Exxon Valdez Oil Spill
Long-term Monitoring Program (Gulf Watch Alaska) Final Report

Science Coordination and Synthesis for the Long-term Monitoring Program

Exxon Valdez Oil Spill Trustee Council Project 16120114-H
Final Report

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Study History: The Gulf Watch Alaska program was initiated in 2012 in response to an invitation for proposals from the *Exxon Valdez* Oil Spill Trustee Council for a long-term monitoring program that would monitor the recovery of resources from the initial injury, and monitor how factors other than oil may inhibit full recovery or adversely impact recovered resources. The program also needed to integrate ecosystem components (environmental drivers, pelagic ecosystem, and nearshore ecosystem) and a management team to administer the program (program leader, science leader, science coordinator, science review team, and science coordinating committee). In addition, the invitation required a science synthesis workshop and report in the third year of the program. The science coordination and synthesis project was developed in response to the *Exxon Valdez* Oil Spill Trustee Council's requirements. Coordinating multiple projects under the umbrella of one self-managed long-term monitoring program was a new direction in the *Exxon Valdez* Oil Spill Trustee Council's history. Based on the success of the first five-year period, the Gulf Watch Alaska program submitted a proposal to continue long-term monitoring for fiscal years 2017-2021 and will continue the science coordination and synthesis project with minor modifications to the program management team based on lessons learned from the first five years.

Abstract: The science coordination and synthesis project formed at the beginning of the Gulf Watch Alaska program to ensure that the goal to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impact of these changes on injured resources and services was met. Objectives included improving communication, data sharing and coordinating field work planning; improving and documenting integration of science monitoring results; and improving communication of monitoring information to resource managers and the public. The Gulf Watch Alaska program integrated monitoring results through annual reporting; coordinating projects; a science synthesis workshop and report in year 3 of the program; and assisting in data integration. Significant outcomes of the project include the synthesis report and publication of a special issue of the journal Deep Sea Research Part II. Scientists published over 30 peer-reviewed papers and presented findings at more than 30 scientific meetings. The science coordinator facilitated the use of program findings in outreach to thousands of people over the five-year period. Data and findings from the program were used for resource management. As the nexus for all aspects of the program, the science coordinator was the key to program success.

Key words: Gulf of Alaska, Kachemak Bay, Katmai, Kenai Fjords, lower Cook Inlet, Prince William Sound, program management, Resurrection Bay, science coordination, science synthesis

Project Data: This project did not include data collection. Data collected for projects that contributed to this report are available through the Alaska Ocean Observing System (AOOS) Gulf of Alaska data portal: http://portal.aoos.org/gulf-of-alaska.php#module-search?lg=5040a46e-25db-11e1-94b9-0019b9dae22b&page=1&tagId=Tag%3AEVOS+Gulf+Watch+Projects&q=&tags=Tag%3AEVOS+Gulf+Watch+Projects

The AOOS data custodian is Carol Janzen, 1007 W. 3rd Ave. #100, Anchorage, AK 99501, 907-644-6703, janzen@aoos.org.

There are no limitations on the use of Gulf Watch Alaska data, however, it is requested that the authors be cited for any subsequent publications that reference Gulf Watch Alaska data. It is strongly recommended that careful attention be paid to the contents of the metadata file associated with these data to evaluate data set limitations or intended use.

Citation:

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EXECUTIVE SUMMARY

The overarching goal of the Gulf Watch Alaska (GWA) long-term monitoring (LTM) program is to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources and services. The science coordination and synthesis project was formed at the beginning of the GWA LTM program to ensure that goal was met.

GWA was developed in response to an invitation for proposals from the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) for a long-term monitoring program that would monitor the recovery of resources from the initial injury, and monitor how factors other than oil may inhibit full recovery or adversely impact recovered resources.

The objectives of this project were to improve communication, data sharing and coordinating field work planning; improve and document integration of science monitoring results across the GWA LTM program; and improve communication of monitoring information to resource managers and the public.

Key elements in developing the science coordination and synthesis project included (1) creating a program management team to provide administrative support and other functions to the GWA LTM program; (2) developing methods for all members of the GWA LTM program to communicate, coordinate, and share information; and (3) creating science leadership and oversight teams to ensure program and project objectives would be met and scientific quality would remain high. A science coordinator ensured the science coordination and synthesis met the EVOSTC's requirements for the LTM program. This included a commitment to make data, documents and reports available electronically to the public; continued reassessment of data collection; program progress and relevancy; synthesis of existing scientific literature relevant to the program; and established timelines and milestones for the overall program. To fulfill these requirements we built the science coordination and synthesis project from scratch at the start of the GWA LTM program to meet project and program objectives.

