the humpback whale survey data to display potential changes in humpback whale distribution over time. As an example, the herring spawn survey data from the Alaska Department of Fish and Game through spring 2015 was updated in the data portal (Figure 11) during this reporting period. The location and total length of herring spawn activity have been visualized for this entire dataset (1973 to 2015). The herring spawn data can be displayed as either a plotted survey line or hexed heat map to represent the area when herring spawn was observed. This data set can be co-visualized (or 'stacked') together with humpback whale data to explore how distributions may coincide both spatially and temporarily with aggregations of spawning herring (Figure 12). Additionally, the polygon tool can be applied to generate summary statistics of herring spawn and/or humpback whale observations within a user-defined area (Figure 13).

Available in the Gulf of Alaska data portal are hundreds of additional data sets that allow for simplified, visual integration. As additional data are added from the GWA and HRM programs, the portal will continue to provide researchers with a streamlined visual environment for data selection, filtering, and exploration from multiple sources (including environmental, atmospheric, and numeric models). This tool allows rapid discovery of interesting findings to support (or deny) initial study hypotheses, inform further experimentation and experimental design, and generate additional hypotheses or "hot spots" related to drivers of environmental change in Prince William Sound.

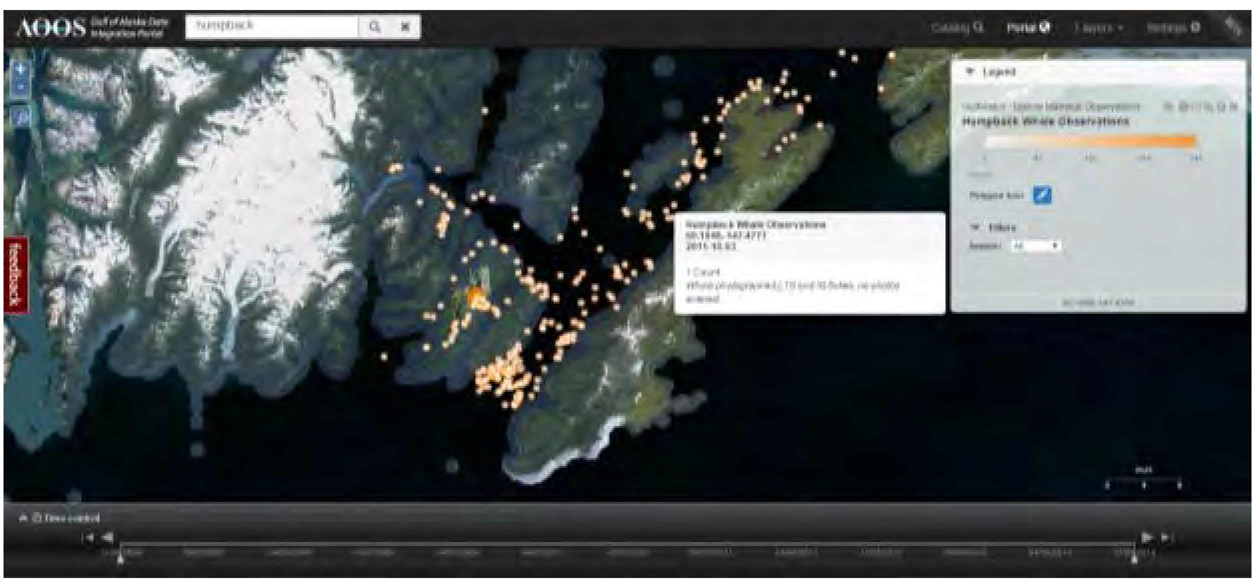


Figure 8. Screenshot of AOOS Gulf of Alaska Data Portal showing humpback whales survey observations made under the GWA program. Color represents counts of humpback whales in Prince William Sound. The date, time, location, and comments of interest (e.g., individual humpback ID) can be shown for each observation.

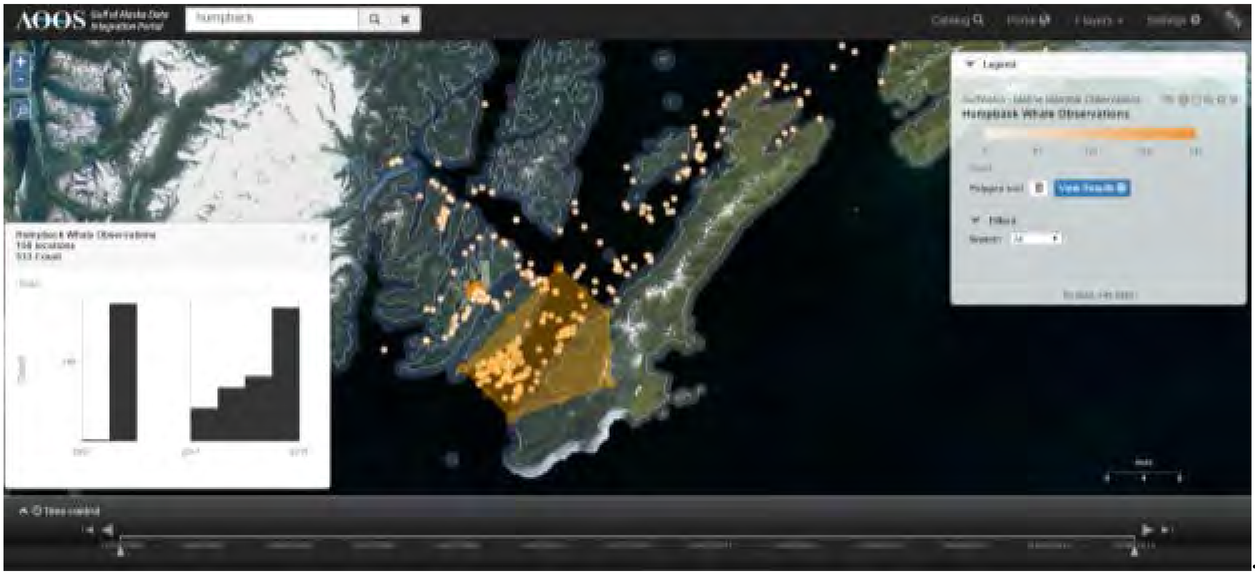


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Figure 9. Screenshot of AOOS Gulf of Alaska Data Portal showing polygon tool that automates summary statistics within user-defined spatial areas. A histogram of the number of humpback whales observed during GWA survey is shown over time.

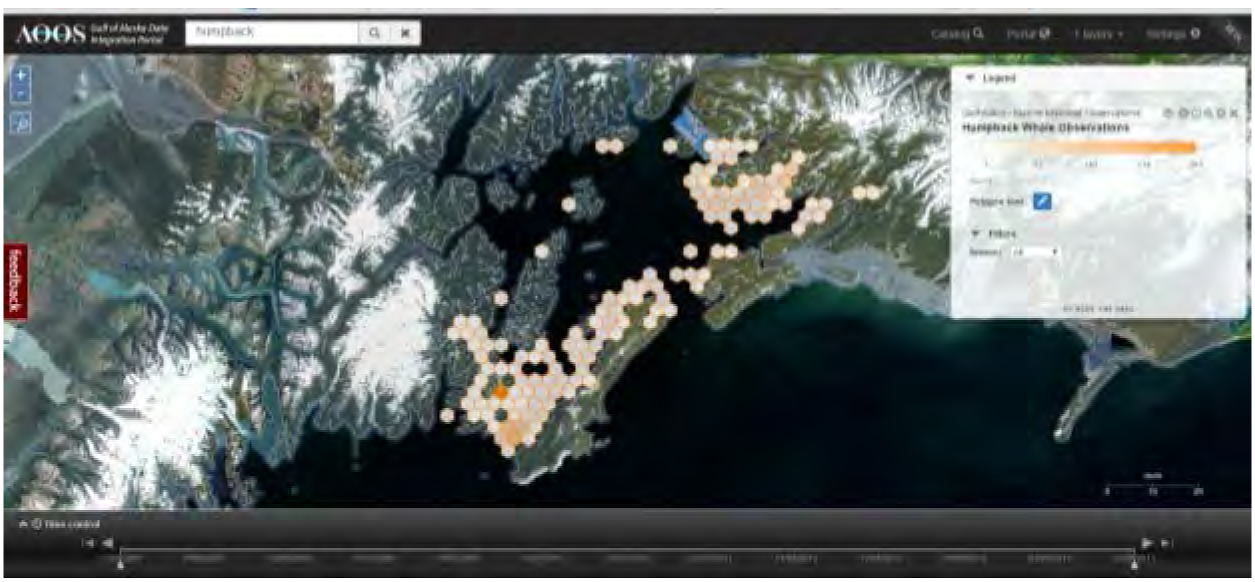


Figure 10. Screenshot of AOOS Gulf of Alaska Data Portal showing a hexed heat map of humpback whales observations in Prince William Sound. The darker the color, the greater the number of humpback whales observations per unit area. Using the time slider (at the bottom) or seasonal filter (in the right hand legend) to the heat map, the change in humpback whale distribution can also be explored over time.

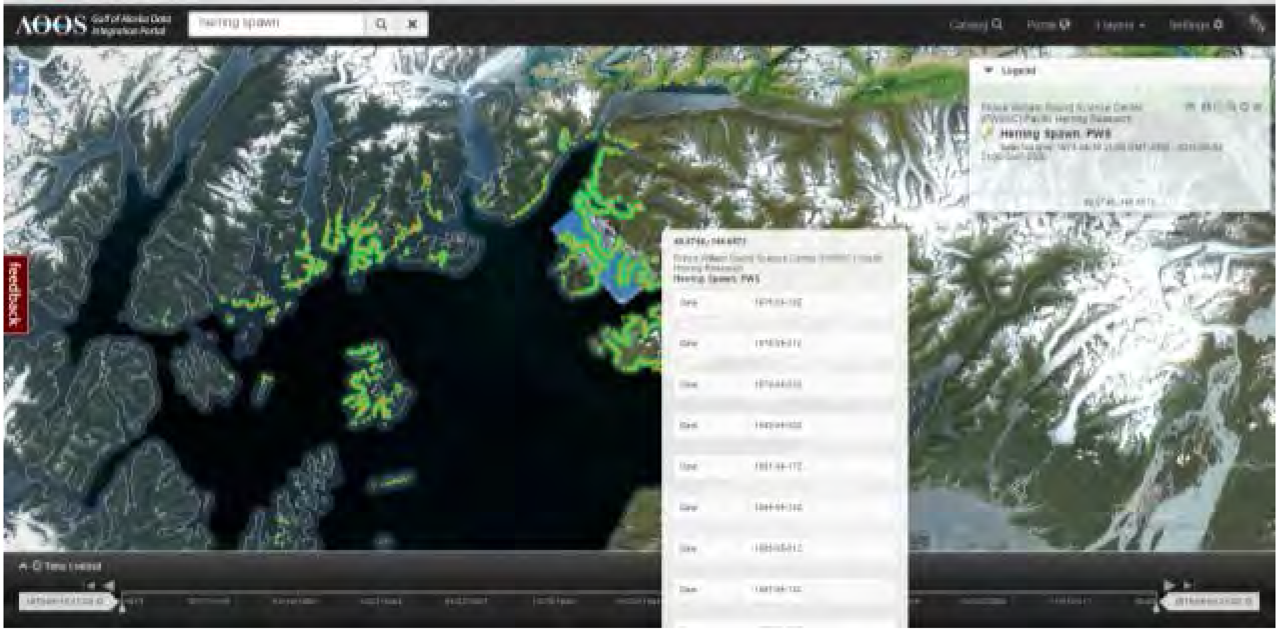


Figure 11 a. Linear display of herring spawn lengths.

Figure 11 b. Hex heat map display of the frequency and total length of herring spawn activity.

Figures 11 a & b, above. Screenshots of AOOS Gulf of Alaska Data Portal showing two different graphical displays of herring spawn observations in Prince William Sound from surveys conducted 1973 to 2015. The upper figure shows the length (km) of observed spawning area, whereas the heat map in the lower figure shows the sum of observed spawning lengths within a given area. The darker the color, the greater the length of total spawning activity observed per unit area. Using the time slider (at the bottom), the change in herring spawn activity can also be explored over time.

Figure 12. Screenshot of AOOS Gulf of Alaska Data Portal showing a polygon tool that automates summary statistics within user-defined spatial areas. A histogram of the length of herring spawn observed during aerial survey is shown over time from 1973 to 2015.

Figure 13. Screenshot of AOOS Gulf of Alaska Data Portal co-visualizing (or 'stacking') different data layers to allow for exploration of possible relationships. The length of observed herring spawn is shown along the coast in a green and orange dashed line. The number of humpback whales observed during surveys are shown in orange dots. The larger the dot and the darker the color, the greater the number of humpback whales observed. Using the time slider (at the bottom), the change in humpback distribution relative to herring spawn activity can be explored over time and area.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

A. Collaboration and coordination both within your program and between the two programs: The data management tools and services provided to the EVOSTC LTM and HRM programs are coordinated and collaborative by their very nature. As users of a central data management system, both programs provide useful feedback that informs the features Axiom develops and implements for the Ocean Workspace and the Gulf of Alaska Data Portal. Through ingesting, synthesizing, and prioritizing feedback and feature requests from both programs, the project team coordinates the needs of each program into a set of tools useful to both. Similarly, by making data from each program available in the Gulf of Alaska Data Portal, the project team helps the two programs collaborate to provide a comprehensive, holistic portrait of the conditions monitored in the Gulf of Alaska by both programs.

B. Coordination with other EVOSTC funded projects: None

C. Coordination with our trust agencies:

The project team provides data management visualization, and preservation services, including providing access to and facilitating the use of the Ocean Workspace, to a number of other programs that receive funding from or are administered or are overseen by representatives from the trustee agencies. Some of these programs and their associated trustee agencies are provided in Table 3.

Table 3. Collaborating projects and trust agencies.

Collaborating Project	Trust Agency
Arctic Marine Biological Observation Network (AMBON)	BOEM
Arctic Ecosystem Integrated Synthesis (Arctic EIS)	BOEM
Marine Arctic Ecosystem Study (MARES)	BOEM
Integrated Ocean Observing System (IOOS)	NOAA
Beluga Sightings Database Visualization	National Marine Fisheries Service (NMFS)
Alaska Ocean Observing System (AOOS) Data Management	NOAA
Central and Northern California Ocean Observing System (CeNCOOS) Data Management	NOAA
Gulf of Alaska Integrated Ecological Research Program (GOAIERP)	NMFS
Russian-American Long-term Census of the Arctic (RUSALCA)	NOAA
Spatial Tools for Arctic Mapping and Planning (STAMP)	NOAA
Alaska Data Integration working group (ADIwg)	USGS

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

Publications produced during the reporting period: None completed.

Conference and workshop presentations and attendance during the reporting period:

The AOOS data team at Axiom Data Science attended the GWA PI meeting in November 2015, and the team meeting in January 2016 at the Alaska Marine Science Symposium (AMSS). Additionally, the AOOS data team met with individual PIs of the GWA and HRM programs in Anchorage, Homer, Cordova, and Juneau during December and January 2016. Hands-on demonstrations of the AOOS Workspace and Gulf of Alaska Data Portal were given at this time. Throughout the year, the project team keeps in contact with the GWA program management team with regular email and phone calls.

Demonstrations of the Ocean Workspace and the AOOS data portals have been given to a wide variety of users including GWA PIs. Demonstrations have also been given to PIs with the North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program, the BOEM-funded Arctic Ecosystem Integrated Survey, the Distributed Biological Observatory, the Marine Arctic Ecosystem Study and many other related research programs for which AOOS or Axiom also provides data management or visualization services. The AOOS Gulf of Alaska Data Portal, featuring GWA data sets, was demonstrated at AMSS during several workshops and was on display at the AOOS booth during the AMSS poster session.

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

Science Panel 2015 Comments

None provided.

Science Panel 2014 Comments

It was encouraging for the Science Panel to hear via a conference call with Kris Holderied, Tammy Neher, and Scott Pegau that the standardized forms for metadata submission had been recently modified, and that a more refined version is now available to investigators. The Panel is hopeful that this will facilitate all investigators' compliance on submission of both metadata and data in a timely manner (within one year of collection) as agreed upon when accepting funding from EVOSTC.

Data Management Team Response

As was described above, in 2015 the project team worked with GWA program management to continue to inventory what data has been delivered, which PI is responsible for the dataset, and the status of data preparation, processing and metadata development. This inventory was used to motivate and direct the meetings between Axiom staff and PIs or team leaders of individual projects.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$138.5	$118.0	$122.300	$122.3	$121.3	$622.4	$ 514.6
Travel	$0.0	$0.0	$0.000	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$0.000	$0.0	$0.0	$0.0	$0.0
Commodities	$0.0	$0.0	$0.000	$0.0	$0.0	$0.0	$0.0
Equipment	$5.1	$4.8	$0.000	$0.0	$0.0	$9.9	$0.0
Indirect Costs (*will vary by proposer*)	$31.4	$27.1	$28.129	$28.1	$27.9	$142.7	$ 110.2
SUBTOTAL	$175.0	$149.9	$150.429	$150.4	$149.2	$774.9	$624.8
General Administration (9% of subtotal)	$15.8	$13.5	$13.5	$13.5	$13.4	$69.7	$56.2
PROJECT TOTAL	$190.8	$163.4	$164.0	$164.0	$162.6	$844.7	$681.1
Other Resources (in kind Funds)	$683.0	$640.0	$620.0	$500.0	$500.0	$2,943.0	$2,443.0

Leveraged Funding Sources
AOOS - Data management Activities (FY12 - 500K, FY13 - 500K, FY14 - 500K, FY15 - 500K, FY16 - 500k)
PWSSC -Project level data management system (FY12 - 48K)
Northern Forum/USFWS - North Pacific Seabird Data System (FY12 - 50K, FY13 - 50K, FY14 -50K)
ADF&G/AOOS - Data integration partnership/sharing (FY12 - 60K, FY13 - 90K, FY14 -70K)
CIRCAC - Regional Data Management Support for CI (FY12 - 25K)
Kenai Fish Habitat Partnership: FY15-28K
NPRB GOAIERP- FY15-80k
USFWS Seabird program: FY15- 50k

FY12-16

Program Title: 15120114-D Data Maanagement
Team Leader: Rob Bochenek, AOOS

SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See*, Reporting Policy at III (C) (1).

15150114-T

2. Project Title: *See*, Reporting Policy at III (C) (2).

Supplemental Data Management Support for EVOSTC Monitoring Programs

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

Rob Bochenek, Alaska Ocean Observing System (AOOS)

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

February 1, 2015 – January 31, 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

AOOS Workspace Herring Research and Monitoring Program group: https://workspace.aoos.org/group/3503/projects

AOOS Gulf of Alaska Data Portal:

http://portal.aoos.org/gulf-of-alaska.php#

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

Deliverable/Milestone	**Status**
Objective 1. Provide additional, needed data management support for LTM and PWS Herring programs.	Ongoing
Objective 1, Task 1: Establish data coordinator position to lead the PWS Herring program and assist the LTM program.	Completed. ● Data coordinator Stacey Buckelew was recruited and hired in June 2015
Objective 1, Task 2: Help PWS Herring program PIs generate metadata for existing data, and add NCML metadata to preservation-ready LTM and PWS Herring data.	Ongoing. ● One-on-one PI meetings held with PIs in December 2015 and January 2016 to implement best practices for metadata record creation

Deliverable/Milestone	Status
Objective 2. Implement technical mechanisms to seamlessly transfer LTM and PWS Herring program data from the AOOS data system to systems maintained by DataONE Network.	Ongoing
Objective 2, Task 1: Extend the LTM (Gulf Watch Alaska) data portal to participate in the DataONE network as a DataOne Member Node.	Ongoing Feasibility and registration for becoming DataOne Member Node completed; implementation planning and development underway

The major focus of this work has been to respond to *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) and staff feedback by implementing a supplemental data management effort to execute on tasks that have been deemed of high importance, but were not being addressed by previous data management projects supporting EVOSTC programs (Projects 1412011D and 1412011C). Under this effort, the data management support for both Long Term Monitoring (LTM) and Prince William Sound (PWS) Herring programs has been increased by establishing a data coordinator position. Axiom recruited and hired Ms. Stacey Buckelew into this position beginning June 1, 2015. Her responsibilities have targeted improving metadata quality and best practices. As such, the AOOS Herring Research and Monitoring (HRM) program Workspace group was reorganized in fall 2015 to create a cohesive organizational structure to the Gulf Watch Alaska (GWA) program Workspace group. Additionally, one-on-one meetings were scheduled with individual PIs from the LTM and PWS Herring programs during fall 2016 and winter 2016 to provide guidance and support on data submission and metadata authoring. PIs received individual instruction in the use of the AOOS Workspace and exploration of data available in the Gulf of Alaska Data Portal. A metadata process was also established to ease the authoring process by PIs and to help standardize the metadata formats across programs.

Objective 1. Provide additional, needed data management support for LTM and PWS Herring programs.

Task 1: Establish data coordinator position to lead the PWS Herring program and assist the LTM program.

AOOS, through its technical arm at Axiom Data Science, hired Ms. Stacey Buckelew in June 2015 as the data coordinator to lead the PWS Herring program data ingestion effort. Beyond becoming oriented to the data management team, Stacey met with the LTM data coordinator (Tammy Hoem-Neher), the Herring program coordinator (Scott Pegau), and the Program Management team in Homer in July 2015. During these meetings, conventions were laid out to help establish a cohesive organizational scheme between the two programs. Additionally, Stacey attended the annual PI meeting in Anchorage during November 2015 and the PI meeting in January 2016 at the Alaska Marine Science Symposium, where she became acquainted with the project PIs for both programs.

Task 2: Help PWS Herring program PIs generate metadata for existing data, and add NCML metadata to preservation-ready LTM and PWS Herring data.

The data coordinator has led the PWS Herring program PIs in organizing their project information and generating metadata records, similar to those created by the LTM program. Generating standardized metadata is critical to ensure that the research investment is capitalized in future research efforts in addition to reducing duplication of effort and increasing data discovery and usability.

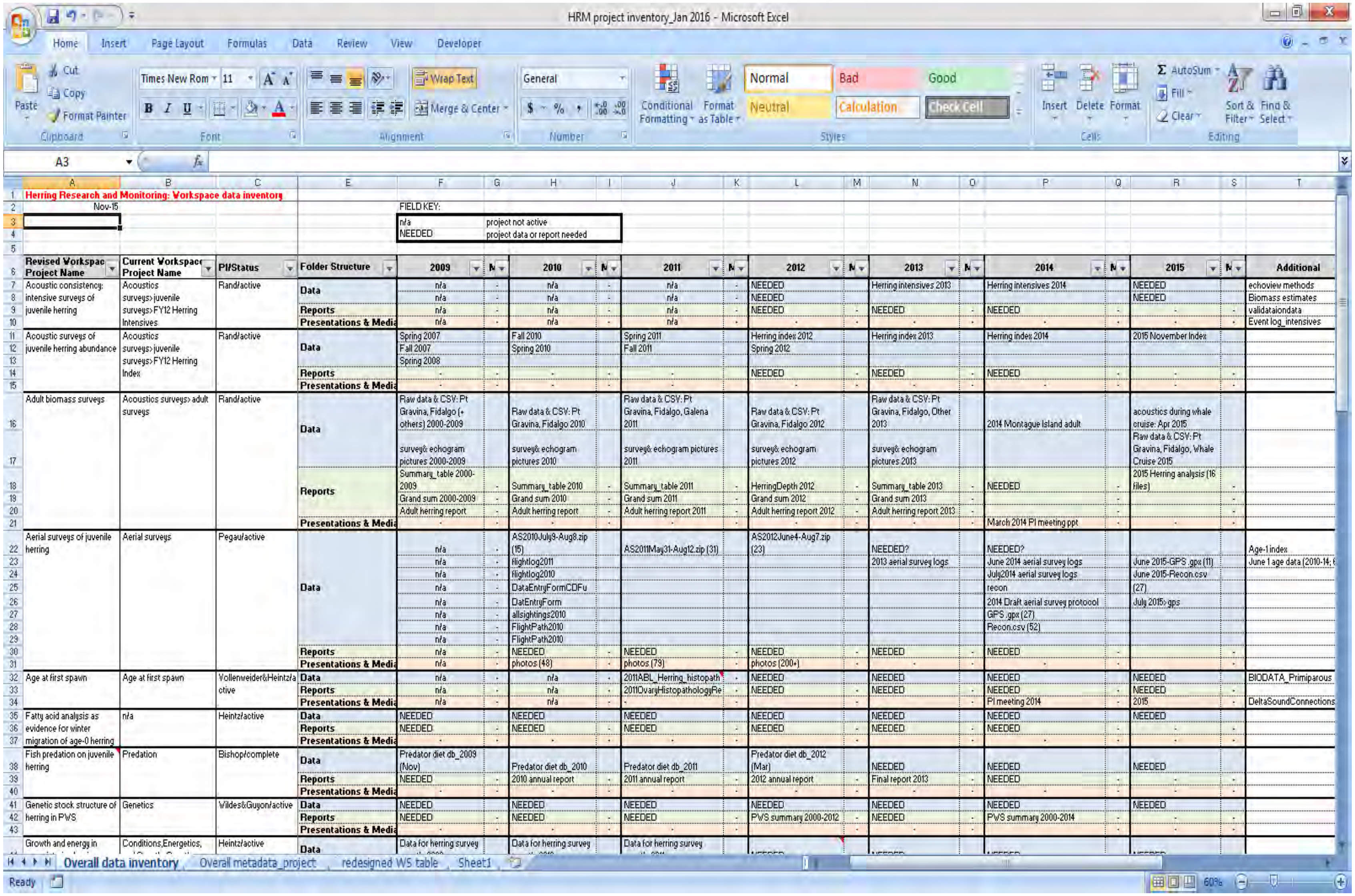
The AOOS HRM program Workspace group was reorganized in fall 2015 to create a cohesive organizational structure to the GWA program Workspace group. Several meetings were held with HRM Program Manager, Scott Pegau to discuss an agreed-to organizational structure. Workspace folders were then reorganized and retitled according to individual projects in order to clearly establish the association of PIs to project and enhance their sense of 'ownership.' Additionally, data sets were reorganized by projects and tags added by current status, herring age class, and survey type to ease Workspace access by all PIs.

In concert with the Workspace restructure, a data file and metadata inventory by project was completed. The inventory was cross-referenced with project proposals and progress reports to determine which data files had not been submitted to the Workspace (Figure 1). At the PI meeting in November, the data coordinator presented the inventory and discussed a process for meeting the submission benchmarks with the PIs. The process was agreed-to by all PIs present at the meeting to include the PIs collecting content for the metadata record followed by one-on-one meetings to provide guidance and support on data submission and metadata authoring.

From December 2015 to February 2016, the data management team scheduled 24 meetings with over 30 program PIs or researchers to discuss data submissions and metadata authoring (Table 1). Additionally, PIs received written instructional materials about the Workspace metadata editor and hands-on instruction in the AOOS Workspace (refer to Appendix 1), its metadata editor, and linkage to the Gulf of Alaska data portal including exploration of available data sets. A metadata process was also established to ease the authoring process by PIs and to help standardize the metadata formats across programs. The process included the PI completing a metadata questionnaire document before the meeting that included a set of questions about the project research in order to organize content for the metadata record. The questionnaire was adapted from the U.S. Geological Survey (USGS) best management practices to adhere to International Organization of Standards (ISO) metadata standards. For those projects for which a reasonably complete metadata record already existed, the data management team instead utilized the metadata questionnaire as a completeness check. Prior to the meeting, the data management team reviewed the questionnaires and then used the meeting to assist the PIs in walking through creation of the content need to complete or revise the metadata record.

Table 1. A list of the in-person meetings held with HRM and GWS PIs and researchers this reporting period to discuss data submission benchmarks and metadata authoring.

PI & Researcher name (s)	Project	Meeting	Location	Axiom lead
In person PI meetings with data management team				
Gorman	HRM	Jan 2016	Prince William Sound Science Center (PWSSC), Cordova	Buckelew
Pegau	HRM	Jan 2016	PWSSC, Cordova	Buckelew
Bishop, Schaefer	HRM, GWA	Jan 2016	PWSSC, Cordova	Buckelew
Bishop, Lewandoski	HRM	Jan 2016	PWSSC, Cordova	Buckelew
Gay	HRM	Jan 2016	PWSSC, Cordova	Buckelew
Campbell	HRM	Jan 2016	PWSSC, Cordova	Buckelew
Heintz, Sewall, Lindeburg	HRM	Jan 2016	Auke Bay, Juneau	Buckelew
Wildes	HRM	Jan 2016	Auke Bay, Juneau	Buckelew
Moran, Lindeberg	GWA	Jan 2016	Auke Bay, Juneau	Buckelew
Arimitsu, Heflin	HRM	Jan 2016	USGS, Juneau	Buckelew
Branch, Trochta	HRM	Jan 2016	Alaska Marine Science Symposium (AMSS), Anchorage	Buckelew
Boswell, Zezone	HRM	Jan 2016	AMSS, Anchorage	Buckelew
Rand	HRM	Jan 2016	AMSS, Anchorage	Buckelew
Moran, Straley, Lindeberg	GWA	Jan 2016	AMSS, Anchorage	Buckelew
Batten	GWA	Jan 2016	AMSS, Anchorage	Buckelew
Iken	GWA	Jan 2016	AMSS, Anchorage	Buckelew
Kaler	GWA	Jan 2016	U.S. Fish and Wildlife Service (USFWS), Anchorage	Buckelew
Olsen, Coletti, Kloeker	GWA	Jan 2016	AMSS, Anchorage	Turner
Olsen (for Matkin)	GWA	Jan 2016	AMSS, Anchorage	Turner
Holderied, Powell	GWA	Feb 2016	Homer	Buckelew
Doroff	GWA	Feb 2016	Homer	Buckelew
Hershberger	HRM	Feb 2016	By phone	Buckelew
Lindeberg	GWA	Feb 2016	By phone	Turner
Danielson	GWA	Feb 2016	By phone	Turner
Hopcroft	GWA	Feb 2016	By phone	Turner
PIs that have not met with data management team				
Vollenweider				



Herring Research and Monitoring: Workspace data inventory

Nov-15

FIELD KEY:

n/a	project not active
NEEDED	project data or report needed

Row	Revised Workspace Project Name	Current Workspace Project Name	PI/Status	Folder Structure	2009	N	2010	N	2011	N	2012	N	2013	N	2014	N	2015	N	Additional
7	Acoustic consistency: intensive surveys of juvenile herring	Acoustics surveys>juvenile surveys>FY12 Herring Intensives	Rand/active	Data	n/a	-	n/a	-	n/a	-	NEEDED		Herring intensives 2013		Herring intensives 2014		NEEDED		echoview methods
8					n/a	-	n/a	-	n/a	-	NEEDED						NEEDED		Biomass estimates
9				Reports	n/a	-	n/a	-	n/a	-	NEEDED	-	NEEDED	-	NEEDED	-	-	-	validataiondata
10				Presentations & Media	n/a	-	n/a	-	n/a	-	-	-	-	-	-	-	-	-	Event log_intensives
11	Acoustic surveys of juvenile herring abundance	Acoustics surveys>juvenile surveys>FY12 Herring Index	Rand/active	Data	Spring 2007		Fall 2010		Spring 2011		Herring index 2012		Herring index 2013		Herring index 2014		2015 November Index		
12					Fall 2007		Spring 2010		Fall 2011		Spring 2012								
13					Spring 2008														
14				Reports	-	-	-	-	-		NEEDED	-	NEEDED	-	NEEDED	-	-	-	
15				Presentations & Media	-	-	-	-	-		-	-	-	-	-	-	-	-	
16	Adult biomass surveys	Acoustics surveys> adult surveys	Rand/active	Data	Raw data & CSV: Pt Gravina, Fidalgo (+ others) 2000-2009		Raw data & CSV: Pt Gravina, Fidalgo 2010		Raw data & CSV: Pt Gravina, Fidalgo, Galena 2011		Raw data & CSV: Pt Gravina, Fidalgo 2012		Raw data & CSV: Pt Gravina, Fidalgo, Other 2013		2014 Montague Island adult		acoustics during whale cruise: Apr 2015		
17					survey& echogram pictures 2000-2009		survey& echogram pictures 2010		survey& echogram pictures 2011		survey& echogram pictures 2012		survey& echogram pictures 2013				Raw data & CSV: Pt Gravina, Fidalgo, Whale Cruise 2015		
18				Reports	Summary_table 2000-2009	-	Summary_table 2010	-	Summary_table 2011	-	HerringDepth 2012	-	Summary_table 2013	-	NEEDED	-	2015 Herring analysis (16 files)	-	
19					Grand sum 2000-2009	-	Grand sum 2010	-	Grand sum 2011	-	Grand sum 2012	-	Grand sum 2013	-		-		-	
20					Adult herring report	-	Adult herring report	-	Adult herring report 2011	-	Adult herring report 2012	-	Adult herring report 2013	-		-		-	
21				Presentations & Media	-	-	-	-	-	-	-	-	-	-	March 2014 PI meeting ppt	-	-	-	
22	Aerial surveys of juvenile herring	Aerial surveys	Pegau/active	Data	n/a	-	AS2010July9-Aug8.zip (15)		AS2011May31-Aug12.zip (31)		AS2012June4-Aug7.zip (23)		NEEDED?		NEEDED?				Age-1 index
23					n/a	-	flightlog2011						2013 aerial survey logs		June 2014 aerial survey logs		June 2015-GPS .gpx (11)		June 1 age data (2010-14;
24					n/a	-	flightlog2010								July2014 aerial survey logs		June 2015-Recon.csv		
25					n/a	-	DataEntryFormCDFu								recon		(27)		
26					n/a	-	DatEntryForm								2014 Draft aerial survey protocol		July 2015>gps		
27					n/a	-	allsightings2010								GPS .gpx (27)				
28					n/a	-	FlightPath2010								Recon.csv (52)				
29					n/a	-	FlightPath2010												
30				Reports	n/a	-	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-		-	
31				Presentations & Media	n/a	-	photos (48)	-	photos (79)	-	photos (200+)	-	-	-	-	-		-	
32	Age at first spawn	Age at first spawn	Vollenweider&Heintz/active	Data	n/a	-	n/a	-	2011ABL_Herring_histopath	-	NEEDED		NEEDED		NEEDED		NEEDED		BIODATA_Primiparous
33				Reports	n/a	-	n/a	-	2011OvaryHistopathologyRe	-	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-	
34				Presentations & Media	n/a	-	n/a	-	-	-		-		-	PI meeting 2014	-	2015	-	DeltaSoundConnections
35	Fatty acid analysis as evidence for winter migration of age-0 herring	n/a	Heintz/active	Data	NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		
36				Reports	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-	NEEDED	-	-	-	
37				Presentations & Media	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
38	Fish predation on juvenile herring	Predation	Bishop/complete	Data	Predator diet db_2009 (Nov)		Predator diet db_2010		Predator diet db_2011		Predator diet db_2012 (Mar)		NEEDED		NEEDED		NEEDED		
39				Reports	NEEDED	-	2010 annual report	-	2011 annual report	-	2012 annual report	-	Final report 2013	-	NEEDED	-	-	-	
40				Presentations & Media	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
41	Genetic stock structure of herring in PWS	Genetics	Wildes&Guyon/active	Data	NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		NEEDED		
42				Reports	NEEDED	-	NEEDED	-	NEEDED	-	PWS summary 2000-2012	-	NEEDED	-	PWS summary 2000-2014	-	-	-	
43				Presentations & Media	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
44	Growth and energy in	Conditions,Energetics,	Heintz/active	Data	Data for herring survey		Data for herring survey		Data for herring survey		NEEDED		NEEDED		NEEDED		NEEDED		

Figure 1. An excerpt of the inventory of submissions made to the HRM Workspace in November 2015. This inventory was presented and discussed with PIs at the Nov 2015 annual program meeting.

The outcome of the meetings was organizing PIs to start writing or make significant progress towards completing a metadata record. In cases, this involved making a plan for how project data files should be structured to assist in describing large data sets or data collections. Information that was already developed for projects, including existing or legacy metadata records, funding proposals, and reports, were utilized to the extent possible. Project titles were adjusted to ensure they were descriptive and included key information for data exploration, including what the data are and where they are located. Additional metadata fields were requested from the PIs to provide details to allow readers to better surmise the data before exploring it further. In cases, this included adding additional metadata fields from the ISO standard format that are not currently recognized in the Workspace metadata editor.

To facilitate continued monitoring of data and metadata submission benchmarks, the Workspace metadata editor was expanded to include a data and metadata file tracking tool for project administrators. This tool eases data management by providing a transparent view of each project's data submissions, metadata record completeness, and data publication to the Portal. The data management team will continue to utilize this tool to monitor the submission progress and maintain regular communications through email, phone, and in-person to assist with metadata authoring.

Objective 2. Implement technical mechanisms to seamlessly transfer LTM and PWS Herring program data from the AOOS data system to systems maintained by DataONE Network.

Task 1: Extend the LTM (Gulf Watch Alaska) data portal to participate in the DataONE network as a DataOne Member Node.

During this reporting period, progress was made in the planning and early development for the Gulf of Alaska portal to become a DataOne Member Node (MN). The feasibility of the data portal becoming a DataOne MN was assessed. AOOS is considered a strong candidate as the long term availability of data and hosting of metadata documents alongside data products already exists within the portal. As such, AOOS has registered as a DataOne MN to begin the implementation. The approach for implementation is currently being planned, which includes a specific, preservation-oriented repository that uses persistent identifications (i.e., digital object identifiers [DOIs]) and "resource maps" to document the relationship between data products and metadata documents in a data package. The implementation work is ongoing and expected date of completion is end of 2016. As part of the implementation planning Axiom met with the National Center for Ecological Analysis and Synthesis (NCEAS) in fall 2015 to begin collaboration regarding the DataONE member node design for the Gulf of Alaska Data Portal. This collaboration will continue through the implementation phase in 2016.

Work Underway

The data management process will continue through the end of 2016 as additional data sets are submitted. The data coordinator, together with the data management team, will review submitted metadata records for completeness and accuracy. Once metadata records have been validated, they will be published to the portal. Metadata disseminated through the portal will improve the discoverability, access, and reuse of the data by a broader audience. One-on-one meetings with PIs will be scheduled again in fall 2016 to revise the metadata records by reviewing them for clarity and omissions. This quality control of the metadata from PIs will ensure records are both understandable and meet standards requirements. Validation will also involve comparing the metadata output to the Federal Geographic Data Committee

(FGDC)/ISO standard for the DataOne portal to ensure the record conforms with the standardized format structure.

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

A. Collaboration and coordination both within your program and between the two programs:
This project is focused on increasing the data management support for both LTM and PWS Herring programs by establishing a data coordinator position to improve metadata quality and best practices. Furthermore, this project also develops a mechanism to transfer and integrate LTM and PWS Herring program data products into DataONE. As such, the data management tools and services provided to the EVOSTC LTM and Herring programs are coordinated and collaborative by their very nature. As users of a central data management system, both programs provide useful feedback that informs the features Axiom develops and implements for the Ocean Workspace and the Gulf of Alaska Data Portal. A data management and metadata authoring process are being implemented uniformly across both programs to create a clear organizational structure and standard format. Additionally, by ingesting, synthesizing, and prioritizing feedback and feature requests from both programs, the project team coordinates the needs of each program into a set of tools useful to both. Similarly, by making data from each program available in the Gulf of Alaska Data Portal, the project team helps the two programs collaborate to provide a comprehensive, holistic portrait of the conditions monitored in the Gulf of Alaska by both programs.

B. Coordination with other EVOSTC funded projects:
Based on feedback acquired from the EVOSTC Science Panel and staff, this project was implemented as a supplemental data management effort to execute on major tasks that have been deemed of high importance but are not being addressed by existing data management projects supporting EVOSTC programs (Projects 1412011D and 1412011C). Therefore, all tasks associated with this project are by nature aligned with tasks from the coordinated projects.

C. Coordination with our trust agencies:
The project team provides data management visualization, and preservation services, including providing access to and facilitating the use of the Ocean Workspace, to a number of other programs that receive funding from or are administered or are overseen by representatives from the trustee agencies. Some of these programs and their associated trustee agencies are given in Table 2 below.

Table 2. Collaborating projects and trust agencies

Collaborating Project	Trust Agency
Arctic Marine Biological Observation Network (AMBON)	Bureau of Ocean Energy Management (BOEM)
Arctic Ecosystem Integrated Synthesis (Arctic EIS)	BOEM
Marine Arctic Ecosystem Study (MARES)	BOEM
Integrated Ocean Observing System (IOOS)	National Oceanic and Atmospheric Administration (NOAA)
Beluga Sightings Database Visualization	National Marine Fisheries Service (NMFS)
Alaska Ocean Observing System (AOOS) Data Management	NOAA
Central and Northern California Ocean Observing System (CeNCOOS) Data Management	NOAA
Gulf of Alaska Integrated Ecological Research Program (GOAIERP)	NMFS
Russian-American Long-term Census of the Arctic (RUSALCA)	NOAA
Spatial Tools for Arctic Mapping and Planning (STAMP)	NOAA
Alaska Data Integration working group (ADIwg)	USGS

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

A. **Publications produced during the reporting period**: None.

B. **Conference and workshop presentations and attendance during the reporting period**:
The AOOS data team at Axiom Data Science attended the GWA and HRM PI meetings in November 2015, and the team meetings in January 2016 at the Alaska Marine Science Symposium (AMSS). Presentations were given to PIs at both meeting regarding use of the Workspace, Workspace reorganization, data submission, and metadata authoring process. Additionally, the data coordinator team met with individual PIs of the GWA and HRM programs in Anchorage, Homer, Cordova, and Juneau during December and January 2016. Hands-on demonstrations of the AOOS Workspace and Gulf of Alaska data portal were given at this time. Throughout the year, the project team keeps in contact with the GWA program management team with regular email and phone calls.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

Science Panel 2015 Comments

The possibility of AOOS joining the DataOne system was discussed at the March 2014 Data Meeting as a way to ensure that the data collected as part of the Programs would be available to the widest audience possible. After reviewing the submitted proposal and the budget clarification provided, we would support the funding of the Data Coordinator position and the tasks associated with becoming a DataOne node. The Data Coordinator position should only be funded for the task of preparing the resource maps for data collected as part of the Council funded Programs. We would recommend that the funding of the NODC and OBIS Submission and associated staff time be considered at a later date.

Data Management Team Response

As was described above, in 2015 AOOS (through Axiom) hired the Data Coordinator position. The Data Coordinator together with Axiom Data Science, has worked to inventory what data has been delivered, which PI is responsible for the dataset, the status of data preparation, processing and metadata development. These are the requisite tasks required to prepare HRM data to be published through the DataOne MN. The implementation work, including preparing the resource maps for data collected, is ongoing and expected date of completion is end of 2016.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see program budget work book.

Appendix 1. Ocean Workspace- Metadata Quick Reference Guide

This guide is designed as a quick-reference to assist metadata writers in the production of metadata using the Ocean Workspace by providing definitions and examples for the metadata elements.

General notes:

- This version of the Workspace supports two levels of metadata creation: project and file level metadata.
    - Project level metadata is created for the parent folder (in which associated data files are nested). Project-level metadata is recorded at a broad level for an entire project (irrespective of the techniques used) and covers general project elements, such as project overview, dates, keywords, study species, project details, and geographic location.
    - The file-level metadata is created for individual files within a project. File-level metadata is typically very specific and metadata provides technical information about the associated dataset, including methods for data collection, instrumentation, data processing, etc. The file-level metadata also provides descriptive information about the encoded dataset.
    - This version of the Workspace does not support the creation of metadata for nested subfolders.