The science coordinator facilitated communication among the GWA LTM program principal investigators (PIs), supported data sharing, and coordinated with the Herring Research and Monitoring (HRM) program (EVOSTC program 12160111) and other research in the Gulf of Alaska. The GWA LTM program integrated science monitoring results through annual reporting by all projects; coordinating with data management, conceptual ecological modeling, and historic data synthesis; coordinating the science synthesis workshop and report in year 3 of the program; and assisting in the improvement of data integration. We employed numerous means and tools to communicate results to resource managers and the public. These included the following: the GWA website, incorporation of program data into resource management reports, presentations and posters at scientific and resource management meetings, scientific publications, data publication, and public outreach.

Significant outcomes of the science coordination and synthesis project include the synthesis report prepared in conjunction with the HRM program following a workshop

during year 3 of the program and publication of a special issue of the journal Deep Sea Research Part II. In addition, scientists published more than 30 peer-reviewed papers using data collected under the GWA program and presented GWA findings at scientific meetings across the country. The science coordinator also facilitated the use of GWA findings in public outreach to thousands of people over the five-year period.

Data and findings from GWA were used by resource managers such as Alaska Department of Fish and Game, National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS) stock assessment reports; NMFS and USFWS Endangered Species Act evaluations; Bureau of Ocean Energy Management (BOEM) oil and gas lease sale assessments; National Park Service (NPS) state of the park reports; USFWS migratory bird management applications; NMFS marine ecosystem consideration ecosystem indicators report cards for the Gulf of Alaska; and Fisheries and Oceans Canada state of the Pacific reports.

The science coordination and synthesis project tied together all the projects in the GWA LTM program and facilitated collaboration, data management and synthesis, and outreach. As the nexus for all aspects of the program, the science coordinator was the key to program success. The science coordination and synthesis project met each of its objectives.

INTRODUCTION

The scientists responded to *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) invitation for long-term monitoring (LTM) proposals represented diverse agencies and organizations with a history of conducting studies in the northern Gulf of Alaska, including resources injured by the *Exxon Valdez* oil spill (EVOS). The scientists understood that a successful LTM program required an organizational structure that provided leadership, organized administrative and logistical functions, facilitated data management, guided outreach activities, tracked progress, and aided coordination and synthesis of scientific information. The scientific team established the following three projects to meet these organizational and oversight needs:

- Administration, logistics and outreach
- Data management
- Science coordination and synthesis

The first two projects were based on specific requirements in the invitation for proposals. The third project, science coordination and synthesis, responded to unstated requirements in the invitation—namely that someone needed to focus on the science program as a whole to coordinate the group, develop a sense of cohesiveness within the program, meet required deadlines, and synthesize data.

The overarching goal of the GWA LTM program is to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources and services. The science coordination and synthesis effort supported this goal by improving information sharing between principal investigators (PIs) and with the Herring Research and Monitoring (HRM) program, assisting in development of multi-disciplinary datasets and tools, informing an ongoing evaluation of the program's effectiveness and priorities in meeting EVOSTC goals, and ensuring documentation of data collection and products.

The GWA program included a program management team, an external science review team; data collection components focused on environmental drivers, the pelagic ecosystem, the nearshore ecosystem, and lingering oil; and program-level projects to administer the projects, conduct outreach, manage data, and synthesize data. The science coordination and synthesis project pulled together all these pieces of the program. The science coordinator worked with all projects and PIs, facilitated interactions and information exchange, drove deadlines, and supported data synthesis. This design allows for flexibility as needs and issues arise over the lifetime of the program and ensure its long-term success. Science coordination and synthesis was an important addition to the program management team at the beginning of the project and proved to be key to the success of the overall program.

OBJECTIVES

The purpose of the science coordination and synthesis project was to guide and support the overall GWA LTM program team in meeting objectives.

The objectives of the first five years of the science coordination and synthesis project for the GWA LTM program were as follows:

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

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

3. Improve communication of program results 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.

METHODS

The scope of the science coordination and synthesis project was inclusive of all components—environmental drivers, pelagic, nearshore, and lingering oil—and projects associated with the GWA LTM program. The study area included the *Exxon Valdez* oil spill affected area, specifically the northern Gulf of Alaska including Prince William Sound, Kenai Fjords, lower Cook Inlet, and the Katmai Coast in Shelikof Strait (Fig. 1).