PROJECT-LEVEL METADATA DEFINITIONS

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
Identification	Title	The name given to the project.	YES	The title should include descriptive elements of: where, what, when.	1.1
	Abstract	An abstract describing the project content (e.g., data). It contains a concise and significant summary of the project data, and is generally intended to serve as a stand-alone description. Coupled with pertinent bibliographic information, it provides users with supportive information for evaluation when conducting a data search. Be sure to include:	YES	The abstract contains generalized statements to convey to the user what the project data are about. It is brief and does not contain specific findings. Its purpose is to acquaint users with the subject content of the data and to help them decide whether or not to consult the original source. In other words, the abstract may be the only text that users search and consult (if they choose not to retrieve the original data). Remembering this may help the writer focus on the key elements and	1.2

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
		• overview statement summarizing why the study was conducted; a short description of data parameters (e.g., summary of what the data are); • a brief description of how the data were created; (continued) • a general timeline for when the data were collected (by season or month and year); • a general location where data were collected.		select terminology to be included.	
	Purpose	A brief summary of the intentions with which the data or information resource was developed. This statement describes the "why" aspects of the data set (e.g., Why were the data collected?). The Purpose differs from the Abstract in that the latter describes the "what" aspects of the data (e.g., What information is in the data set? etc).	YES	The Purpose should include a summary narrative about : i) what motivated the question (or focus) of the study or the relevancy of data collected; ii) the focal ecosystem; and iii) how the project is associated or contributes to an overarching effort (i.e., assuming project is part of an integrated ecosystem study).	1.3
	Supplemental Information	A comment field where information that is not elsewhere covered can be placed. This item describes information which is deemed unnecessary to include in the abstract, but which is important to further explain the pertinent usage of the	NO	Information relevant and important to the project may be included, such as related studies: additional taxonomic or keywords that are not listed in the respective dictionaries; citations to associated project reports and publications; ancillary files to the dataset (e.g., ReadMe or	1.4

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
		data.		Species List, refer to Taxonomy below); information about specialty equipment used; credit to funders, partners, and/or research affiliates.	
	Time Period	The time period(s) to which the project or dataset corresponds.	YES	The time period should represent the temporal bounds (beginning and end) of the project. This can be a single date, multiple dates, a range of dates, or multiple data ranges. For a project that includes a series of data collection efforts (e.g., cruises) the exact dates of each of these efforts should be specified in the Lineage section.	1.5
	Online Links	The Online Link is intended to provide reference or additional information about the project or data set.	NO	Links are not intended to replace fields in the metadata record because long-term preservation or archiving of the website cannot be assumed. Links that point to archived contextual documents (e.g., those with an associated digital object identifier [DOI] or persistent identifier) would be the exception and are the preferred types of online links to provide.	1.6
	Contact	The individual(s) primarily responsible for creating the project content and who should be contacted with questions. Contact includes name, address, email, and organizational affiliation for those listed.	YES	The contact(s) is typically the lead principal investigator (PI) or author associated with the project. Profile information: first and last name; job title; group or organization names in full. Contact information includes mailing address, phone number, email, and website (if applicable). Information should be completed for all contact	1.7

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
				fields. This will ensure appropriate contacts are made for data inquiry and use. This is particularly important considering PIs may retire or change organizational affiliation over time.	
	Geographic Coverage	The geographic area domain for the project or dataset.	YES	At a minimum, the location name should be provided in the text box and/or a description of the study area bounding box (e.g., 5 transects with 20 sampling points). To provide finer spatial resolution, the bounding coordinates of the study area can be included. These can be created manually using the polygon tool, or exact coordinates imported to create a bounding box of the study area.	1.8
	Keywords	Keywords are words or phrases summarizing the project or dataset. There are two categories of keywords: controlled and uncontrolled. Controlled keywords are terms taken from an established authoritative list (thesaurus) of indexing terms. Uncontrolled keywords are terms applied as free text and are not derived from an established authoritative list. Keywords are used to describe data themes, strata, places, and/or temporality.	YES	In this version of the Workspace, the keyword text box only accepts keywords from the 'science keywords' controlled vocabulary from National Aeronautics and Space Administration's (NASA's) Global Change Master Directory (GCMD). The GCMD science keywords are a standardized, hierarchical set of Earth science keywords. While globally recognized, this directory is not as precise for biological and ocean sciences. We still recommend users to select keywords from the GCMD controlled vocabulary. If keywords must be used to describe data that do not exist in the GCMD, then provide these additional keywords in the Supplemental Information. Insert specialized keywords under a Keywords header using a	1.9

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
				comma-separated list.	
	Taxonomy	Taxonomy is the common-use or Latin name used to describe the subject of the data.	YES, if applicable	In this version of the Workspace, the Integrated Taxonomic Information System (ITIS) is used to search common or scientific names. Results from this directory are reasonably comprehensive, although species recognition limitations may exist for some marine species or taxonomic groups. It is encouraged to utilize the controlled vocabulary for assigning taxonomy to the extent possible. If a taxonomy is not recognized by ITIS, then use the Supplemental Information. Insert taxonomy (using common and Latin names) under a Taxonomy header using a comma-separated list. If there are a large number of taxa (> 30) referenced, consider including a separate csv with the data files that list the common and scientific names for all the species. Reference this csv in the Supplemental Information section of the metadata.	1.10
Lineage *lineage of a dataset consists of its entire processing history. This includes its origin (e.g., the source data set, the recording*	Statement	This element describes how the data were created (akin to data collection methods) and any data sources used. Lineage is narrative information about the data collection events, parameters, and source data which was used to construct the dataset, and information about the responsible parties.	YES	This summary statement provides information about the events or source data used in constructing the dataset. This information may include: ● Events or transformation in the life of a dataset ● Information about equipment used ● Source data used in creating the data ● Spatial reference system used by the source	2.1

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
instrument, the instrument's operating parameters) as well as all subsequent processing steps (algorithms and respective parameters) applied to it.				data ● Published references for the source data	
	Processing Steps	Describe the general steps or process used for the data set. For example, How was the data entered? Digitized? Scanned?	YES, if applicable	Processing steps can be a single collective description or individual process steps based upon: stages of processing, incorporation of sources, or project milestone. For each processing step, provide (where possible) the name, date and scale of the source data, a description of the processing steps performed, scanning or digitizing specs, equipment calibrations, software used, tolerances set, etc. This information is hard to remember later, so it's best written down as the data is created.	2.2
Constraints	Access	Any restrictions or legal prerequisites to accessing the actual data set. Commonly applies to data sets that are exempt from public records laws such as endangered species, personal health, and intellectual properties.	YES	Access restraints to data are not common. Examples may include the need to protect the exact location of threatened or endangered species. When there are no access constraints, the words "none" or something equivalent should be written; blank fields are ambiguous.	3.1

Group	Metadata Element	Definition	Mandatory	Notes	Example Reference
	Use	Any restrictions or legal prerequisites to using the data set.	YES	Common constraints include: • Must read and fully comprehend the metadata prior to data use • Acknowledgement of the Contact/Originator when using the data set as a source • Sharing of data products developed using the source data set with the Contact/Originator • Data should not be used beyond the limits of the source scale • The data set is NOT a survey document and should not be utilized as such. When there are no access constraints, the words "none" or something equivalent should be written; blank fields are ambiguous.	3.2

FILE-LEVEL METADATA DEFINITIONS

General notes:

- File-level metadata **includes the identical metadata elements for Project-level metadata** __**plus**__ the addition of these below elements.
- File-level metadata is encouraged to be created for data records within the Workspace. At a minimum, file-level metadata is required to be completed for data that will be shared publically in an online portal or published to a national data repository.
- File-level metadata should provide granular information that is specific to the associated file(s) in the collection.
- If file-level metadata applies to more than one file, metadata records can be easily copied and pasted to another file. To do this, click on the file of interest to expand the metadata record view. In the upper right hand corner of the metadata view, select the gear icon. Click "Copy metadata". Then, select the file to where you would like to paste the metadata. Expand the metadata record view. Select the gear icon and click "Paste metadata".

Group	**Metadata Element**	**Definition**	**Mandatory**	**Notes**	**Example Reference**
Data Attributes	Name	The name of the attribute encoded in the file.	YES	This is the name for the associated data column.	4.1
	Definition	A brief narrative description of the attribute. Provide this if your database is not documented in another form such as a data dictionary or data specification manual.	YES, if applicable	Provide a narrative descriptive of what the data is this field describes. If data within this field are encoded provide a list/dictionary for the encoded values here.	4.2
	Measurement type	A categorical descriptor for the	YES	Select from the drop down list the type that	4.3

		measurement scale or type of data: unordered, ordered, relative, absolute, or data/time.		best describes the data for that attribute: ● unordered= unordered categories or text ● ordered= ordered categories ● relative= values from a scale with equidistant points but no meaningful zero point (e.g. temperature, dollars, etc.) ● absolute= measurement scale with a meaningful zero point (e.g. wind velocity, wave height, age) ● date/time= date or time values (continued)	
	Reference url	If this attribute is described in detail elsewhere, provide a link to the attribute definition, data specification manual or some other format that describe your data, if applicable. Otherwise leave this element blank.	YES, if applicable	A website link to the document.	-

The purpose of this section is to provide examples for metadata fields found in the Workspace metadata editor. Many of these are examples from research and management agencies that have been collected across different scientific disciplines. If you have any specific questions about what information you should provide for any metadata field or element, contact your data management administrator.

1. Introduction

1.1 Title

Example 1 Title: Conductivity, temperature and depth data for 12 northwestern Gulf of Mexico locations, May to July 2012

Example 2 Title: Bicknell's Thrush Habitat in the Gulf of Maine (BICKHAB83), 1983-1999

Example 3 Title: Northeast Fisheries Science Center 2001 Fall Bottom Trawl Survey

Example 4 Title: Aerial survey data for the assessment of the distribution of cownose rays (*Rhinoptera bonasus)* in the Eastern Gulf of Mexico, from May to October 2008

1.2 Abstract

Example 1 Abstract: Gulf of Maine Habitat Mapping Project for Bicknell's Thrush
The Gulf of Maine Habitat Mapping Project used occurrence information and species/habitat models to map potential habitat for 64 species of primary concern to the U.S. Fish and Wildlife Service between 1983 to 1993. These species include migratory birds, anadromous and estuarine fishes, and threatened or endangered species. The habitat models are based on published literature, agency reports, and knowledge of experts working with the species.

For Bicknell's thrush, the model considered elevation, cover type, and sites of known occurrence. We selected as 'potential habitat' areas with elevations at or over 3000'. Bicknell's thrush occurrences in the Northeast were digitized as point locations. Where 'potential habitat' coincided with observed use, these areas were scored according to the cover type. Point occurrences at lower elevations were buffered 100 m, and these areas also were scored according to cover type. Other areas having elevations at or over 3000' and appropriate cover type, but not known to be used, were scored at 0.5 times the nominal values. *(source: US FWS)*

Example 2 Abstract: Northeast Fisheries Science Center 2001 Fall Bottom Trawl Survey
The NEFSC bottom trawl survey is a fisheries independent, multi-species survey that provides the primary scientific data for fisheries assessments in the U.S. mid-Atlantic and New England regions. Two bottom trawl surveys are conducted each year, one in the spring and one in the autumn. The survey is a standardized, stratified random design, with stratification based on bathymetry and multiple trawl sites within each stratum. Trawl sites are selected randomly, but the overall ship path is south to north. The survey covers the continental shelf and U.S. exclusive economic zone (EEZ) from Cape Hatteras, North Carolina into the Canadian EEZ. The primary gear is a bottom trawl, with CTD, multifrequency echosounder, and a host of other scientific sensor data collected ancillary to the bottom trawl catches. (*Source: DOC/NOAA/NOS/OCS > Office of Coast Survey, National Ocean Service, NOAA, U.S. Department of Commerce*)

Example 3 Abstract: Physical Oceanographic Surveys of DeSoto Canyon, Gulf of Mexico 2012
Forty three conductivity, temperature and depth (CTD) casts made from the RV Walton Smith in the northern Gulf of Mexico near DeSoto Canyon in July-August 2012 as part of the Grand Lagrangian

Deployment (GLAD) experiment. These CTD casts were made to determine the hydrography of the upper water column as one way to characterize the meso- and submesoscale variability in the region where 297 CODE-type ocean drifters were launched in an attempt to measure multi-scale near surface dispersion. The drifters were deployed at 1 meter and most of them were launched in triplets (initially separated by roughly 100 meters). This dataset was created by the Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE). This research was made possible by a grant from BP/The Gulf of Mexico Research Initiative.
(*source: Gulf of Mexico Research Initiative*)

1.3 Purpose

Example 1-Purpose: The data provide consultants, planners, and resource managers with information on wetland location and type. The data were collected to meet U.S. Fish and Wildlife Service's mandate to map the wetland and deep water habitats of the United States.
(source: US FWS)

Example 2-Purpose: The NEFSC bottom trawl survey provides fisheries independent abundance and biological data for fisheries assessments along the U.S. east coast.
(*Source: DOC/NOAA/NOS/OCS > Office of Coast Survey, National Ocean Service, NOAA, U.S. Department of Commerce*)

Example 3- Purpose: These CTD casts were made as part of the GLAD experiment to determine the hydrography of the upper water column as one way to characterize the meso and submesoscale variability in the GLAD experiment region.
(*source: Gulf of Mexico Research Initiative*)

Example 4- Purpose: This dataset was developed as part of a research project investigating the effects of the Deepwater Horizon oil spill on salt marsh biogeochemistry. This particular project was directed to determine: 1) if the marsh's ability to cycle reactive nitrogen was inhibited (nitrification potential); 2) if there was a significant impact on AOB and/or AOA; and 3) if there were spatial (regional, within marsh) or temporal patterns in nitrification potential.
(*source: Gulf of Mexico Research Initiative*)

1.4 Supplemental Information

Example 1- Supplemental Information: Chum Salmon Stock Discrimination using Microchemistry

Keywords, theme: Otolith element analysis, chum salmon
Keywords, place: Arctic, Bering Sea, Chukchi Sea, U.S. Exclusive Economic Zone

These data contributed to the following manuscript:

Sutton, T. M., and K. L. Pangle. Regional discrimination of chum salmon in Alaskan waters of the Bering and Chukchi seas using otolith elemental analysis. Deep-Sea Research Part II: Topical Studies in Oceanography.

This is the first version of the Global Subnational Infant Mortality Rates dataset. If you discover any errors or have any issues with the data, please let us know at ciesin.info@ciesin.columbia.edu.

Example 2- Supplemental Information: Data of field activity of 03008 in Puerto Rice trench, Caribbean Sea, 0201802993 to 03-08-2003

Equipment Used - tempsalinometer

Notes - Vessel from NOAA. Related Web Sites: http://oceanexplorer.noaa.gov/explorations/03trench/explorers/explorers.html

Publications -

http://oceanexplorer.noaa.gov/explorations/03trench/explorers/explorers.html

ten Brink, Uri, Danforth, W., Polloni, C.F., Parker, C.E., Uozumi, T.,Williams, G.F., 2004, Project PROBE Leg II - Final Report and Archive of Swath Bathymetric Sonar, CTD/XBT and GPS Navigation Data Collected During USGS Cruise 03008 (NOAA Cruise RB0303) Puerto Rico Trench 18 February - 7 March, 2003, U.S. Geological Survey Open-File Report 2004-1400, available on line at: http://pubs.usgs.gov/of/2004/1400/data/oceanography/ctd/ctd.htm

Similar information is available for thousands of other USGS/CMG-related Activities.

If known, available are Activity-specific navigation, gravity, magnetics, bathymetry, seismic, and sampling data; track maps; and equipment information; as well as summary overviews, crew lists, and information about analog materials.

If available, access to physical samples is described in the "WR CMG Sample Distribution Policy" at: http://walrus.wr.usgs.gov/infobank/programs/html/main/sample-dist-policy.html

Primary access to the USGS/CMG Information Bank's digital data, analog data, and metadata is provided through: http://walrus.wr.usgs.gov/infobank/

This page accommodates a variety of search approaches (e.g., by platform, by region, by scientist, by equipment type, etc.).

1.5 Time Period

2011-02-15: single date

2013-06-01; 2013-07-15; 2014-06-10; 2014-07-12, etc: multiple dates

2012-07-01 to 2015-06-30: date range

2012-07-01 to 2015-06-30; 2009-09-05 to 2015-12-03: multiple date ranges

1.6 Online Links

Example 1 (preferred link to persistent identifier): https://search.dataone.org/#view/doi:10.5063/F1TB14

Example 2 (relevant link but not preferred as website may not be archived in the long-term): www. Gulfwatchalaska.org

1.7 Contact

Jane Researcher
Professor of High Esteem
University of Somewhere
123456 Apple Road
Somewhere, AK 98765
(111) 111-1111
jane.researcher@somewhere.edu
www.somewhereuniveristy.com

1.8 Geographic Coverage

West and East Coordinates must be between -180.0 and 180.0
North and South Coordinates must be between -90.0 and 90.0

1.9 Keywords

Aquatic ecosystems, marine habitat, plankton, phytoplankton, zooplankton, primary production, oil spill, ocean temperature chlorophyll

1.10 Taxonomy

Pacific herring (*Clupea pallasii*)
Common murre (*Uria aalge*)

2. Lineage

2.1 Statement

Example 1- Lineage Statement: The list of evaluation species was created in a series of steps, starting with a comprehensive survey of species of high national importance occurring within USFWS Region 5. This was developed by combining lists of all federally listed Threatened and Endangered species, 'nongame birds of Management Concern', and waterfowl, shorebirds, anadromous and interjurisdictional fishes (inshore species of concern to the USFWS and National Oceanic and Atmospheric Administration, NOAA), which have significantly and persistently declined in abundance.

The watershed boundary was constructed by selecting the outer boundaries of all smaller watersheds in Maine, New Hampshire, and Massachusetts that flow into the Gulf of Maine. These watersheds were identified using U.S. Geological Survey (USGS) 1:24,000- and 1:100,000-scale hydrology coverages. The boundary was extended into the Gulf at Cape Cod and eastern Maine.

Atwood et al. (1996) developed a habitat model for Bicknell's thrush and found that occurrences were associated with vegetation, elevation, and latitude. Our model applied the same elevation and, as far as possible, cover type parameters. We also integrated sites of known past occurrences. We selected as 'potential habitat' areas with elevations at or over 3000', based on digital contour maps (Maine) or digital raster graphics (New Hampshire). Lower elevations were regarded as likely to be unsuitable. Bicknell's thrush occurrences in the Northeast are listed by mountain name in Atwood and Rimmer (1994), supplemented with information from Tom Hodgman, Maine Department of Inland Fisheries and Wildlife. These were digitized as point locations. Where 'potential habitat' coincided with observed use, these areas were scored according to their cover type (see http://r5gomp.fws.gov/gom/habitatstudy/metadata/Bicknell's_thrush_model.htm). Point occurrences at lower elevations were buffered 100 m, and these areas also were scored according to cover type. Other areas having elevations lower than 3000' and appropriate cover type, but not known to be used, were scored at 0.5 times the tabulated values.

(source: US FWS)

Example 2- Lineage Statement: The source data set provided 467 weekly images of each of the nine regions of the world oceans; these weekly files were averaged in the present data set to provide monthly composite images.

Source citation: Smith, E. 1991 NOAA Advanced Very High Resolution Radiometer Multichannel Sea Surface Temperature data set. Temperature data set produced by the Univ of Miama/Rosenstiel School of Marine Atmospheric Science.

Example 3- Lineage Statement: The geographic area boundaries, names, codes, and the relationships among the various geographic levels are found on Statistics Canada's Spatial Data Infrastructure. These data for administrative areas are updated using information from provincial and territorial sources. These data for statistical areas are updated using the results of the previous census and input from users."

Source citation: The Spatial Data Infrastructure (SDI) is the source for all 2006 Digital Boundary File products.

Example 4- Lineage Statement:
Source Data:

1. National High Altitude Program (NHAP) color infrared and black and white aerial photography, 6/1979 - 5/1988, 1: 58000 and 1:80000.

2. National Aerial Photography Program (NAPP) black and white aerial photography, 1990-1996, 1:40000.

3. Topographic maps, U.S. Geological Survey, 1955-1996, 1:24,000, stable-base material.

4. National Wetlands Inventory maps, U.S. Fish & Wildlife Service, 1988-1992, 1:24,000, stable-base material.

U.S. Fish & Wildlife Service Processing Steps:
NWI maps are compiled through manual photointerpretation of NHAP aerial photography supplemented by Soil Surveys and field checking of wetland photo signatures. Delineated wetland boundaries are manually transferred from interpreted photos to USGS 7.5 minute topographic quadrangle maps and then manually labelled. Quality control steps occur throughout the photointerpretation, map compilation, and map reproduction processes.

Digital wetlands data are either manually digitized or scanned from stable-base copies of the 1:24,000 scale wetlands overlays registered to the standard U.S. Geological Survey (USGS) 7.5 minute quadrangles into

topologically correct data files using Wetlands Analytical Mapping System (WAMS) software. Files contain ground planimetric coordinates and wetland attributes. The quadrangles were referenced to the North American Datum of 1927 (NAD27) horizontal datum. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. Manual digitizing used a digitizing table to capture the digital data at a resolution of at least 0.005 inches; attribution was performed as the data were digitized. The determination of scanning versus manual digitizing production method was based on feature density, source map quality, feature symbology, and availability of production systems. The data were checked for position by comparing plots of the digital data to the source material.
(*source: USFWS National Wetland Inventory)*

2.2 Processing Steps

Example 1- Processing Steps:
LG data for all of Minnesota was downloaded from the NWI ftp server. Wetland codes for each 7.5 minute quadrangle were loaded into a statewide NWI code list from which a unique code number was assigned for each wetland type. Wetland code data from FWS were incorrectly coded into all capital letters on the following 100K sheets: Bigfork, Duluth, Ely, Milbank, Pokegama Lake, Vermilion Lake and Willmar. These data were changed into the correct upper and lower case codes. The DLG files were translated into ARC/INFO double precision net (polygon/line) and point coverages and the Minnesota unique wetland code number was moved into the data set. (nwi2arc.aml). Labelerrors in the net covers were cleaned up if any existed.

The coverages were then snapped to an existing 7.5 minute quadrangle coverage and corner tics were added to create a seamless data base. Additional locational attributes were added and projection information copied into each coverage (nwiproc.aml). Coding and positional discrepancies between 7.5 minute quadrangles were identified and fixed (nwiatt.aml).

7.5 minute quadrangles in Iowa and Canada that contain small areas of Minnesota NWI data were merged into adjacent 7.5 minute quadrangles. The following 100K sheets have such data: Austin, Albert Lea, Hallock and Cavalier. The quads from Charles City and Mason City that were merged into Albert Lea and Austin quads are 4827-4836.

Final NWI data was summarized by type (point, line and polygon), projection information added and the files were exported for archive purposes (nwiexp.aml). The data was transformed into single precision shifted NAD27 coverages for use in PC ARC/INFO. The data was also projected into double precision NAD83 coordinates, but the 7.5 minute quadrangle frame still has the NAD27 boundary.

Staff either at LMIC or DNR converted the data to shapefile format for posting on the DNR Data Deli.

Example 2- Processing Steps: The source data set (Smith 1991) provides 467 weekly images of each of the nine regions of the world oceans; these weekly files were averages in the present dataset to provide monthly composite images.

Calculate monthly averages and composite monthly averages. The included C-language programs sum.c and combine.c were used to calculate the monthly and weekly average SST files. For each grid cell in the images, sum.c calculates the arithmetic average of the corresponding cell in the input files for each month or week of the year. Results are written to a set of intermediate files which are interpreted by combine c. The program combine decodes the intermediate files written by sum and writes each average image into a new files.

Create GIF and PICT images of month and weekly averages. The C-language program mrletoppm.c converts a monthly or weekly average file into a portable pixmap. GIF and PICT images were derived from these pixmpas using the freely available PbmPlus toolkit developed by Jeff Poskanzer.

Source reference Smith E. 1991. A user's guide to the NOAA Advance High Resolution Radiometer Multichannel Sea Surface Temperate data set. Internal report, 10 p.

Example 3- Processing Steps: This dataset has a simple version of observed velocities, useful for most purposes. The complete data sets with all configuration and processing details and diagnostic data (e.g. error velocity, AGC, spectral width) are available from the NODC Joint Archive for Shipboard ADCP, or by request from S. Pierce. Processing steps included: editing of the data using various diagnostics, calibration of the phase and amplitude errors of the ADCP/navigation/gyrocompass system by covariability analysis between currents and ship velocity, reference layer velocity smoothing, and final production of earth-referenced velocities. For more details regarding methods, see: Pierce et al. (2000), DSR II 47, 811-829. (*Source: DOC/NOAA/NOS/OCS > Office of Coast Survey, National Ocean Service, NOAA, U.S. Department of Commerce*)

Example 4- Processing Steps: Octopus were collected from commercial fishers during regular fishing operations targeting Pacific cod using pot gear. Octopus were assessed for condition and placed in tanks on board the fishing vessels. After a period of seventy two hours or less they were transported to the Kodiak Laboratory either via a tender vessel or the fishing vessel. Octopus were placed in individual tanks upon arrival at the laboratory. Within a 48 hour period a detailed assessment of the condition of each octopus was conducted, the gender of the octopus was determined, and each octopus was weighed. To weigh individual octopus, they were removed from their tanks, excess water was released from the mantle, and the octopus were weighed using standard bench top scales. Octopus were held for twenty one days; during this period they were fed herring to satiation two times per week. After 21 days, another detailed assessment was conducted.
(Source: Discard mortality for the giant Pacific octopus in the Gulf of Alaska, 2014-15, NPRB Project 1203)

Example 5- Processing Steps: AVHRR Binary Flat Files were loaded into SeaDAS. SeaDAS is a comprehensive image analysis package for the processing, display, analysis and quality control of all SeaWIFS data products. It also displays AVHRR Binary Flat Files and many other data products. The file, mbari.lut, is used as the colormap for the images. Processing scripts include: musesst.pro for bulk processing, musebit1.pro, musebit2.pro, and musebit3.pro for bit shifting.
(*source: MBARI Upper Water Column Science Experiment*)

Example 6: Sediment samples were washed on a 0.062 mm sieve to separate the foraminifera from the silt and clay. Foraminifera were picked from the fraction retained on the sieve and individually identified and counted with a binocular microscope using reflected light.
(*Source: USGS Benthic Foraminifera samples)*

3. Constraints

3.1 Access
Example 1- Access Constraints: None

Example 2-Access Constraints: CIESIN offers unrestricted access and use of data without charge, unless specified in the documentation for particular data. All other rights are reserved.

Example 3- Access Constraints: While every effort has been made to ensure that these data are accurate and reliable within the limits of the current state of the art, NOAA cannot assume liability for any damages caused by any errors or omissions in the data, nor as a result of the failure of the data to function on a particular system.
NOAA makes no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.

Example 4- Access Constraints: Not to be used for navigation. Although these data are of high quality and useful for planning and modeling purposes, they are not suitable for navigation. For navigation, please refer to the NOS nautical chart series.

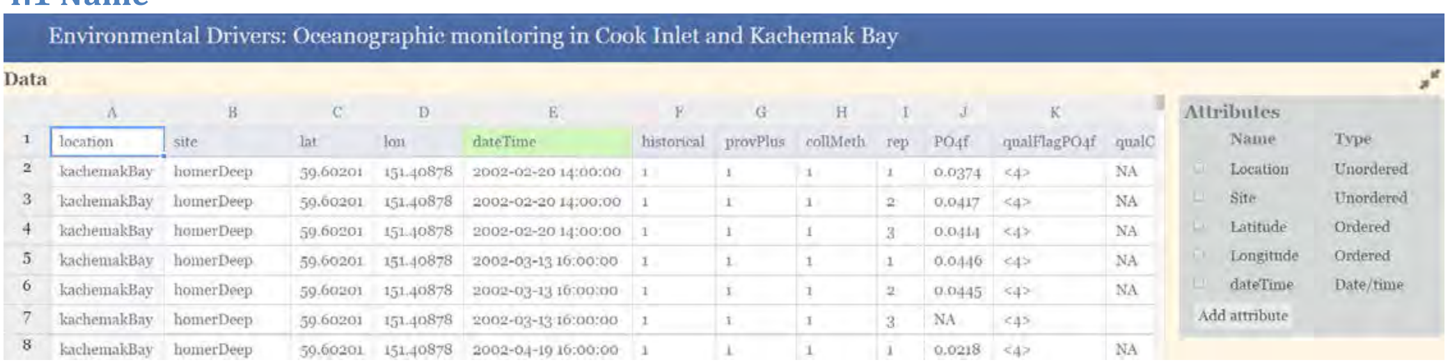
3.2 Use
Example 1-Use Constraints: None

Example 2-Use Constraints: The Wildlife Conservation Society (WCS) and Trustees of Columbia University in the City of New York hold the copyright of this dataset. Users are prohibited from any commercial, non-free resale, or redistribution without explicit written permission from WCS or CIESIN. Users should acknowledge WCS and CIESIN as the source used in the creation of any reports, publications, new datasets, derived products, or services resulting from the use of this dataset. WCS or CIESIN also request reprints of any publications and notification of any redistributing efforts.

Example 3- Use Constraints: There are no restrictions on the use of this data. However, secondary distribution must be accompanied by this documentation. Credit should always be given to the data source when this data is transferred or printed.

4. Data Attributes

4.1 Name


Environmental Drivers: Oceanographic monitoring in Cook Inlet and Kachemak Bay

Data

	A	B	C	D	E	F	G	H	I	J	K	
1	location	site	lat	lon	dateTime	historical	provPlus	collMeth	rep	PO4f	qualFlagPO4f	qualC
2	kachemakBay	homerDeep	59.60201	151.40878	2002-02-20 14:00:00	1	1	1	1	0.0374	<4>	NA
3	kachemakBay	homerDeep	59.60201	151.40878	2002-02-20 14:00:00	1	1	1	2	0.0417	<4>	NA
4	kachemakBay	homerDeep	59.60201	151.40878	2002-02-20 14:00:00	1	1	1	3	0.0414	<4>	NA
5	kachemakBay	homerDeep	59.60201	151.40878	2002-03-13 16:00:00	1	1	1	1	0.0446	<4>	NA
6	kachemakBay	homerDeep	59.60201	151.40878	2002-03-13 16:00:00	1	1	1	2	0.0445	<4>	NA
7	kachemakBay	homerDeep	59.60201	151.40878	2002-03-13 16:00:00	1	1	1	3	NA	<4>	
8	kachemakBay	homerDeep	59.60201	151.40878	2002-04-19 16:00:00	1	1	1	1	0.0218	<4>	NA

Attributes

Name	Type
Location	Unordered
Site	Unordered
Latitude	Ordered
Longitude	Ordered
dateTime	Date/time

Add attribute

In the above example, the attribute name for column A is ‘location, column B ‘site’, column C ‘lat’, etc.

4.2 Definition

Example 1- Name= Location; Definition= region where sampling occurred

Example 2- Name= Site; Definition= Homer or Seldovia, surface or deep mooring

Example 3- Name= Length; Definition= The fish length from the tip of the nose to the tip of the longer lobe of the caudal fin. Measured in mm.

Example 4- Name= Otter Behavior; The predominant behavior of the animal at the time of observation.

R= resting
T=traveling
G= grooming
F= foraging

4.3 Measurement Type

Unordered= unordered categories or text (statistically nominal)

Examples: Male/Female; Homer/Seldovia; Site A/Site B

Ordered= ordered categories (statistically ordinal)

Examples: Low/High; Surface/Mid-water/Bottom

Relative= values from a scale with equidistant points (statistically interval)

Examples: 12.2 degrees Celsius;

Absolute= measurement scale with a meaningful zero point (statistically ratio)

Examples: 273 Klein; 5.4 kg; 217 mm

Date/time= date or time values from the Gregorian calendar

Examples: 2012-10-24

2015-04-23

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$0.0	$90.9	$94.0	$184.9	$90.9
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$0.0	$20.9	$21.6	$42.5	$20.9
SUBTOTAL	$0.0	$0.0	$0.0	$111.7	$115.6	$227.4	$111.7
General Administration (9% of subtotal)	$0.0	$0.0	$0.0	$10.1	$10.4	$20.5	$10.1
PROJECT TOTAL	$0.0	$0.0	$0.0	$121.8	$126.0	$247.8	$223.5
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS:

FY12-16

Program Title: Supplemental Data Management Support for EVOSTC Monitoring Programs
Team Leader: Rob Bochenek, AOOS

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-E

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long term monitoring of oceanographic conditions in Prince William Sound

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Robert W. Campbell

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

Feb. 1 2015 – Jan. 31 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatch.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

The six planned surveys of Prince William Sound (PWS) were conducted during the reporting period (Table 1), and all 12 standard stations (Figure 1) were occupied. All conductivity, temperature, and depth (CTD) data have been processed, and seasonally detrended anomalies of temperature and salinity at selected depths in central PWS are shown in Figures 2 and 3. Temperatures in central PWS have been above average since late 2013, as has been observed elsewhere in the Gulf of Alaska (see Hopcroft and Danielson/Weingartner reports). It appears that PWS exhibited the same "warm blob" anomaly seen throughout the Gulf of Alaska with approximately the same timing. Salinity anomalies in central PWS were less informative and more variable, but have for the most part tended towards fresh anomalies, presumably reflecting warmer than average summers throughout Alaska during the last two years.

Plankton, nutrient, and chlorophyll-a samples were collected from all stations with no incidents. As of January 2015 All plankton samples have been enumerated from this project (Lower Cook Inlet samples will be done in the first quarter of 2016), and all chlorophyll-a filters have been run (chlorophyll analysis is done shortly after each cruise to minimize storage artefacts). Analysis of nutrient samples is progressing: A Seal Analytical AA3 autoanalyzer was purchased in 2015, and sample analysis continues apace at the writing of this report (~40 samples per day on average); it is expected that the backlog will have been worked through by the second quarter of 2016.

The Autonomous Moored Profiler (AMP) profiling mooring experienced a battery failure at some point during winter storage, and was returned in February 2015 for service. The profiling mooring was deployed in late March, well ahead of the spring bloom (the extraordinarily early spring bloom observed in 2014 led us to plan an early deployment this year). The 2015 deployment was the most successful to date, with daily profiles over most of the growing season, with small gaps due to service periods.

The 2015 time series from the AMP mooring shows the annual cycle of stratification and productivity at previously un-measured scales (Figure 4). Thermal stratification began in late May, and was very strong into late July/August (the temperature in the surface layer was > 16 °C, approximately 4 °C warmer than average). The spring bloom, however, appears to have been quite weak and late in 2015 (which is remarkable because 2014 was also a warmer than average year, had a very early and strong bloom). There was a very short-lived bloom in late April-early May, and subsurface productivity (at the nitricline) into June. High concentrations of nitrate were observed in surface waters through much of May and into June, but did not show corresponding increases in productivity.

Table 1: Status of project milestones for FY14.

Deliverable/Milestone	Status
PWS Survey, Deploy mooring	Conducted 21-22 March 2015
Mooring service	Conducted 13 April 2015
PWS Survey / service mooring	Conducted 23-25 April 2015
PWS Survey / service mooring	Conducted 23-25 May 2015
Mooring service	Conducted 25 June 2015
PWS Survey / service mooring	Conducted 24-25 July 2015
Mooring service	Conducted 2 September 2015
Mooring retrieval / service in Cordova	Conducted 6 September 2015
Mooring deployment	Conducted 18 September 2015
PWS Survey	Conducted 25-26 September 2015
Mooring retrieval	Conducted 22 October 2015
PWS / Seabird mortality Survey	Conducted 6-8 January 2016
CTD data processed	Completed January 2016
Chlorophyll-a samples processed	Completed January 2016
Plankton samples enumerated	Completed January 2016 (this project)/ March 2016 (Doroff)

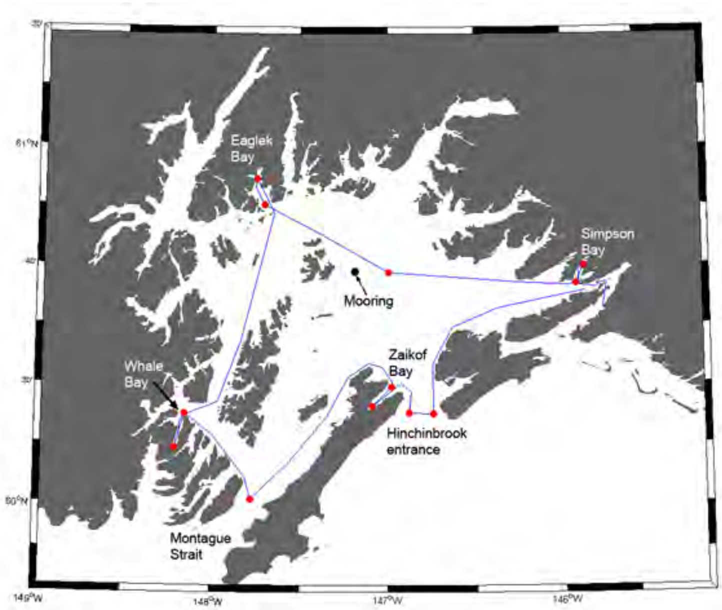


Figure 1: Map of the standard cruise track and stations, and the location of the AMP mooring.

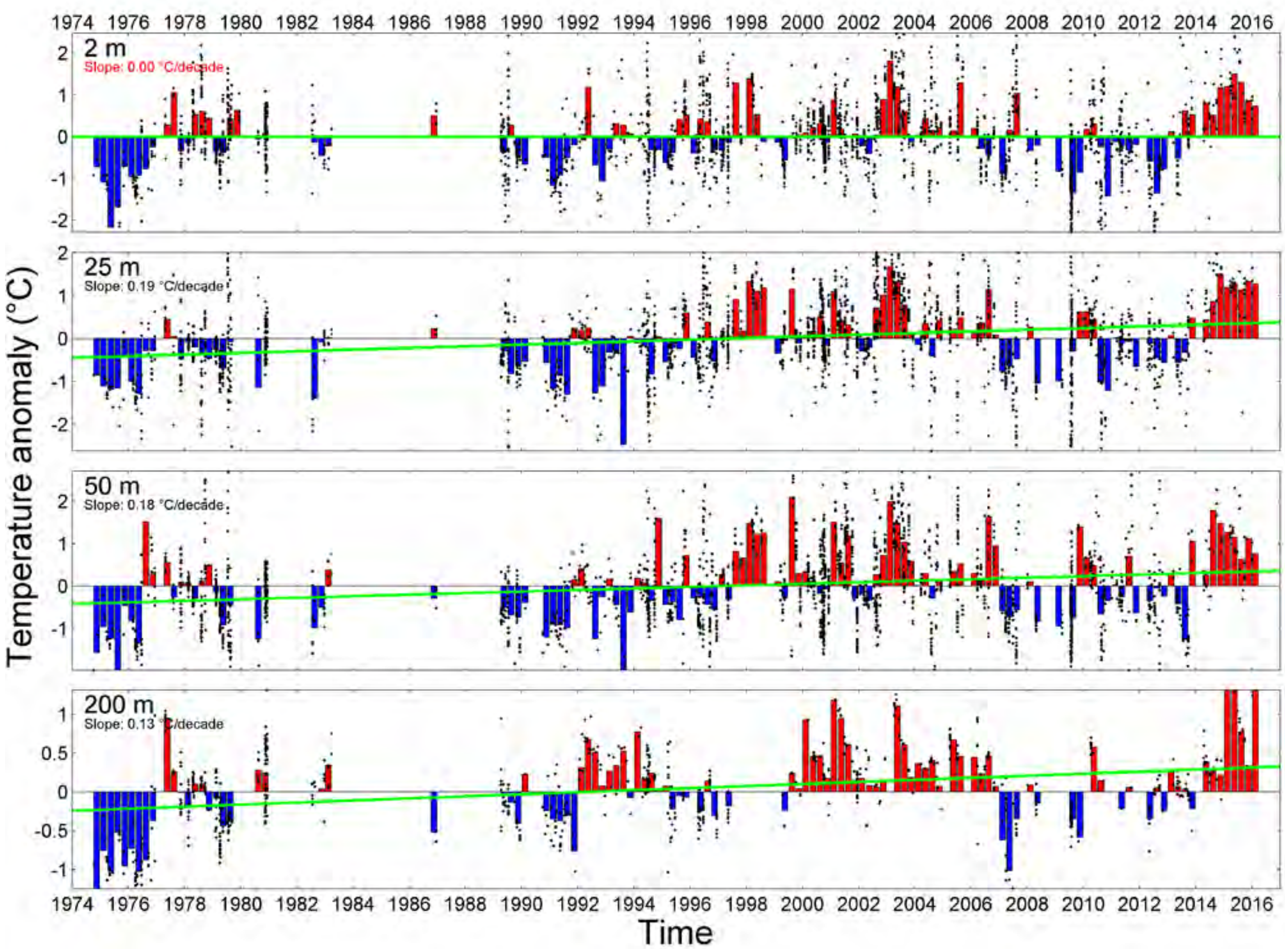


Figure 2: Temperature anomaly time series at selected depths in central Prince William Sound. Anomalies were calculated as the residual from a second order cosine fit to Julian day (for all years data) and thus represent seasonally detrended values. Vertical bars indicate quarterly average anomalies, black dots represent individual observations, the green line indicates the linear trend. Red text for the slope indicates that the slope is not significantly different from zero (p>0.05).

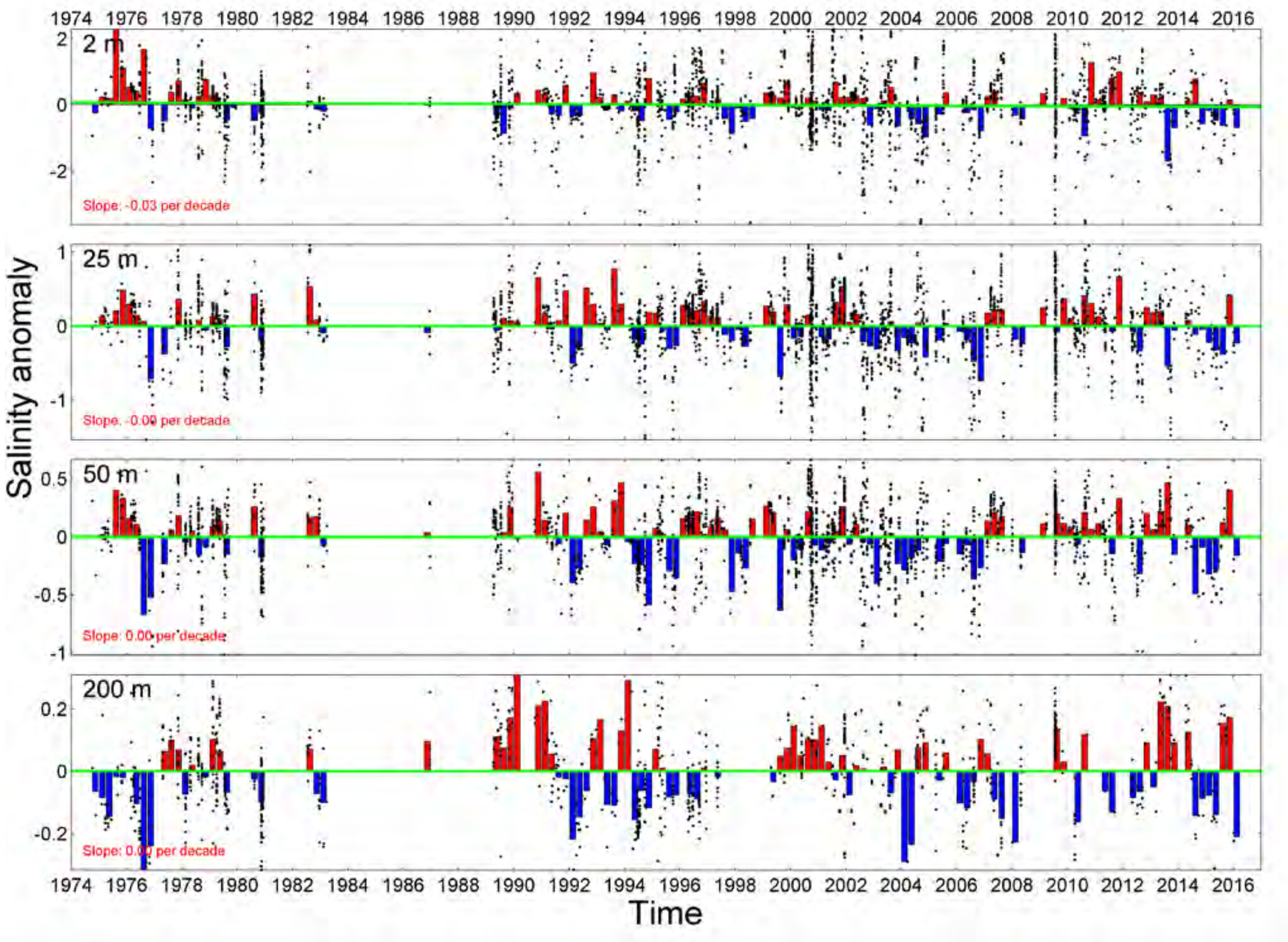


Figure 3: Salinity anomaly time series at selected depths in central Prince William Sound. Anomalies were calculated as described in Figure 2.

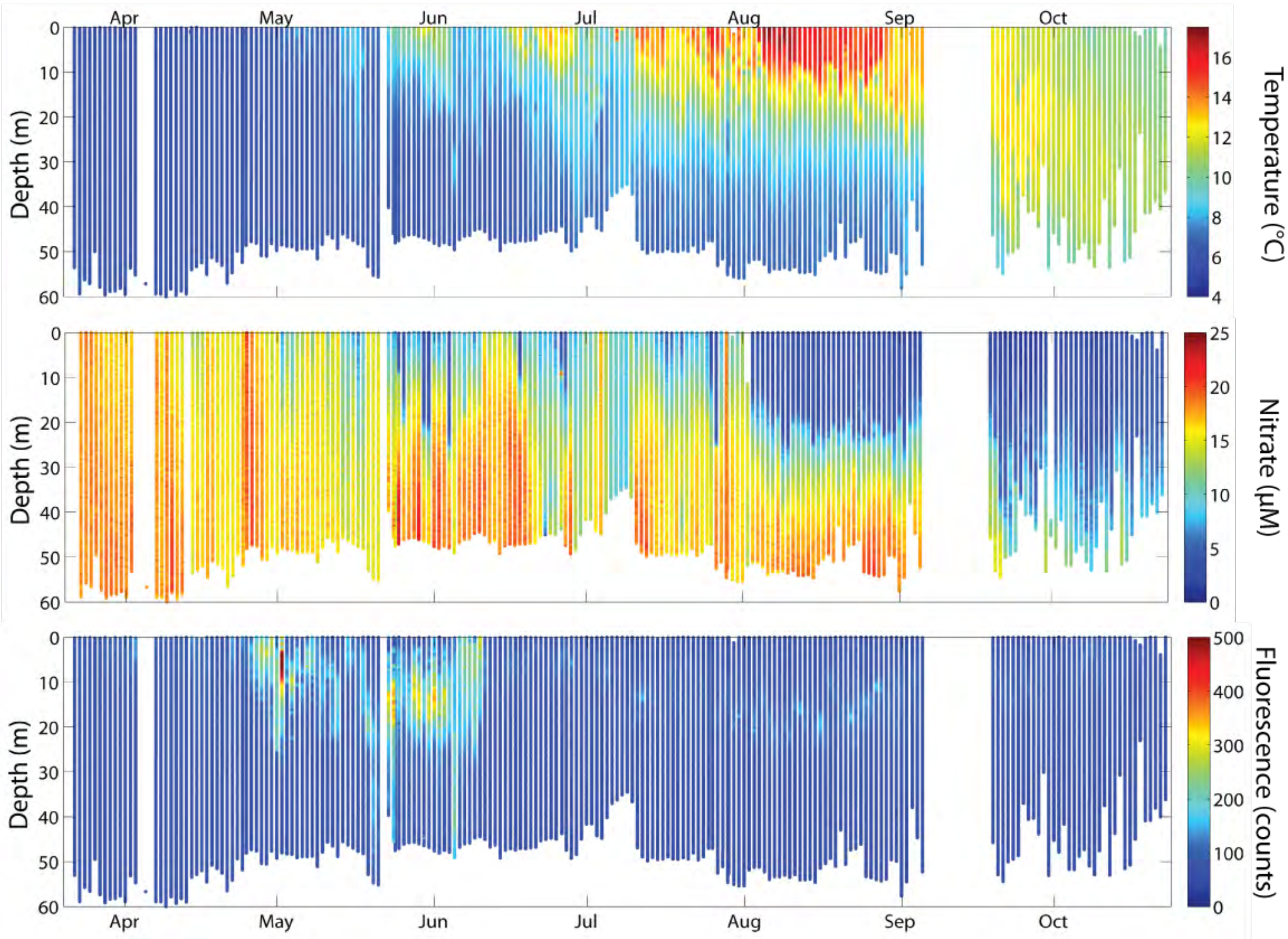


Figure 4: Time series of temperature (top panel), nitrate concentration (middle panel) and chlorophyll-a fluorescence (bottom panel) in the surface layer of PWS in 2015 measured by the AMP profiler. Each vertical line represents a single profile, and colors correspond to values of each observation. Fluorescence is presented as digital counts from the fluorometer, and are linearly proportional to chlorophyll-a concentration.

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

8.A. Within the GWA and Herring Research and Monitoring program:

- All plankton samples collected as part of project 12120114-G ("Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay") are processed and identified by this project.
- Plankton samples for herring disease studies (PI: Paul Hershberger, 1212011-K) were collected from several locations during 2014 surveys.
- Campbell has provided plankton data (and abstracted plankton taxa) to the Herring Condition Monitoring project (Project 12120111-L)
- Campbell collaborated with Sonia Batten (Project 12120114-A) on a publication ("Plankton indices explain interannual variability in Prince William Sound herring first year growth."), manuscript is in review following minor revisions.

8.B. With other EVOSTC funded projects: NA

8.C. With trustee agencies:

- Additional plankton samples were sent to the USGS Marrowstone group for tests for the presence of *Ichthyophonus* life stages.
- Photos were taken at two long term study locations for Alan Mearns (NOAA).
- The January 2016 survey coincided with an unusual mortality event of common murres, first observed in Whittier and the northwestern portion of PWS; NOAA researchers also passed on observations of fewer than average wintering humpback whales in Hawaii. A bird and mammal observer rode along on the January survey, to enumerate and collect seabird carcasses (for USFWS) and to look for whales.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

- Campbell, R.W. 2016. Surface layer and bloom dynamics in Prince William Sound. Alaska Marine Science Symposium, Anchorage.
- Campbell, R.W. 2016. Effects of the 2013-2015 warm anomaly in Prince William Sound, Alaska. Pacific Anomalies Workshop 2, Seattle.
- Campbell, R.W. 2015. State of the Sound: Oceanography, surface layer dynamics, and plankton blooms in PWS. PWSSC Lecture series, Cordova.
- Campbell, R.W. 2015. Oceanography, surface layer dynamics, and plankton blooms in PWS. PWS Regional Citizens' Advisory Council, Anchorage.
- Campbell, R.W. 2015. State of the Sound: Oceanography, surface layer dynamics, and plankton blooms in PWS. PWSSC Pub Talk, Cordova.
- Campbell, R.W. 2015. Recent trends in the oceanography of Prince William Sound. Poster presented at Alaska Marine Science Symposium, January 2015.
- Joint presentation: Environmental drivers. Gulfwatch AK PI meeting, November 2015.
- All CTD, chlorophyll-a, and zooplankton data collected in FY14 have been uploaded to the ocean workspace.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

No specific comments or recommendations were made in this project year.

11. Budget: *See,* Reporting Policy at III (C) (11).

Spending on personnel has been slightly behind schedule because Campbell's salary was largely covered by other projects in prior years that needed to be spent down. The unspent salary is currently being drawn down and is also being used for additional technician time for nutrient analysis.

Travel spending has been over budget due to a miscommunication over budgeting during the proposal process. Campbell has been attending both the annual PI meeting in November and the Alaska Marine Science Symposium in January, which has slightly exceeded the budget. Equipment spending was over budget in 2015 because funds from this project were used to contribute towards the purchase of the nutrient autoanalyzer.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$12.4	$121.6	$125.4	$131.2	$136.3	$526.8	$338.8
Travel	$0.0	$1.0	$1.0	$1.0	$1.0	$4.0	$5.0
Contractual	$1.0	$43.7	$43.7	$43.7	$43.7	$175.8	$117.8
Commodities	$0.0	$11.0	$11.0	$11.0	$11.0	$44.0	$30.6
Equipment	$205.0	$0.0	$0.0	$0.0	$0.0	$205.0	$222.0
Indirect Costs (will vary by proposer)	waived	waived	waived	waived	waived	waived	
SUBTOTAL	$218.4	$177.3	$181.1	$186.9	$192.0	$955.6	$714.29
General Administration (9% of subtotal)	$19.7	$16.0	$16.3	$16.8	$17.3	$86.0	$68.72
PROJECT TOTAL	$238.1	$193.2	$197.3	$203.7	$209.3	$1,041.6	$783.01
Other Resources (Cost Share Funds)	$23.3	$23.3	$23.3	$145.0	$135.0	$349.9	$214.90

COMMENTS: The Science Center waives Indirect Costs for this project due to its administration of the overall proposal. PWSSC provides a CTD profiler (SBE model 25plus) with several auxiliary sensors (chlorophyll fluorometer, backscatter turbidometer, oxygen sensor, solid state active fluorometer and nitrate analyser), which is used for all field surveys, and to cross-calibrate with the profiler (value ~$75K). Extracted chlorophyll-a is read on a Turner Designs TD-700 fluorometer (replacement cost ~$10K). As well as the moored profiler, PWSSC provides a pair of acoustic releases, and a 1-m diameter syntactic foam float with upward and downward looking RDI ADCP current profilers (value ~$50K). The Alaska Ocean Observing System has also contributed $10K in FY14 for surveys in PWS.

FY12-16

Program Title: 15120114-E PWS Oceanographic monitoring
Team Leader: Robert Campbell

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-S

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term Monitoring: Lingering Oil - Extending the Tracking of oil levels and weathering (PAH composition) in PWS through time

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Mark Carls, Mandy Lindeberg

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015 - January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

http://www.gulfwatchalaska.org/monitoring/lingering-oil/lingering-oil-weathering-and-tracking/

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Key Findings:

- A new forensic biomarker model provides more source information than the standard Nordtest approach.
- *Exxon Valdez* oil was definitively identifiable with biomarkers in sequestered oil from 1989 to 2015.
- Biomarker concentrations initially increased as the oil lost volatile components.
- Biomarker concentrations generally declined thereafter; rates varied within and among beaches.
- Differential biomarker weathering was observed.
- Biomarkers generally weathered less loss in the Gulf of Alaska (except Cape Gull) than in Prince William Sound.
- Polynuclear aromatic hydrocarbon (PAH) weathering patterns were similar, though the process was more rapid for these smaller molecules.
- Current PAH loss rates are low, demonstrating oil deposits are no longer a threat for organisms that live outside of beach sediment.
- PAH and alkane loss rates decreased with molecular mass; this is controlled by thermodynamics.

Appendix A *(see accompanying pdf document*) contains three draft papers in support of these observations. Chapter X reviews PAHs and alkanes across multiple sites in Prince William Sound (PWS) and the Gulf of Alaska from the year of the spill (1989) through the most recent collection (2015). Chapter Y presents the biomarker history from 1989 to 2014; this was written and submitted to a journal before completion of the 2015 data. Chapter Z adds the 2015 biomarker data and places them in the historical context. It significantly improves on interpretation of the biomarker record by interpreting the weathering patterns and finding that biomarker loss rates are generally higher in PWS than in the Gulf of Alaska, consistent with the same geographic pattern observed for PAHs.

- Field sampling has been completed to determine the quantity and weathering state of oil on 9 PWS beaches. We proposed 10 sites would be sampled but due to higher charter and fuel costs the survey was reduced by one day. Samples have been processed amd quantified. A report is being drafted. Preliminary results are:
    - The total mass of oil varied from 0 to 3,600 kg per beach; no oil was discovered at Evans Island (EV039A) and one of the Eleanor Island beaches contained the most oil (EL056C; Figure 1). Proportionate oiling ranged from 0 (EV039A) to 40% (EL056C) overall based on the number of oiled pits or 0 to 30% when based on oiled area (Table 1).
    - The amount of oiling was consistent with previous estimates; in general the proportion oiled remains the same (Figure 2). The percent oil discovered increased in one beach (EL058B), declined in another (EV039A) and remained constant in the others. This variance is likely simply statistical noise; on average the amount of oil remaining is roughly the same.
    - Polynuclear aromatic hydrocarbons (PAHs) were not discovered in passive samplers deployed on one beach in 2015; total PAH concentrations were low and modeling revealed no oil. Concentrations in field samples were about the same as in blanks. In sharp contrast, samplers deployed in 2002 in Herring Bay acquired orders of magnitude greater total PAH concentrations and they were petrogenic.

Table 1. Estimates of oil remaining in Prince William Sound beaches in 2015; % oiling is calculated on an area basis (pit area / total area) and % oil is based on the number of oiled pits divided by the total number of pits on that beach. Mmodel is the predicted %oil by a model (Nixon and Michel 2015).

			m	m^2	m^2	per area	Est. based on n pits	
SiteCode	**Location**	**Segment**	**Length**	**Site Area**	**Oil Area**	**%Oiling**	**% oil**	**Mmodel**
1	Eleanor Is.	EL056C	90	13,212	3,898	29.5%	40%	>30%
2	Eleanor Is.	EL058B	51	9,372	1,698	18.1%	30%	>30%
3	Evans Is.	EV039A	109	26,716	0	0.0%	0%	1-5%
4	Greens Is.	GR103B	100	20,742	802	3.9%	10%	1-5%
5	Herring Bay	KN0114A	68	13,605	1,855	13.6%	23%	>30%
6	Herring Bay	KN0300A-2	52	11,135	267	2.4%	3%	1-5%
7	Knight Island	KN0506A	50	9,171	13	0.1%	3%	0-1%
8	Sleepy Bay	LA018A-1	100	15,722	71	0.5%	4%	5-15%
9	Smith Is.	SM006B	100	28,014	2,504	8.9%	22%	>30%

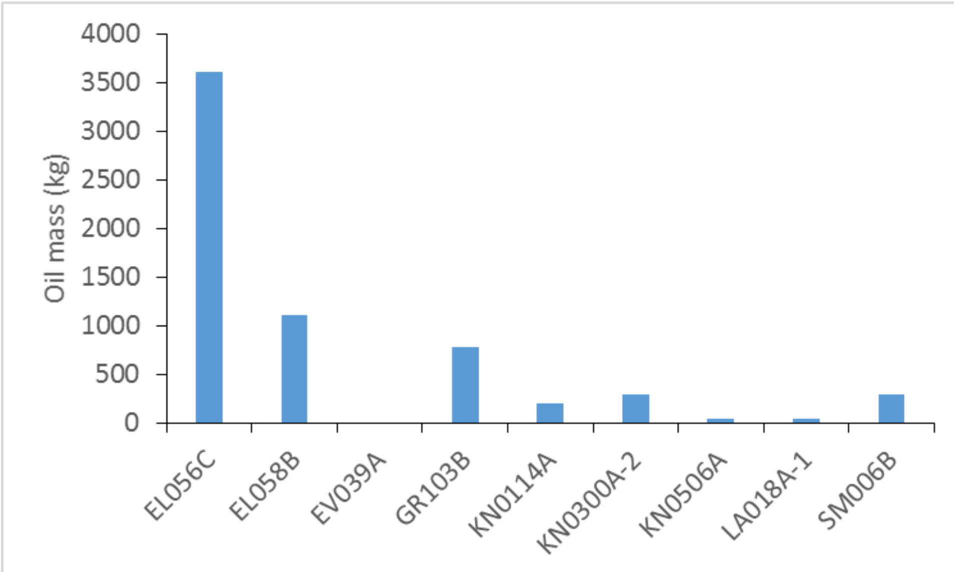


Figure 1. Total oil mass per beach surveyed in Prince William Sound summer of 2015.

Project Status for year 4:

Deliverable/Milestone	Status
Objective 1: field work	Field work is complete.
Objective 2: supplemental analyses	No supplemental analyses have been requested by other Gulf Watch researchers.
Objective 3: hydrocarbon database	Maintenance of the hydrocarbon database is up to date through 2015 and available on Ocean Workspace/public.
Objective 4: Reporting	Reports have been submitted as required and publications have been published and drafted.

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

We continued collaboration with the Prince William Sound Regional Citizens' Advisory Council on long-term environmental monitoring, an Alaska Department of Fish andGame bird study (outside PWS), and hydrocarbon contamination in Cordova Harbor (Ivy Patton, Environmental Coordinator Native Village of Eyak).

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

Publications and Reports:

Carls MG, Larsen ML, Holland LG. 2015. Spilled oils: static mixtures or dynamic weathering and bioavailability? Plos One DOI:10.1371/journal.pone.0134448.

Carls MG, Holland L, Pihl E, Zaleski MA, Moran J, Rice SD. 2015. Polynuclear aromatic hydrocarbons in Port Valdez shrimp and sediment. Report to Prince William Sound Regional Citizen's Advisory Council. AKC-075.5. 31 pages.

Carls MG. 2015. Overview, Deepwater Horizon. Report to DOJ lawyers in support of Phase 3 BP trial. 155 pages.

Carls MG, Holland L, Irvine GV, Mann DH, Lindeberg M. Submitted. Biomarkers as tracers of *Exxon Valdez* oil.

Carls MG, Holland L, Pihl E, Zaleski MA, Moran J, Rice SD. Submitted. Polynuclear aromatic hydrocarbons in Port Valdez shrimp and sediment. Target Journal: ET&C.

Carls MG, Vanderhoof L, Shaufler L. Submitted. Carbonate cycling in a north temperate fjord.

Carls MG, Larry Holland, Corey Fugate, and Mandy Lindeberg. In prep. Review of PAH and alkane retention in sediment oiled by the *Exxon Valdez*.

Carls MG, Larry Holland, Corey Fugate, and Mandy Lindeberg. In prep. Biomarkers in *Exxon Valdez* oil from Prince William Sound, 2015.

Incardona JP, Carls MG, Holland L, Linbo TL, Baldwin DH, Myers MS, Peck KA, Tagal M, Rice SD, Scholz NL. 2015. Embryonic crude oil exposure causes cardiac hypertrophy and reduced aerobic performance in juvenile pink salmon and Pacific herring. Nature Scientific Reports DOI: 10.1038/srep13499.

Nesvacil K, Mark Carls, Larry Holland, Sadie Wright. In prep. Assessment of bioavailable hydrocarbons in Pribilof rock sandpiper overwintering habitat in Cook Inlet, Alaska.

Payne JR, Driskell WB, Carls MG, Larsen ML, Holland LG. 2015. Long-term environmental monitoring program. Results and interpretations from sampling, 2008-2013. PWSRCAC Contract No. 951.10.01. 109 pp.

Presentations and outreach:

Carls, MG and RA Heintz. *Persistent Alaska North Slope crude oil: a quarter century of weathering*. Ocean Sciences meeting, New Orleans 2016.

Lindeberg, M.R. *Seaweeds, Fishes, Monitoring and More!* PWSSC and Cordova Night Lecture Series. December 2015.

Fugate, C., M.R Lindeberg, J.M. Maselko, L. Holland and M.G. Carls. *Recent Survey Confirms Persistence of Lingering Oil 26 Years after the Exxon Valdez Oil Spill.* Alaska Marine Science Symposium. Anchorage, Alaska. January 2016.

Meeting attendance:

January 2016, Alaska Marine Science Symposium, Anchorage: Mandy Lindeberg, Corey Fugate.

November 2015, Gulf Watch Alaska annual principal investigator meeting, Anchorage: Mandy Lindeberg, Ron Heintz.

Data and Metadata:

Ocean Workspace now has:

- 2015 update of the hydrocarbon database and supporting documentation (e.g legacy or data dictionary pdf, macro for filtering GCMS output, and updated metadata). All reports and publications on biomarkers and *Exxon Valdez* oil analyses are based on data in the hydrocarbon database.

- A file on gravimetric samples (raw data for calculating mass of oil in pits) from the summer survey has been added.

- A chain of custody file of all samples collected during the lingering oil survey.

- Site photos from the Prince William Sound lingering oil survey have also be uploaded with metadata file.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

There were no recent comments for this project from EVOS reviews.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Our overall budget expenditures are on target with the proposed expenditures. The majority of remaining funds are encumbered in a contract and all funds will be exhausted by the end of the fiscal year.

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

1. Program Number: *See*, Reporting Policy at III (C) (1).

15120114-R

2. Project Title: *See*, Reporting Policy at III (C) (2).

Gulf Watch Alaska: Nearshore Benthic Systems in the Gulf of Alaska

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

H. Coletti, D. Esler, B. Ballachey, J. Bodkin, T. Dean, K. Kloecker, M. Lindeberg, D. Monson, B. Weitzman

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

February 1, 2015 – January 31, 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

www.gulfwatchalaska.org, http://science.nature.nps.gov/im/units/swan/

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

Our field work for year 4 (the 2015 field season, with field work from April through July) was performed with no problems or concerns, with project components completed on schedule. We conducted 5 field trips, including 1 to Katmai National Park (KATM), 1 to Kenai Fjords National Park (KEFJ), 2 to western Prince William Sound (WPWS), and 1 to northern PWS (NPWS). At all areas, we re-sampled nearshore sites that were established in previous years. Work completed in all areas included monitoring of rocky intertidal sites, mussel sites, soft sediment sites, and eelgrass beds. At KATM, KEFJ, and WPWS, we also monitored black oystercatcher nests and collected sea otter forage data. We completed marine bird and mammal surveys in KATM and KEFJ, and sea otter carcass collections in WPWS, KATM and KEFJ. An aerial survey of sea otters in KATM was completed in July 2015. Additionally, we have continued to closely coordinate monitoring efforts with the Gulf Watch Alaska (GWA) nearshore project in Kachemak Bay (KBAY; K. Iken and B. Konar; GWA Nearshore Project 12120114-L).

A detailed description of the nearshore component of GWA is presented by Dean et al. (2014) in the *Protocol Narrative for Nearshore Ecosystem Monitoring in the Gulf of Alaska*, updated in 2014 to reflect the joint effort of the National Park Service (NPS) Southwest Alaska Vital Signs Monitoring Program and the Exxon Valdez Oil Spill (EVOS) GWA Long-term Monitoring of nearshore sites in the Gulf of Alaska. In brief, the nearshore component of GWA is a carefully designed set of measurements, which are spatially and temporally coordinated and taken across a broad swath of shoreline in the northern Gulf of Alaska. This program collects information on biota from throughout the nearshore food web, allowing considerations of the trophic levels and spatial scales over which environmental variation has effects. Figure 1 illustrates some of the species and processes addressed by the nearshore component of GWA.

Figure 1. The nearshore ecosystem monitored by GWA in the northern Gulf of Alaska.

In addition to core monitoring work, we also were engaged in several collaborative efforts to understand nearshore processes, leveraging the field presence facilitated by GWA. We continued collections of nearshore species including mussels, clams, and kelps for stable isotope analyses, collaborating with Dr. S. Newsome at the University of New Mexico. We collected additional mussels for two studies, to: 1) assess rates of growth at study sites across the Gulf of Alaska, and 2) evaluate gene expression, as a tool for monitoring long-term health of the nearshore, in collaboration with Drs. L. Bowen and K. Miles U.S. Geological Survey (USGS)-Western Ecosystem Research Center.

We surveyed sea stars at our nearshore sites for sea star wasting disease, which has been widely observed in stars along the California, Oregon, Washington and British Columbia coasts. We initially collaborated with an experienced star observer from the University of California Santa Cruz (on our eastern PWS trip in 2014). In 2014, a concerted effort to look for wasting disease at GWA intertidal long term monitoring sites in southcentral Alaska detected only 9 diseased stars out of 1,588 counted across

30 sites (0.6%), far fewer than expected given the prevalence of wasting disease further south. In 2015, we recorded 69 diseased stars out of 2,016 stars observed (3.4%); almost all of these (67) were observed in KBAY (Iken and Konar pers. comm.). Although there was a slight increase in 2015, the occurrence of diseased stars is still low in contrast to southeast Alaska and the Lower 48. Additional surveys of stars will continue this summer (2016), as part of our scheduled nearshore monitoring activities. Because of public interest in the topic of sea star wasting disease, we developed a "Resource Brief" to distribute to managers, educators and the public in 2014 (http://science.nature.nps.gov/im/units/swan/assets/docs/reports/resourcebriefs/GWA_2014_SeaStarWasting_RB.pdf). Additionally, a poster on the 2014 and 2015 sea star observations was presented at the 2016 Alaska Marine Science Symposium, and we are working to establish a network of scientists who are available to interact with the public when suspected cases of sea star wasting disease are seen.

Considerable effort has been invested during 2015 on data coordination and management. Specifically, nearshore data sets have been modified to ensure consistency in data structure across years, metadata records have been updated to enhance clarity, and data have been posted on-time to the workspace, as well as shared with the National Center for Ecological Analysis and Synthesis (NCEAS) when appropriate. We are committed to providing clean, accessible, understandable, and timely data for the life of this program.

<u>2015 Highlights</u>

Below we present results from several aspects of our nearshore studies, as examples of the variety of findings that are emerging from this long-term program, both expected and unanticipated. These include: (1) nearshore water temperature anomalies in 2014, (2) common murre numbers observed in nearshore areas during summer surveys, (3) a summary of aerial surveys of sea otters and energy recovery rates through 2015, (4) variation in selected mussel metrics across the Gulf of Alaska, and (5) descriptions of clam assemblages at sand/gravel sites in KATM, KEFJ, and WPWS. Additional data syntheses and analyses have been presented in a variety of reports, journal articles, posters, presentations, and outreach events, listed below.

(1) Water temperature across the northern Gulf of Alaska: Does "the blob" affect the nearshore?

Observations by the Environmental Drivers component of GWA have revealed anomalously high water temperatures in offshore waters throughout the northern Gulf of Alaska in 2014 and 2015; this concurs with documentation of a large area of warm water in the northeast Pacific, referred to as "the blob". These observations have been associated with important biological effects in pelagic food webs, e.g., in phytoplankton and zooplankton abundance and species composition. However, the extent to which elevated water temperature reaches the nearshore is unknown, and is complicated by many factors specifically affecting water conditions in nearshore systems, including freshwater inputs, glacial melt, tidal exchange, nearshore currents, etc. Our regular nearshore component activities include deployment of sensors to record temperature at rocky intertidal sites throughout the year. Based on data through July 2014, elevated temperatures in offshore areas corresponded to slightly higher than normal temperatures in the nearshore (Figure 2). The next steps will be to analyze temperature through 2015 and consider whether elevated water temperatures affected abundance, species composition, or performance of intertidal biota monitored at the same sites where temperature was recorded.

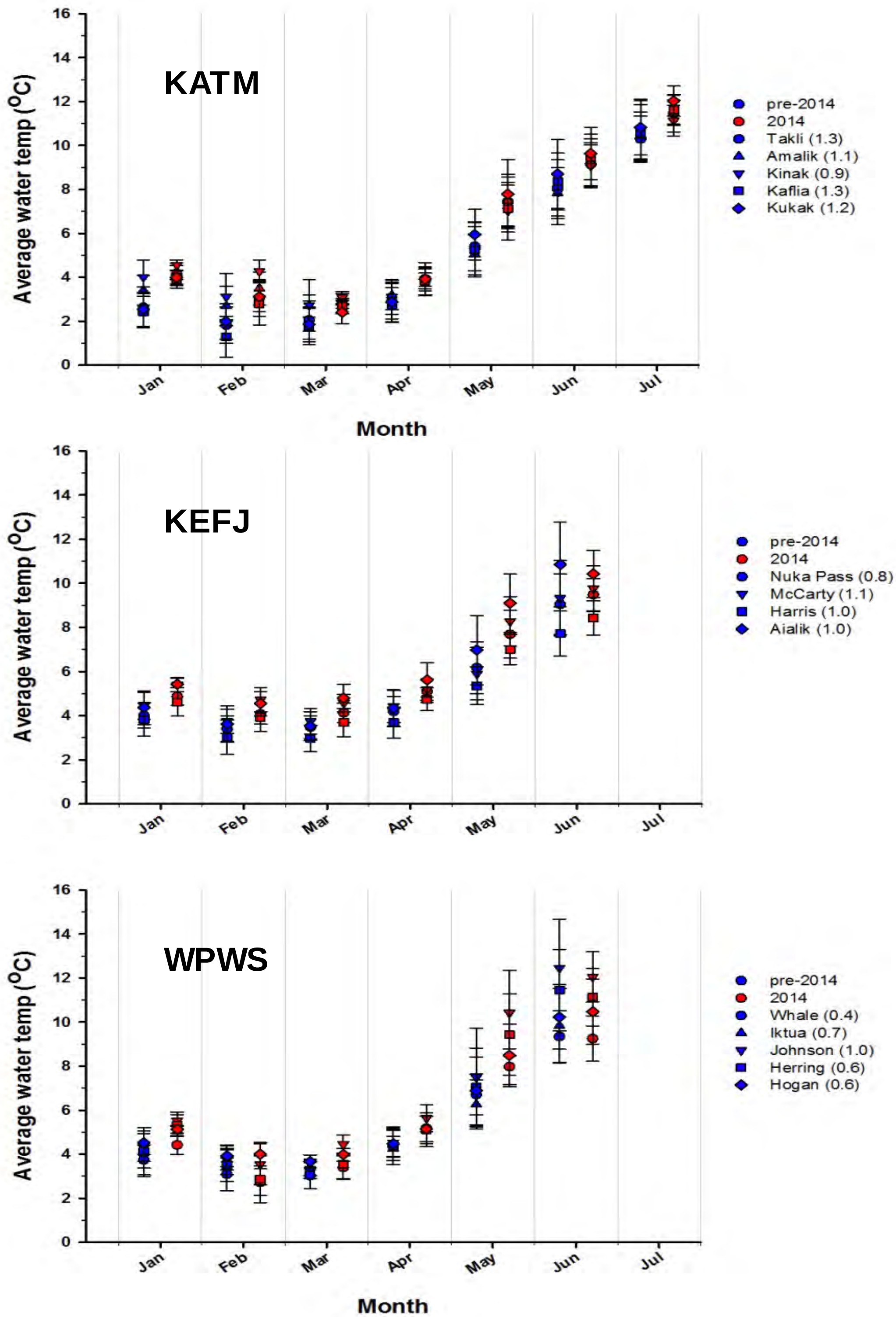


Figure 2. Contrasts of intertidal water temperature in 2014 (red) and 2006-2013 (blue) in Katmai (top), Kenai Fjords (middle), and western Prince William Sound (bottom). Numbers in parentheses in the legend indicate the average temperature difference between pre-2014 and 2014 by site.

(2) Common Murres (*Uria aalge*): Unexpected high numbers of common murres in nearshore areas during 2015 summer surveys

In KATM and KEFJ, as part of the nearshore component, we conduct skiff-based marine bird and mammal surveys along coastal (nearshore) transects. We observed large increases in common murres during the summer of 2015 relative to previous years. This increase was particularly evident in KATM (Figure 3) where there are no murre colonies and densities of murres are generally low. This increase in numbers is most likely a function of changed distribution. In poor conditions, these long-lived birds will readily defer breeding, therefore they are not tied to colonies and thus ended up nearshore, likely searching for food. KEFJ does have common murre colonies, however we still have evidence of an increase of these birds moving into coastal areas not associated with colonies (Figure 4). Our documentation of unusual murre distributions correspond to observations of large die-offs of murres throughout the north Pacific in winter 2015-2016. We speculate that high water temperature may have disrupted prey abundance or availability, leading to changes in murre distribution, behavior, condition, and mortality rates. Our results contribute to observations across GWA components that demonstrate that 2015 was an anomalous year.

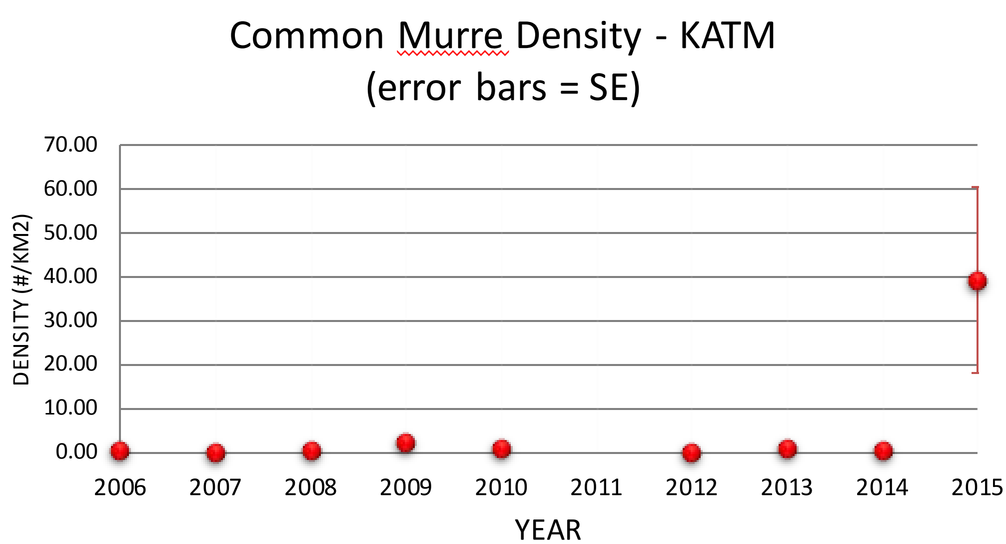


Figure 3. Common murre density estimates in KATM from 2006-2015. 2011 was not surveyed.

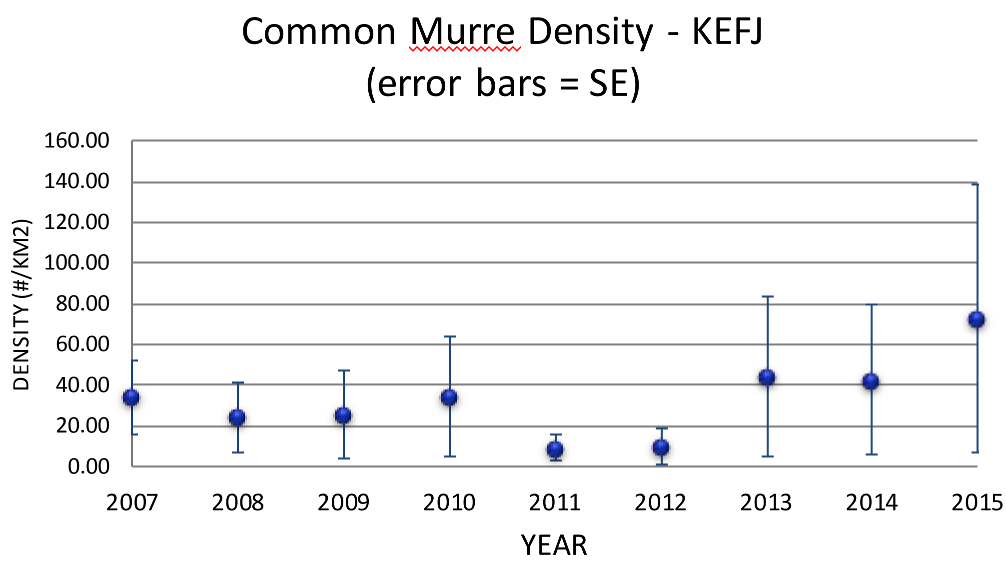


Figure 4. Common murre density estimates in KEFJ from 2007-2015.

(3) Sea Otters (*Enhydra lutris*): Varying population trajectories and energy recovery rates point to different factors affecting populations at small spatial scales

As part of the nearshore component, aerial surveys to calculate sea otter abundance were flown in KATM (2008, 2012, and 2015), KEFJ (2007 and 2010) and WPWS (annually from 1993 through 2005, 2007-2009, and 2011-2013). Sea otter foraging data also were collected annually in these regions to estimate energy recovery rates, which are known to indicate population status relative to a food-limited carry capacity. In KATM, our data suggest that sea otter numbers increased substantially since the early 1990s and have been at high and stable densities in recent years (Figure 5). This corresponds with declining energy recovery rates, suggesting that otters have reached a food-limited state (Figure 6). Densities of otters in KEFJ have been stable and relatively low (Figure 5) with stable energy recovery rates (Figure 6), indicating a population at carrying capacity and low food availability compared to KATM. In WPWS, initially, food was not a limiting factor in sea otter recovery from the EVOS, but more recently we have observed a moderate increase in density with a subsequent decline in energy recovery rates indicating that the population may be reaching carrying capacity (Figures 5 and 6). The design and coordination of the nearshore component of GWA allows us to infer cause and spatial extent of observed changes and provide recommendations to management.

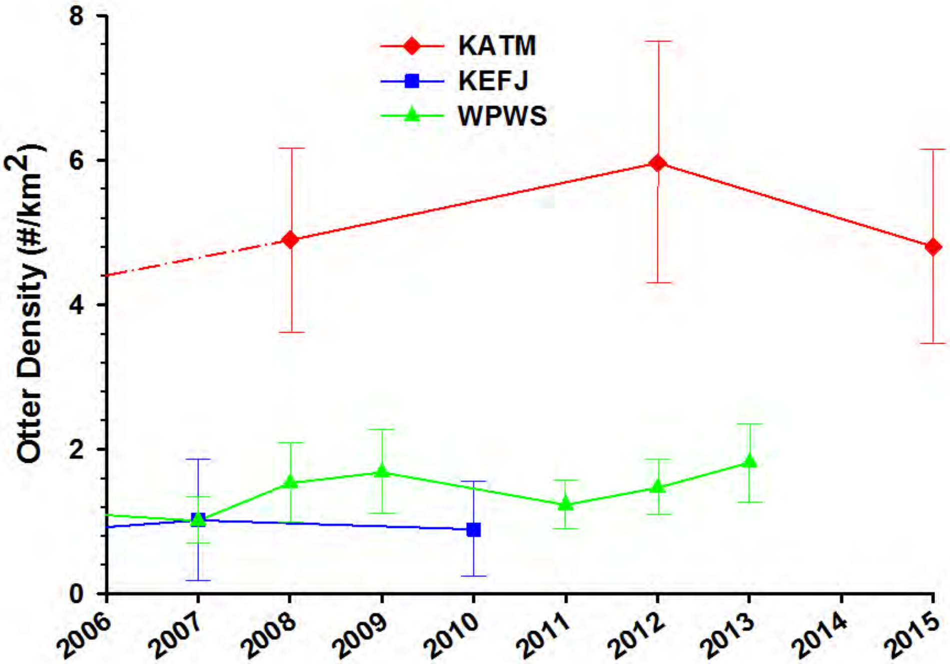


Figure 5. Density (estimated abundance/available suitable habitat) of sea otters living in the KATM, KEFJ and WPWS study blocks.

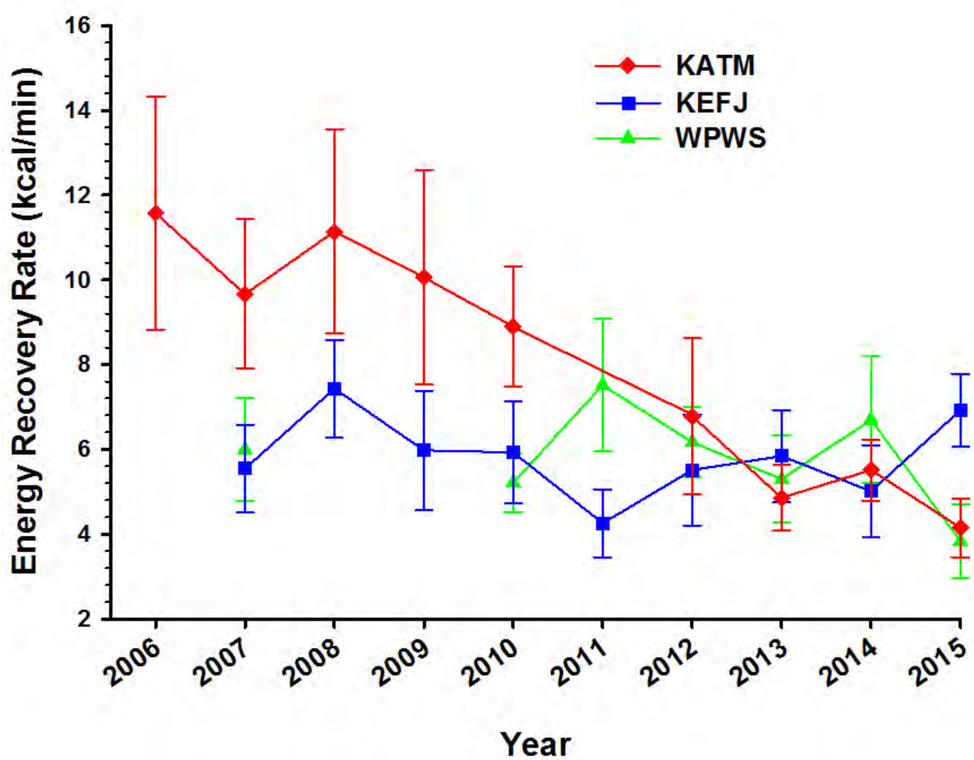


Figure 6. Energy recovery rates (kcal/min) for sea otters foraging in WPWS, KEFJ and KATM. Error bars represent Monte Carlo simulation-based 95% confidence intervals.

(4) Pacific Bay Mussels (*Mytilus trossulus*):Variation in selected mussel metrics across the Gulf of Alaska

Since 2008 we have monitored 15 mussel beds at sites in KATM, KEFJ and WPWS. When we began sampling, beds were largest in KEFJ, averaging about 5,000 m^2 and about 2,000 m^2 at KATM and WPWS. Although rate and timing of declines varied among sites, by 2012-13 average bed size had declined by about 50% across the Gulf of Alaska and some beds essentially vanished. Since 2012-13 we have observed recovery to near or above initial dimensions at most sites (10 of 15), although the largest beds in KEFJ (mostly on unconsolidated sediments) have not recovered, resulting in the patterns seen in Figure 7. We also monitor abundance of small mussels through cores to see how recruitment of juvenile mussels will eventually affect bed size. We see similar patterns of mussel abundance from these cores when viewed across the Gulf, with core densities at KEFJ (about 25,000 m^2) generally more than 5 times the average in other areas (Figure 8). Relationships among environmental conditions, recruitment and settlement, and survival of settled mussels, along with their relative effects on abundance and bed size, are topics that warrant additional study. Understanding how and why mussel populations vary over time will aid management and conservation of not only mussels, but also of the many consumers that rely on this important bivalve.

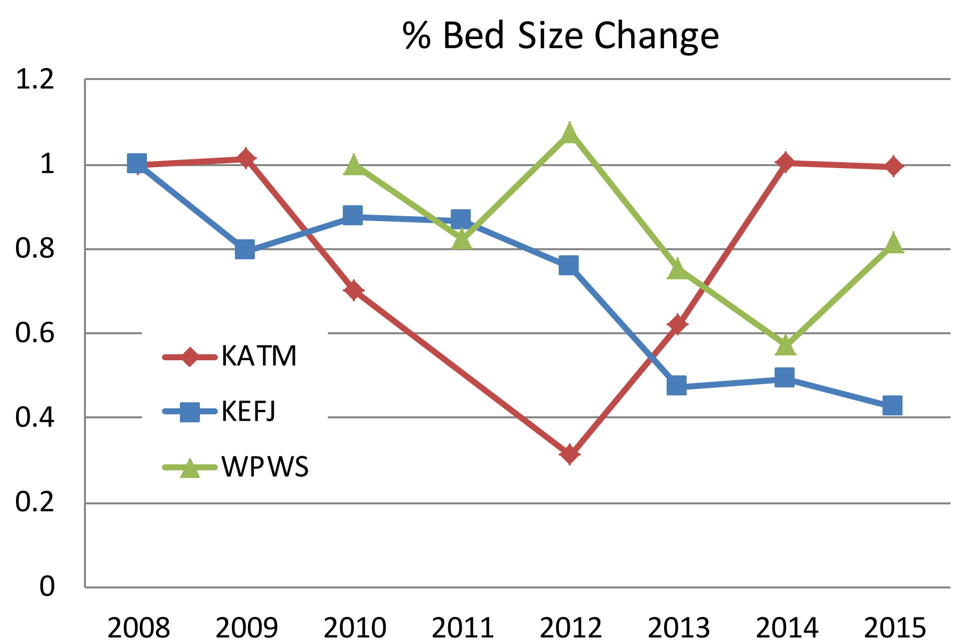


Figure 7. Percent change in mussel bed from size when sampling was initiated. Error bars were omitted for clarity of divergent trends.

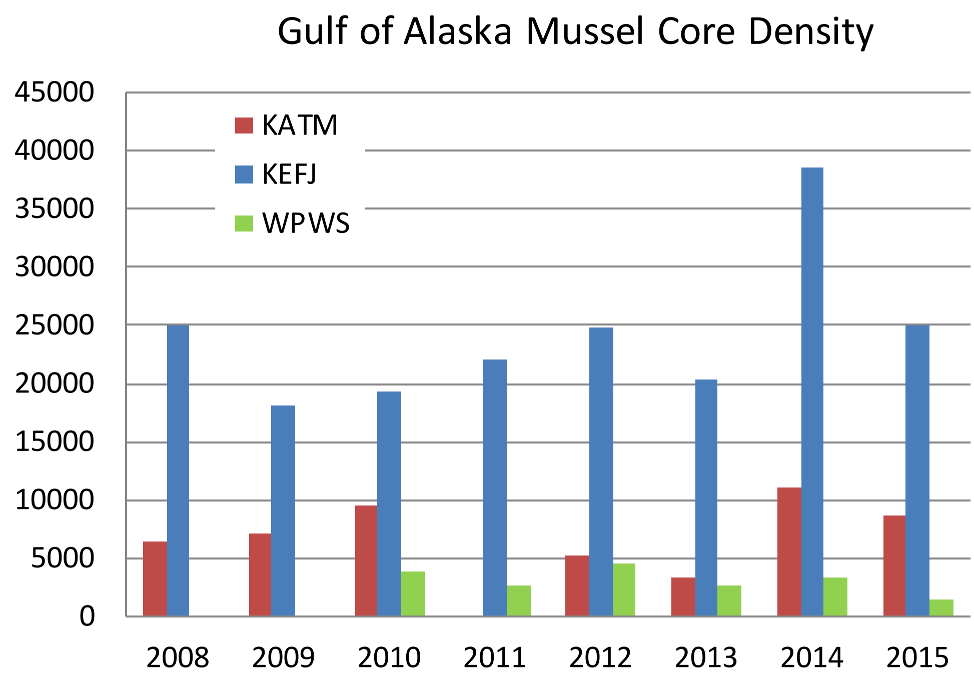


Figure 8. Density of mussels in cores in the Gulf of Alaska.

(5) Bivalve Assemblages: Density and diversity across time and space.

Soft sediment sites have been monitored every other year at 15 sites since 2007 to evaluate variation in infaunal bivalve species composition, abundance, size, and available biomass. The most common species encountered include infaunal bivalves such as *Saxidomus gigantea*, *Leukoma staminea*, *Clinocardium nuttallii*, *Hiatella arctica*, *Mya arenaria*, *Mya truncata*, and multiple species of the genus *Macoma*, as well as epibenthic bivalves such as the mussel *Mytilus trossulus*. Biomass of infaunal bivalves has decreased since the program began in 2007, and is apparent in the declines of density for infaunal species where we have yet to see any major recruitment events, except in the case of *H. arctica* in 2015 (Figure 9). Interestingly, mussel biomass at soft sites was low from 2007 through 2014; in 2015, mussel biomass increased over fourfold in KATM and KEFJ (Figure 10) following observed trends from our mussel and rocky intertidal monitoring sites. Understanding drivers underlying bivalve population dynamics warrants further study. In subsequent years we will be compiling and evaluating bivalve abundance and size data from around the Gulf of Alaska and Northeast Pacific to ascertain the extent of intertidal clam declines. Through collaboration with bivalve experts Gary Shigenaka and Allan Fukuyama, we aim to develop better monitoring tools and elucidate potential drivers behind clam recruitment and growth.

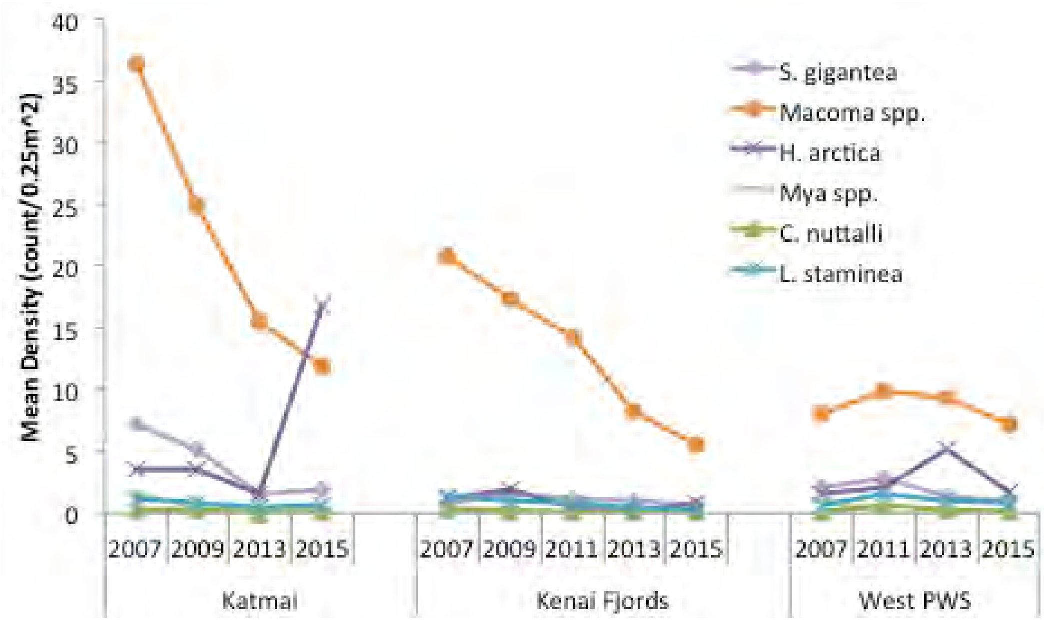


Figure 9. Mean density of infaunal clam species by block over time. *M. trossulus* has been excluded to show trends by species of clams.

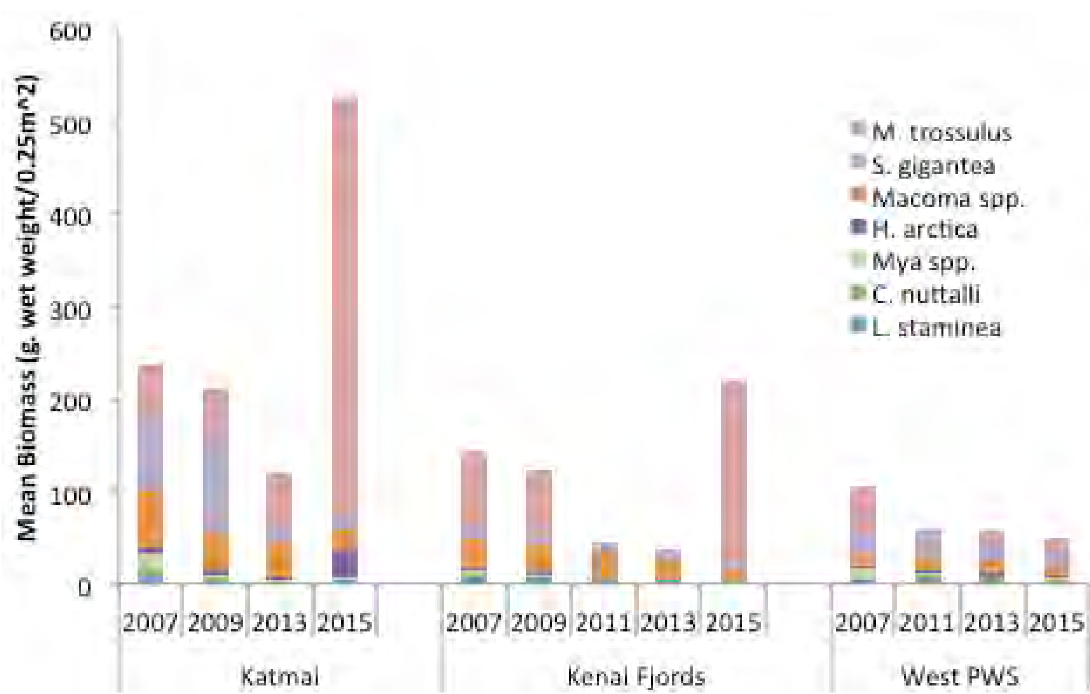


Figure 10. Mean biomass of intertidal bivalves, including *M. trossulus*, by block over time.

Deliverable/Milestone	Status
Field work (5 trips, multiple tasks per trip to collect data on series of nearshore metrics); KATM, KEFJ, WPWS, NPWS	Completed, June - July 2015
Upload 2014 data to project website	Completed, August 2015
PI's attend annual Gulf Watch meeting	Completed, November 2015

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

8.A.: Collaboration and coordination both within your program and between the two programs.

As noted above, the nearshore component of GWA is a highly coordinated effort involving multiple principal investigators (PIs) with expertise on various aspects of nearshore ecosystems; the overall design and coordination are critical for drawing inference about factors affecting the nearshore. We are working closely with the other nearshore project (12120114-L, Ecological Trends in Kachemak Bay; B. Konar and K. Iken) to ensure that data collected in Kachemak Bay are comparable with those from other nearshore sites and provide another window into the causative factors and spatial extent of changes in nearshore systems. For example, we collaborated with Drs. Konar and Iken to combine data sets for analyses presented in the 2014 GWA Science Synthesis report, which has subsequently been submitted to a peer reviewed journal. We also worked more closely in 2015 with the other GWA components (Environmental Drivers and Pelagic), to identify data sets that can be shared (e.g., Environmental Drivers data were used extensively in our analysis of mussel trends across the Gulf of Alaska, presented in the GWA Science Synthesis report). In July 2015, during our fieldwork in KATM, we coordinated with the Environmental Drivers component (Holderied and Doroff) to collect phytoplankton and mussel samples in light of the harmful algal bloom documented in 2015. These samples are still being analyzed. We have been working with Tuula Hollmen and Lisa Sztukowski of the Alaska Sea Life Center (ASLC) on a nearshore conceptual model, leading from variation in prey to variation in behavioral and demographic responses in consumers such as sea otters and sea ducks. Finally, data collected by the nearshore component are relevant for understanding ecosystem recovery with respect to the Lingering Oil component (e.g., sea otter abundance, energy recovery rate, and age-at-death data have all been used to evaluate population recovery).

8 B.: Coordination with other EVOSTC funded projects.

None to report.

8.C.: Coordination with trust agencies.

In 2013, building on GWA findings indicating that sea otters in KEFJ consume mussels at much higher frequencies than at other areas, we initiated a study of annual patterns in mussel energetics and sea otter foraging at KEFJ, funded by NPS and USGS. That study is to be completed in 2016. Initial results indicate that mussel energy density varies seasonally, likely corresponding to spawning condition. Further, we found that mussel consumption by otters varied slightly seasonally in association with varying mussel energy density, but overall mussel consumption was high in KEFJ across seasons.

Our GWA nearshore data from KATM contributed to USGS and North Pacific Research Board (NPRB) studies of the status of the southwest Alaska stock of sea otters, which is listed as threatened under the Marine Mammal Protection Act. These data are shared with the U.S. Fish and Wildlife Service, Marine Mammals Management, who is responsible for sea otter management.

Nearshore GWA PIs (Ballachey, Bodkin, Coletti, and Esler) worked with NPS on the 'Changing Tides' Project. This study examines the linkages between terrestrial and marine ecosystems and is funded by the National Park Foundation. Field work was initiated in July 2015 with in-kind support from our KATM vessel charter. National Parks in Southwest Alaska are facing a myriad of management concerns that were previously unknown for these remote coasts, including increasing visitation, expanded commercial and industrial development, and environmental changes due to natural and anthropogenic forces. These are concerns because of their potential to significantly degrade and potentially impair resources in coastal systems. The project has three key components: (1) brown bear fitness and use of marine resources, (2) health of bivalves (clams and mussels), and (3) an integrated outreach program. We (GWA nearshore component) assisted with the collection of a variety of bivalve species from the coast of Katmai National Park and Preserve. Several specimens were kept live in small aquarium-like containers, and condition and performance metrics were assessed in the laboratory by ASLC collaborators Tuula Hollmen and Katrina Counihan. Others are being used to perform genetic transcription diagnostics (gene expression) to measure the physiologic responses of individuals to stressors, in collaboration with Liz Bowen and Keith Miles of USGS. This project will increase our understanding of how various stressors may affect both marine intertidal invertebrates and bear populations at multiple spatial and temporal scales.

Nearshore component PIs (Coletti, Iken, Konar and Lindeberg) have been working on development of recommendations to the Bureau of Ocean Energy Management (BOEM) for nearshore community assessment and long-term monitoring. The BOEM Proposed Final Outer Continental Shelf (OCS) Oil and Gas Leasing Program 2012-2017 includes proposed Lease Sale 244 in the Cook Inlet Planning Area in 2017. An OCS Cook Inlet Lease Sale National Environmental Policy Act (NEPA) analysis has not been undertaken since 2003. Updated information is needed to support an analysis associated with the planned lease sale. The overall objective of this study is to provide data on habitats and sensitive species to support environmental analyses for NEPA documents, potential future Exploration Plans, and Development and Production Plans. The goal was to utilize existing protocols already developed thorough GWA when possible to ensure data comparability. The project will be ongoing through 2019 and all data are being provided to the Alaska Ocean Observing System data portal.

USGS and NPS provide logistical, administrative, and in-kind support for the GWA Nearshore component.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

Publications & Reports:

Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and H.A. Coletti. 2015. Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Ballachey, B.E. and J.L. Bodkin. 2015. Challenges to sea otter recovery and conservation. Chapter 4 in Larson SE, Bodkin JL, VanBlaricom GR., Eds. Sea Otter Conservation. Academic Press, Boston. Pp 63-96.

Ballachey, B., J. Bodkin, H. Coletti, T. Dean, D. Esler, G. Esslinger, K. Iken, K. Kloecker, B. Konar, M. Lindeberg, D. Monson, M. Shephard, and B. Weitzman. 2015. Variability within nearshore ecosystems of the Gulf of Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Bodkin, J.L. 2015. Historic and Contemporary Status of Sea Otters in the North Pacific. Chapter 3 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 43-61.

Bowen, L., A. K. Miles, B. Ballachey, S. Waters and J. Bodkin. Gene transcript profiling in sea otters post-*Exxon Valdez* oil spill: A tool for marine ecosystem health assessment. In review, *J. Mar. Sci. Eng.*

Coletti, H.A. and T.L. Wilson. 2015. Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Coletti, H.A. and T.L. Wilson. 2015. Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 12120114-F), National Park Service, Anchorage, Alaska.

Coletti, H.A., J.L. Bodkin, D.H. Monson, B.E. Ballachey and T.A. Dean. In review. Engaging form and function to detect and infer cause of change in an Alaska marine ecosystem. Ecosphere.

Esler, D., and B.E. Ballachey. 2015. Long-term monitoring program - evaluating chronic exposure of harlequin ducks and sea otters to lingering Exxon Valdez oil in western Prince William Sound. Exxon Valdez Oil Spill Trustee Council Restoration Project Final Report (Project 14120114-Q), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Esler, D., B. Ballachey, M. Carls, and M. Lindeberg. 2015. Introduction to lingering oil monitoring. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Esler, D., J. Bodkin, B. Ballachey, D. Monson, K. Kloecker, and G. Esslinger. 2015. Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Larson, S., J.L. Bodkin, and G.R. VanBlaricom. 2015. Sea Otter Conservation. Academic Press, Boston. 447 p.

Konar, B., K. Iken, H.A. Coletti, T.A. Dean, and D.H. Monson. 2015. Research Summary: Influence of static habitat attributes on local and regional biological variability in rocky intertidal communities of the northern Gulf of Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

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Kuletz, K., and D. Esler. 2015. Spatial and temporal variation in marine birds in the northern Gulf of Alaska: the value of marine bird monitoring as part of Gulf Watch Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Monson, D.H. and L. Bowen. 2015. Evaluating the Status of Individuals and Populations: Advantages of Multiple Approaches and Time Scales. Chapter 6 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 121-158.

Monson D.H., T.A. Dean, M.R. Lindeberg, J.L. Bodkin, H.A. Coletti, D. Esler, K.A. Kloecker, B.P. Weitzman and B.E. Ballachey. 2015. Inter-annual and spatial variation in Pacific blue mussels (*Mytilus trossulus*) in the Gulf of Alaska, 2006-2013. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Weitsman, B.P., and G.G. Esslinger. 2015. Aerial Sea Otter Abundance Surveys – Prince William Sound, Alaska, Summer 2014. U.S. Geological Survey Administrative Report.

Presentations:

Coletti, H., D. Esler, B. Ballachey, J. Bodkin, T. Dean, G. Esslinger, K. Iken, K. Kloecker, B. Konar, M. Lindeberg, D. Monson and B. Weitzman. Updates of key metrics from long-term monitoring of nearshore marine ecosystems in the Gulf of Alaska: Detecting change and understanding cause. Alaska Marine Science Symposium, Anchorage, January 2016.

Coletti, H., G. Hilderbrand, J. Pfeiffenberger, C. Turner, B. Ballachey, L. Bowen, K. Counihan, J. Erlenbach, D. Esler, T. Hollmen, D. Gustine, B. Mangipane, B. Pister, C. Robbins, and T. Wilson. Changing tides – The convergence of intertidal invertebrates, bears and people. Alaska Marine Science Symposium, Anchorage, January 2016.

Esler, D., B.Ballachey, C.Matkin, D. Cushing, R. Kaler, J. Bodkin, D. Monson, G. Esslinger, and K. Kloecker. Long-term data provide perspective on ecosystem recovery following the *Exxon Valdez* oil spill. Oil Spill and Ecosystems Conference, Tampa, February 2016.

Esler, D.. Oil and wildlife don't mix: 25 years of lessons from the *Exxon Valdez* oil spill. Seminar at University of Quebec Rimouski, November 2015.

Pister, B., B. Ballachey, H. Coletti, T. Dean, K. Iken, B. Konar, M. Lindeberg and B. Weitzman. Multi-agency efforts to monitor sea star wasting disease in Alaska: Results and recommendations for future efforts. Alaska Marine Science Symposium, Anchorage, January 2016.

Neher, T., M. McCammon, K. Hoffman, K. Holderied, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner, Gulf Watch Alaska in hot water! Ecological patterns in the northern Gulf of Alaska under the Pacific 2014-2015 warm anomaly. Alaska Marine Science Symposium, Anchorage, January 2016.

Meeting attendance:

January 2016, Alaska Marine Science Symposium, Anchorage: Doroff, Esler, Esslinger, Kloecker, Lindeberg, Monson, Shephard, Weitzman.

November 2015, Gulf Watch PI meeting, Anchorage: Ballachey, Bodkin, Coletti, Dean, Doroff, Esler, Kloecker, Lindeberg, Monson.

October 2015, GWA Nearshore PI meeting, Port Townsend, WA: Ballachey, Bodkin, Coletti, Dean, Esler, Monson, and Weitzman.

February 2016, Oil Spills and Ecosystems Conference, Tampa: Esler.

December 2015, Marine Mammal Society Conference, San Francisco: Monson

Outreach activities:

Ballachey, B. (USGS) February 2015. Guest Lecture, University of Calgary, Continuing Education Course: Environmental Site Assessment: “Long-term Effects of the 1989 Exxon Valdez Oil Spill on Sea Otters and Nearshore Ecosystems”

Bodkin, J. (USGS). November 2015. Public presentation at the Prince William Sound Science Center, Cordova. “Gulf Watch Alaska and the Nearshore Food Web.”

Coletti, H. (NPS). April 2015. Overview of SWAN and GWA to interpretive rangers at Kenai Fjords National Park.

Esler, D. (USGS). January 2015. USGS Alaska Science Center Participates in on-line Gulf Watch Alaska curriculum in an outreach partnership effort with the Alaska SeaLife Center (ASLC).

Esler, D. (USGS). 2015-2016. Delta Sound Connections Article - Tidewater Trends in Nearshore Ecosystems.

Esler, D. (USGS). November 2015. Interviewed by Hayley Hoover, education and outreach specialist with the Prince William Sound Science Center (PWSSC) for "Field Notes" radio program.

Jones, R. (NPS). July 2015. NPS Interpretive Ranger Provides Educational Outreach about NPS SWAN and the Alaska Gulf Watch Program during a Discovery Lab event held at the Alaska Islands & Ocean Visitor Center in Homer, Alaska.

Kloecker, K. (USGS). July 2015. USGS Scientist Provides Educational Outreach about the Alaska Gulf Watch Program—26 Years of Ocean Monitoring during a Discovery Lab event held at the Alaska Islands & Ocean Visitor Center in Homer, Alaska.

Kunisch, E. and H. Coletti (NPS). Spring 2015. DOI Newswave Article – Monitoring for Sea Star Wasting Disease in the Northern Gulf of Alaska.

Data & metadata uploaded to data portal:

- SOP01=CoastlineSurveys: sea otter carcass and age at death data and metadata
- SOP02=SeaOtterForage: raw data and metadata
- SOP03=MarBirdMammalSurveys: raw survey data and metadata
- SOP04=InvertsRockyShores: limpet size, Nucella and Katharina counts, algae and invertebrate percent cover, sea star counts, substrate composition, and metadata
- SOP05=SeaOtterAerialSurveys: KATM 2008 and 2012 raw data and metadata, KEFJ 2007, 2010, 2013 raw data and metadata
- SOP06=InvertsGravelSandBeaches: species count, size, and metadata
- SOP07=BlackOystercatcher: nest density, chick diet, and metadata
- SOP08=MusselBeds: mussels >20mm counts and sizes, mussel core sample counts and sizes, site layout (used for bed size calculations), site substrate, site slope, and metadata
- SOP 09=Eelgrass

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

There were no recommendations for modifications to the Nearshore component of GWA in the recent EVOS reviews.

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Our overall budget expenditures are on target with the proposed expenditures, and are in keeping with the objectives of the project. However, our agency financial system codes categories somewhat differently than the EVOS categories, so that the total for each EVOS category sometimes varies between the proposed and the actual. Further detail, if needed, will be provided upon request.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$3.1
Travel	$1.5	$1.5	$1.5	$4.2	$1.5	$10.2	$7.5
Contractual	$14.0	$9.0	$5.5	$130.0	$4.0	$162.5	$123.4
Commodities	$2.5	$1.5	$1.0	$21.0	$0.5	$26.5	$9.3
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$2.0
Indirect Costs (will vary by proposer)							
SUBTOTAL	$18.0	$12.0	$8.0	$155.2	$6.0	$199.2	$145.3
General Administration (9% of subtotal)	$1.6	$1.1	$0.7	$14.0	$0.5	$17.9	$13.1
PROJECT TOTAL	$19.6	$13.1	$8.7	$169.2	$6.5	$217.1	$158.4
Other Resources (in kind Funds)	$50.0	$50.0	$50.0	$50.0	$50.0	$250.0	$200.0

Original COMMENTS: Unexpected overtime during field work ($3.1K) was incurred and laboratory equipment replacement ($2K). Remaining contractual is encumbered for analytical work and commodities will be spent replenishing instrument and lab supplies used for analyses.

FY12-16

Program Title: 15120114-S Lingering Oil Monitoring
Team Leader: Mark Carls

FORM 4A
TRUSTEE AGENCY
SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

14120114-G

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay to understand recovery and restoration of injured near-shore species

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Angela Doroff (Kachemak Bay National Estuarine Research Reserve, Alaska Center for Conservation Science, University of Alaska) and **Kris Holderied** (National Oceanic and Atmospheric Administration/National Ocean Service/National Centers for Coastal Ocean Science/Kasitsna Bay Laboratory)

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Introduction (see annual work plans for more details on methods):

In project year 4 the Kachemak Bay National Estuarine Research Reserve (KBNERR) and National Oceanographic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory (KBL) continued to conduct oceanographic surveys in lower Cook Inlet (Transects 3, 6, and 7) and Kachemak Bay (Transects 4 and 9) along with shore-based oceanographic data collection (see Figure 1 for locations). We survey the outer Kachemak Bay (Transect 4) and lower Cook Inlet transects quarterly with a chartered vessel and the mid-Kachemak Bay transect (Transect 9) monthly from NOAA Kasitsna Bay Laboratory small boats. Given the limits of charter vessel time funded for this project and challenging weather conditions in lower Cook Inlet, we prioritize data collection along the northern (Transect 3 – to monitor freshwater input from the upper inlet) and southern (Transect 6 – to monitor connections with the shelf) Cook Inlet transects, with sampling also conducted on the middle line (Transect 7) when conditions allow. Oceanographic data are collected at vertical stations with conductivity-temperature-depth (CTD) profilers (shown as dots on Figure 1), using Seabird Electronics 19plus CTD profilers. Plankton sampling is conducted at three of the stations along each transect. Vertical zooplankton tows are conducted with 333 µm bongo nets and surface water is filtered through 20 µm nets for phytoplankton sampling. Oceanographic and plankton sampling, including instrument calibration, data collection, sample processing, quality control, and quality assurance, are conducted in accordance with the project sampling protocols (available on the Ocean Workspace). To provide more temporal resolution, continuous oceanographic measurements are made year-round at System Wide Monitoring Program (SWMP) water quality stations at the Seldovia and Homer harbors as well as in ice-free months from a buoy in Bear Cove (Figure 1). Nutrient and chlorophyll measurements are made monthly at the SWMP stations, with concurrent testing of a chlorophyll probe for a continuous measurement capability.

In year 4 we continued to coordinate on oceanographic and zooplankton sampling protocols and on the region-wide Pacific warm anomaly with other principal investigators (PIs) in the Environmental Drivers component group, as well as with fishery, marine mammal, and seabird researchers and managers at the NOAA, Alaska Department of Fish and Game (ADFG), U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey. As one result of the PI group discussions on improving sampling protocols, in our Cook Inlet project we concurrently sampled zooplankton with two different net sizes (150 µm in addition to 333 µm) at select stations to compare the results between net sizes. The results are being incorporated in planning for the next 5 year phase of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) long-term monitoring program. We also worked with PIs across the program on the final Gulf Watch Alaska (GWA) program science synthesis report, contributing to the program overview chapter (Holderied) and the Environmental Drivers component chapter (Doroff and Holderied), and authoring a paper on regional variability in oceanography across the northern Gulf of Alaska (Holderied).

Field Sampling: Oceanographic and Plankton Surveys

In 2015, oceanographic surveys were successfully conducted monthly along Transect 9 in Kachemak Bay, with marine plankton sampling also completed in all months except January 2015 (due to poor weather conditions and scheduling conflicts). We conducted seasonal surveys in Kachemak Bay and Cook Inlet in February and April 2015 and a summer survey on the east side of Cook Inlet and Kachemak Bay in August 2015. We leveraged additional funding obtained by KBL (Holderied) from the Bureau of Ocean Energy Management (BOEM) to add a third seasonal Cook Inlet survey to the two funded by EVOSTC for project year 4. We planned to conduct the extra survey in October 2015, but were significantly delayed by issues with the vessel contract and then with nearly continuously stormy weather in lower Cook Inlet (affecting Transects 6 and 7 the most) from November 2015 to January 2016. We did complete a fall survey of Kachemak Bay and mid-Cook Inlet (Transect 3) in November 2015. Within our study area there are 88 oceanographic stations; 68 in lower Cook Inlet and 20 in Kachemak Bay. In year 4, we conducted CTD profiler sampling at 366 stations, with a subset of those stations also sampled for zooplankton (n=66 samples) and phytoplankton (n=68 samples). In addition, we continued to leverage collaborations with other organizations (NOAA National Centers for Coastal and Ocean Science [NCCOS], Aleutian Islands Pribilof Association, Inc.) and other funding from the Alaska Ocean Observing System (AOOS) to collect water samples for ocean acidification analyses and collect plankton and shellfish samples to assess threats from toxic phytoplankton (for species causing paralytic and amnesiac shellfish poisoning). Kachemak Bay experienced the first paralytic shellfish poisoning event in over 10 years in September 2015, which temporarily closed oyster farm harvests and was likely associated with persistently warm water temperatures that were up to 2^{o}C above the average for that time of year. The routine sample collection dates and locations to date for this project are summarized in Table 1.

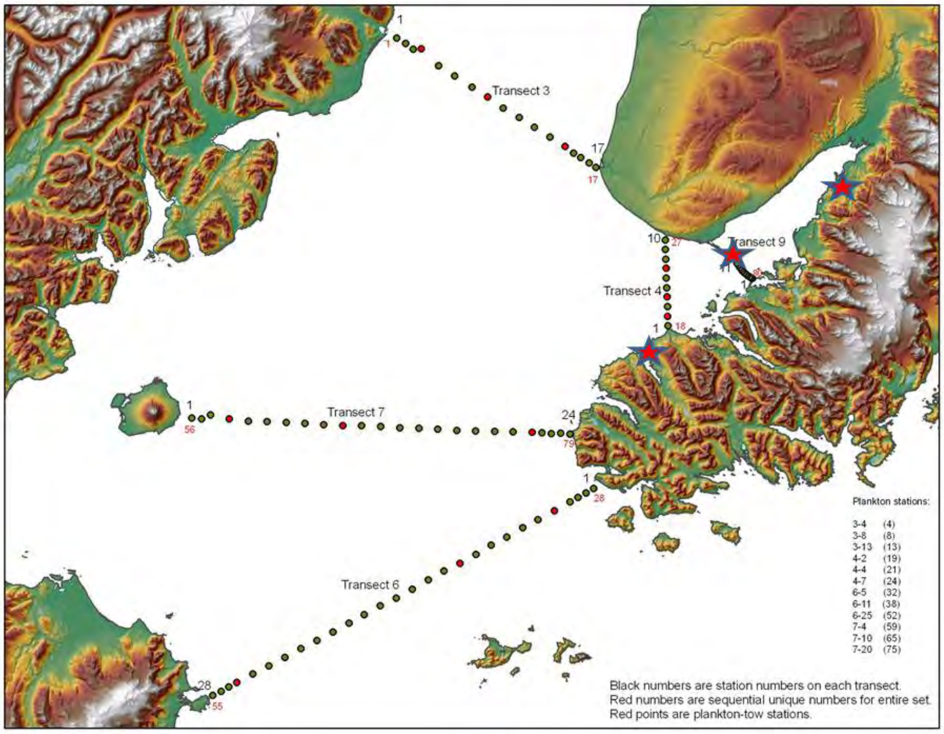


Figure1. Lower Cook Inlet and Kachemak Bay transects and sampling station locations for oceanographic sampling by CTD (all stations marked with dots) and phytoplankton and zooplankton sampling (red dots). Transects 3, 4, 6, and 7 are sampled quarterly (with assistance from BOEM funding for years 4 and 5) and Transect 9 is sampled monthly. Stars indicate the location of water quality and nutrient monitoring stations in Kachemak Bay at the Homer and Seldovia harbors and seasonally in Bear Cove.

Table 1: Sampling frequency at Lower Cook Inlet* and Kachemak Bay* transects during years 2012-2015;
Environmental Drivers Gulf Watch Alaska Program

		CTD					**Zooplankton**					**Phytoplankton**					**Water Samples**				
		Transect No.					Transect No.					Transect No.					Transect No.				
Month	Year	3	4	6	7	9	3	4	6	7	9	3	4	6	7	9	3	4	6	7	9
February	2012					10															
March	2012					10															
April	2012					20					4					2					4
May	2012	16	30	27	18	20	3	3	3	3	6	3	1	3	3	11	3	3	3	3	6
June	2012		20			33					6		5			6		7			6
July	2012	16	10	28	12	31	3	3	3	2	3	3	3	3	2	3	3	3	3	2	3
August	2012		10			41					3		3								3
Septembe	2012					57										9					3
October	2012	16	10	28	17	20	1		3	3	3	1		3	3	6	1		3	3	3
	∑ =	**48**	**80**	**83**	**47**	**242**	**7**	**6**	**9**	**8**	**25**	**7**	**12**	**9**	**8**	**37**	**7**	**13**	**9**	**8**	**28**
January	2013					10					3					3					
February	2013		10			11		3			3		3			3		2			
March	2013					10					3					2					2
April	2013	16	10	23	24	10	3	3	3	3	3	3	3	3	3	2	2	1	4	3	1
May	2013					10					3					3					3
July	2013	16	10	28	23	10	3	3	3	3	3	3	3	3	3	3			4	4	
August	2013					10					3					3					
Septembe	2013					10					3					3					
October	2013		10			10		4			3		7			9					2
Novembe	2013	16		20		1	3		3			3		3							
Decembe	2013					10					3					3					
	∑ =	**48**	**40**	**71**	**47**	**102**	**9**	**13**	**9**	**6**	**30**	**9**	**16**	**9**	**6**	**34**	**2**	**3**	**8**	**7**	**8**
January	2014					10					3					3					
February	2014	16	10		12	10	3	3		3	3	3	3		3	4					
March	2014					10					5					3					
April	2014	16	10	28	23	10	3	3	3	3	3	3	3	3	3	3					
May	2014					11					3					3					1
June	2014					11					3					3					
July	2014	17	10	28	22	12	3	4	7	6	3	3	3	3	3	3	2	2	6		1
August	2014		10			10		3			2		3			3					
Septembe	2014					10					3					3					
October	2014	16	10	22	22	10	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2
Novembe	2014					10					3					2					
Decembe	2014					10					3					3					
	∑ =	**65**	**50**	**78**	**79**	**124**	**12**	**16**	**13**	**15**	**37**	**12**	**15**	**9**	**12**	**36**	**4**	**4**	**10**	**2**	**4**
January	2015					10															
February	2015	15	11	28	17	12	3	3	3	3	3	3	3	3	3	3	1		1		
March	2015					10					3					3					
April	2015	16	10	10	17	10	3	3	2	3	3	3	3	2	2	3				1	
May	2015					10					3					3					
June	2015					10					3					2					
July	2015					12					3					3					
Septembe	2015		10			20					3		2			5					
October	2015		10			10		3			3		3			3		3			3
Novembe	2015	17	11			11	3	4			3	3	4			3	3	4			4
Decembe	2015		10			10		3			3		3			3					
	∑ =	**48**	**62**	**38**	**34**	**125**	**9**	**16**	**5**	**6**	**30**	**9**	**18**	**5**	**5**	**31**	**4**	**7**	**1**	**1**	**7**

** Lower Cook Inlet - Transects 3, 6, and 7; Kachemak Bay - Transects 4 and 9*

Oceanographic Monitoring:

Oceanographic profile data from CTD casts were processed with standard SeaBird Electronics algorithms, exported to Excel spreadsheets, entered in an Access database and visualized in graphs of salinity, temperature, density profiles, along-transect contour maps and anomaly time series plots (used in publications and presentations listed in Section 8 of this report). Raw (hex format) and processed (.csv and netcdf format) data files were provided to the Ocean Workspace with updated metadata.

Water Quality Monitoring

Continuous data collection and reporting continued throughout year 4 for the KBNERR SWMP stations for meteorological, water quality, and monthly nutrient samples; all data are being quality controlled and archived through the National Estuarine Research Reserve program's Central Data Management Office, with near real-time access to provisional water quality station data in Seldovia and Homer. A YSI moored buoy system was used to deploy an additional oceanographic data sonde in Bear Cove from April to November 2015. During ice-free months in Kachemak Bay, all three surface data sondes also monitor chlorophyll-a. The Bear Cove mooring data were telemetered to provide researchers and local oyster farmers real-time access to the water quality data. Near real-time data access was also provided through the AOOS Data Portal.

Zooplankton Sampling

During this reporting period, 66 zooplankton samples were collected (Table 1), preserved, and are being analyzed at the Prince William Sound Science Center (PWSSC) in collaboration with Rob Campbell and his GWA Environmental Drivers oceanography project in Prince William Sound. Sample analyses are complete through November 2014 and all remaining year 4 samples are at PWSSC for analysis.

Phytoplankton Sampling

In year 4, we collected and processed 68 phytoplankton samples from filtered surface water samples that were collected, preserved, and analyzed during our sampling efforts in lower Cook Inlet and Kachemak Bay. Phytoplankton samples were collected during all monthly and quarterly shipboard surveys, at the same stations where zooplankton sampling was conducted. Phytoplankton samples were visually identified and enumerated using a light microscope and volumetric Palmer counting cells at NOAA Kasitsna Bay Laboratory. A subset of the samples was also analyzed at the NOAA NCCOS laboratory in Beaufort, North Carolina, by using the more sensitive molecular technique of quantitative polymerase chain reaction assay (qPCR).

Recent Results and Scientific Findings

Oceanography sampling results: Kachemak Bay and lower Cook Inlet waters were much warmer than average in 2015, continuing the pattern that started in late 2013 and persisted through all of 2014 and 2015, reflecting the large-scale Pacific warm anomaly. Warmest anomalies were observed in the winter of 2014-2015, with observations of over 2.5^{o}C above the monthly average from 2001-2015 at the Seldovia SWMP station and similar changes seen throughout the study area (Figure 2). The last time the Seldovia water temperatures were this much warmer than the average of this period was in 2003. The temperature patterns in Cook Inlet and Kachemak Bay continue to be coherent with observed patterns on the shelf (Weingartner/Danielson and Hopcroft projects at GAK1 and Seward Line) and in Prince William Sound (Campbell project) at time scales of longer than a couple months. This is consistent with the results from our analysis of oceanographic variability across the northern Gulf of Alaska region (see Holderied and Weingartner article in the GWA science synthesis document, entitled "Linking Variability in Oceanographic Patterns Between Nearshore and Shelf Waters Across the Gulf of Alaska"). In addition to the persistent warm temperatures, we also observed a persistent freshening of waters at the Seldovia station for most of 2014 and 2015 (Figure 3), which is also consistent with observations at the GAK 1 mooring. Figure 4 shows a comparison of the annual cycles of photosynthetically available radiation (PAR) and chlorophyll along Kachemak Bay, between the Bear Cove station at the head of the bay and the Seldovia station in the outer bay. There are significant differences in the timing, duration and intensity of the phytoplankton bloom between the two stations, which has implications for helping to understand observed differences in toxic algae concentrations between sub-bays in Kachemak Bay, as well as potential differences in food web processes.

While warm temperatures persisted from 2014 to 2015, the biological response was much more dramatic in 2015, with extensive seabird and sea otter mortalities, and the first paralytic shellfish poisoning event and oyster farm closures in Kachemak Bay in over a decade (September 2015). However, in anecdotal observations of what may be a more positive response, feeder king salmon were much more abundant in the bay in both 2014 and 2015 and, in 2015 very large and perhaps unprecedented numbers (>50) of actively feeding humpback whales were observed in the bay all summer and into November. Significant numbers of herring (likely age 0 based on size, but also older year classes) also appear to have returned to Kachemak Bay in significant numbers in the summer of 2015, based on numerous sightings of schools reported by fishermen, water taxi operators and local researchers and in limited salmon diet observations reported by fisherman. Given the changes observed this past year and the significance of a potential herring return to the bay (which had large herring fisheries in the 1920s and 1930s), we are exploring options with ADFG, researchers in the GWA pelagic component and Herring Research and Monitoring (HRM) researchers to start some direct or indirect (fish diet) forage species sampling in the bay.

Zooplankton sampling results: We analyzed zooplankton samples from 15 stations throughout the study area during all seasons 2012-2014. We utilized only most frequently observed taxa (present in > 5% of samples) in multivariate analyses of these data. Abundance data were transformed [log(n + 1)] to stabilize variance (Keister and Peterson 2003). Using Ward's agglomerative method, a hierarchical cluster analysis (HCA) produced distinct groups based on species assemblage. These groups were used in the Indicator Species Analysis (ISA; Dufrene and Legendre 1997) to examine which species were indicative of each group. The Indicator Species Value (ISV) varied based on how consistently present taxa were in their group (0 [absent] to 1 [present in all group samples]). A total of 212 zooplankton samples were analyzed from lower Cook Inlet, outer Kachemak Bay, and inner Kachemak Bay (n = 66, n = 64, n = 85 for 2012, 2013, and 2014, respectively). Figure 5 is a composite histogram of the most frequently encountered species in all sample periods and locations combined. We developed a hierarchical cluster analysis grouping with all data during all time periods and the associated ISVs for each species in each group (see Figures 6 and 7). We show only the first five species with statistically significant ($p < 0.05$) presence in the groups. Finally, a visual comparison of meroplankton abundances in 2012, 2013 and 2014 is shown in Figure 8. In Kachemak Bay, meroplankton were present during all months sampled and were more abundant during summer and fall months.

Phytoplankton sampling results: This project has improved the time series and geographic scope for existing phytoplankton monitoring for harmful algal species conducted by KBL and KBNERR. The phytoplankton species that cause 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. In 2015, we also saw a bloom of *Pseudo-nitzschia sp.* that occurred much earlier than usual. This bloom occurred in May shortly after the normal *Chaetoceros spp.* bloom (Figure 9). The *Pseudo-nitzschia* bloom persisted through most of the summer and our toxin testing of plankton and shellfish samples indicated that domoic acid toxins were present, but only in relatively low amounts, in contrast to the high domoic acid toxin levels that were observed along the coasts of California and Oregon last summer. We are collaborating with other NOAA colleagues to help understand what drives those differences. In addition to the *Pseudo-nitzschia* bloom, we observed a late summer bloom of *A. fundyese* that resulted in the first paralytic shellfish poisoning event in Kachemak Bay in over ten years, with temporary closure of portions of the Kachemak Bay commercial oyster shellfishery in September 2015. Shellfish samples taken from several sub-bays in Kachemak Bay indicated that the saxitoxin that causes paralytic shellfish poisoning was present above the regulatory limit of 80 µm per 100 g tissue sample.

Results figures:

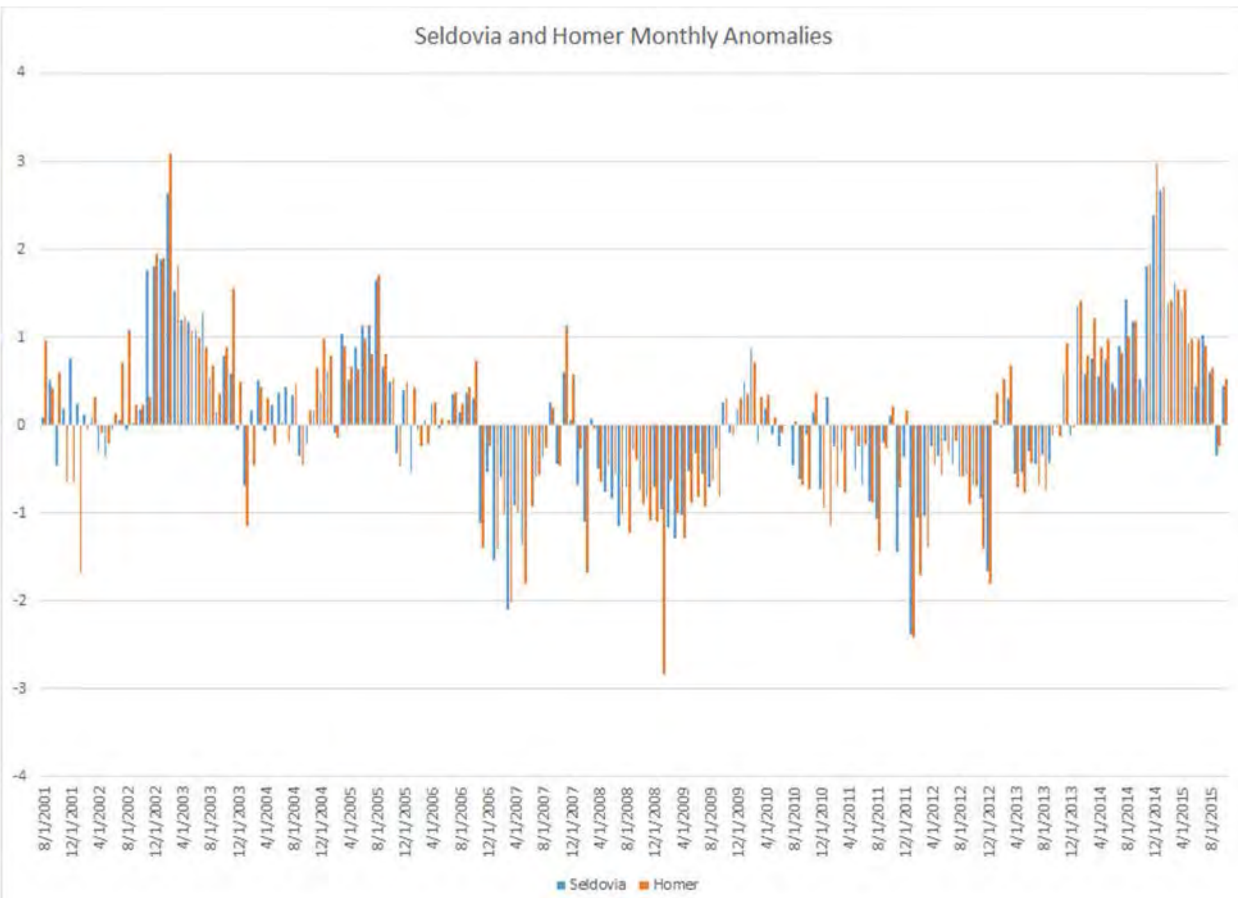


Figure 2. Monthly temperature anomalies based on water temperatures recorded 1m above the benthos at KBNERR long-term water quality monitoring sites in Homer and Seldovia harbors from Aug 2001- Aug2015. The anomaly is calculated as the difference between the monthly average value and the monthly mean value for the time period.

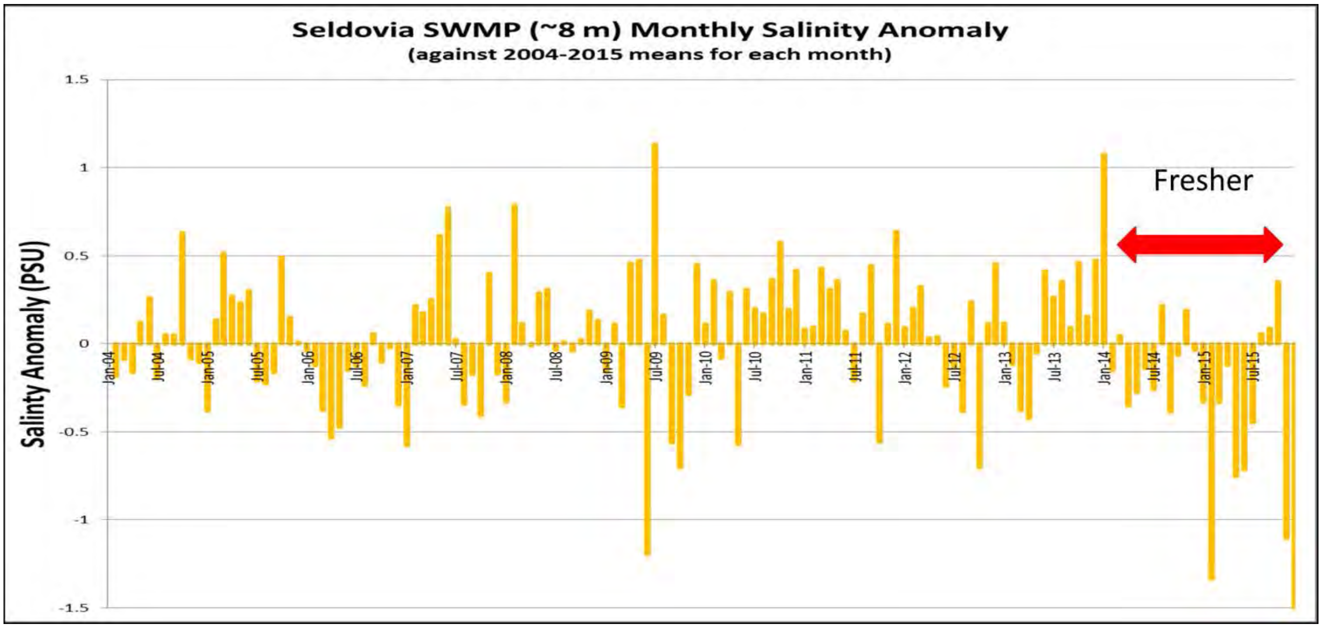


Figure 3. Monthly salinity anomalies calculated from continuous salinity data recorded 1m above the bottom (~8m depth) at the KBNERR long-term water quality monitoring site in Seldovia harbor. The anomaly is calculated as the difference between the monthly average and the 2004-2015 mean for that month. Note that the time period is shorter than the temperature anomalies shown in Figure 2 due to some early data quality issues. The 2014—2015 warm period was also consistently fresher than average.

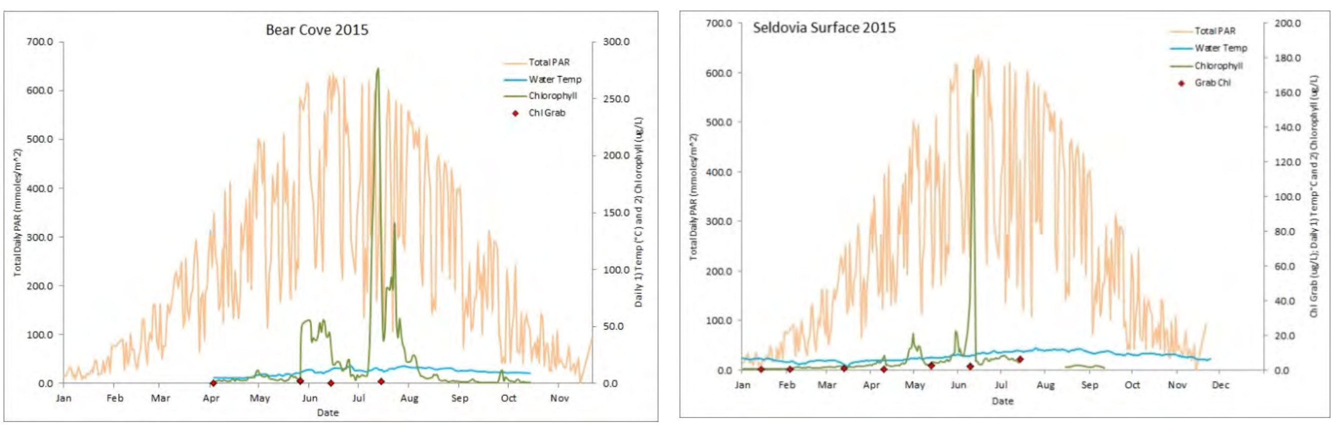


Figure 4. Monthly water temperature (blue) and Chlorophyll (probe [green] and water grab sample [red diamond]) from Bear Cove (1m below the water surface at the head of Kachemak Bay) and Seldovia Harbor (1m below the water surface at the mouth of Kachemak Bay) plotted with the total photosynthetically active radiation data (red) in the KBNERR long-term monitoring sites from Jan-Dec 2015.

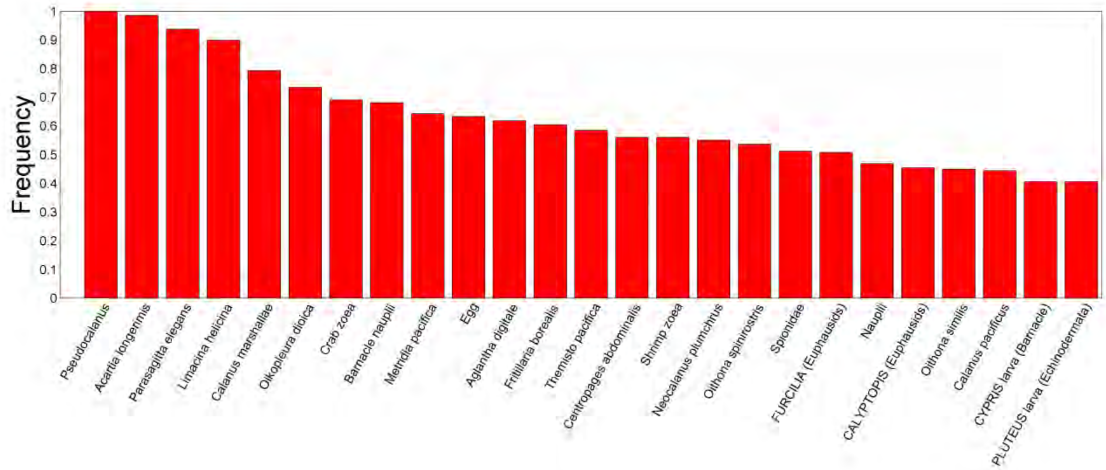


Figure 5. The most frequently (0 = absent; 1 = observed in all samples) observed zooplankton at all sampling locations for Kachemak Bay and lower Cook Inlet, Alaska during 2012-2014.

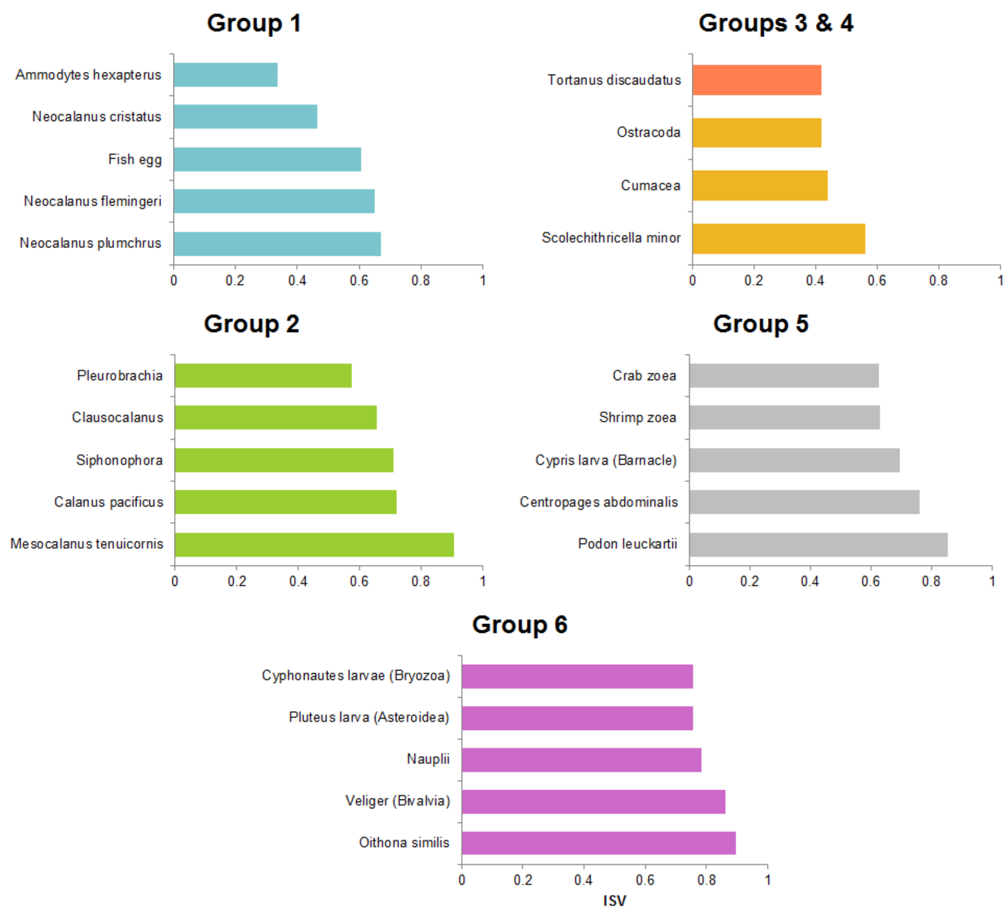


Figure 6. There were six groups identified in the hierarchical cluster analysis; we show the five significant ($p < 0.05$) indicator species within each grouping. The Indicator Species Value (ISV) on the X axis varies based on how consistently present taxa were in their group (0 = absent; 1 = present in all group samples). Group 4 contained only one species (*Tortanus discaudatus*) and was included with the Group 3 graph for brevity.

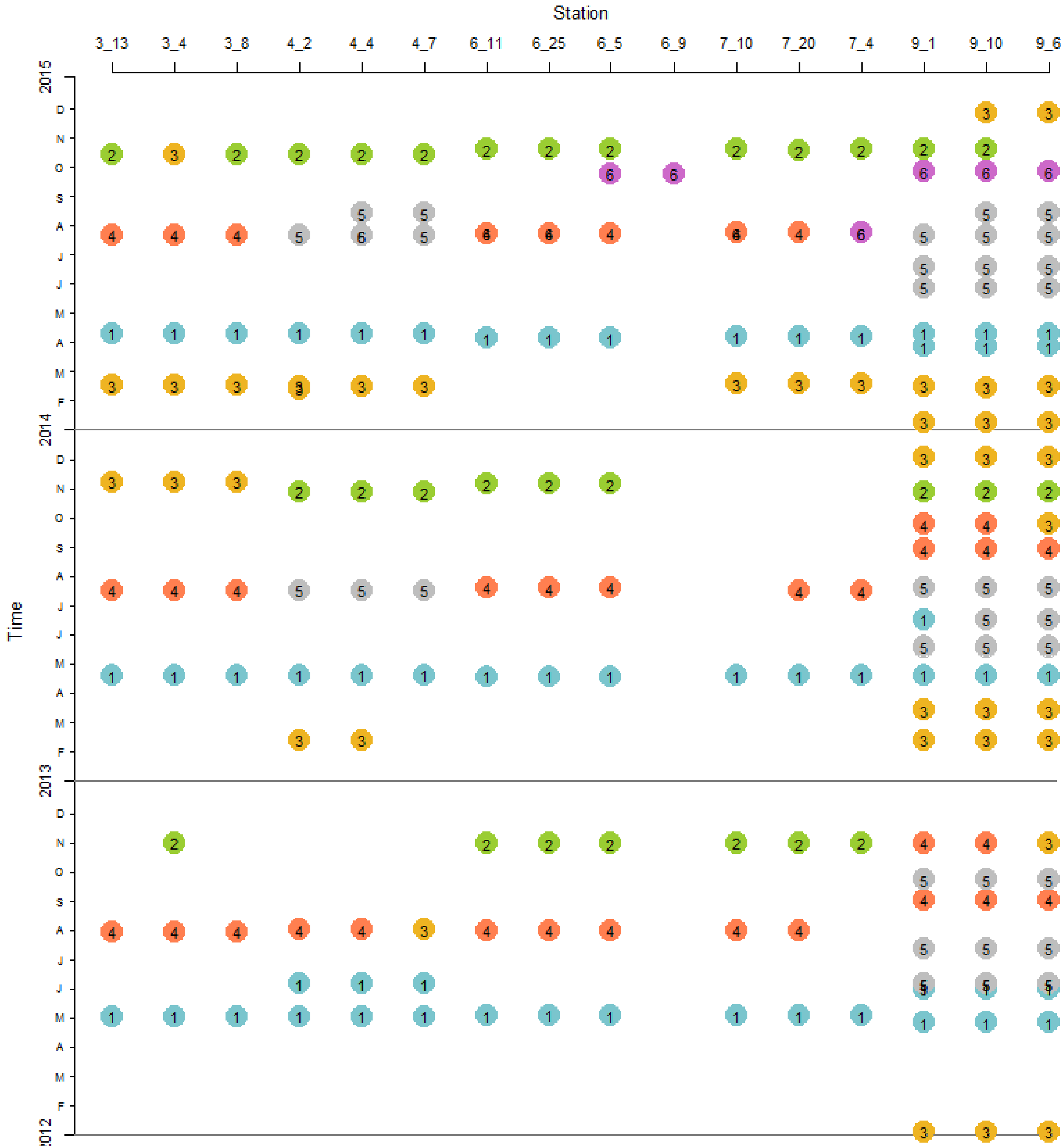
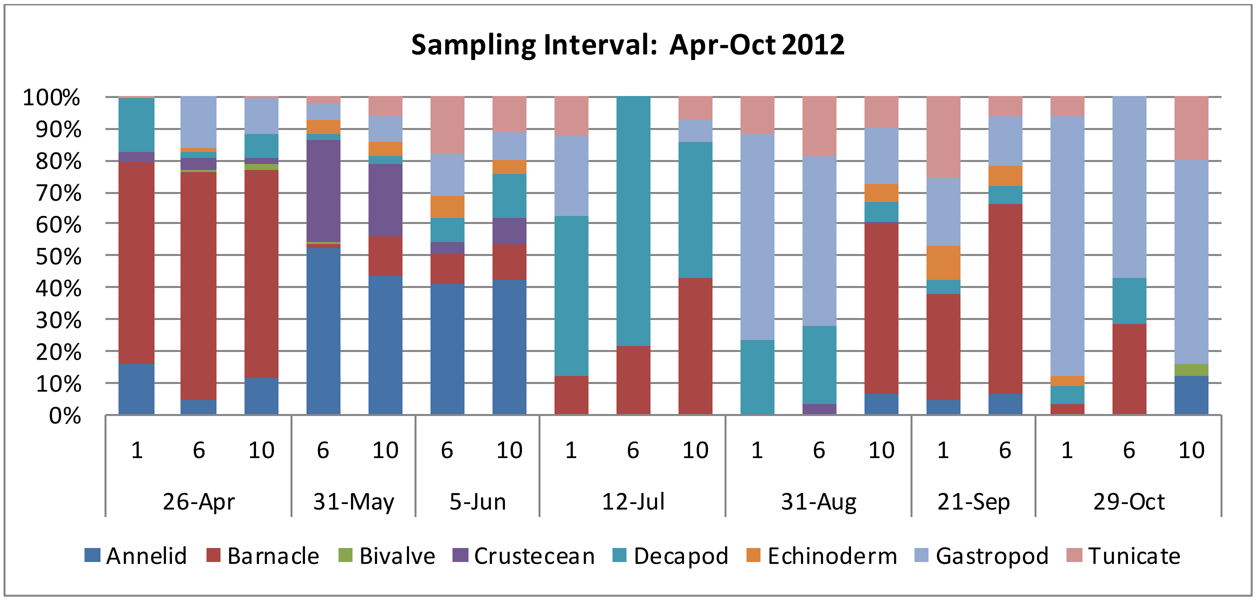
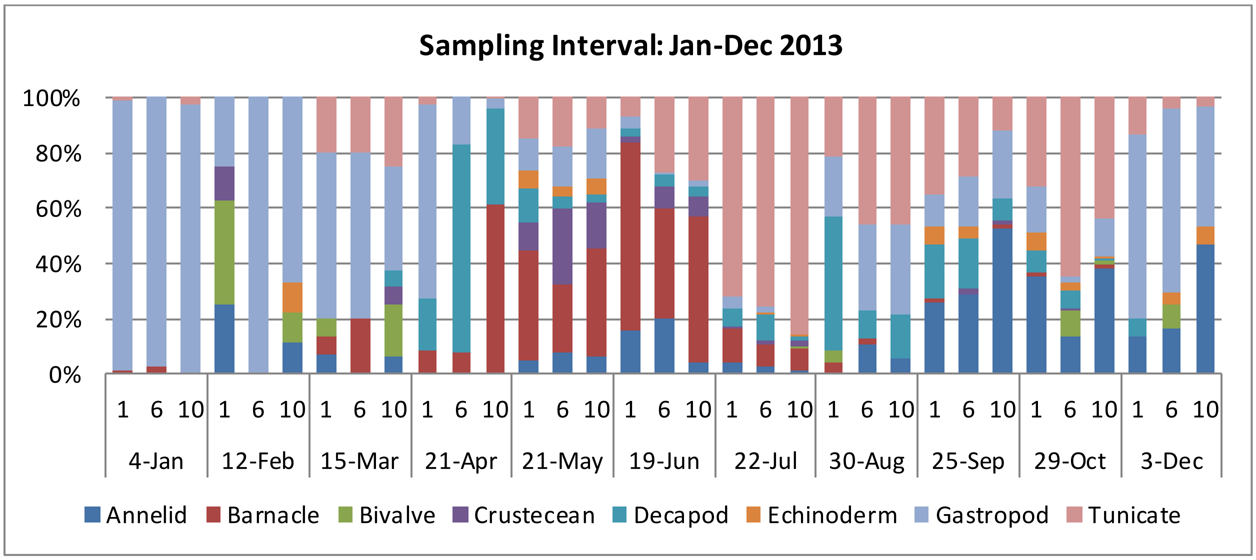
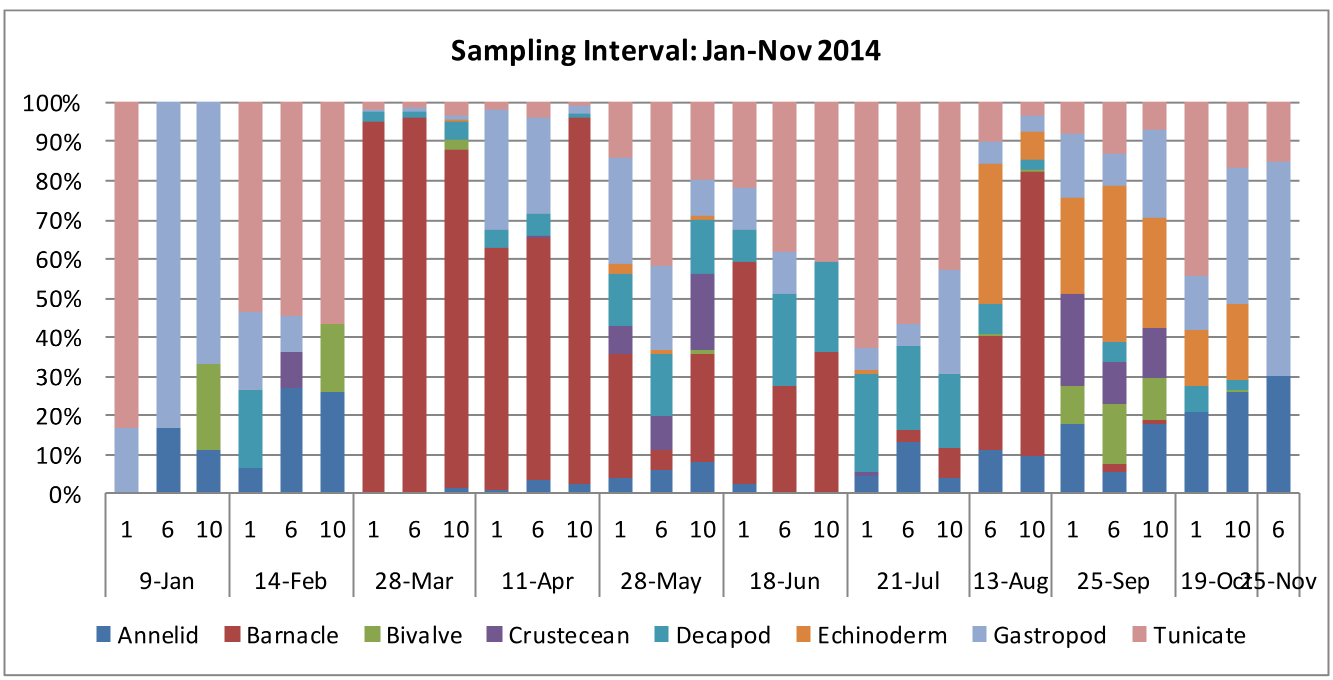


Figure 7. Plot of indicator species contained in zooplankton tows for each station (Transect #_station) by location, month, and year collected. Transects 4 and 9 are located in Kachemak Bay all others in lower Cook Inlet. Colored dots and numbers indicate the hierarchical cluster group (see Figure 6) to which each sample belongs.

Figure 8 (see NEXT PAGE). In Kachemak Bay, meroplankton were present during all months sampled and were more abundant during summer and fall months (see Figure 7). These three histograms show the percent occurrence of broad classifications by station by sampling date during 2012-2014 along Transect 9.


Sampling Interval: Apr-Oct 2012
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 6 10 6 10 6 10 1 6 10 1 6 10 1 6 1 6 10
26-Apr
31-May
5-Jun
12-Jul
31-Aug
21-Sep
29-Oct
Annelid Barnacle Bivalve Crustecean Decapod Echinoderm Gastropod Tunicate


Sampling Interval: Jan-Dec 2013
100%
80%
60%
40%
20%
0%
1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10
4-Jan
12-Feb
15-Mar
21-Apr
21-May
19-Jun
22-Jul
30-Aug
25-Sep
29-Oct
3-Dec
Annelid Barnacle Bivalve Crustecean Decapod Echinoderm Gastropod Tunicate


Sampling Interval: Jan-Nov 2014
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 1 6 10 6 10 1 6 10 1 10 6
9-Jan
14-Feb
28-Mar
11-Apr
28-May
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25-Sep
19-Oct
25-Nov
Annelid Barnacle Bivalve Crustecean Decapod Echinoderm Gastropod Tunicate

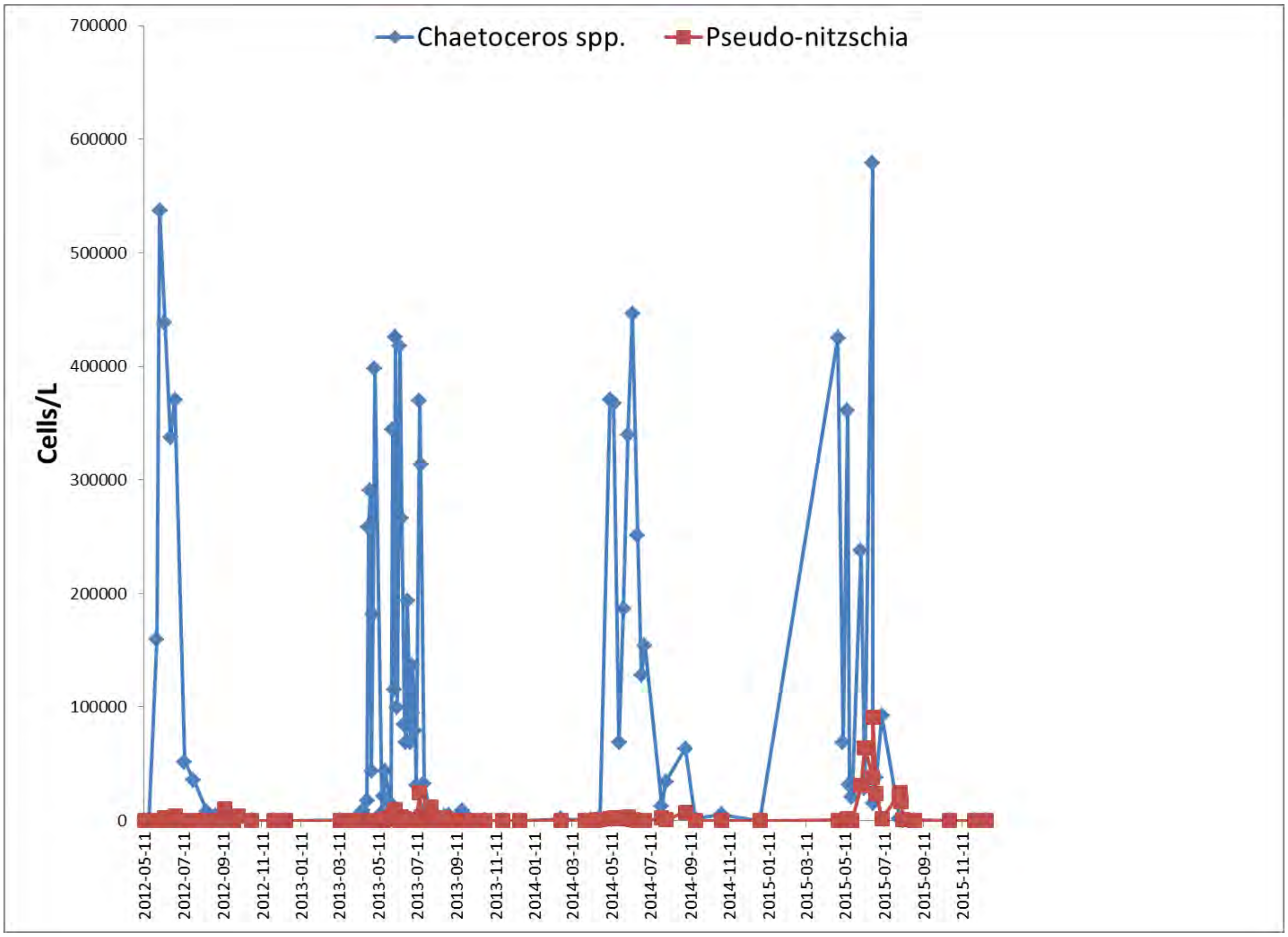

Figure 9. Graph showing the time series of cell concentrations of *Chaetoceros spp*. and *Pseudo-nitzschia spp*. from January 2012 through December 2015 observed from routine phytoplankton sampling conducted at the NOAA KBL dock. Note the increase in *Pseudo-nitzschia* concentrations during the 2015 bloom.

Deliverables and Milestones:

Deliverable/Milestone	Status
Monthly Kachemak Bay CTD & plankton surveys	Completed. Note, only CTD data collected in Jan 2015 due to weather and personnel schedule conflict.
Two seasonal lower Cook Inlet/Kachemak Bay CTD & plankton surveys	Completed. February (all), April (T3, T4, T9, partial T6 & T7). Additional seasonal surveys in August (T4, T9, partial T6 & T7) and November (T3, T4, T9).
Annual PI Meeting and AMSS PI meeting	Completed. Doroff and Holderied attended November 2015 PI meeting and attended PI meeting at the Alaska Marine Science Symposium in January 2016.
Present work at Alaska Marine Science Symposium	Completed January 2016.

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

a) Collaborations with the Gulf Watch Alaska and Herring Research and Monitoring programs.

1) *Environmental Drivers component*: We continued to coordinate on oceanographic and zooplankton sampling protocols and monitoring results with other Environmental Drivers component PIs (Weingartner, Hopcroft, Batten, Campbell) through teleconferences and in breakout discussions at the annual PI meeting. Zooplankton data from this project and the PWSSC are being jointly analyzed and presented by Doroff, Campbell, and McKinstry; this ensures the maximum comparability between the nearshore regions. Holderied also participated with other environmental drivers PIs in the Pacific Warm Anomaly workshops at Scripps in May 2015 and at the University of Washington in January 2016, presenting monitoring results from this project.

2) *Pelagic component*: We continued to coordinate with Kathy Kuletz of the USFWS Migratory Bird Management office to host a seabird/marine mammal observer on our quarterly Cook Inlet surveys, with the goal of improving understanding of relationships between marine conditions, primary productivity, and seabird and marine mammal populations. Starting in federal FY15, USFWS is also leveraging funding from a separate Cook Inlet project with the BOEM to support the seabird and marine mammal observing effort.

3) *Herring Research and Monitoring Program*: We continue to have informal discussions on oceanographic patterns and relationships between marine conditions and plankton, herring, and forage fish populations with the HRM program lead (Scott Pegau), to compare conditions between Prince William Sound and Cook Inlet. We are particularly interested in understanding the causes behind the large increase in whales, and apparently herring, in Kachemak Bay in 2015 and are working with the GWA pelagic component PIs, HRM program PIs and ADFG to explore how we might cost-effectively sample forage fish species presence in Kachemak Bay.

b) Collaborations with other Trustee Council-funded projects not part of integrated programs.

N/A

c) Collaborations with Trustee or Management Agencies

1) *NOAA/National Ocean Service/National Centers for Coastal Ocean Science.* We continue to collaborate with researchers at our National Ocean Service NCCOS Beaufort Laboratory in North Carolina to use the oceanography and phytoplankton sampling data to identify environmental triggers for increases in the phytoplankton species (*Alexandrium* spp.) that cause paralytic shellfish poisoning events. We are partnering with AOOS/Axiom to develop a web-based paralytic shellfish poisoning risk management tool, based initially on real-time temperature data collected at the Seldovia SWMP station. Holderied presented the initial version of this tool in November 2015 at the Coastal and Estuarine Research Federation conference in Portland, Oregon.

2) *NOAA Kasitsna Bay Laboratory and BOEM*:

NOAA KBL and BOEM initiated a collaboration in FY2014 to update information on marine conditions and ecological linkages in Cook Inlet, to support BOEM's environmental analysis needs for potential oil and gas lease sales in the region. BOEM is providing $150K to KBL to conduct seasonal Cook Inlet surveys and develop oceanographic data analysis to support BOEM's environmental analysis needs for potential oil and gas lease sales in the region. The BOEM funding will allow us to conduct additional

Cook Inlet cruises in Year 5, for which there was not sufficient funding available under our original EVOSTC proposal.

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

a) Publications

Hoem Neher, T., B. Ballachey, K. Hoffman, K. Holderied, R. Hopcroft, M. Lindeberg, M. McCammon, and T.Weingartner, editors. 2016. Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska program science synthesis report for the Exxon Valdez Oil Spill Trustee Council.

Batten, S., R. Campbell, A. Doroff, K. Holderied, R. Hopcroft and T. Weingartner. 2016. Chapter 2: Environmental Drivers: Regional Variability in Oceanographic Patterns across the Gulf of Alaska. In Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska program science synthesis report. Exxon Valdez Oil Spill Trustee Council.

Holderied, K. and T. Weingartner. 2016. Linking Variability in Oceanographic Patterns Between Nearshore and Shelf Waters Across the Gulf of Alaska. In Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska program science synthesis report for the Exxon Valdez Oil Spill Trustee Council.

b) Conference/workshop presentations and attendance

Doroff, AM, R. Campbell, C. McKinstry. 2016. Zooplankton assemblages in lower Cook Inlet and Kachemak Bay 2012-2014. Poster presentation at Alaska Marine Science Symposium, Anchorage AK. Jan 2016.

Holderied, K. 2015. How connected are Kachemak Bay and the Gulf of Alaska? And why it matters. Oral presentation at the Kachemak Bay Science Conference, Homer AK. Mar 2015.

Holderied, K., R. Hopcroft, T. Weingartner, S. Batten, R. Campbell, S. Danielson, and A. Doroff. 2014-2015 Oceanographic Anomalies in the Gulf of Alaska Oral presentation at Pacific Anomalies Workshop I, NOAA Integrated Ocean Observing System, La Jolla, CA. May 2015.

Holderied, K., D. Hondolero, S. Kibler, W. Litaker, and A. Doroff. 2015. A web-based, paralytic shellfish poisoning risk assessment tool for Kachemak Bay Alaska. Poster presentation at the Coastal and Estuarine Research Federation Conference, Portland, OR. Nov 2015.

Holderied, K., A. Doroff and D. Hondolero. 2015. Seasonal variability in oceanography and ocean acidification in Kachemak Bay and lower Cook Inlet, Alaska. Poster presentation at the American Fisheries Society, Alaska chapter meeting, Homer AK. Nov 2015.

Holderied, K. and D. Hondolero. 2016. Oceanographic and ecosystem response to the 2013-2015 Pacific Warm Anomaly in Kachemak Bay Alaska. Poster presentation at the Pacific Anomalies Workshop II, NOAA Integrated Ocean Observing System, Seattle, WA. Jan 2016.

Holderied, K., A. Doroff, and D. Hondolero. 2016. From cool to hot: 2012-2015 transition in Kachemak Bay and Cook Inlet Alaska waters. Poster presentation at the Alaska Marine Science Symposium, Anchorage AK. Jan 2016.

Hondolero, D. 2015. Kachemak Bay phytoplankton and harmful algal bloom patterns. Oral presentation at the Kachemak Bay National Estuarine Research Reserve Harmful Algal Bloom Workshop, Homer AK. February 2015

Hondolero, D. 2015. Monitoring Phytoplankton in Kachemak Bay and lower Cook Inlet. Oral presentation at the Kachemak Bay Science Conference, Homer AK. Mar 2015.

Hondolero, D., S. Kibler, M. Vandersea, W. Litaker, and K. Holderied. 2015. Effects of Stratification and Nutrient Limitation on Phytoplankton Blooms in Kachemak Bay. Oral presentation at the American Fisheries Society, Alaska chapter meeting, Homer AK. Nov 2015.

Hondolero, D. and K. Holderied. 2016. Monitoring Phytoplankton in Kachemak Bay, Alaska. Poster presentation at Alaska Marine Science Symposium, Anchorage AK. Jan 2016.

c) Data/information products

Numerous data and information products have been developed for the GWA science synthesis report, the EVOSTC joint science workshop, and the public presentations listed above. Data products include graphics of oceanographic time series plots, time series anomalies, comparisons of temperatures between different regions (e.g., GAK1, Seldovia, and Cordova), and along-transect vs depth contour plots. Data and graphic products from this project have been made available to and used by three 2015 summer interns working with Holderied from Middlebury College, Mt Holyoke College and the University of Massachusetts Amherst, as well as by University of Alaska Anchorage (UAA) Kachemak Bay Campus Semester on the Bay undergraduate student interns working with Holderied and Doroff in fall 2015. All the student interns provided public science outreach talks on their results and the summer interns developed outreach materials for public, free-learning "Discovery Labs" hosted by KBNERR.

d) Data sets uploaded to the data portal

- CTD data sets and associated metadata from 2012, 2013, and 2014 have been uploaded to the AOOS Ocean Workspace, with 2012 and 2013 data published to the Gulf Watch Alaska Data Portal. The 2014 data will be published after final review is completed with the GWA science coordinator.
- Zooplankton data and associated metadata that has been analyzed through 2014 have been uploaded to the AOOS Ocean Workspace. Metadata have been generated and data will be uploaded to the Gulf Watch Alaska Data Portal.
- KBNERR SWMP water quality data from Bear Cove, Homer, and Seldovia water quality data sondes and associated metadata through 2015 have been uploaded to the Ocean Workspace and are published on the Gulf Watch Alaska Data Portal. Data are also publicly available through 2015 on the NOAA National Estuarine Research Reserve site: http://cdmo.baruch.sc.edu/

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

N/A for this project.

11. Budget: *See,* Reporting Policy at III (C) (11).

See attached budget sheets for Doroff (ADFG/UAA/KBNERR) and Holderied (NOAA/KBL) in the consolidated GWA budget spreadsheet.

KBNERR Budget Narrative: In Project Year 1, KBNERR leveraged our long-term monitoring grant to obtain $102K for new water quality monitoring equipment to have Chl_a probes at each of the water quality monitoring sites in Kachmak Bay. In kind annual contributions are as follows: $120K KBNERR SWMP; $5K KBRR CTD use. On 13 July 2015, KBNERR transferred fiscal agents from ADFG Division of Sport Fish to UAA, Alaska Center for Conservation Science. At the close of State fiscal year (30 June 2015), the budget for this project was held pending final building transfers and project audits. UAA allowed spending against the project for salary and required PI meetings; however, the budget was not fully transferred until 28 January 2016. The funding was transferred to UAA by a reimbursable services agreement and incurred an additional 25% overhead. Since then, we've had good support for securing two necessary ship charters in February and April for next project year; we will conduct necessary equipment calibrations and maintenance, and will be able to meet project deliverables by extending these funds through the end of the State fiscal year (30 June 2016).

KBL Budget Narrative: See NOAA budget report in the program budget spreadsheet.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$66.0	$69.3	$72.8	$64.2	$63.2	$335.5	$262.4
Travel	$3.7	$3.7	$3.7	$6.1	$3.7	$20.9	$14.3
Contractual	$49.8	$51.8	$51.8	$25.8	$11.8	$191.0	$178.7
Commodities	$8.1	$16.6	$10.8	$8.4	$8.5	$52.4	$43.2
Equipment	$23.8	$0.0	$0.0	$0.0	$0.0	$23.8	$23.8
SUBTOTAL	$151.4	$141.4	$139.0	$104.6	$87.2	$623.5	$522.4
General Administration (9% of subtotal)	$13.6	$12.7	$12.5	$9.4	$7.8	$56.1	$47.0
PROJECT TOTAL	$165.0	$154.1	$151.6	$114.0	$95.0	$679.6	$569.4
Other Resources (In kind Funds)	$227.0	$125.0	$125.0	$125.0	$125.0	$727.0	$602.0

COMMENTS: In Project Year 1, KBNERR leveraged our LTM grant to obtain $102K for new water quality monitoring equipment to have Chl_a probes at each of the water quality monitoring sites in Kachmak Bay. Annual in-kind contributions were: $120K KBNERR SWMP; $5K KBNERR CTD use. On 13 July 2015, KBNERR transferred fiscal agents from ADF&G DSF to UAA. As of 30 June 2015, the budget for this project was held pending final building transfers and project audits. UAA allowed spending against the project for salary and required PI meetings, however, funds were not transferred until 28 January 2016. A combination of carryover funds and PY4 funds were transferred to KBNERR/UAA; a 25% OH was assessed. Since then, we’ve had good support for securing two necessary ship charters in Feb and Apr for PY5; we will conduct necessary equipment calibrations and maintenance, and will be able to meet project deliverables by extending these funds through the end of the State fiscal year (30 June 2016).

FY12-16

Project Title: 15120114-G Kbay/Cook Inlet Oceanography
Team Leader: Angela Doroff

FORM 4A
TRUSTEE AGENCY SUMMARY

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Travel	$4.2	$4.2	$4.2	$6.6	$4.0	$23.1	$8.9
Contractual	$2.5	$2.5	$2.5	$2.5	$2.7	$12.7	$3.9
Commodities	$13.0	$7.0	$7.0	$9.0	$6.0	$42.0	$28.5
Equipment	$5.0	$7.7	$0.0	$0.0	$0.0	$12.7	$0.0
SUBTOTAL	$24.7	$21.4	$13.7	$18.1	$12.7	$90.5	$41.3
General Administration (9% of subtotal)	$2.2	$1.9	$1.2	$1.6	$1.1	$8.1	$3.7
PROJECT TOTAL	$26.9	$23.3	$14.9	$19.7	$13.8	$98.6	$45.0
Other Resources (In kind Funds)	$55.0	$55.0	$55.0	$130.0	$130.0	$425.0	$295.0

COMMENTS:
Other resources: Yr 4 in kind contribution of $5K for CTD equipment and $25.0K in salary for KBL staff. Yr 4 funds for attendance at national science conference used to present results at Ocean Sciences conference in Feb 2016. Additional leveraged funds obtained by KBL: $150K from BOEM ($75 in FY14, $75K in FY15) for Cook Inlet monitoring which support additional seasonal Cook Inlet surveys (EVOSTC project funding was not sufficient for quarterly surveys in years 4 and 5). $25K from AOOS for additional Kachemak Bay oceanographic sampling in Yr 4.

FY12-16

Project Title: 15120114-G Kachemak Bay/Cook Inlet Oceanography
Team Leader: Kris Holderied
Agency: NOAA Kasitsna Bay Laboratory

FORM 4A
TRUSTEE AGENCY SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-H

2. Project Title: *See,* Reporting Policy at III (C) (2).

Science Coordination and Synthesis

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Kris Holderied and Tammy Hoem Neher

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Work in year four was focused on development of a plan and outline for a special journal issue, coordination of data delivery, metadata and updated sampling protocols to the Alaska Ocean Observing System (AOOS) Ocean Workspace, updates to outreach and data management tools, and planning and coordination for the program teleconferences and annual meeting. We provided formal and informal outreach of program findings, with program presentations at several science conferences, including the Alaska Marine Science Symposium in January 2016 and at workshops on the oceanographic and ecosystem effects of the Pacific warm water anomaly in May 2015 and January 2016. We are planning a joint Gulf Watch Alaska (GWA)-Herring Research and Monitoring (HRM) program special issue in the journal Deep Sea Research II. Guest editors and the submission framework have been established, with a manuscript submission period starting July 1, 2016. The annual program meeting was held in November 2015 with principal investigators (PIs) from the GWA and HRM programs, and the meeting was focused on preparing for the journal special issue and developing a proposal for the 2017-2021 *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) Invitation. We also coordinated with the HRM program to present findings and share lessons learned from EVOSTC-funded ecosystem research and monitoring with organizations working on post-Deep Water Horizon oil spill efforts during a workshop held at the Gulf of Mexico Research Initiative conference in February, 2016.

Additional highlights from coordination and synthesis project efforts in year 4 include continuing to expand coordination with other organizations and we are participating in the Gulf of Alaska science synthesis effort led by the North Pacific Research Board (NPRB) Gulf of Alaska Integrated Ecosystem Research Program. We also participated in and shared information with the National Center for Ecological Analysis and Synthesis working groups (See project report for project number 15120120, M. Jones for details). Below is a summary of science coordination and synthesis work performed during the reporting period by project objective, Table 1 highlights the project milestones and deliverables met during this reporting period.

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

Two teleconferences were held with PIs and the Science Coordinating Committee (SCC) for GWA in May and August 2015. Most PIs attended the teleconference meetings and those that did not received meeting notes and held short discussions with the science coordinator and management team members. The annual program meeting was attended by all PIs (or representatives) in November and a second in-person meeting (with video-conference connection) was held in conjunction with the Alaska Marine Science Symposium in January 2016, with all PIs present in person or by phone. Meeting agendas, summaries, and other materials are posted on the internal AOOS GWA program Workspace (Program Coordination>Meetings). The SCC and program management team met formally via teleconference in April, July, September, October, and December 2015 with extensive additional coordination by email and in person to plan and discuss layout, content, and authorship of manuscripts for the journal special issue, provide input on needed data management services, start planning for the FY17-21 EVOSTC Invitation, and address ongoing program coordination issues.

We organized a small team to assist with the journal selection, the initial preproposal, timeline development, and guest editorial board for the joint programs special journal issue. The team met by teleconference in August, five guest editors were selected, the journal Deep Sea Research II was contacted, and the preproposal forms for the issue were submitted in November 2015 following the annual program meeting.

Much of the focus since October 2015 for the program and science coordination has been on development of the program proposal and projects under the 2017-2021 Invitation. This includes facilitating discussions on potential program changes, reaching out to scientists outside of the current team, creating budget estimates, organizing teleconferences, and writing drafts of the program and science coordination project proposals.

We continue to make changes to the AOOS Ocean Workspace, GWA website, and Gulf of Alaska Data Portal to facilitate communication between PIs and improve data access. This year, we developed an initiative to facilitate use of the data publishing tools, edit all project metadata, and create all file level metadata by holding one-on-one meetings with GWA and HRM science coordinators (Neher and Buckelew), Axiom staff and GWA program PIs. This initiative was well received and allowed us to make another leap forward in program data access and communication. All of the GWA projects housed within the AOOS Ocean Workspace, and Gulf of Alaska Data Portal have had the metadata reviewed and edited by the program PIs.

Finally, in partnership with the National Oceanic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory, we continue to maintain our interactive intranet Google Site for the program management team and PIs to share program updates, field highlights, and research discussions. To improve program coordination, the site is also linked to Google Drive folders and the GWA Google calendar.

Objective 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.

We continued our progress in integration between the GWA-HRM programs in 2015-2016 with the initial planning of a joint program special journal issue and joint annual program meeting. PIs are closely coordinating across the programs on field activities, process studies, modeling, and working groups. Examples include integrated work between the HRM program and scientists from three of the environmental drivers component projects, as well as the humpback whales, marine birds, and forage fish projects, that was presented during the January 2015 Alaska Marine Science Symposium and February 2015 EVOSTC joint science workshop and described in the synthesis reports from both programs. These collaborations are ongoing and the lessons learned are being incorporated in planning for the FY17-21 phase of the long-term monitoring program.

The conceptual modeling project developed a series of sub-models to assist with understanding of ecology by focusing on various drivers of ecosystem function. These models are being used to facilitate discussion within the program teams and for outreach. One sub-model completed this year was a conceptual figure for the nearshore component provided for the synthesis report and several presentations. Three additional sub-models are in progress and are centered on: 1) top-down processes, such as whale predation; 2) bottom-up processes such as the effects of temperature and nutrients on plankton production; and 3) "lynch-pin" processes, such as the key role of forage fish in the ecological processes in the Gulf of Alaska. We are assisting in coordination with EVOSTC staff and project PIs on a revised timeline and final deliverables for the conceptual modeling project, in light of the Council decision not to fund year 5 of that project.

Objective 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.

One of our highlights from this year's work on program data communication includes assisting with the development of a data visualization prototype by Axiom staff under the program data management project (15120114-D, McCammon and Bochenek). Based on needs expressed by Alaska Department of Fish and Game (ADFG) and NOAA fishery and marine mammal managers and researchers, the tool displays spatial observation data for humpback whales (15120114-N, Moran and Straley) with potentially related information, such as environmental data and ADFG herring spawn and school observations. The tool facilitates examination of co-located patterns of whale, herring, and oceanographic data in both space and time, and provides a simple way to explore relationships between key drivers, such as temperature or salinity, with herring and/or whale distributions. Axiom staff successfully demonstrated the prototype to GWA PIs during the in-person program meeting held at the AMSS in January 2016, generating much interest.

Table 1. Status of deliverables and milestones.

Deliverable/Milestone	Status
Continue to assist development of new data visualization and access tools	Tools were developed and a prototype was demonstrated for the program PIs during the AMSS program meeting.
Submit year 5 work plan.	Year 5 work plans were prepared or edited as needed and were provided Sept. 1 to Trustee Council staff. Work plans were approved during the November EVOSTC meeting.

Facilitate annual PI meeting	The program management team and SCC planned the meeting agenda, conducted the meeting, and coordinated associated work group discussion sessions. Meeting was held in November 2015 in conjunction with the HRM program meeting and focused on the joint special journal issue and the program proposal for the FY2017-2021 Invitation.
Attend AMSS and provide update to GWA program	Tammy Hoem Neher presented an update on monitoring program highlights from the GWA program at the CERF conference in November 2015 and at AMSS in January 2016. Kris Holderied provided monitoring program highlights at the Pacific Warm Anomaly Workshops in May 2015 and January 2016.
Submit report on synthesis of all available historical data from LTM projects	The NCEAS project is submitting a progress report on the historical data collection in conjunction with this annual report.
Submit annual project report	This document constitutes report submission.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

As described above in the summary of work performed, many of the objectives and tasks performed under this project are efforts to build and facilitate coordination both within the GWA program and between the GWA and HRM programs as well as outreach information to other entities.

a. Coordination within and between council funded programs

- Planned GWA program meetings, teleconferences, and workshops
- Planned joint annual meeting with HRM program lead and attended HRM program meeting at the Alaska Marine Science Symposium. Also work closely with HRM program lead (Pegau) and science coordinator (Buckelew).
- Worked closed with the program PIs, data management, and outreach teams to provide program information and data on the website, Workspace, and public Data Portal.
- Worked with National Center for Ecological Analysis and Synthesis program working group team members to collect information for analyses and use by the team, including maps of the spill affected region, sampling data for lingering oil, oceanographic data, and humpback whale population data.
- Worked with GWA outreach committee to develop new outreach products (Discovery labs, virtual field trips, GWA YouTube channel and video, Prince William Sound Science Center Field Notes and video).
- Coordinated preparation of GWA annual reports and work plans.

b. Coordination with other Council funded projects –none during this reporting period

c. Coordination with management agencies and Trustees

- Presented program materials at numerous meetings, workshops, radio broadcasts, and conferences, including the American Fisheries Society Alaska chapter meeting in November 2015.
- Worked with Dr. Wayne Litaker (NOAA National Centers for Coastal Ocean Science) and Dr. Bruce Wright (Aleutian Pribilof Islands Association, Inc.) to review and discuss harmful algal bloom information from across the Gulf of Alaska to help understand potential impacts of toxic algaes to communities and ecosystems. This information was used in program presentations to demonstrate some of the ecological shifts under anomalously high water temperatures.
- Worked with researchers from other NOAA offices (National Marine Fisheries Service, National Ocean Service, NOAA Research), U.S. Fish and Wildlife Service, U.S. Geological Survey, and ADFG throughout 2015 on the ecosystem responses to the Pacific warm anomaly, including

extensive seabird mortalities throughout the Gulf of Alaska, greatly increased sea otter mortalities in Kachemak Bay, toxic algae blooms throughout the GWA study area, and changes in species distributions, including increased numbers of herring, humpback whales, and king salmon in Kachemak Bay.

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

We are in the process of assisting the GWA outreach team in preparing the annual updates to the program website; these were last completed in May, 2015 and are done each year. Updates from this past year of monitoring are crucial as they will include information collected through the Pacific warm anomaly (late 2013 through present). We provided content and editorial review for a variety of outreach products in the past year, including review of Virtual Field Trip programs developed by the Alaska Sea Life Center (Screen shot in Figure 1, view it: http://www.alaskasealife.org/gw_introduction). Program PIs and their staff have participated in three public outreach events: the Kachemak Bay Science Conference in March, 2015, public Discovery Labs at the Kachemak Bay Research Reserve in Homer, Alaska in July, 2015 and the International Shorebird Festival in Cordova, Alaska in May, 2015. We also worked with program PIs to update all of the project level metadata and developed a GWA program YouTube channel to provide public access to program video and audio segments.

Figure 1. Screen shot of introductory page to the GWA program virtual field trip created by the Alaska Sea Life Center.

Publications: We did not publish peer reviewed literature as a program during this reporting period, a special journal issue is in development for publication during the spring of 2017.

Conference and workshop presentations and attendance: Multiple public presentations were made in a variety of venues on the integrated GWA program during this year. Dr. Tammy Hoem Neher gave the GWA program overview presentation at the March 2015 Kachemak Bay Science conference, the August 2015 National American Fisheries Society conference, the November 2015 Coastal Estuarine Research Federation conference, the January 2016 Alaska Marine Science Symposium, and the February 2016 Oil Spills and Ecosystems conference. Kris Holderied presented GWA program ecosystem monitoring results at the Pacific Anomalies Workshops in May 2015 (Scripps) and January 2016 (University of Washington). The science synthesis team also supported outreach for the GWA program during a

Kachemak Bay Research Reserve Discovery Lab on the program in July 2015, with over 300 people attending on three separate days. Topics included monitoring program results, history of the *Exxon Valdez* oil spill, and information on harmful algal blooms, seabirds, killer whales, nearshore ecosystems, and sea otters.

Data and/or Information Products: Efforts to develop information products this year were focused on development of the joint special journal issue with the HRM program to be published in the spring of 2017. In addition, we worked with the program PIs to update all project and file level metadata available on the Gulf of Alaska Data Portal.

Project data uploaded to program data portal: Not applicable to this project.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

None for this project

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$90.0	$111.6	$115.2	$117.6	$121.2	$555.6	$434.4
Travel	$10.8	$9.4	$11.4	$9.9	$11.4	$52.9	$36.5
Contractual	$7.5	$5.5	$5.5	$5.5	$5.0	$29.0	$21.2
Commodities	$1.0	$1.0	$1.0	$1.0	$1.5	$5.5	$2.3
Equipment	$4.0	$0.0	$3.0	$0.0	$0.0	$7.0	$0.0
Indirect Costs (*will vary by proposer*)							
SUBTOTAL	$113.3	$127.5	$136.1	$134.0	$139.1	$650.0	$494.4
General Administration (9% of subtotal)	$10.2	$11.5	$12.2	$12.1	$12.5	$58.5	$44.5
PROJECT TOTAL	$123.5	$139.0	$148.3	$146.1	$151.6	$708.5	$538.9
Other Resources (in kind Funds)	$13.0	$13.0	$13.0	$13.0	$13.0	$65.0	$52.0

Cumulative spending is slightly delayed, which has allowed us to provide a turn-over period for the change in science coordinator (from Tammy Neher to Donna Aderhold). Other resources: In-Kind contributions: NOAA Kasitsna Bay Laboratory salary for Holderied ($65K total for FY12-16, $13K for project year 4). No changes to total budget amount proposed in year 5 from original proposal. Minor (<10%) change in budget categories was approved in year 5 workplan.

FY12-16

Program Title: 15120114-H Coordination & Synthesis
Team Leader: Kris Holderied
Agency: NOAA

FORM 4A
TRUSTEE AGENCY
SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

12120114-128102

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term Monitoring: Synthesis and Conceptual Modeling - Conceptual Ecological Modeling

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Dr. Tuula Hollmen

Suresh A Sethi (Collaborator)

Lisa Sztukowski (Research Associate)

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015 to January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

February 15, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

http://www.gulfwatchalaska.org/program-services/conceptual-modeling/

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

Conceptual ecological models synthesize information about complex systems into visual frameworks which promote understanding, communication and offer guidance to future research. Key to this process are clearly defined objectives, defined spatial and temporal boundaries, and decisions on the currency of the system (e.g. energy transfer) to ultimately produce a model structure. In the current reporting period, work has focused on four areas:

1. Publishing results from the first two years of method development and modeling, and developing manuscripts for additional papers.
2. Development of a framework and working groups for a suite of submodels to explore and represent key hypotheses relating to the components of our program: environmental drivers, pelagic, and nearshore.
3. Development of visual aids to represent ecosystem structure and monitoring efforts related to the program components.
4. Development of a framework to consider monitoring priorities and management relevance to assist long term programmatic planning efforts.

We continued to make progress on series of submodels which require the collaboration among the key program components: nearshore (Submodel 1), pelagic (Submodel 2), and environmental drivers (Submodel 4). The first manuscript based on conceptual modeling development for Gulf Watch Alaska program was published in Arctic (2015) and was based on Submodel 3. We presented a poster 'Mesoscale ecosystem processes in the Gulf of Alaska' at Alaska Marine Science Symposium on development of submodels. We are continuing to work with the pelagic group on Submodel 2, including discussion on a conceptual spatial model and a structured framework to help integrate sampling efforts within their component. Summary of work for our suite of submodels follows:

Submodel 1: Key Trophic Linkages in Nearshore Northern Gulf of Alaska Ecosystem

The overall goals of the modeling effort are to 1) examine the impact of changes in invertebrate prey fields on consumers of interest [sea otters and Barrow's goldeneye] as measured by a suite of behavioral and demographic performance metrics, 2) provide semi-quantitative simulation models to forecast consumer population outcomes/effects on consumer performance metrics, 3) identify data gaps, and 4) prioritize research to fill data gaps. After reviewing the available methods used to create conceptual models (Bayesian Belief Networks, EcoPath models and the methods used by Sethi & Hollmen 2015) we decided to employ goal-specific Bayesian Belief Network for the nearshore submodel as it provides a suitable modeling framework that allows for the use of a combination of quantitative information and expert opinion. We have collaborated with the nearshore group to define clear objectives, decide site-specific and population-level spatio-temporal boundaries, and determined the model structure. The sea otter model framework has been built, and scenarios of interest will be run based on PI input. A similar model for Barrow's goldeneye will be constructed. Based on this work, we plan to develop a manuscript that examines the influence of changes in the invertebrate prey in Alaska nearshore systems on the response of both generalist consumers (sea otter) and specialist consumers (Barrow's goldeneye).

Submodel 2: Ecological Linchpin with Forage Fish Abundance

The conceptual submodel examines linkages among environmental indices, forage fish prey, a suite of selected forage fish species, and higher trophic species populations. Abundance and temporal distributions of forage fish such as salmon, capelin, sand lance, and herring provide a key trophic element in the Gulf of Alaska (GOA); thus forage fish can provide unique insights into food web dependencies and future management considerations. We have completed a draft model which is ready for expert input. The working group of experts has been identified.

Submodel 3: Top-down Control with Humpback Whale Predation

The pelagic team explored movements and distribution of humpback whales in Prince William Sound, represented in a conceptual model. Current understanding about the processes affecting herring-whale dynamics in the Northern GOA was explored in a submodel exercise rating properties of linkages in a zooplankton-herring-whale submodel system, including assessment of the state of knowledge, the strength of ecological impact, and the state of management or research attention devoted to a given component. This model framework has been published in Sethi & Hollmen 2015. Conceptual modeling proved to be an effective and efficient tool for synthesizing information about ecological systems and a transparent system for prioritizing components for future attention. This effort highlighted uncertainties about the mechanisms of energy movement in zooplankton-herring-whale system, and the potential importance of long-term effects of ocean acidification.

Submodel 4: Bottom-up Control with Environmental Forcing on Plankton Populations

Since winter of 2013, several large masses of warm, nutrient poor water have formed off the Western coast of the United States and Canada, including in the GOA. Nicknamed "the Blob", this warm water has coincided with changes in environmental forcing and plankton communities and abundance which are critical to the survival of many larger predators. Understanding mechanisms of these bottom-up processes are key to predicting ecosystem changes. Thus we have combined the original intent of this submodel with the most current issues in the GOA. The bottom-up conceptual model continues to focus on plankton production and the various environmental conditions that are thought to act as drivers of primary and secondary production in the northern GOA, but will also explore potential effects of warmer ocean temperatures and associated environmental changes on primary production. The properties of system components, such as strength of interactions, spatio-temporal linkages, variability, and uncertainty will be quantitatively rated. We have produced draft models which are ready for expert evaluation.

In the first year of the program, we developed a parsimonious general conceptual model for the Northern GOA which visually linked components based on the knowledge and program PI expert opinion at that time. Visualizations categorized model elements into forcing factors, biophysical processes, and biophysical components. The spatial arrangement of elements indicated the spatial scale at which the model components operated, and linkages represented interactions in the conceptual model. Using expert input, we will re-evaluate and update the general model to demonstrate learning and highlight contributions by the Gulf Watch program during the first five years of the long-term monitoring program. The updated model will illustrate changes in the framework and strength of interactions within the ecosystem.

Deliverable/Milestone	Status
Objective 1. Continue development of conceptual models. *To be met by January 2016*	In Progress: We continue development of submodels in collaboration with GulfWatch PI groups.
Objective 2. Continue development of interactive/data visualization tools. *To be met by January 2016*	In Progress: We continue development of interactive/data visualization tools and plan to use the nearshore submodel as the template.
Objectives 3. Attend annual PI meetings and Alaska Marine Science Symposium. *To be met by November 2015 and January 2016*	Completed: Tuula Hollmen and Lisa Sztukowski attended both the PI meeting and Alaska Marine Science Symposium (AMSS). A poster focusing on development of submodels was presented at AMSS.
Objective 4: Prepare modeling progress update for annual report. *To be met by February 2016*	Enclosed. Please see text section above.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

A.

- The process of developing component submodels involves close internal coordination and collaboration within and among Gulf Watch program components nearshore (Sub-model 1), pelagic (Sub-models 2, 3), and environmental drivers (Sub-model 4).
- Submodels 2 and 3 focused on collaboration within Gulf Watch Alaska program and between Gulf Watch Alaska and Herring Research Program.

B. N/A
C. N/A

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

- Publication: Sethi, SA and Hollmen, TE. 2015. Conceptual Models for Marine and Freshwater Systems in Alaska: Flexible Tools for Research Planning, Prioritization and Communication + Supplementary Appendices (See Article Tools). Arctic 68(4): 422–434.
- Conference poster: Sztukowski, LA, Sethi, SA and Hollmen, TE. Mesoscale ecosystem processes in the Gulf of Alaska. Alaska Marine Science Symposium, Anchorage, Alaska January 2016

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

N/A.

11. Budget: *See,* Reporting Policy at III (C) (11).

Report attached. Report does not reflect all expenses incurred on the project; due to timing of invoicing with contracts which are in progress. The project start date was initially delayed due to delays in funding allocation.

12. Research highlights

- Published a novel framework for evaluating zooplankton-herring-whale trophic dynamics (Sethi & Hollmen 2015). Presented a poster describing mesoscale submodels at the Alaska Marine Science Symposium (Sztukowski, Sethi and Hollmen 2016).
- Constructed a Bayesian Belief Network model to explore scenarios of changes in nearshore prey base and impacts on higher tropic level consumers. This model framework is suitable for consideration of management approaches under different ecological conditions in the Gulf nearshore system.
- In response to emerging environmental conditions in the GOA ecosystem, incorporating current events and issues into structured models to forecast potential outcomes resulting from warmer ocean temperatures.

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-J

2. Project Title: *See,* Reporting Policy at III (C) (2).

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

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Russell R Hopcroft

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

Text www.gulfwatchalaska.org and ttps://www.sfos.uaf.edu/sewardline/

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

This project revolves around executing multidisciplinary oceanographic cruises along the Seward Line and in Prince William Sound (PWS) each May and September. The objectives that are met each cruise are:

1. Determine thermohaline, velocity, and nutrient structure of the Seward Line across the Gulf of Alaska shelf, and at stations throughout PWS
2. Determine phytoplankton biomass and size distribution (chlorophyll)
3. Determine the distribution and abundance of micro-zooplankton (starting in 2014)
4. Determine the distribution and abundance of meta-zooplankton
5. Opportunistically, determine rates of growth and egg production of selected key zooplankton species
6. Support determination of carbonate chemistry (i.e., ocean acidification)
7. Determine distribution and composition of seabirds (and marine mammals) along the Seward Line, PWS and Kenai coastline
8. Provide at-sea experience for graduate students within the University of Alaska

Deliverable/Milestone	Status
Execute May 2015 cruise	Completed
Execute September 2015 cruise	Completed
Attend Principal Investigator meeting and Alaska Marine Science Symposium to present results	Completed

The spring 2015 cruise was conducted during one of the largest warm-water anomalies observed in the North Pacific during the past 50 years. Above average temperatures extend deep into the water column. Within the upper-100m temperatures averaged 1.06°C above the long-term May mean making in the warmest may in the 19 year time-series (panel A, Figure 1). By September the intensity of the anomaly had declined, and averaged 0.50° above the long-term mean (Panel B, Figure 1).

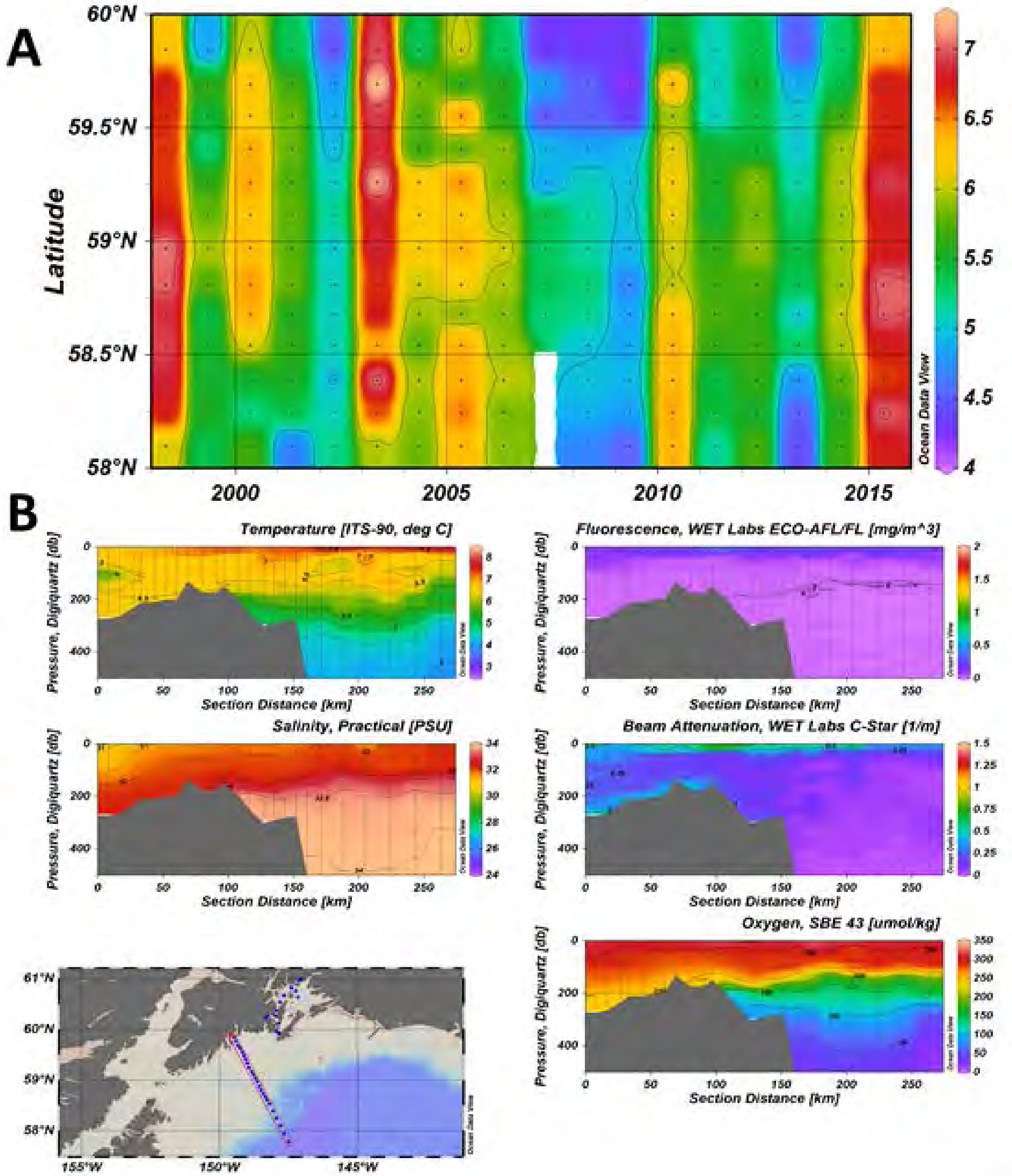

Figure 1. Seward Line May temperature time-series (average of upper 100m) and the detailed May 2015 section. Panel A shows temperature averaged for the first 100 m depth across the Seward line (location on y-axis) by year (x-axis). Panel B illustrates September physical ocean conditions across the Seward line section (x-axis) at depth (y-axis).

Although the zooplankton community was generally typical for the May cruise, it was notable that the southern (i.e., California Current) copepod *Calanus pacificus* was detected in extremely low numbers (Figure 2)

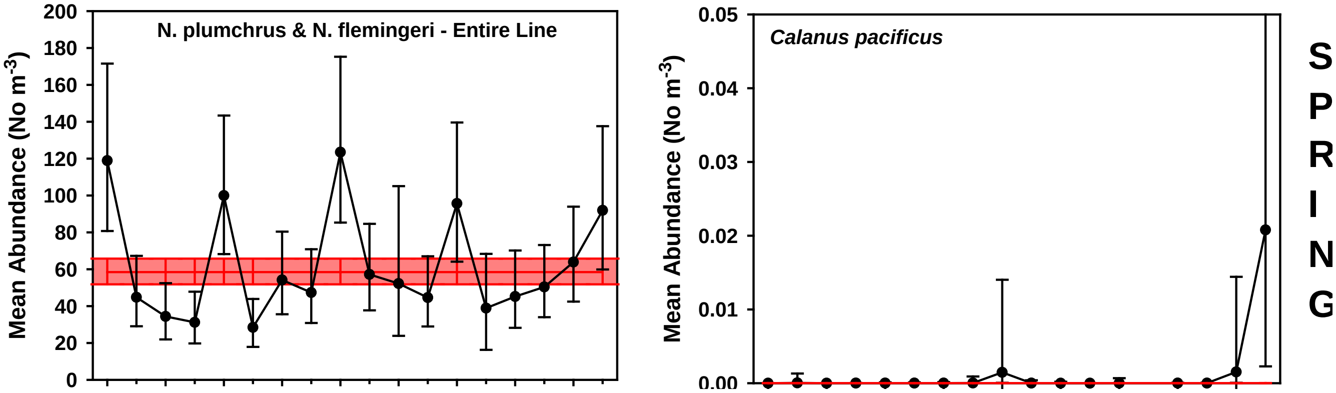

Figure 2. Spring species abundances for key copepod species: C. pacificus and N. plumchrus over time.

In September significant numbers of *C. pacificus* and other southern copepods were present along the Seward Line. Although their abundances were low compared to the entire copepod community, they were among the highest observed over the 19 years of observations along the Seward Line (Figure 3).

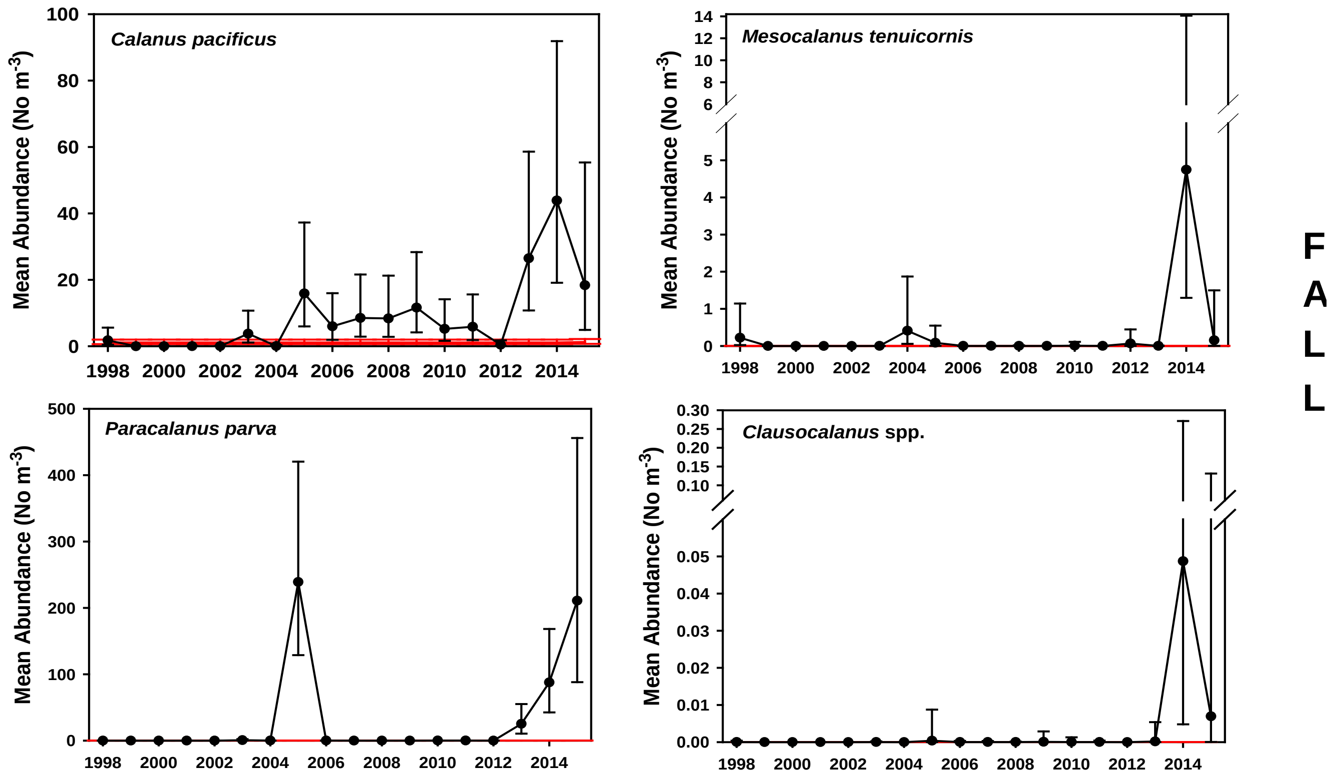

Figure 3. Abundances of key taxa from the Fall Sewardline survey through time.

In 2015, the Seward Line provided the logistical foundation for two National Science Foundation projects, one focused on transciptomics of diapause for the copepod *Neocalanus flemingeri* and one examining vertical flux on the Gulf of Alaska Shelf.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

- Hopcroft interacts with other PIs within Environmental drivers component of this program on a regular basis, and is the component team lead.
- Hopcroft servers on the Gulf Watch Science Coordinating Committee
- Hopcroft is involved in other major activities in the Gulf of Alaska funded by the North Pacific Research Board and the National Oceanographic and Atmospheric Association

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

- 2014 datasets delivered to the Oceans workspace, 2015 draft conductivity, temperature, and depth data placed on the Oceans workspace immediately after each cruise
- Presentations related to the Seward Line were made at the Alaska Marine Science Symposium
- Several publication arising from Seward Line sampling are in review or in press for a special issue on the Gulf of Alaska

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

There were no recommendations for this project.

11. Budget: *See,* Reporting Policy at III (C) (11).

See budget form in program work book. Over-runs in Contractual Services are largely associated with costs to load and unload the winch from the *Tiglax* now that Seward Marine Center can no longer provide this service. Overall costs for nutrient analysis have also increased.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$10.0	$14.4	$19.2	$20.1	$21.0	$84.7	$30.8
Travel	$5.7	$5.7	$5.7	$5.7	$5.7	$28.5	$11.6
Contractual	$38.4	$40.2	$42.0	$29.2	$30.6	$180.4	$115.6
Commodities	$4.0	$4.0	$0.0	$0.0	$0.0	$8.0	$4.7
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	$18.1	$20.0	$20.8	$17.1	$17.8	$93.8	$53.6
SUBTOTAL	$76.2	$84.3	$87.7	$72.1	$75.1	$395.4	$216.4
General Administration (9% of subtotal)	$6.9	$7.6	$7.9	$6.5	$6.8	$35.6	$19.5
PROJECT TOTAL	$83.1	$91.9	$95.6	$78.6	$81.9	$431.0	$235.8
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In our original 5-year proposal, the conceptual ecological modeling project was envisioned to be carried out in years 2-5 with support from a part time postdoctoral researcher. The proposed plan was later revised to allow recruitment of a full time postdoctoral researcher during years 4-5 of the program. As a result, the majority of modeling work was planned for the final 2 years of the 5 year program. The revised work plan to focus modeling efforts on years 4-5 was based on three factors: funding to support a full time postdoctoral researcher was not available until year 4 of the program, we believe that a full time postdoctoral researcher position provided efficiency of work effort, and results from years 1-3 of GWA program could be best utilized in modeling efforts during years 4-5. The revised staffing plan was described in FY 14 in response to comments received and in annual work plans since then. Funding was pulled from the project for year 5 by the council and the work to complete products with which sufficient funding exists, is under way. This budget report does not reflect all expenses incurred on the project in year 4 due to timing of invoicing with contracts which are in progress. The project start date was initially delayed due to delays in funding allocation.

FY12-16

Program Title: 15120114-I Conceptual Modeling
Team Leader: Tuula Hollmen

SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120120

2. Project Title: *See,* Reporting Policy at III (C) (2).

Collaborative Data Management and Holistic Synthesis of Impacts and Recovery Status Associated with the Exxon Valdez Oil Spill

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Matthew B. Jones

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Data collection, collation, and assembly for synthesis continued, and closely targeted questions and topics the working groups are studying. Some fisheries independent data was collated, but other requests are still outstanding. Research topics are in different phases; however, data cleaning and preliminary analyses are on-going.

Historical data archiving: Initial efforts to archive historical Gulf Watch Alaska (GWA) program data returned 27% of known data sets; therefore this project was re-invigorated in December 2015. Four student interns have been hired to assist in this effort, and in December we started a new process to prioritize and identify mechanisms to obtain important historical data sets. Couture has identified management team liaisons from each of the major agencies that still hold historical data, including Alaska Department of Fish and Game (ADF&G), National Oceanic and Atmospheric Administration (NOAA), University of Alaska Fairbanks, U.S. Geological Survey (USGS), and Prince William Sound Science Center (PWSSC). Discussions began at the 2015 Alaska Marine Science Symposium (AMSS) to include those managers in priority setting for data recovery, with the plan that the agency researchers will be more responsive when there is support for the activity from within their respective agencies.

A manuscript is in preparation documenting patterns in data recovery. Specifically, we are evaluating whether data type (e.g., oceanographic, fishery), collection agency (e.g., government, academic, non-governmental organization), and data age are correlated with likelihood of recovery.

Synthesis Working Groups: As planned in the previous year, both the Social-ecological Systems working group and the Portfolio Effects working group were convened in FY15, and each held two working group meetings at the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, California to further their synthesis goals. The two postdocs associated with these groups (Blake and Ward) also started just before FY15, and so their work is now synchronized and proceeding according to last year's revised plan. Both groups will hold two additional synthesis meetings in FY16, and complete submission of synthesis manuscripts this year. The budget for both the working groups and postdoc activities is being used in years 4 and 5 according to this revised plan. A summary of work from each group follows.

Social-ecological Systems (working group): This working group seeks to understand the relationships between social and ecological systems in the Gulf of Alaska, understand past changes in social-ecological systems, and develop linked social-ecological models to improve management and adaptation to change. The overarching goal is to develop an integrated social-ecological systems model, but the initial approach will build to this goal by examining four component research topics that were developed at the first group meeting in Santa Barbara in February 2015:

(i) Retrospective socio-ecological analysis will examine the historic impacts of the 1964 earthquake and the 1980 *Exxon Valdez* oil spill (EVOS) on social communities in the context of community resilience. Specifically, the group seeks to determine which factors affect the well-being and adaptive capacity of social communities affected by the earthquake and EVOS (Figure 1). A case study approach is being focused on six communities: Valdez, Cordova, Chenega, Tatilek, Kodiak, and Seward. Community profiles have been developed, and are currently under expert review. Community characteristics will be compared to assess what attributes may confer persistence.

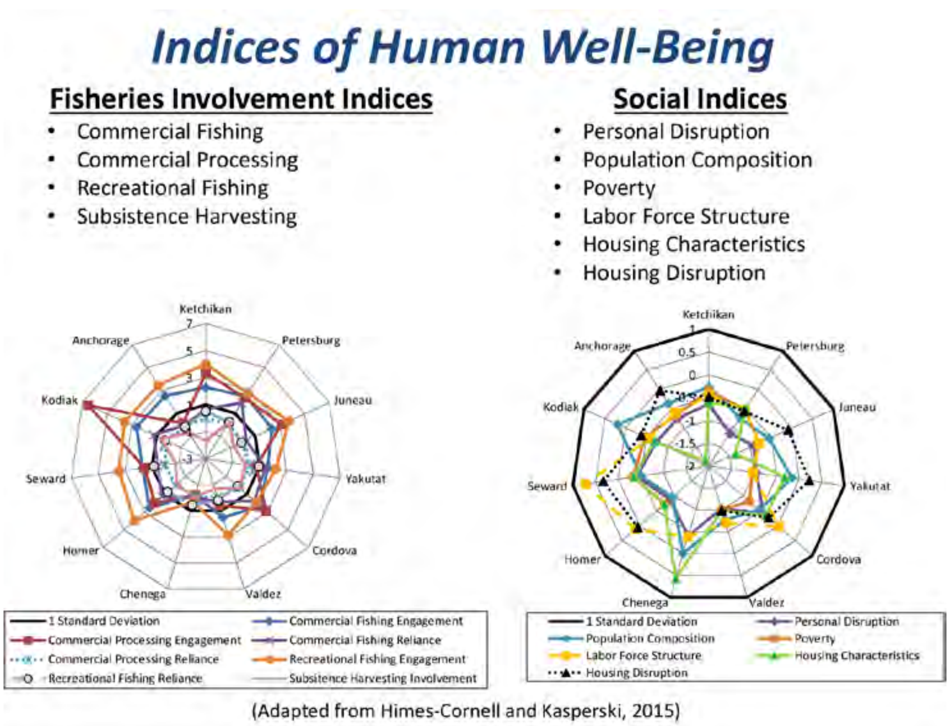

Figure 1: Indices of human well-being divided into social and fisheries related indices.

(ii) Human responses to ecosystem and management change are being evaluated. Research questions include: How do communities respond to changes at the environmental, ecological, and management levels? What community capital supports resilience (e.g., food and nutrition security)? What are the threats to this capital and implications of those threats to community resilience? Social and economic approaches are being used to answer these questions and look at indirect effects, for example, of changes in fisheries management policy on job and food security. Data collation and preliminary analysis are underway.

(iii) Biophysical drivers of ecological change are being examined at the large scale for the central Gulf of Alaska, and at the smaller scale for PWS for both pelagic and benthic ecosystems. The goals are to identify drivers of seasonal and interannual productivity and variability, characterize stressors on certain focal species/groups of species, and shed light on triggers of tipping points or regime shifts (Figure 2). Ecopath models, which will be used to examine pelagic ecosystems, are currently being re-parameterized as data become ready. Benthic ecosystems will use Structural Equation Models or other community metrics to examine relationships between biological and physical parameters. Approximately 30 unique data sets have been obtained, cleaned, collated, and assembled, and preliminary analyses have begun.

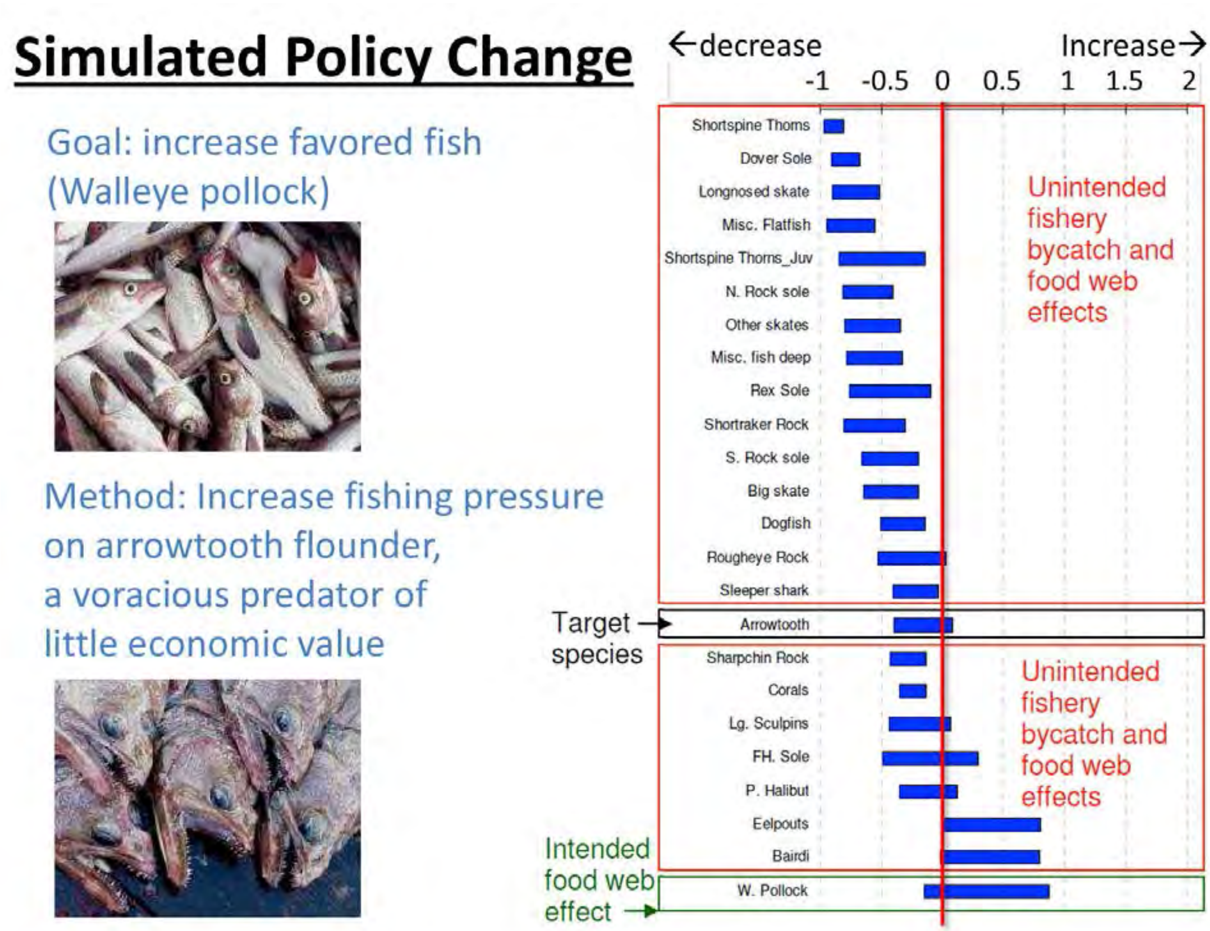

Figure 2: Simulation of policy change for a particular species, and wider unintended impacts in the foodweb. Adapted from Sarah Gaichas.

(iv) Finally, linking human and ecological indicators using model systems seeks to bring the social and biological data together (Figure 3). Specific research questions include: Can we identify linkages and feedbacks between ecological and human systems? Can we characterize how stressors acting on these connections affect human and ecosystem well-being and the strength of the social-ecological system? Can we identify frameworks and methodologies for linking human and ecological systems going forward? Current methods under consideration include Dynamic Factor Analysis, Random Forests, and Structural Equation Modeling. Another 30 unique data sets have been obtained from various sources including government agencies, state agencies, and academic research scientists. Data have been cleaned and unified (homogeneous column headings, uniform data and taxa codes etc.), georeferenced, and assembled into a large data set. Preliminary analyses are on-going and currently in the second phase, with plans for final analyses to start in the spring.

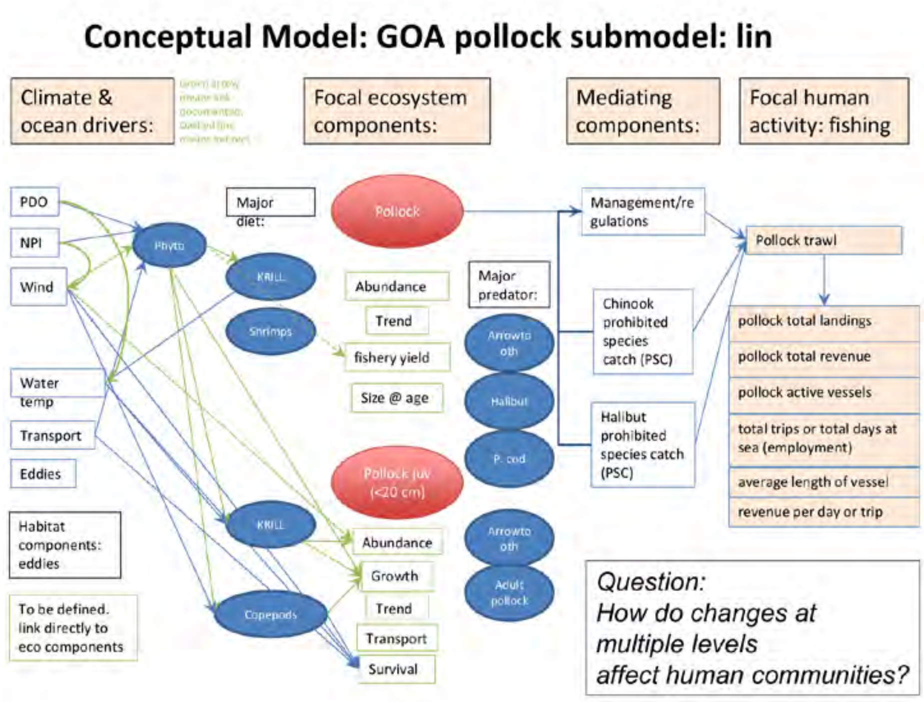

Figure 3: Conceptual model for pollock in the Gulf of Alaska (GOA), linking human activities to ecological components and climate drivers.

Applying Portfolio Effects to the Gulf of Alaska (working group): The overarching goal of this group's research is to assess the relationship between biodiversity and stability of ecological populations and communities, as well as harvest of marine species, in the Gulf of Alaska. This group has five research projects underway in various stages:

(i) Drivers of long-term herring and salmon population dynamics in coastal Alaska. Using data pre- and post-EVOS (Figure 4), this group applied time series methods to evaluate support for how herring and salmon recruitment has been affected by five hypothesized factors: (1) effects of density dependence, or decreasing population growth rate at increasing population density, (2) immediate and/or prolonged impacts of the EVOS event, (3) effects of interspecific competition on juvenile fish, (4) effects of predation from adult fish or other predators, and (5) impacts of changing environmental conditions. The resulting manuscript will be submitted to a journal by Spring 2016.

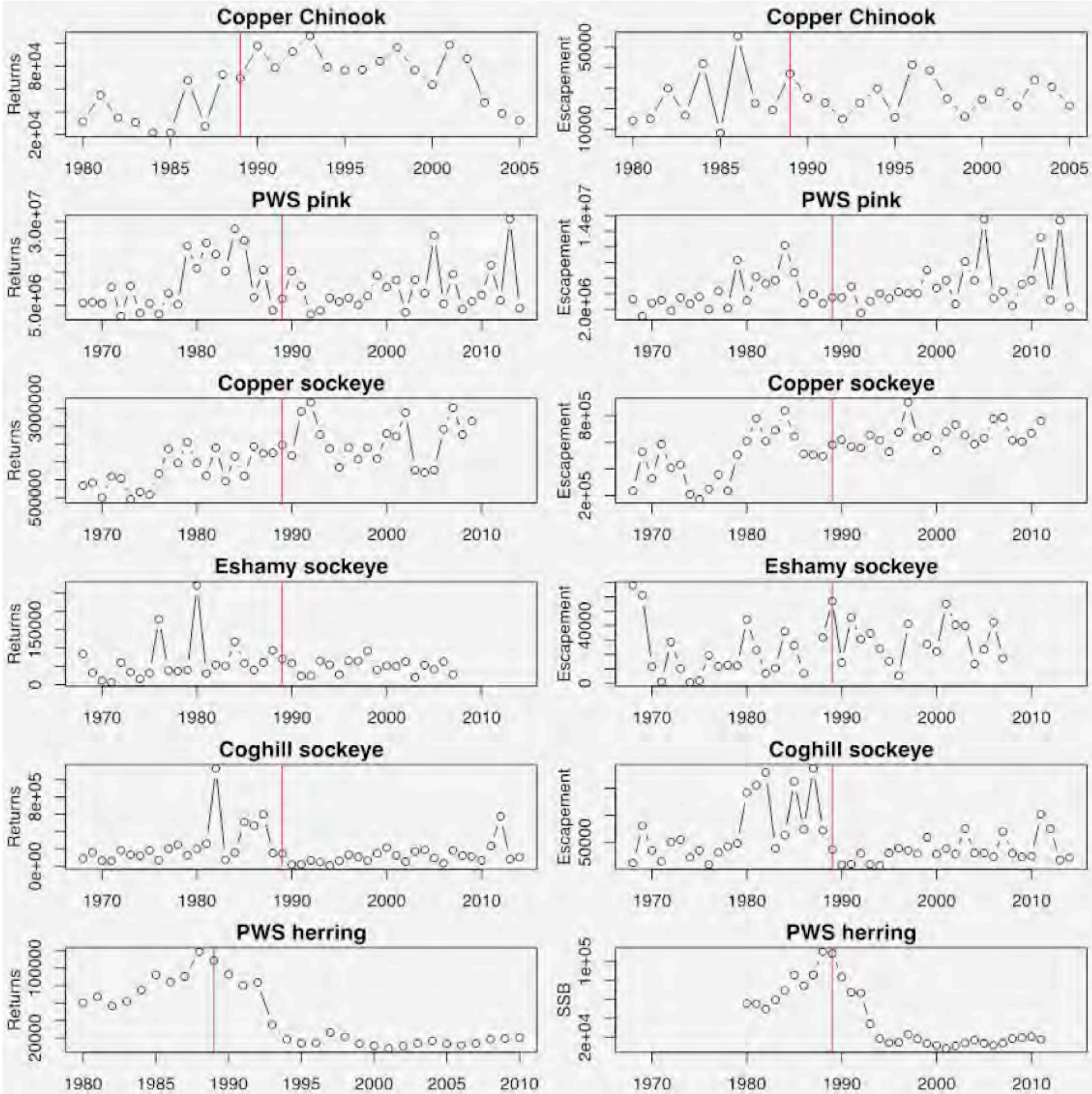

Figure 4. Time series plots of recruitment and spawning stock for herring and salmon in the PWS area. Red line indicates EVOS in 1989.

Assembly of key data sets is nearing completion and analyses are underway for several other projects:

(ii) Subsistence Harvest portfolios. This subgroup is evaluating whether subsistence harvest portfolios showed evidence of resource substitution following EVOS. Specifically, were oil-impacted species replaced with unimpacted species? The group is undertaking a literature review and is currently analyzing community subsistence data (resource use) collected by ADF&G Community Subsistence Information System database from eight coastal regions (Figure 5). Resource use is measured in terms of harvest level, species composition of harvest, and the number of people participating in subsistence activities. Preliminary results suggest that in oil-impacted communities (e.g., PWS; Figure 6) total harvest declined immediately following EVOS and showed some recovery within five years. The greatest decline was observed in the harvest of marine mammals and invertebrates, likely due to food safety concerns and declines in resource availability. There was no evidence of resource substitution, although the harvest portfolio shifted towards fish over time. Preliminary results also suggest that the most pronounced effects were observed in the PWS region; effects on adjacent regions were equivocal.

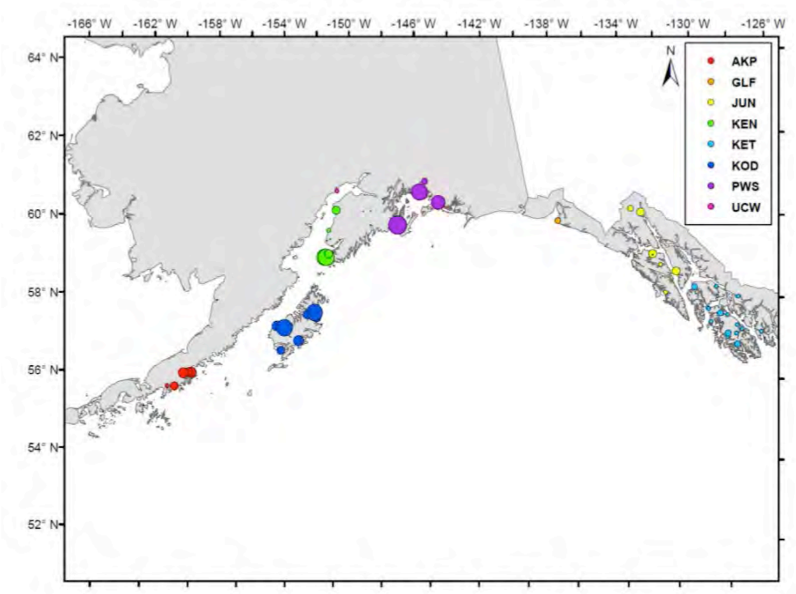

Figure 5. Coastal communities for which subsistence harvest data are being evaluated by the Subsistence Harvest subgroup.

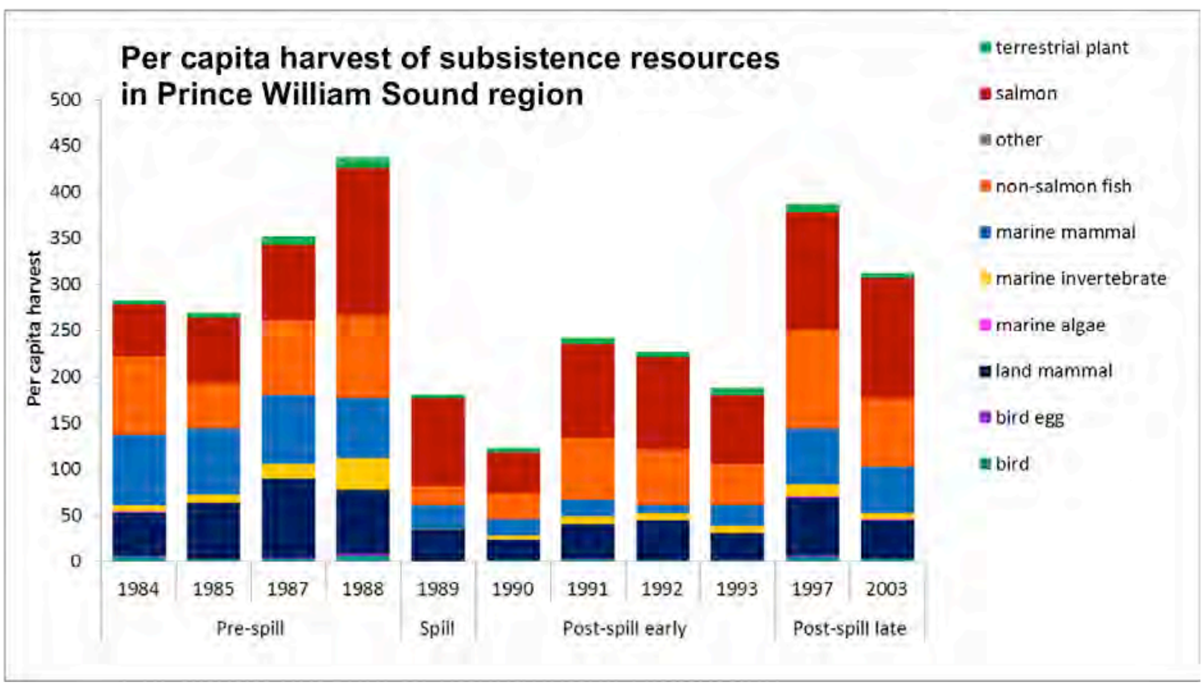

Figure 6. Per capita harvest of subsistence resources in the PWS region, 1984 - 2003.

(iii) Commercial Harvest portfolios. This subgroup is evaluating whether events such as climatic regime shifts and EVOS had detectable effects on the diversity and economic values of commercially harvested species, and whether diverse commercial portfolios buffered fishers against these events. Preliminary results suggest that diversity of species landed by the PWS commercial fishery increased following EVOS (Figure 7), that the value of commercial deliveries becomes less variable as the number of species harvested increases (Figure 8), and that the overall value of the harvest increases with number of species delivered.

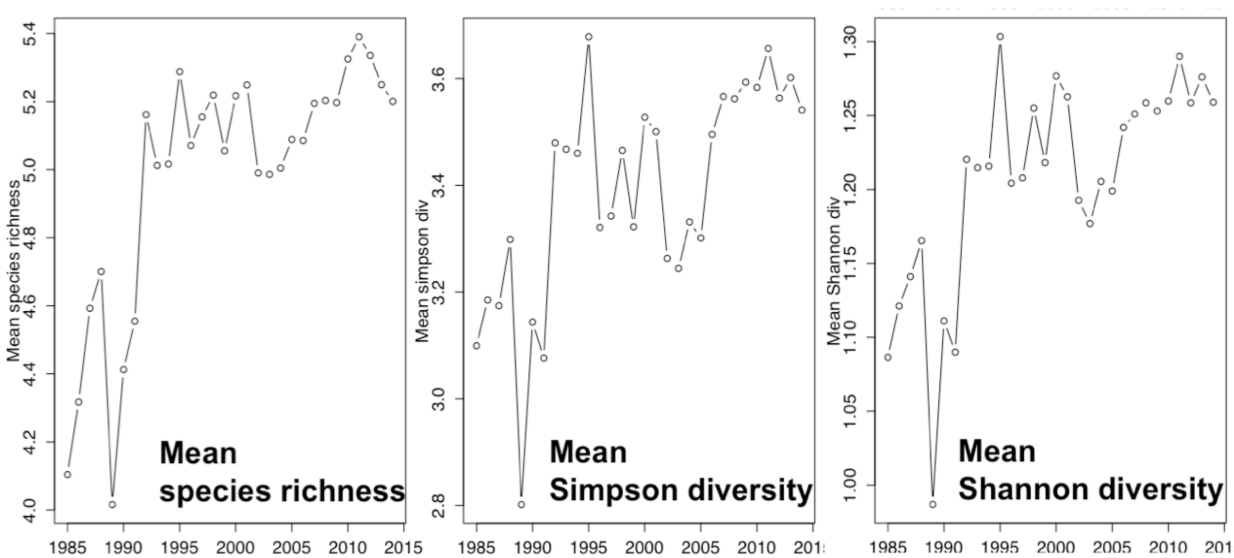

Figure 7. Diversity of species landed by the PWS commercial fishery (annual per vessel commercial deliveries), 1985-2015. Results should be considered preliminary.

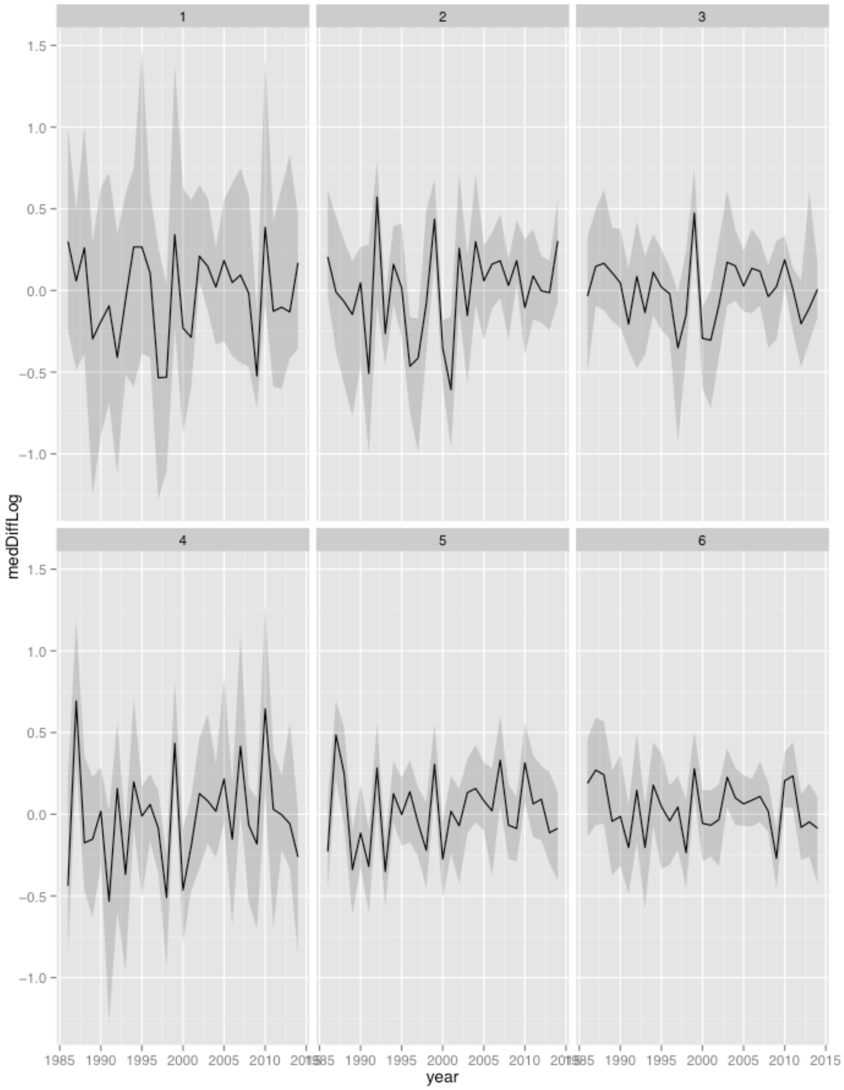

Figure 8. Log difference in earnings for individual vessels in PWS, log et+1 - log e_t (median and quartiles (25/75) across all vessels), 1985-2015. Panels represent the number of species fished in consecutive years (1 = more specialized, 6 = generalist). Results should be considered preliminary.

(iv) Ichthyoplankton. This subgroup is assessing long-term trends in diversity, individual species abundances and occurrences, and synchrony thereof in the spring ichthyoplankton community southwest of Shelikof Strait, using data from NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations (EcoFOCI) program collected annually since 1981. The group will also assess whether there was a detectable impact of EVOS and long-term climate indices in these metrics.

(v) Groundfish. This subgroup is evaluating spatio-temporal patterns in occurrence, catch per unit effort (CPUE), and diversity of Alaskan shelf groundfish assemblages. The group has used delta-generalized linear mixed models (delta-GLMM) to estimate occurrence and CPUE across space and time for 54 fish and three crab species representing the most commonly-occurring species in NOAA's bottom trawl survey (Figure 9). Using eleven discrete and roughly comparable areas (50-150m depth) with differing exposure to oil following EVOS (Figure 10), the group is assessing whether there occurred detectable changes in the spatial distribution of groundfish related to EVOS.

The group is also assessing whether responses to EVOS and long-term trends vary with life history characteristics and functional traits. Preliminary results suggest that species abundances were relatively synchronous over time in the eleven discrete areas (Figure 11).

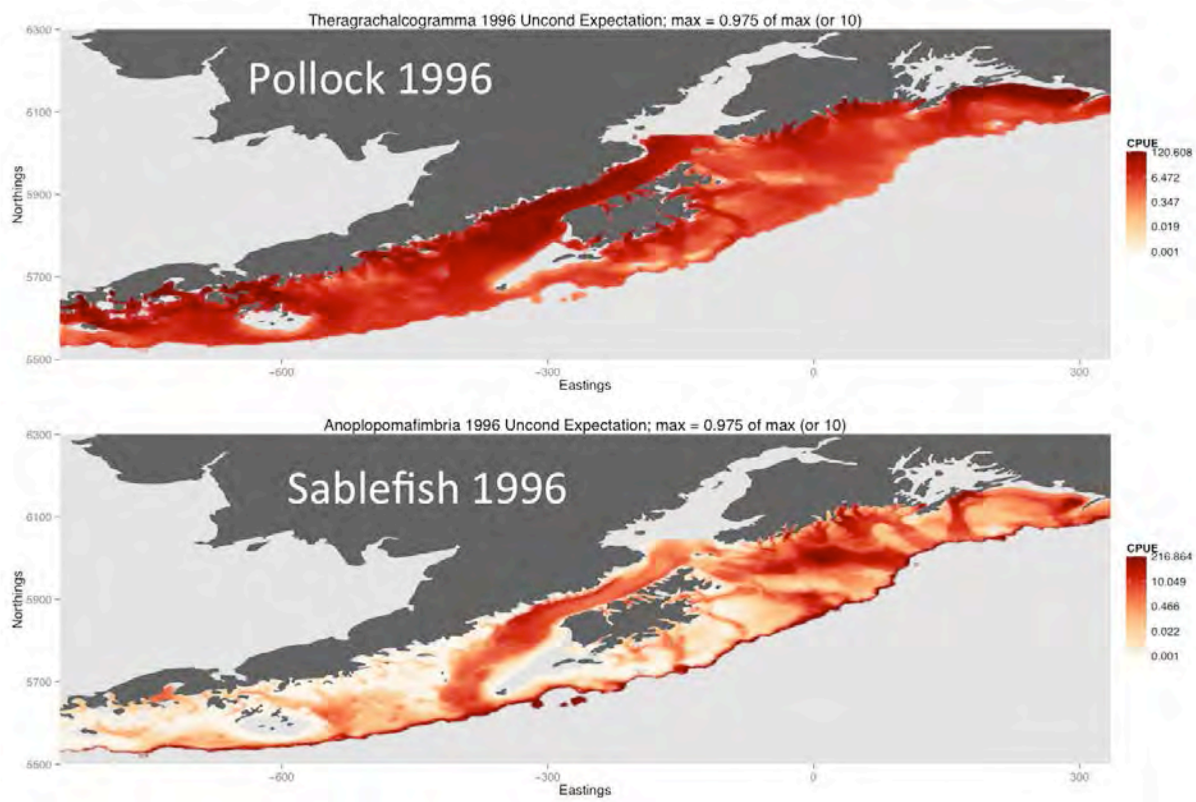

Figure 9. Example delta-GLMM output of 1996 CPUE for walleye pollock (*Theragra chalcogramma*) and sablefish (*Anoplopoma fimbria*).

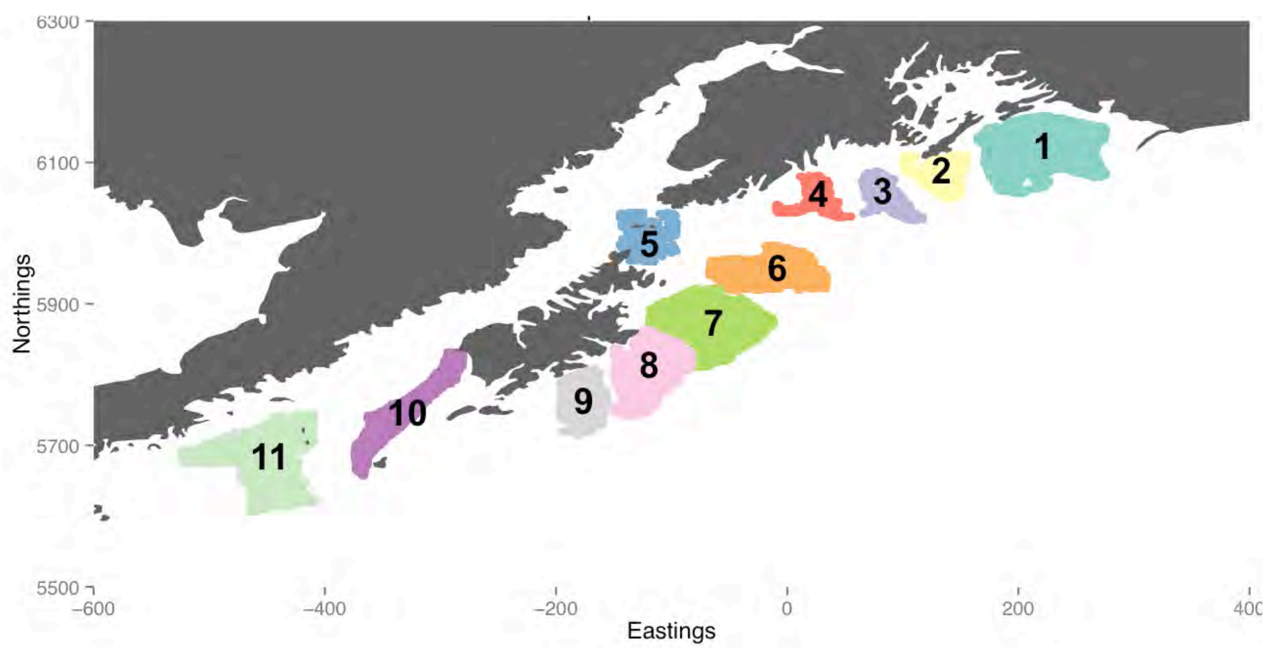

Figure 10. Map of eleven discrete regions with depth 50-150m, exposed to varying levels of oil following the EVOS event.

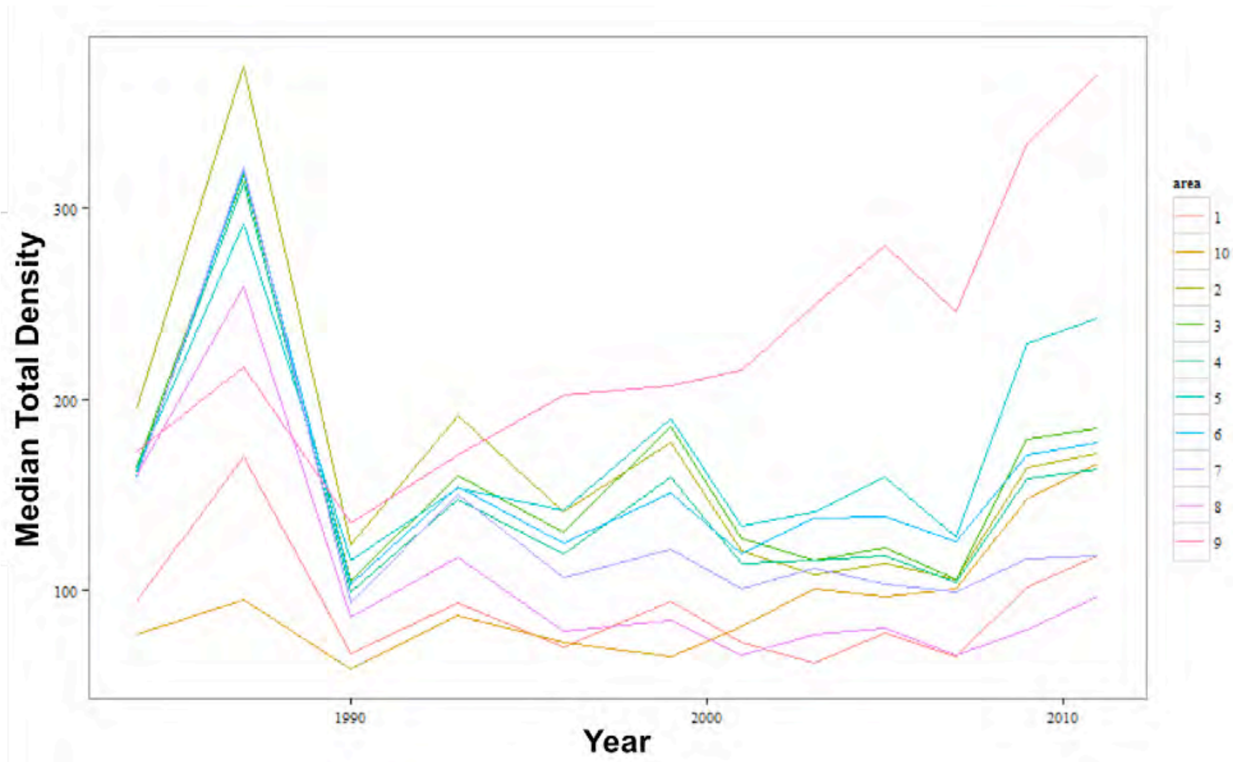

Figure 11. Median total density of groundfish species from delta-GLMM, 1984-2011; area numbers correspond to map in Figure 10. Results should be considered preliminary.

Rachael Blake (post-doc): In addition to facilitating working group projects, Blake's independent project is centered on understanding the relative importance and impacts of multiple stressors for nearshore ecological communities in the Gulf of Alaska. The largest effort this year has gone into finding a geographic area and ecosystem that has been sampled across many levels of biological organization in concordant time steps. The focal area is PWS because data on organisms from plankton to mammals have been collected historically and in on-going sampling efforts in nearshore habitats. So far, data for nearshore vertebrate predators, ducks, and invertebrates have been located and obtained. Data from the mid-1990s was obtained most recently and is still in raw form awaiting cleaning that will unify column names, standardize taxa codes, and georeference sampling locations. Data from the ongoing GWA program (http://www.gulfwatchalaska.org/) has generally been obtained (but still missing data for some taxonomic groups) and has been cleaned as above. Oceanographic and climate data have also been downloaded from NOAA websites. Together these data comprise about 30 unique data sets that have been cleaned, assembled, and collated in preparation for analysis. This effort was aided by working group members who work in PWS. The analysis approach is to use multivariate analyses to examine research questions such as: What are the impacts of extreme physical stressor events for the benthic infaunal community? How do biological and physical stressors interact? Does stressor relative importance and impact vary through time? Data cleaning is in the final stages, and preliminary analysis has started.

An additional project is on-going, examining the hurdles to conducting large-scale collaborative synthetic analyses. This work is a joint effort of the two post-docs (Blake and Ward), as well as data manager (Couture). We have hosted two roundtable discussions:

(http://roundtable.nceas.ucsb.edu/2015/07/01/july-7-discussion-about-hurdles-to-synthesis-and-navigating-collaborations-in-working-groups/ and http://roundtable.nceas.ucsb.edu/2016/01/05/synthetic-ecology-across-scales-a-follow-up-discussion-on-hurdles-to-synthesis/) with the NCEAS community to draw on the wider experience of research scientists and staff in facilitating scientific collaborations. We also presented a poster at the Coastal and Estuarine Research Federation meeting in Portland, Oregon in November 2015 titled Synthetic ecology across scales: a Gulf of Alaska case study in the session called "Estuarine and coastal data-centric synthesis studies: case studies and pathways for moving forward". We highlighted hurdles and solutions to hurdles for a case study analysis of zooplankton data in the Gulf of Alaska, and shared information about collaboration and synthetic analyses tools and technology.

Colette Ward (post-doc): The goal of Ward's project is to assess how the Gulf of Alaska and PWS food webs have changed as a whole since the early 1980s. This work will (i) identify patterns of energy flow (e.g., what are the primary pathways of energy flow, what is the relative importance of benthic and pelagic pathways, and do these show evidence of spatial and temporal patterning?), and evaluate (ii) how natural and anthropogenic phenomena (e.g., atmospheric forcing, climate change, EVOS, commercial harvest) have influenced these patterns, and (iii) how these patterns shape food web structure and function (e.g., trophic control, topological patterns of biomass accumulation, ecosystem stability).

Because this work relies on the availability of time series at all levels of the food web, work in 2015 focused on identifying locations in the Gulf of Alaska that have been sampled across as many trophic levels and years (in the same season) as possible, particularly the five years preceding and following EVOS. Several large multi species data sets encompassing trophic levels from plankton through fish predators have been processed (including sorting, aggregation, and adding higher-order taxonomic information), each yielding 10 - 40 unique time series. Data collection, collation, and cleaning are nearing completion and preliminary analyses are underway.

Resultant data sets are contributing to analyses of several working group projects described above. Ward is also involved in collaborations with R. Blake and J. Couture (described above) and with data collection, collation, and analyses for several working group projects.

Deliverable/Milestone	Status
Assess year 3 data sets and metadata submitted through AOOS	February 2015; Completed; missing data sets have been identified, and contact initiated to obtain additional data.
Submit input for five-year plan for FY17-22	August 2015; Completed (not participating)
Participate in LTM program PI meeting	November 2015; Completed
Create synopsis of FY15 synthesis WG meetings, draft and submit publications	December 2015; Synopsis completed (inline); data collation, analysis, and modeling in progress on synthesis working groups and are on-track under the revised time plan (in which working groups operate in FY15 and FY16).

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

a. Coordination within and between Council funded programs

This project continues to be highly collaborative within GWA and between programs. The continued management and addition of data are done in coordination with Alaska Ocean Observing System (AOOS) and Axiom Consulting, along with the GWA investigators. Historical data collation is ongoing. Additionally, data from syntheses are shared on the AOOS data platforms and include data from various synthesis projects.

Both NCEAS working groups include members from the GWA and/or Herring Research and Monitoring (HRM) programs as well as various local and governmental agencies: ADF&G, NOAA Alaska Fisheries Science Center, and USGS.

b. Coordination with other Council funded projects

Data collation activities continue to engage various historical *Exxon Valdez* Oil Spill Trustee Council- (EVOSTC)-funded projects as well as external agencies. FY16 will see a final major push to obtain historical data from these projects, and all of this data will be deposited in the AOOS data platforms.

c. Coordination with management agencies and Trustees

None during this reporting period.

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

In addition to continued data maintenance and sharing through the historic EVOS data site, this year's data and progress were shared at conferences, meetings and through the internal GWA program Oceans Workspace. Data syntheses and visualizations were presented at synthesis meetings throughout the year as well the GWA annual meeting in Anchorage. Combined data sets and spatial and temporal representations of data available are also shared with the GWA and HRM programs through the Oceans Workspace as well as the historical data portal. In addition, we are continuing work to collate data for the two NCEAS synthesis groups, with a major effort on collating fisheries independent data from large regions of the Gulf of Alaska from the ADF&G.

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

None needed.

11. Budget: *See*, Reporting Policy at III (C) (11).

Please see provided program work book.

The projected budget allocation for 2016 is as originally budgeted, with some changes in personnel details. Some expenditures for 2015 were delayed because, as expected, the synthesis working groups and synthesis postdocs were selected during 2014 but did not start activities until January, 2015. Both synthesis working groups and postdocs are actively meeting and plan their final meetings and activities in FY16. Thus, we expect to rollover these expenses so that the postdocs and working groups will take place in years 4 and 5 (rather than years 3 and 4 as originally planned). We still have not been utilizing the software engineering funds after our initial work on provenance was completed as we need a more effective plan to integrate with AOOS and Axiom infrastructure. During the mid-year plan work plan, we requested a re-budget to reallocate some of these funds to the continued effort of data collation. These retargeted salary funds are being used to fund the project data manager and students to do data entry, collation, and preservation work for historical EVOSTC project data. A small amount of funding remains for the software engineer to support

Axiom in FY16 to enable the AOOS systems to fully interoperate with DataONE, which will allow the historical data portal and the Gulf of Alaska Data Portal to be merged. We plan to expend the remaining software engineering funds in year 5 after another discussion with Axiom about how to best continue to collaborate.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$294.2	$329.1	$148.6	$153.7	$41.5	$967.1	$724.3
Travel	$2.8	$2.8	$121.0	$121.0	$2.8	$250.3	$13.9
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Supplies	$6.5	$6.5	$1.4	$1.4	$9.5	$25.3	$87.3
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (will vary by proposer)	$78.9	$88.0	$70.5	$71.8	$14.0	$323.1	$200.0
SUBTOTAL	$382.4	$426.3	$341.4	$347.9	$67.8	$1,565.8	$1,025.6
General Administration (9% of subtotal)	$34.4	$38.4	$30.7	$31.3	$6.1	$140.9	$92.3
PROJECT TOTAL	$416.8	$464.7	$372.1	$379.2	$73.9	$1,706.7	$1,117.9
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	0

COMMENTS:

Cumulative spending is low because of the delay in start of working groups for synthesis and postdoctoral researchers. Both of these were originally budg

FY12-16

Program Title:12120120 Collaborative Data Management and Holistic Synthesis of Impacts and Recovery Status Associated with the Exxon Valdez Oil Spill
Team Leader:Matthew B. Jones

FORM 3A
NON-TRUSTEE AGENCY
SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See*, Reporting Policy at III (C) (1).

15120114-K

2. Project Title: *See*, Reporting Policy at III (C) (2).

Long-term Monitoring: Pelagic Monitoring Component - Continuing the Legacy: Prince William Sound Marine Bird Population Trends

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

Kathy Kuletz and Robb Kaler (David Irons, retired U.S. Fish and Wildlife Service [USFWS])

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

1 February 2015-31 January 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

This project had no field work scheduled in 2015. Progress was made on data analysis, data transfer, updating metadata, and summarizing of project results.

Deliverable/Milestone	Status
Gulf Watch PI annual meeting, AOOS office	Attended November 2015
Gulf Watch PI, AMSS meeting	Attended January 2016
PWS Marine Bird Survey synthesis report, 2012-2014	In progress, to be completed by June 2016
Historic data (1989-2010) submitted	Completed, November 2015

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

8A: Collaboration and coordination both within the pelagic program and between the two programs

- Kathy Kuletz and Robb Kaler have been participating in discussions and meeting on opportunities to integrate the pelagic components of the Long-Term Monitoring effort.

- Kathy Kuletz and Mary Ann Bishop (Prince William Sound [PWS] Science Center) continue to collaborate on marine bird and herring survey work in PWS.
- Collaboration within the pelagic program (forage fish, humpback whale, killer whale, and marine bird) and between the pelagic and herring programs will continue to discuss local areas where whales and seabirds have been determined to overlap in time and space.

8B: Collaboration and coordination with other EVOSTC funded projects

- Marine bird data from this study collected at the Naked Island group (Naked, Storey, & Peak islands) will be used to help evaluate the pigeon guillemot restoration effort.

8C: Coordination with trust agencies

- Kathy Kuletz completed forth season of marine bird and mammal survey in Lower Cook Inlet in cooperation with the National Oceanographic and Atmospheric Association and the Kachemak Bay Research Reserve. The survey contributes to the longer-term Gulf Watch Alaska monitoring program and provides information on the marine regions affected by the Exxon Valdez oil spill. The funding for this effort was obtained via an intra-agency agreement between Bureau of Ocean Energy Management and USFWS-Migratory Bird Management.
- Kathy Kuletz, with funding from the North Pacific Research Board (NPRB), to conducted marine bird and mammal surveys as part of the long-term monitoring program for the northern Gulf of Alaska (a.k.a. the 'Seward Line'), which is part of the multi-agency (University of Alaska Fairbanks, North Pacific Research Board, USFWS) program.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

- Following extensive clean-up and reformatting, the 1989-2012 PWS marine bird survey data were uploaded to the Ocean Workspace in November 2015.
- November 2015, Kathy Kuletz and Robb Kaler participated in Gulf Watch Alaska Principal Investigators Meeting.
- January 2016, Kathy Kuletz and Robb Kaler participated in Gulf Watch Alaska Principal Investigators Meeting.
- Robb Kaler is working with Stacey Buckelew to finalize metadata on the Ocean Workspace, and will be completed by end of February 2016.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

We are making the suggested edits as provided for our sampling protocol. A final revised protocol will be completed by March 2016.

11. Budget: *See,* Reporting Policy at III (C) (11).

Current expenditures are within planned budget. Please see provided program work book.

ATTACHMENT C *EVOSTC Annual Project Report Form*

1. Program Number: *See*, Reporting Policy at III (C) (1).

12120114-M

2. Project Title: *See*, Reporting Policy at III (C) (2).

Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

Craig O. Matkin

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

www.whalesalaska.org

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

February–April 2015. The current killer whale photographic reference catalogue was updated with 2014 field data. Matriline diagrams were updated to reflect changes in structure based on 2014 data. The updated catalogue was provided electronically to all tour boat operators and to the Kenai Fjords National Park. Work was continued on a journal publication titled "Shifting Hot Spots: Seasonal and pod-specific habitat use by resident killer whales in the Northern Gulf of Alaska." Collaborative work with Dr. David Herman/NOAA/NWFSC continued, examining long term trophic changes in resident killer diet. This work involved the analysis of stable isotope, lipid, and contaminant data from blubber biopsies taken over the past 20 years. Preparation for the 2015 field season also occurred during this period. Current databases were uploaded to the AOOS Ocean Workspace for Gulf Watch Alaska.

May-October 2015. A total of 75 days of fieldwork was performed during this period, with 60 days aboard the R.V. Natoa,and 15 days contributed by other vessels. We logged 54 total encounters with killer whales; 41 with residents, 2 with AT1 transients, 11 with Gulf of Alaska transients, and 1 with offshores. Survey tracklines (with or without whales present), totaled 4922 km and encounter tracklines (with whales present) totaled 1084km.

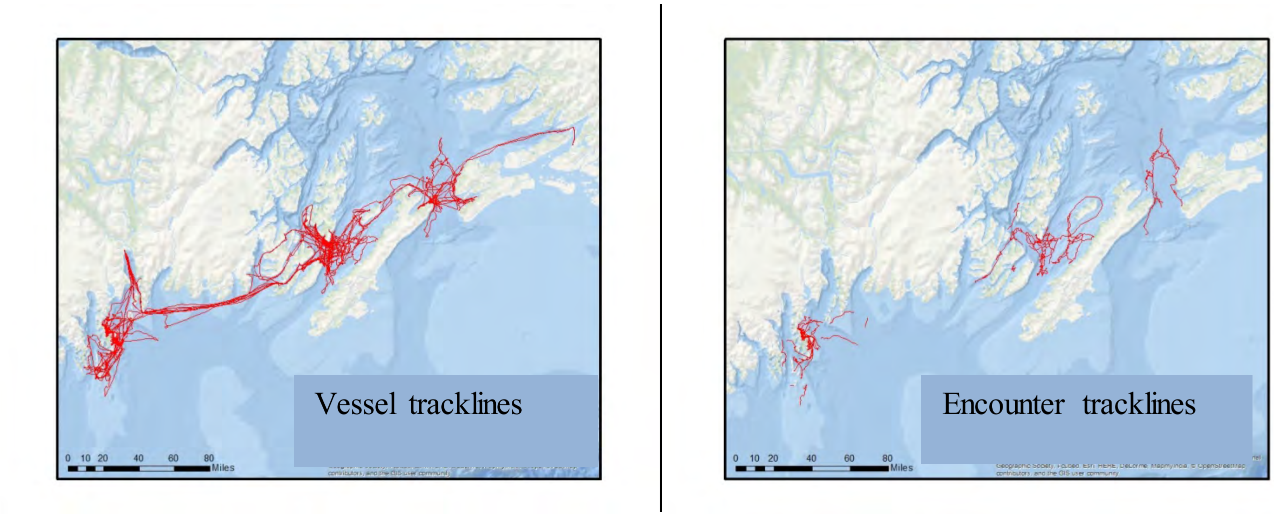

Figure 1. Vessel and encounter tracklines for sampling in 2015

We continued to emphasize photoidentification in this study year to complete our coverage of less frequently seen matrilines. During 2015 fieldwork we documented 264 resident killer whales in 17 pods, all of 7 remaining whales in the AT1 transient population, and 24 whales in the Gulf of Alaska transient population. As resident (fish eating) pods continued to grow, splitting of pods and some range changes have occurred. In the future, it will likely be necessary to examine population dynamics using resident matrilineal groups rather than pods. We improved our coverage of transient killer whales (both AT1 and GAT populations) in part by using contributed photographs from vessels of opportunity. We encountered Offshore ecotype killer whales once this year, as they are always encountered infrequently.

The AB pod was photographed completely this year. There were no new deaths and two new calves were recruited. AB80 is a second calf to AB54, and AB81 is the fourth calf to matriarch AB26. There may have been a late season calf to AB59 (which would be her first), but this could not be concluded from photos. The AB pod now numbers 21 individuals. For the first time in several years we were able to document all remaining seven individuals of the AT1 (Chugach) transients. This was possible because of cooperative effort with tourboats in Valdez Alaska that focus on glacial areas (e.g. Columbia glacier) and are able to provide sightings/photos of AT1 transients. The AT1 transients, which are the only transients we have observed that specialize in glacier fjord foraging, appear to have retreated from historic open water and rocky shoreline foraging area and in recent years appear focused on glacial foraging areas.

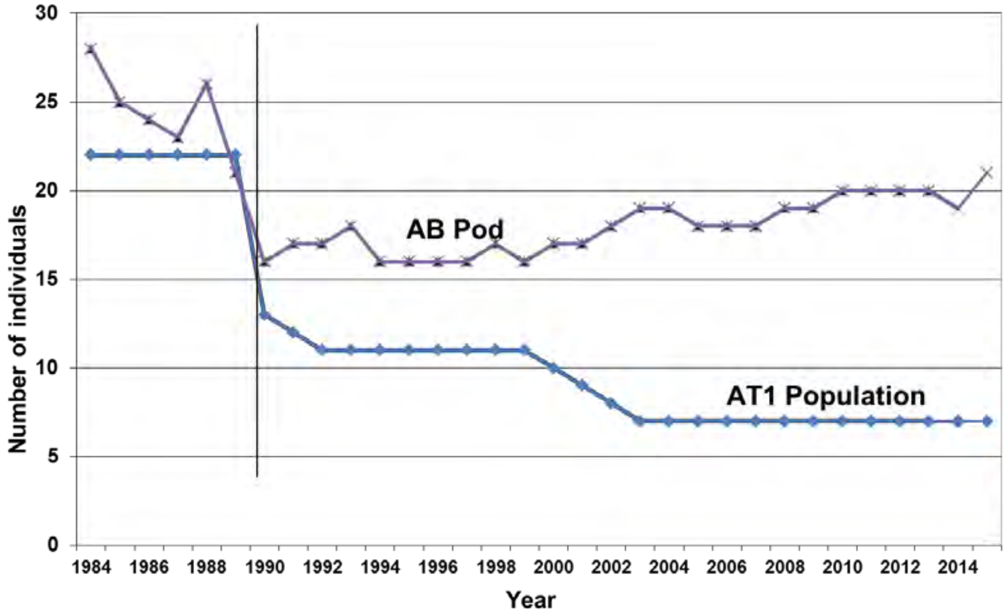

Figure 2. Number of whales in AB pod and AT1 population from 1984 to 2015

We collected 8 biopsy samples with temporal spacing in 2015 to examine seasonal and long-term changes in food habits, using stable isotope, lipid, and contaminant analysis. All samples were sequenced for mtDNA, and were analyzed for stable isotope ratios, lipids, fatty acids, and a suite of environmental contaminants. Analysis of 2014 samples was completed and results are held in a database at NOAA/NWFSC. The analysis over the past 12 years has revealed a long-term trend of declining C13 and N15 stable isotope values (Figure 3.) and contaminant levels (Figure 4.) that suggest a change in diet to lower trophic level. The typical reduction in contaminant (mainly PCBs and DDTs) values due to natural attrition is approximately 2%, yet in southern Alaska residents has been 8-10%. The concurrent decline of both stable isotope and contaminant values suggest a decrease in chinook salmon in diet and increase in coho and chum salmon, which may represent a reduction in Chinook availability.

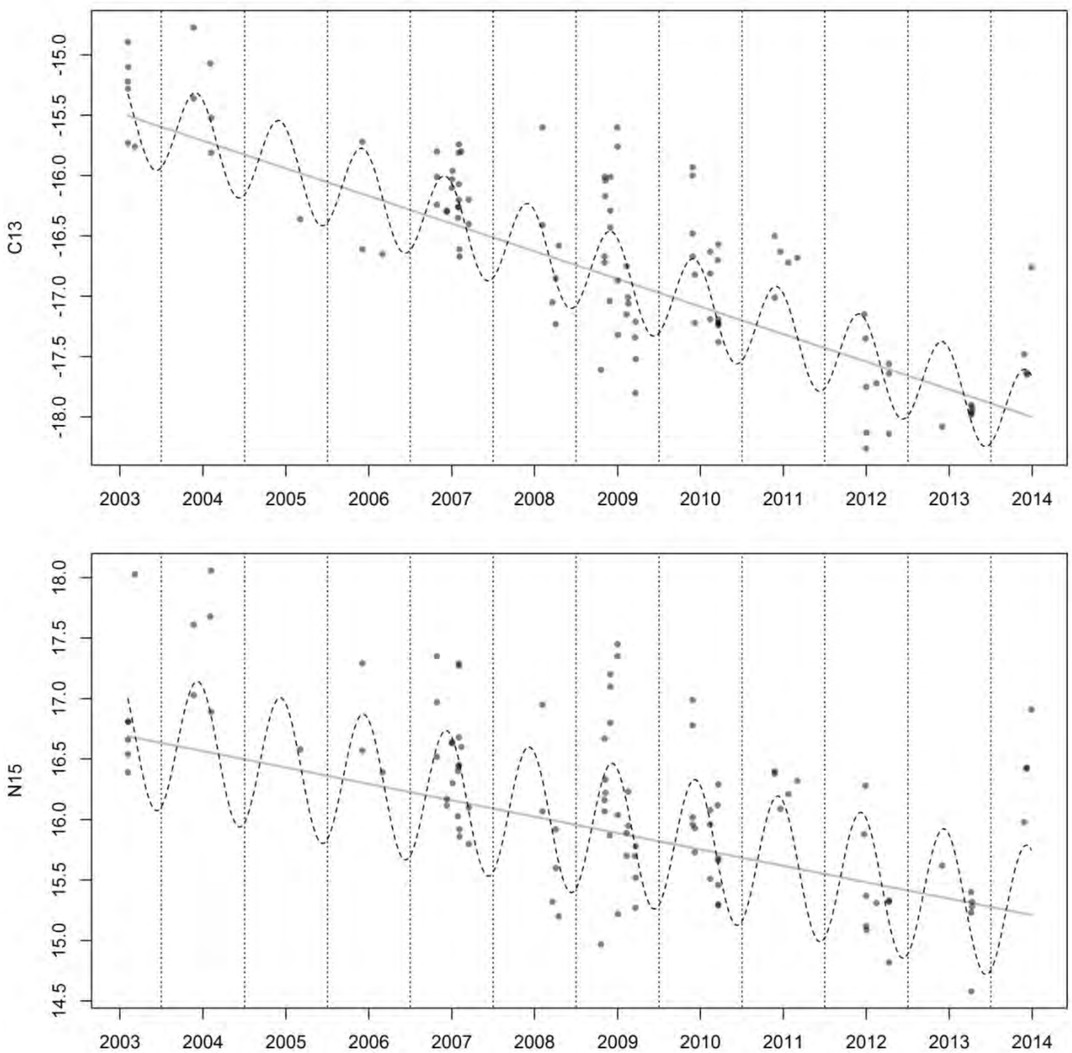

Figure 3. Changes in carbon and nitrogen stable isotope levels from skin biopsy samples of Southern Alaska resident killer whale (2003-2014). Dotted lines represent seasonal pattern of change within years.

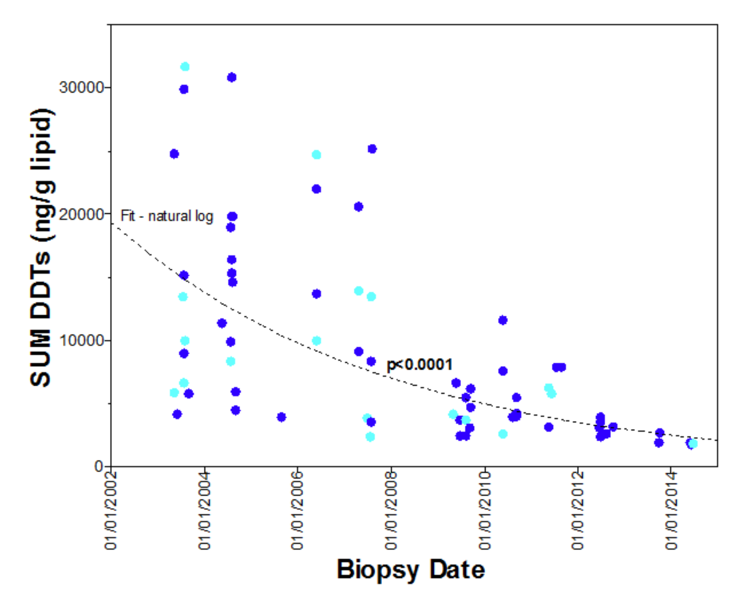

Figure 4. Decline in DDTs from skin biopsy samples of Southern Alaska resident killer whale (2002-2014).

These declines have not been as dramatic for the endanged Southern Resident killer whale population of Puget Sound for either C13 and N15 levels (Figure 5). The contaminant levels for the Southern Resident population declined closer to the 2% which is the expected natural attrition rate (Figure 6). This combination of factors suggests a relatively stable diet in the Puget Sound region over this period.

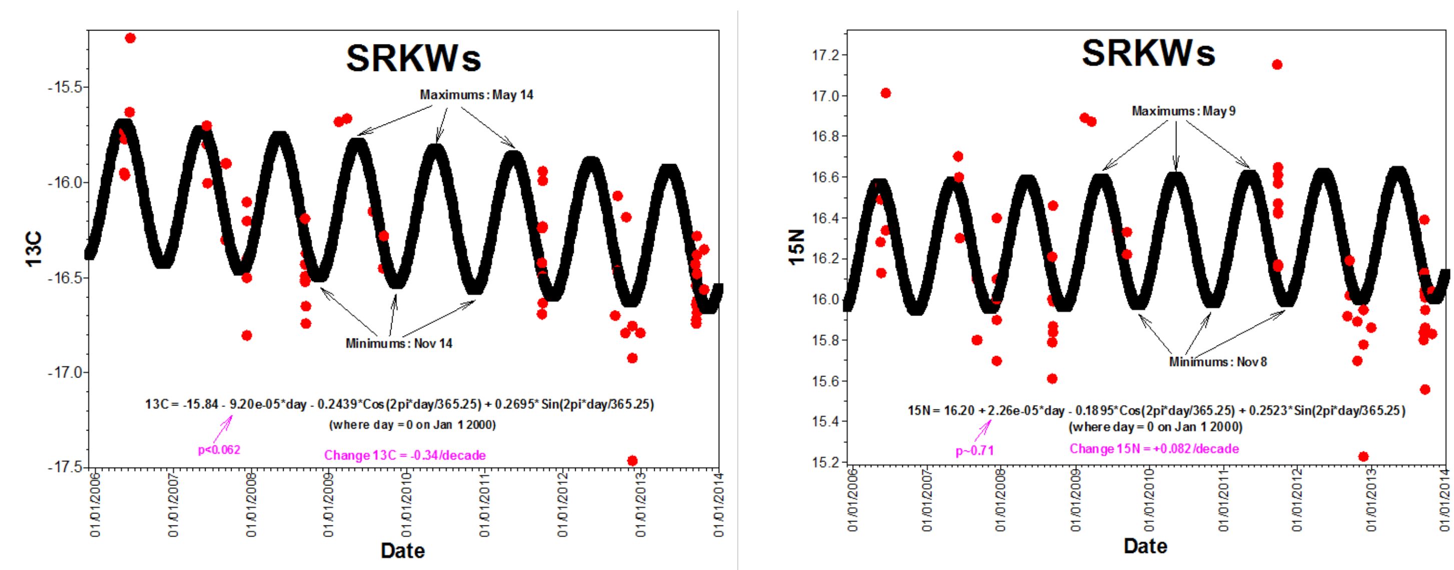

Figure 4. Changes in carbon and nitrogen stable isotope levels from skin biopsy samples of Southern resident killer whales (2006-2014). Dark lines represent seasonal pattern of change within years.

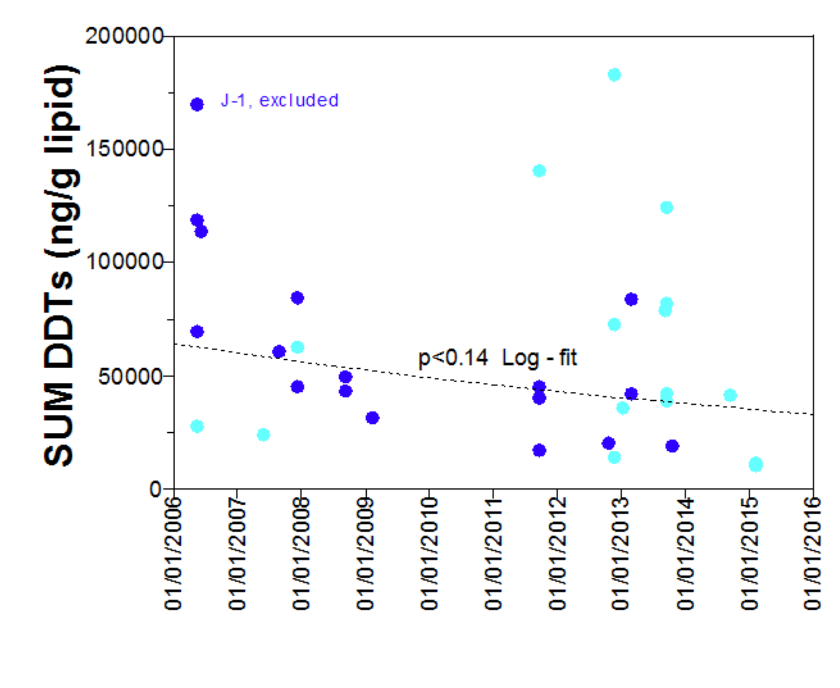

Figure 5. Changes in DDT levels from skin biopsy samples of Southern resident killer whales (2006-2014)

This year was exceptional for coho and chinook salmon abundance in Prince William Sound. By Fall, whales had noticeable fat deposits behind the blowhole and on the body behind the jaw. When nutritionally stressed, the reverse is often the case with a depression forming behind the blowhole ("peanut head" condition), and a narrow appearance in the area behind the jaws. The fat deposits were so noticeable that we termed it a "doughnut head" condition. In the future we hope to develop the use of overhead cameras in drones (hexacopters) to quantitatively determine body condition (morphometrics) and pregnancy rates. The downside of their fat condition in September was that whale aggregations in Montague Strait/Knight Island Passage lacked concerted feeding activity and their behavior was dominated by socializing and resting which eliminated focused feeding studies and resulted in no deployment of time/depth/location tags.

October 2015-January 2016. Field equipment was cleaned and stored. Preparation was made for the annual Gulf Watch meeting in November. Craig Matkin and Dan Olsen attended this meeting and presented updates on current projects. We updated numerous databases at NGOS with 2015 field data including survey and encounter database (ACCESS) and biopsy summaries. Analysis was completed (Dan Olsen) for preparation of a journal publication on habitat use and pod range, based on tagging location and encounter data. In October 2015, samples of tissue and scales were sent to NWFSC for analysis (described above). We supplied our humpback whale photo-identification and encounter data to Project 12120114-N (Humpback Whale Predation on Herring in Prince William Sound). Photo analysis of all 2015 data was completed during this period, which included identification of all individuals in each digital photograph for every encounter. Encounter tables were updated to summarize the presence of all individuals in each encounter

We followed our list of objectives as stated in the original proposal, although this year did not permit use of time/depth tags due to whale behavior in Fall (see above). With limited field time and the single vessel it was difficult to complete all aspects of the project, especially prey sampling during deep diving behavior, when focal follows are required due to infrequent prey samples at the surface.

Public outreach was enhanced through the updates of Facebook and the North Gulf Oceanic Society website. The Facebook page for the North Gulf Oceanic Society allows timely posting of events and more direct interaction than the website. It has become an extremely popular and effective way of engaging the public in our work with a reach of up to 20,000 people.

We are continuing to update our databases on the AOOS Ocean Workspace, through GulfWatch Alaska. These updates will be completed by May, 2016.

Table 1. Status of project milestones for year 2

Deliverable/Milestone	Status
Update of photographic catalogue, population database, mapping database, NWFSC tissue analysis	Completed May 1 (for 2014 data)
Field work: PhotoID, behavioral observations, biopsy, prey sampling, tagging.	07 May through 1 October 2015
Annual meeting Gulf Watch AMSS Poster	November 2015 January 2016

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

A. We collaborated closely with the Humpback Whale and Herring Predation project (Moran/Straley). Our field work in 2015 provided photographic and other data from 23 humpback whale encounters with humpback whales. We also received data from two killer whale encounters from their project. The Nearshore program (Dan Monson) opportunistically provides killer whale identification photographs to our project as well.

B. There was no coordination with other EVOS projects outside of the Gulf Watch program

C. We annually provide our data to the National Marine Fisheries Service/NMML (Paul Wade) to update the killer whale stock assessments for Alaska and we provide a review of current Alaska stock assessments, in part based on data collected in this project. Our genetic/contaminant/ and lipid and fatty acid data that spans two decades is held at the NOAA/NWFSC Contaminant Laboratory (Gina Ylitalo) where it has been used in various projects and publications. Genetic samples/ data generated by this project have also been provided to Southwest Fisheries Science Center (Phil Morin) for examination of worldwide killer whale stock structure.

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

Craig Matkin:

- Presentation/workshop at Alaska Zoo in Anchorage(AprilMatkin
- Presentation at Southern Resident killer whale health workshop in Seattle, WA (April)
- Collaborated on killer whale predation segment in Kenai Fjords for National Geographic film on salmon (May)
- Daily field updates on North Gulf Oceanic Society Facebook page with other research information regularly posted with some posts reaching up to 40,000 people (entire field season)
- Participation in Discovery Lab at Islands and Oceans, Homer, AK including lecture on killer whale populations in the Gulf of Alaska (July)
- Collaborated on killer whale predation segment in Kenai Fjords for National Geographic film on salmon (May)
- Meeting and presentation to Kenai Fjords Tour Boat Association (June)
- Worked with National Geographic Investigation Explorer Series to create web based film on lingering effects of the Exxon Valdez oil spill with focus on killer whales
- Data sets for 2014 field season on Gulf Watch site updated

Dan Olsen:

- Poster Presentation, SMM biennial Conference, December 13-18, 2015
- Poster Presentation, AMSS Conference, January 24-28, 2016
- "Killer whales of the world", Antarctic tourism trip, February 3, 2015
- "Seasonal and pod-specific variation in habitat use, AFS student conference, April 3, 2015
- "Killer Whales of Alaska", Seward Naturalist Guide Training, May 19, 2015
- "Recent research on Alaskan Killer Whales", ASLC Captain Training, May 22, 2015
- "Killer Whale natural history", Kenai Peninsula college Marine Mammals class, October 8, 2015

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

We have responded to all past comments and recommendations

11. Budget: *See*, Reporting Policy at III (C) (11).

Our budget and billing typically runs about 6 months behind the EVOS/Prince William Sound schedule because of our offset with fiscal year (the NGOS fiscal year ends June 1). This has been the case for many years and is the reason our cumulatives (see attached spread sheet) tend to run behind by approximately 6 months.

Attached budget form reflects the notification and acceptance of changes in annual budget category amounts and proposed changes the current fiscal year (FY2016). There was no change in total project budget for any year of the project. At this time there has not been more than 10% deviation in for projected budget category amounts.

12. Research highlights

- AB pod was completely photographed in 2015 and two new calves were recruited. The pod has increased to 21 whales but has not recovered to prespill numbers.
- All of the 7 remaining AT1 (Chugach transients) were photographed for the first time in several years. These whales appear to now focus their foraging in glacial fjords where we seldom operate so we have fewer encounters with them. However, we receive photos and sightings from tourboats that operate in these glacial areas.
- Photographic identification was emphasized in 2015 fieldwork, with which we documented 264 resident killer whales in 17 pods, the 7 remaining whales in the AT1 transient population, and 24 whales in the Gulf of Alaska transient population. This has substantially strengthened our population dynamics database.
- From blubber chemistry results, it appears that there has been a change in diet for resident killer whales over the past 15 years, with animals eating at a lower trophic level. The whales could likely switching from a diet dominated by chinook salmon, to a diet containing more coho and chum salmon.
- For resident (fish eating) killer whales this season presented exceptional feeding opportunities with a large return of coho salmon to inshore waters and significant king salmon activity. Whales appeared robust in late season with fat deposits behind the blowhole and jaws, indicative of good nutritive condition.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$100.0	$22.2	$100.0	$22.2	$100.0	$344.3	$176.6
Travel	$11.6	$0.0	$11.8	$0.0	$11.8	$35.3	$44.2
Contractual	$37.1	$0.0	$37.1	$0.0	$37.1	$111.3	$12.0
Commodities	$34.6	$0.0	$38.8	$0.0	$43.0	$116.3	$68.8
Equipment	$6.0	$0.0	$6.0	$0.0	$6.0	$18.0	$16.8
SUBTOTAL	$189.3	$22.2	$193.6	$22.2	$197.8	$625.2	$318.42
General Administration (9% of subtotal)	$17.0	$2.0	$17.4	$2.0	$17.8	$56.3	$28.7
PROJECT TOTAL	$206.3	$24.2	$211.1	$24.2	$215.7	$681.4	$347.08
Other Resources (Cost Share Funds)	$56.0	$22.0	$56.0	$22.0	$56.0	$212.0	$156.00

COMMENTS: In-kind contribution from USFWS includes $11K/year in salary for Irons and $33K/year in salary for Kuletz. Kuletz's in-kind contribution includes 1 month for PWS marine bird surveys, 1 month for the Lower Cook Inlet marine bird survey (in collaboration with Bureau of Ocean Energy Management) and 1 month for the Seward Line Project (in collaboration with the North Pacific Research Board and the University of Alaska Fairbanks). Our ACTUAL CUMULATIVE Total deviates over or under 10% for most budget catagories. Specifically, for Personnel, costs deviate outside of the 10% proposed budget because we have been fortunate to have several excellent volunteers return each survey year, which has reduced overall personnel costs. Travel and Contractual deviates > than 10% of the proposed budget because we have been unable to locate vendors willing to contract with the FWS resulting in payment for housing using government credit cards rather than contractual argreements. Commodoties are within 10% of the proposed budget. Equipment deviated >10% of the proposed budget owing to greater than expected maintance and repair of our survey fleet.

FY12-16

Program Title: 15120114-K Continuing the Legacy: Prince William Sound Marine Bird Population Trends.
Team Leader: Robert Kaler

FORM 4A
TRUSTEE AGENCY SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

*Please refer to the Reporting Policy for all reporting due dates and requirements.

1. Program Number: *See,* Reporting Policy at III (C) (1).

12120114-B

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long term monitoring: Program management component – Administration, Science Review Panel and PI Meeting Logistics, and Outreach and Community Involvement

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Molly McCammon, Alaska Ocean Observing System (AOOS) & Katrina Hoffman, Prince William Sound Science Center (PWSSC)

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015 – January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Program Coordination and Logistics

PWSSC issued and managed sub-award contracts for all non-Trustee Agency Long-term Monitoring (LTM) Year 4 projects. We remunerated sub-awardees based on demonstrated expenses, tracked spending, and initiated our annual audit in December 2015. We continued the contract with Marilyn Sigman (UAF) to support outreach programming and coordination. We provided outreach funding as directed by McCammon and the outreach steering committee. Semi-annual program reports (to NOAA) and the Year 5 *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) work plans that were submitted on time. We held two quarterly Principal Investigator (PI) meetings by phone; the other two were held in person at AMSS and at the annual PI meeting in Anchorage from November 16-18, 2015. PWSSC coordinated logistics and processed expenses for both of the aforementioned in-person meetings. The fall meeting was coordinated in collaboration with the EVOSTC-funded Herring Research and Monitoring program to enable cross-component and cross-program collaboration. We submitted all financial and project reports to NOAA and the EVOSTC as required.

The LTM Program Management Team, consisting of Molly McCammon, Kris Holderied, Katrina Hoffman and Tammy Neher, actively managed the program throughout the reporting year. The PMT met more than once per month, usually via teleconference. Towards the end of the project year and in anticipation of a new management team structure in the proposed FY17-21 proposal, we began including Mandy Lindeberg in PMT meetings. Katrina Hoffman and Molly McCammon presented program updates to the EVOS Trustee Council on November 12, 2015. As needed, PMT teleconferences included members of the LTM Science Coordinating Committee (Hopcroft; Weingartner; Ballachey; Lindeberg); data management team (Bochenek); and Science Review Team (Bachelder; Holland-Bartels; Klinger; Rice).

<u>Outreach and Community Involvement</u>

A GWA exhibit was installed at the Alaska SeaLife Center, using a design that will allow it to be made available as a traveling exhibit to other locations. The program's online presence was expanded through multiple modes. A virtual field trip featuring the science of each of the project components and the work of individual project scientists for middle school students is now online with instruction for middle school students. This virtual field trip features the four GWA program components, the results and the work and careers of a project scientist for each component, and lesson plans related to the scientific content and concepts. Additionally, films about the response of community members to the spill and stewardship of their local environment. PWSSC conducted three interviews with GWA project scientists, which will be produced and air as *Field No*tes programs in May 2016. GWA Project PIs provided multiple presentations to stakeholder, community, and school groups. The outreach activities of the PIs are compiled in the Information and Data Transfer section below.

Deliverable/Milestone	**Status**
Subaward contract management & monitoring of spending	Contracts issued to six organizations for nine subaward projects. All spending monitored.
Timely submission of narrative and financial reports	All reporting deadlines to EVOSTC and NOAA met in program year.
Conduct annual audit	Conducted at PWSSC in December 2015
Attend annual PAC meeting	Program management team members attended PAC meeting in September 2015
Administration of travel expenses for annual PI meeting	Fulfilled by PWSSC
Administration of expenses for activities directed by the Outreach and Community Involvement committee	Fulfilled by PWSSC
Conduct annual PI meeting	Coordinated and held in November 2015
Attend AMSS	Robust attendance by GWA PIs & PI meeting held
Implement citizen science	Evaluating potential

monitoring program	
Develop data visualizations for website	Website updates ongoing and visualizations and data accessible through Gulf of Alaska Data Portal.
Conduct Outreach & community involvement activities	Ongoing

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

Item 8A) The involvement of the outreach entities active in the GWA region as well as the Program Management Team and Herring Research and Monitoring (HRM) administrative lead ensures that these activities are well coordinated between and among the projects of the GWA Program and the HRM Program.

Item 8B) We do not directly coordinate outreach efforts with other EVOSTC funded projects, but we remain observant for possible synergies. Administration and logistics communicates with the EVOSTC funded HRM program about proposal and reporting requirements.

Item 8C) Trust agencies (NOAA, USFS and DOI) have staff who participate in outreach and community involvement and ensure that GWA activities are coordinated with other outreach activities conducted by their agencies. PWSSC regularly reports to and coordinates with Shawn Carey at NOAA in Juneau for grants management purposes.

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

- The science news magazine that PWSSC publishes annually, called *Delta Sound Connections*, again had a two-page Gulf Watch Alaska spread in the 2015-16 edition.
- When QA/QC has been completed, GWA data has been pushed to the Gulf of Alaska Data Portal at http://data.aoos.org/maps/search/gulf-of-alaska.php
- Program information and media continues to be available on the Internet at http://www.gulfwatchalaska.org/.

Outreach to public and K-12 audiences:

Bodkin, James. 2015. Gulf Watch Alaska and the nearshore food web. PWSSC, Cordova, AK. November, 2015. 14 participants.

Campbell, Robert. 2015. State of the Sound: Oceanography, surface layer dynamics, and plankton blooms in Prince William Sound. Presentations to the Prince William Sound Science Center (PWSSC) lecture series in Cordova (20 participants), PWSSC pub talk series in Cordova (30 participants), and Prince William Sound Regional Citizen's Advisory Council's Science Night event, Anchorage (70 participants).

Kloecker, Kim. Participant in AMSS Ocean Week- Scientist in the Classroom program. Participated in a 90-minute class at an Anchorage School District school in Eagle River. Made a presentation about major categories of human impacts on the ocean (pollution, marine debris, MPAs, etc.) highlighting areas of GWA monitoring and participated in a teaching activity about the effect of marine debris on wildlife. 80 sixth-graders participated.

Lindeberg, Mandy. Seaweeds, fishes, monitoring and more! PWSSC and Cordova Night Lecture Series. December 7, 2015. 18 participants.

Presentations at Scientific Conferences

PICES, 2015, Seattle, WA

Batten, Sonia. The effects of the anomalous warming on lower trophic levels in the NE Pacific, 2015. Annual PICES Meeting. https://pices.int/publications/presentations/PICES-2015/2015-S2/S2-1200-Batten.pdf.

2nd Annual Pacific Anomalies Workshop, January 2016, Seattle, WA

Batten, Sonia. The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling. Poster presentation.

Campbell, Rob. Effects of the 2013-2015 warm anomaly in Prince William Sound. Oral presentation.

Danielson, Seth, Tom Weingartner and Russell Hopcroft. 1970 to 2015 thermal and haline anomalies on the Northern Gulf of Alaska Continental Shelf. Oral presentation

Kris Holderied. Oceanographic and ecosystem response to the 2013-2015 Pacific warm anomaly in Kachemak Bay, Alaska. Oral presentation

Alaska Marine Science Symposium, January 2016, Anchorage, AK

Poster presentation abstracts available at http://www.nprb.org/assets/amss/images/uploads/files/2016_AMSS_Poster_Sessions.pdf
Oral presentation abstracts available at http://www.nprb.org/assets/amss/images/uploads/files/2016_AMSS_Speaker_Presentation_Abstracts.pdf

Batten, Sonia. The effects of the anomalous warming on lower trophic levels in the Gulf of Alaska from Continuous Plankton Recorder sampling. Oral presentation.

Bishop, Mary Anne, Kathy Kuletz, Jessica Stocking, and Anne Schaefer. Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, AK. Poster presentation.

Campbell, Robert. Surface layer and bloom dynamics in Prince William Sound. Oral presentation.

Coletti, Heather, Dan Esler, Brenda Ballachey, James Bodkin, Thomas Dean, George Esslinger, Katrin Iken, Kimberly Kloecker, Brenda Konar, Mandy Lindeberg, Daniel Monson and Benjamin Weitzman. Updates of key metrics from long-term monitoring of nearshore marine ecosystems in the Gulf of Alaska: Detecting change and understanding cause. Poster presentation.

Coletti, Heather, Grant Hilderbrand, Jim Pfeiffenberger, Carissa Turner, Brenda Ballachey, Liz Bowen, Kaiti Chritz, Katrina Counihan, Joy Erlerbach, Dan Esler, Tuula Hollman, Dave Gustine, Buck Mangipane, Benjamin Weitzman, Charlie Robbins and Tammy Wilson. Changing Tides – The convergence of intertidal invertebrates, bears and people. Poster presentation.

Danielson, Seth, Sonia Batten, Robert Campbell, Angie Doroff, Kris Holderied, Russ Hopcroft, Rick

Thoman and Tom Weingartner Gulf of Alaska 2015 Anomalous Conditions Workshop: Oceanography. Large Whale Unusual Mortality Event workshop, AMSS, January 24.

Doroff, AM, R.Campbell, C. McKinstry. 2016. Zooplankton Assemblages in Lower Cook Inlet and Kachemak Bay, 2012-2014. Poster presentation.

Fugate, Corey, Mandy Lindeberg, Mark Carls and Jacek Maselko, Recent survey confirms persistence of lingering oil 26 years after the *Exxon Valdez* Oil Spill. Poster presentation.

Hoem Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. Gulf Watch Alaska in hot water! Ecological patterns in the Northern Gulf of Alaska under the Pacific 2014-2015 warm anomaly. Oral presentation.

Kuletz, Kathy. Seabird die-off events, 2014-2016: A summary of events. Large Whale Unusual Mortality Event workshop, AMSS, January 24.

Lindeberg, Mandy, Mayumi Arimitsu, Mary Anne Bishop, Dan Cushing, Robb Kaler, Kathy Kuletz, Craig Matkin, John Moran, John Piatt, and Jan Straley. Response of top predators and prey to changes in the marine environment: Gulf of Alaska pelagic monitoring program. Poster presentation.

Moran, John and Jan Straley**.** Missing herring: Water temperature, relocation, or dinner? Poster presentation.

Olsen, Dan, Craig Matkin, and Russell Andrews. Shifting hot spots: Seasonal and pod-specific habitat use by resident killer whales in the Northern Gulf of Alaska. Poster presentation.

Pister, Benjamin, Brenda Ballachey, Heather Coletti, Thomas Dean, Katrin Iken, Brenda. Konar, Mandy Lindeberg and Benjamin Weitzman. Multi-agency efforts to monitor Sea Star Wasting Disease in Alaska: Results and recommendations for future efforts. Poster presentation.

Jan Straley and John Moran. Bird killers of Prince William Sound: A foraging strategy used by humpback whales to detect schooling fish. Poster presentation.

Taylor, Audrey, Mary Anne Bishop, Kristine Sowl, Anne Schaefer, and Luis Verissimo. Black turnstone: Evidence for a population decline or shifting migration patterns? Poster presentation.

Sztukowski, Lisa, Suresh Sethi and Tuula Hollmen. Mesoscale ecosystem processes in the Gulf of Alaska. Poster presentation.

Traiger, Sarah, Brenda Konar, Angela Doroff, and L. McCaslin. 2016. Sea otters versus sea stars as major clam predators: Evidence from foraging pits and shell litter. Poster presentation. Best student poster award from the North Pacific Research Board.

Other Presentations

Esler, Dan. Oil and wildlife don't mix: 25 years of lessons from the *Exxon Valdez* Oil Spill. Seminar at University of Quebec Rimouski, November 2015.

Esler, Dan, Brenda Ballachey, Craig Matkin, Dan Cushing, Robb Kaler, James Bodkin, Dave Monson, George Esslinger, and Kimberly Kloecker. 2016. Long-term data provide perspective on ecosystem recovery following the *Exxon Valdez* Oil Spill. Oil Spill and Ecosystems Conference, Tampa, February 2016.

Marcotte, E. and M. Lytle. 2015. Sea otter diet in Kachemak Bay 2015. In fulfillment of thesis research credits. University of Alaska, Kachemak Bay campus. (Results of research conducted by student interns mentored by Angela Doroff, Aug-Dec 2016)

Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. Gulf Watch Alaska in hot water! Ecological patterns in the Northern Gulf of Alaska under the Pacific 2014-2015 warm anomaly. Gulf of Mexico Research Initiative Oil Spills and Ecosystems conference, Tampa, FL. Oral presentation.

Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. Gulf Watch Alaska: Monitoring Ecological Patterns in the Northern Gulf of Alaska. Coastal Estuarine Research Federation conference, Portland, OR. Oral presentation.

Neher, Tammy, Molly McCammon, Katrina Hoffman, Kris Holderied, Brenda Ballachey, Russell Hopcroft, Mandy Lindeberg and Tom Weingartner. Gulf Watch Alaska: Monitoring Ecological Patterns in the Northern Gulf of Alaska. National American Fisheries Society Conference, Portland, OR. Poster presentation.

<u>Peer Reviewed Publications and Reports</u>:

Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and H.A. Coletti. 2015. Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Ballachey, B.E. and J.L. Bodkin. 2015. Challenges to sea otter recovery and conservation. Chapter 4 in Larson SE, Bodkin JL, VanBlaricom GR., Eds. Sea Otter Conservation. Academic Press, Boston. Pp 63-96.

Ballachey, B., J. Bodkin, H. Coletti, T. Dean, D. Esler, G. Esslinger, K. Iken, K. Kloecker, B. Konar, M. Lindeberg, D. Monson, M. Shephard, and B. Weitzman. 2015. Variability within nearshore ecosystems of the Gulf of Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Bodkin, J.L. 2015. Historic and Contemporary Status of Sea Otters in the North Pacific. Chapter 3 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 43-61.

Bowen, L., A. K. Miles, B. Ballachey, S. Waters and J. Bodkin. Gene transcript profiling in sea otters post-*Exxon Valdez* oil spill: A tool for marine ecosystem health assessment. In review, *J. Mar. Sci. Eng.*

Coletti, H.A. and T.L. Wilson. 2015. Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Coletti, H.A. and T.L. Wilson. 2015. Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 12120114-F), National Park Service, Anchorage, Alaska.

Coletti, H.A., J.L. Bodkin, D.H. Monson, B.E. Ballachey and T.A. Dean. In review. Engaging form and function to detect and infer cause of change in an Alaska marine ecosystem. Ecosphere.

Esler, D., and B.E. Ballachey. 2015. Long-term monitoring program - evaluating chronic exposure of harlequin ducks and sea otters to lingering Exxon Valdez oil in western Prince William Sound. Exxon Valdez Oil Spill Trustee Council Restoration Project Final Report (Project 14120114-Q), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Esler, D., B. Ballachey, M. Carls, and M. Lindeberg. 2015. Introduction to lingering oil monitoring. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Esler, D., J. Bodkin, B. Ballachey, D. Monson, K. Kloecker, and G. Esslinger. 2015. Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Larson, S., J.L. Bodkin, and G.R. VanBlaricom. 2015. Sea Otter Conservation. Academic Press, Boston. 447 p.

Konar, B., K. Iken, H.A. Coletti, T.A. Dean, and D.H. Monson. 2015. Research Summary: Influence of static habitat attributes on local and regional biological variability in rocky intertidal communities of the northern Gulf of Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Konar, B, K. Iken, H. Coletti, D. Monson, and B. Weitzman. In review. Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuarine Coastal and Shelf Science

Kuletz, K., and D. Esler. 2015. Spatial and temporal variation in marine birds in the northern Gulf of Alaska: the value of marine bird monitoring as part of Gulf Watch Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Monson, D.H. and L. Bowen. 2015. Evaluating the Status of Individuals and Populations: Advantages of Multiple Approaches and Time Scales. Chapter 6 in Larson SE, Bodkin JL, VanBlaricom GR, Eds. Sea Otter Conservation. Academic Press, Boston. Pp 121-158.

Monson D.H., T.A. Dean, M.R. Lindeberg, J.L. Bodkin, H.A. Coletti, D. Esler, K.A. Kloecker, B.P. Weitzman and B.E. Ballachey. 2015. Inter-annual and spatial variation in Pacific blue mussels (*Mytilus trossulus*) in the Gulf of Alaska, 2006-2013. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Traiger, Sarah, Brenda Konar, Angela Doroff, and Lauren McCaslin. In review. Sea otters versus sea stars as major clam predators: Evidence from foraging pits and shell litter. Marine ecology progress series.

Weitzman, B.P., and G.G. Esslinger. 2015. Aerial Sea Otter Abundance Surveys – Prince William Sound, Alaska, Summer 2014. U.S. Geological Survey Administrative Report.

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

The program was very operational in Year 4 and there were no major comments or recommendations that required significant changes.

11. Budget: *See,* Reporting Policy at III (C) (11).

Some categories continue to be underspent but PIs McCammon and Hoffman, along with Sigman, have reviewed a plan to appropriately spend down funds. Administrative staffing transitions at PWSSC over the course of the four years of the program have left some positions vacant for longer periods of time than expected (although this is not unusual in a rural community where it can be difficult to find the right candidate to fill a position). This has resulted in some underspent personnel funds. Travel ramped up as PIs presented key findings to scientific audiences at national conferences. Science Review Team members have been traveling to meetings, as well. Major outreach projects have been completed and are in progress, allowing us to catch up on spending in a category that saw lighter activity in the earlier years of the program when there were fewer results to report on. The University of California, the University of Alaska Fairbanks, and SAHFOS have all been more disciplined about invoicing with greater regularity.

12. Key Findings: 3-5 key findings

- Installation of a Gulf Watch Alaska exhibit at the Alaska SeaLife Center that can eventually travel to other locations
- Offering of a virtual field trip for middle school students featuring science from each of the program components and the work of individual project scientists
- Films produced by youth in Tatitlek and Nanwalek and an 8-minute composite video produced by Marie Acemah, SeeStories, have been posted to the GWA website
- Overlapping PI meetings to enable cross-program coordination and collaboration among scientists in both the Gulf Watch Alaska and Herring Research and Monitoring programs.

We appreciate your prompt submission
and thank you for your participation.

1. Program Number: *See*, Reporting Policy at III (C) (1).

15120114-N

2. Project Title: *See*, Reporting Policy at III (C) (2).

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

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

John R. Moran (NOAA) and Janice M. Straley (UAS)

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

Feb. 2015-Jan. 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

All work during 2015 proceeded as planned. During the reporting period we completed our scheduled April survey of Prince William Sound (PWS).

All obligations to the Trustees were met.

Unusual whale/herring behavior

In December of 2014 shoals of overwintering Pacific herring and their predators failed to return to Port Gravina. The 2015 spawning event also proved to be unusual: we did not locate large shoals of herring typical of the area in spring and whales targeted small, fast moving herring schools. Figure 1 shows April PWS humpback whale locations in 2015 relative to previous years.

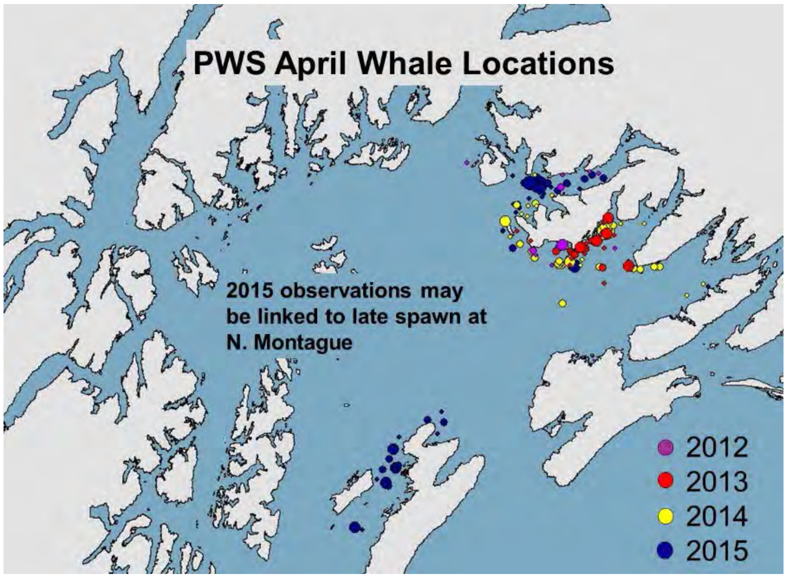

Figure 1. April locations of humpback whales in PWS, 2012-2015.

An increase in whales targeting bird feeding flocks in April.

Typical whale behavior when using feeding flocks of birds to target fish involves fast swimming, shallow dives (without fluking), and frequent changes in direction. When a feeding flock of birds forms (over 1 km away in some cases), the whale beelines to the birds and engulfs the fish school using a vertical or horizontal surface lunge. Whales often change their direction of travel 90^{o} when a bird flock forms, making it clear the whales detected the fish cued by the birds/fish. A noteworthy observation occurred on April 3, 2015 outside of Stockdale Harbor. Two whales, now named the "Bird Killers" engulfed and spit out 8 glaucous winged gulls. In the wake of a lunge through the flocks, the dead and dying birds appeared to have lost their water proofing.

Deliverable/Milestone	Status
April 2015 Survey	completed
Data entry	Data entry completed with QA/QC.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

a. Coordination within and between council funded programs

- Killer whale and humpback whale photos were exchanged with Craig Matkin. This collaboration expands the temporal and spatial scope of both projects.
- Adam Zenone ran hydroacoustic equipment on our April survey. These data will be used for a manuscript on whale/herring interactions.

b. Coordination with other Council funded projects – there was no collaboration with other Trustee funded projects.

c. Coordination with management agencies and Trustees

- We provided data for the Ecosystems Considerations Report to The North Pacific Fishery Management Council.

- John Moran is on the investigative team for the Alaska Large Whale Unusual Mortality Event and contributing Gulf Watch Alaska data.
- John Moran is a member of the humpback whale Post Delisting Monitoring Plan working group.
- John Moran presented at the Whale Tales Conference Kapalua, Maui, February 2016 – Hawaii's Humpbacks: what are they doing in Alaska?

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

Outreach

Prince William Sound Science Center Community Lecture Series, *Field Notes* radio program, Gulf Watch Alaska Virtual Field Trip, Gulf Watch Alaska project brochure, and a KCAW public radio interview.

Alaska Fisheries Science Center quarterly report: http://www.afsc.noaa.gov/Quarterly/OND2015/tocABL.htm and National Oceanographic and Atmospheric Administration Fisheries - Fish News. (Moran)

Presentations

Sea birds as prey indicators. John Moran, 2015 Juneau Marine Naturalist Symposium.

Fisheries Anomalies. John Moran, 2015 Anomalous Gulf of Alaska Workshop, January 2016, Anchorage, AK.

Alaska Marine Science Symposium 2016

Kevin Boswell, Mark Barton, Alexandra Brownstein, Jan Straley, John Moran. Stable Isotope Analysis of Humpback Whales (Megaptera noveangliae) to Confirm Diet During Winter Foraging.

John Moran, Jan Straley. Missing Herring: Water Temperature, Relocation or Dinner?

Jan Straley, John Moran. Bird Killers of Prince William Sound: A Foraging Strategy Used by Humpback Whales to Detect Schooling Fish.

Tammy Hoem Neher, Kris Holderied, Molly McCammon, Katrina Hoffman, Tom Weingartner, Ballachey, Daniel Esler, Heather Coletti. Gulf Watch Alaska in Hot Water! Ecological Patterns in the Northern Gulf of Alaska Under the Pacific 2014-2015 Warm Anomaly.

Publications

Boswell K., Rieucau G. Vollenweider JJ, Moran JJ, Heintz RA, Blackburn JK, Csepp DJ. In Review. Changes in over-wintering Humpback whale abundance structure Pacific herring school distribution, morphology and internal organization. Accepted in CJFAS.

Straley J. and Moran J. 2015. Friends of Admiralty Island Newsletter Issue no.19 February 2015. *Whales in Seymour Canal.*

Data

The PWS humpback whale catalog has been made available to public via Oceans workspace.

All data and metadata have been posted to the Oceans Workspace.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

N/A

11. Budget: *See,* Reporting Policy at III (C) (11).

Please see provided program work book.

At the end of FY15 we are within 10% of the proposed budget in all categories.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$118.8	$122.4	$130.4	$127.3	$129.9	$628.8	$456.1
Travel	$48.3	$51.6	$55.6	$59.7	$61.7	$276.9	$35.4
Contractual	$69.5	$75.0	$84.5	$81.2	$70.2	$380.5	$303.1
Commodities	$5.0	$3.0	$3.4	$1.0	$2.5	$14.9	$14.8
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	waived	waived	waived	waived	waived	waived	
SUBTOTAL	$241.6	$252.1	$273.9	$269.2	$264.3	$1,301.1	$809.5
General Administration (9% of subtotal)	$21.7	$22.7	$24.7	$24.2	$23.8	$117.1	$72.9
PROJECT TOTAL	$263.3	$274.7	$298.6	$293.4	$288.1	$1,418.2	$882.4
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	0

COMMENTS: PWSSC proposes a flat rate in lieu of its federal recognized IDC rate. This $200K itemized budget includes expenses that would normally be charged to IDC, and ALSO INCLUDES travel and meeting setup costs that are direct program charges. We do not seek changes for the FY16 administrative funds as originally proposed. We request permission to move $150K from the travel category to the contractual category. This proposed shift has no net impact on the overall approved budget. There are travel carry-over funds from previous fiscal years. Moving funds to the contractual category, a category in which we have responsibility for things such as aerial surveys, maintenance, etc., will allow us to advance program objectives. Travel is underspent due to PIs using different sources than originally planned to attend some meetings such as AMSS, and the (agreed-upon, purposeful) delayed initiation of the Scientific Review Panel, and lower Outreach Steering Committee travel than originally expected.

FY12-16

Program Title: 15120114-B Administration and Meeting Travel/Logistics
Team Leader: Hoffman

SUMMARY

ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See,* Reporting Policy at III (C) (1).

15120114-P

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK 1

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Seth Danielson and Thomas Weingartner (School of Fisheries and Ocean Sciences, UAF)

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2015-January 31, 2016

5. Date of Report: *See,* Reporting Policy at III (C) (5).

March 1, 2016

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org and http://www.ims.uaf.edu/gak1/

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

The basic objectives of this project include sampling based on quasi-monthly conductivity, temperature, and depth (CTD) casts at station Gulf of Alaska (GAK) 1 (periods of sampling given in Table 1) and the recovery and re-deployment of a string of six temperature-conductivity-pressure (TCP) recorders on a mooring at GAK 1. This mooring is recovered and re-deployed annually in March. In addition, we have begun slowly acquiring historical CTD data (via the National Oceanographic Data Center) and CTD data from the Project ARGO floats from the northern Gulf of Alaska. The focus here is on determining if there are long-term temperature and salinity trends over the slope waters of the north Gulf. On an annual basis these waters flow onto the Gulf of Alaska shelf and occupy the deeper (>100m) portion of the shelf.

Anomalously warm conditions in the northeast Pacific were first observed in the central Gulf of Alaska in 2013 and early 2014. These warm anomalies came to be known in the popular press as "the blob." In 2014 there were warm water anomalies in the Bering Sea, the deep northeast Pacific (the blob) and near Baja. In 2015, these three warm anomalies persisted and a fourth warm anomaly - El Nino - developed along the equatorial eastern Pacific. As observed at GAK1 (Figures 1-3), the coastal northern Gulf of Alaska transitioned from a multi-year cool phase into an extremely warm phase in 2015, with 0-250 m water column temperature anomalies of nearly 2 °C.

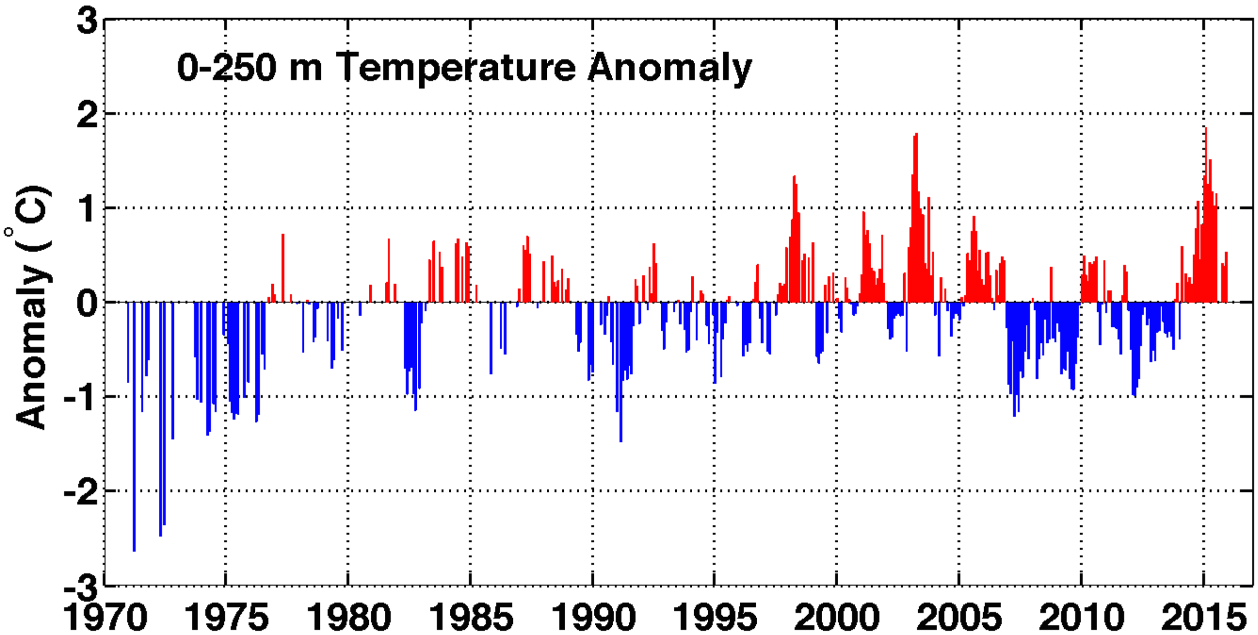

Figure 1. Temperature anomaly averaged over the entire water column at GAK1.

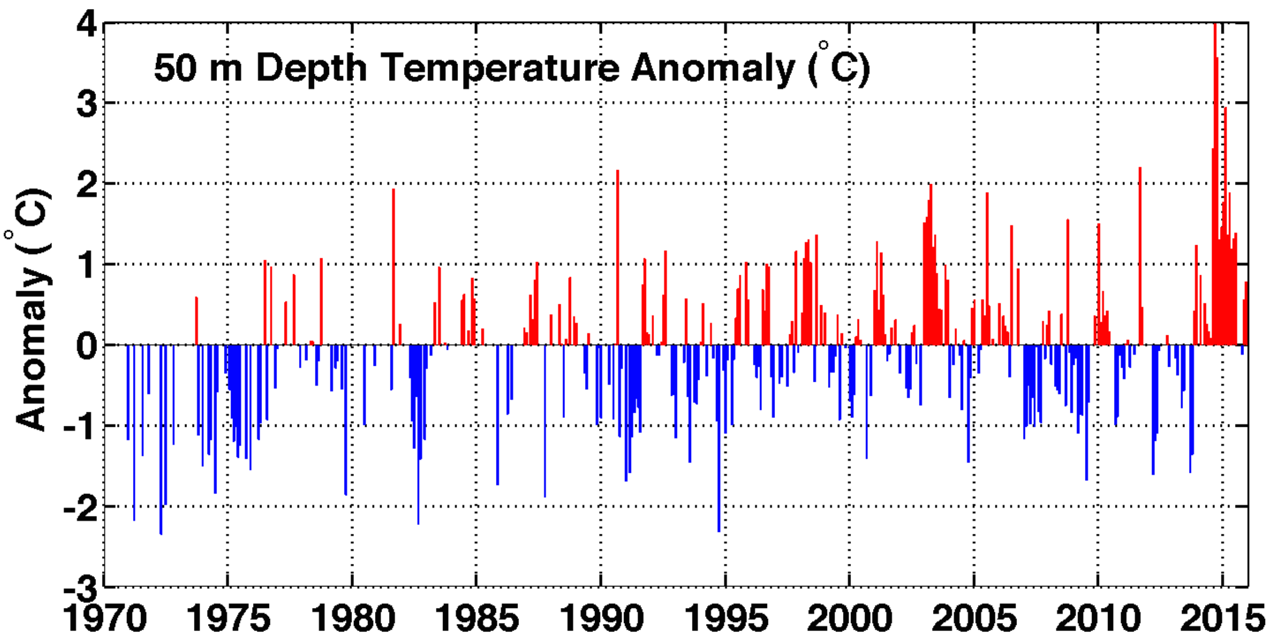

Figure 2. At 50 m depth, the GAK1 temperature anomaly was a full 4 °C higher than normal at the start of the 2014-2015 winter.

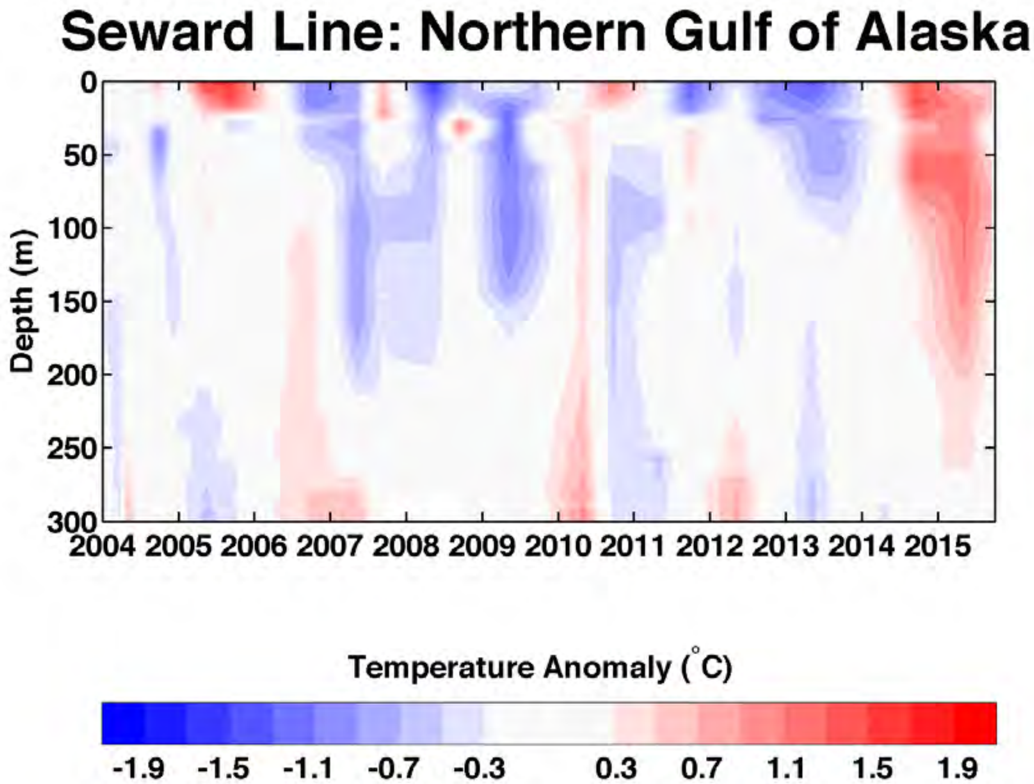

Figure 3. The temperature anomaly extended across the whole shelf in 2014 and through the water column. Above we plot the temperature anomaly averaged over the length of the Seward Line stations GAK1-GAK13 using data collected every May and September from 2004 to the present.

Table 1. Deliverable milestones for GAK 1, year four

Deliverable/Milestone	Status
February 2015 CTD cast at GAK 1	Completed
March 2015 mooring recovery and re-deployment at GAK 1	Completed
March 2015 CTD cast at GAK 1	Completed
April 2015 CTD cast at GAK 1	Completed
May 2015 CTD cast at GAK 1	Completed
June 2015 CTD cast at GAK 1	Completed
September 2015 CTD cast at GAK 1	Completed
October 2015 CTD cast at GAK 1	Completed
November 2015 CTD cast at GAK 1	Completed
January 2016 CTD cast at GAK 1	Completed

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

a. Coordination within and between Council funded programs

GAK-1 data is provided to the other GWA components and programs (e.g.,Nearshore component and Herring Research and Monitoring) and to federal and state agencies. We provide advice on data interpretation and usage when requested. We also integrate the GAK-1 data with data from other GWA projects, especially with the Environmental Drivers component – see below (Section 9. Information and data transfer) for examples of presentations that integrated amongst the Weingartner (GAK-1), Hopcroft (Seward Line), Batten (Continuous Plankton Recorder), Holderied (Lower Cook Inlet) and Campbell (Prince William Sound) projects.

b. Coordination with other Council funded projects

NA

c. Coordination with management agencies and Trustees

Our project data is provided and available for use on both the GWA program website and the UAF IMS website: http://www.ims.uaf.edu/gak1/ and is available to all of the Trustee and management partners. Since 2010, 69 citations to the data set have been reported since 2010, 14 within the past four years of involvement with the GWA program.

9. Information and Data Transfer: See, Reporting Policy at III (C) (9).

There have been 69 publications that have used the data from GAK1 of which we are aware. These include data sets for eight student Master of Science (MS) theses and Doctoral dissertations, for use in peer-reviewed papers, and by the North Pacific Management Council in their Groundfish Stock Assessment and Fishery Evaluation Reports. See the GAK1 page at http://ims.uaf.edu/gak1/ for a full listing.

- Publications produced during the reporting period;

Kelley, J., 2015. An Examination of Hydrography and Sea Level in the Gulf of Alaska. M.S. Thesis, University of Alaska Fairbanks

Fedewa, E.J., J. A. Miller and T.P. Hurst, 2015. Pre-settlement processes of northern rock sole (Lepidopsetta polyxystra) in relation to interannual variability in the Gulf of Alaska. J. Sea Res.2015, http://dx.doi.org/10.1016/j.seares.2015.11.008

Stearns, L. A., G. S. Hamilton, C. J. van der Veen, D. C. Finnegan, S. O'Neel, J. B. Scheick, and D. E. Lawson. 2015. Glaciological and marine geological controls on terminus dynamics of Hubbard Glacier, southeast Alaska. J. Geophys. Res. Earth Surf., 120, 1065–1081. doi:10.1002/2014JF003341.

- Conference and workshop presentations and attendance during the reporting period;

Co-principal investigator (PI) Danielson attended the Gulfwatch PI meeting in November 2015, Weingartner and Danielson attended the Alaska Marine Science Symposium in January 2015 and Weingartner attended the EVOSTC Science Meeting in February 2015.

The following talk was given at the Alaska Marine Science Symposium meeting in January 2015: *Gulf Watch Alaska: Monitoring the Pulse of the Gulf of Alaska's Changing Ecosystems.* Authors K. Holderied, M. McCammon, K. Hoffman, S. Rice, B. Ballachey, T. Weingartner, and R. Hopcroft .

Danielson attended the Pacific Anomalies Workshop 2 (PAW2) in Seattle (January 2016), and presented a poster and slides using GAK1 and Seward Line data. Title: *1970 to 2015 Thermal and Haline Anomalies on the Northern Gulf of Alaska Continental Shelf,* coauthors T. Weingartner and R. Hopcroft.

Danielson attended the Large Whale Unusual Mortality Event workshop in Anchorage on 25 January 2016, and gave an oral presentation with results from all GWA environmental drivers studies to provide environmental context to the unusual mortality event investigation. Title: *Gulf of Alaska 2015 Anomalous Conditions Workshop: Oceanography*. Coauthors S. Batten, R. Campbell, A. Doroff, K. Holderied, R Hopcroft, R. Thoman and T. Weingartner.

- Data and/or information products developed during the reporting period:

  UAF graduate student James Kelly used the GAK 1 data sets to investigate sea level variability in Seward. His goal was to determine the causes of sea level variations and eventually to determine if Seward Sea level can be used as a proxy for current variations in the Alaska Coastal Current (ACC). He found that the annual cycle of sea level variations at Seward are in-phase with dynamic heath (vertically-integrated density) at GAK 1. At periods of days to ~1 month the sea level variations are significantly coherent with and in-phase with the along-shore winds over the Gulf of Alaska shelf, especially in fall, winter, and early spring. Given that the wind is also coherent with ACC transport at these periods it appears that Seward Sea level anomalies at these periods may be useful as an index of ACC transport. Mr. Kelly graduated with an MS degree in spring 2015 and has worked to acquire the Project ARGO CTD data that began in 1999. Graduate student Jonathan Whitefield acquired the historical CTD data from the northern Gulf of Alaska from NODC.

- Data sets and associated metadata that have been uploaded to the program's data portal.

  All Data through spring 2015 (for the mooring) and November 2015 (for the CTD profiles) have been uploaded to www.gulfwatchalaska.org and our UAF project webpage located at http://www.ims.uaf.edu/gak1/.

10. Response to EVOSTC Review, Recommendations and Comments: See, Reporting Policy at III (C) (10).

No recommendations provided

11. Budget: See, Reporting Policy at III (C) (11).

Please see provided program work book.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	Actual Cumulative
Personnel	$52.7	$55.1	$57.5	$60.1	$62.8	$288.2	$72.38
Travel	$1.4	$1.5	$1.5	$1.6	$1.7	$7.8	$3.88
Contractual	$22.9	$22.9	$22.9	$22.9	$22.9	$114.6	$39.41
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.00
Equipment	$10.0	$10.0	$10.0	$10.0	$10.0	$50.1	$16.44
Indirect Costs (will vary by proposer)	$13.4	$13.8	$14.2	$14.5	$14.9	$70.8	$25.63
SUBTOTAL	$100.5	$103.2	$106.2	$109.2	$112.4	$531.5	$157.7
General Administration (9% of subtotal)	$9.0	$9.3	$9.6	$9.8	$10.1	$47.8	$14.2
PROJECT TOTAL	$109.5	$112.5	$115.7	$119.1	$122.5	$579.3	$171.94
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: Actual expenditures are those through Feb. 1, 2016. The GAK1 spend-out has been slower than anticipated because of a combination of factors that include cost-savings in the salary and vessel charter categories. We are aware of the delayed spending and are currently working on updating billing to ensure these funds will be expended as planned.

FY12-16	**Program Title: 15120114-P GAK1** **Team Leader: T. Weingartner**	**FORM 3A** **NON-TRUSTEE AGENCY SUMMARY**