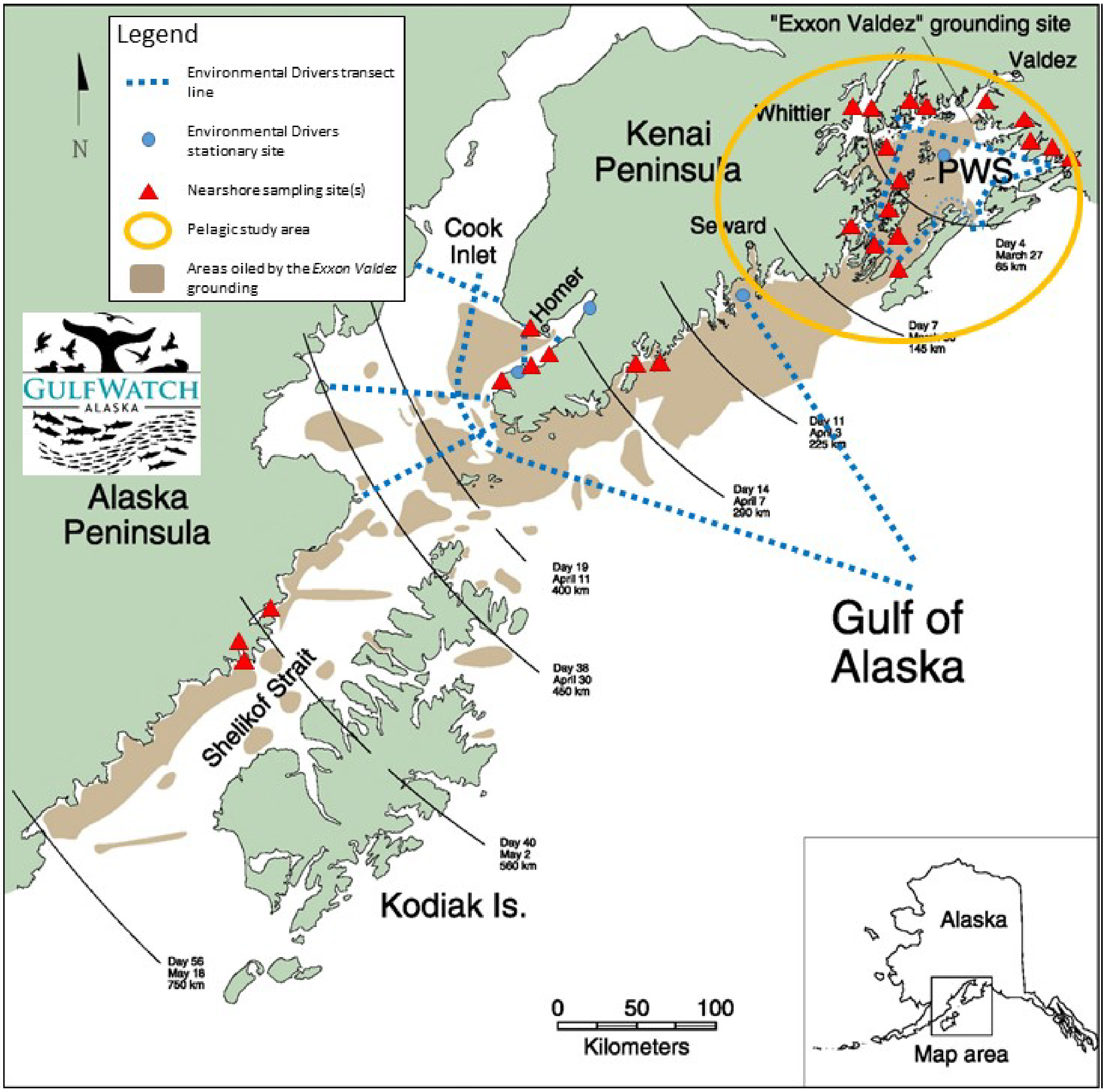

Figure 1. Gulf Watch Alaska long-term monitoring program study area within the *Exxon Valdez* oil spill affected area showing the approximate locations of projects in environmental drivers, nearshore, and pelagic components.

GWA Program Design

Program Management Team

A program management team, consisting of a program coordinator, science team lead, administrative lead, and science coordinator, was established (Fig. 2). The science team lead oversaw the scientific aspects of the program and managed the science coordinator. The science coordinator was hired under the GWA LTM program and worked day to day to meet the objectives of the program. While the program coordinator, science team lead, and administrative lead came from agencies and organizations and support the program part time, the science coordinator was the only full time position providing oversight to the program. Together, the science team lead and science coordinator constituted the science coordination and synthesis team.

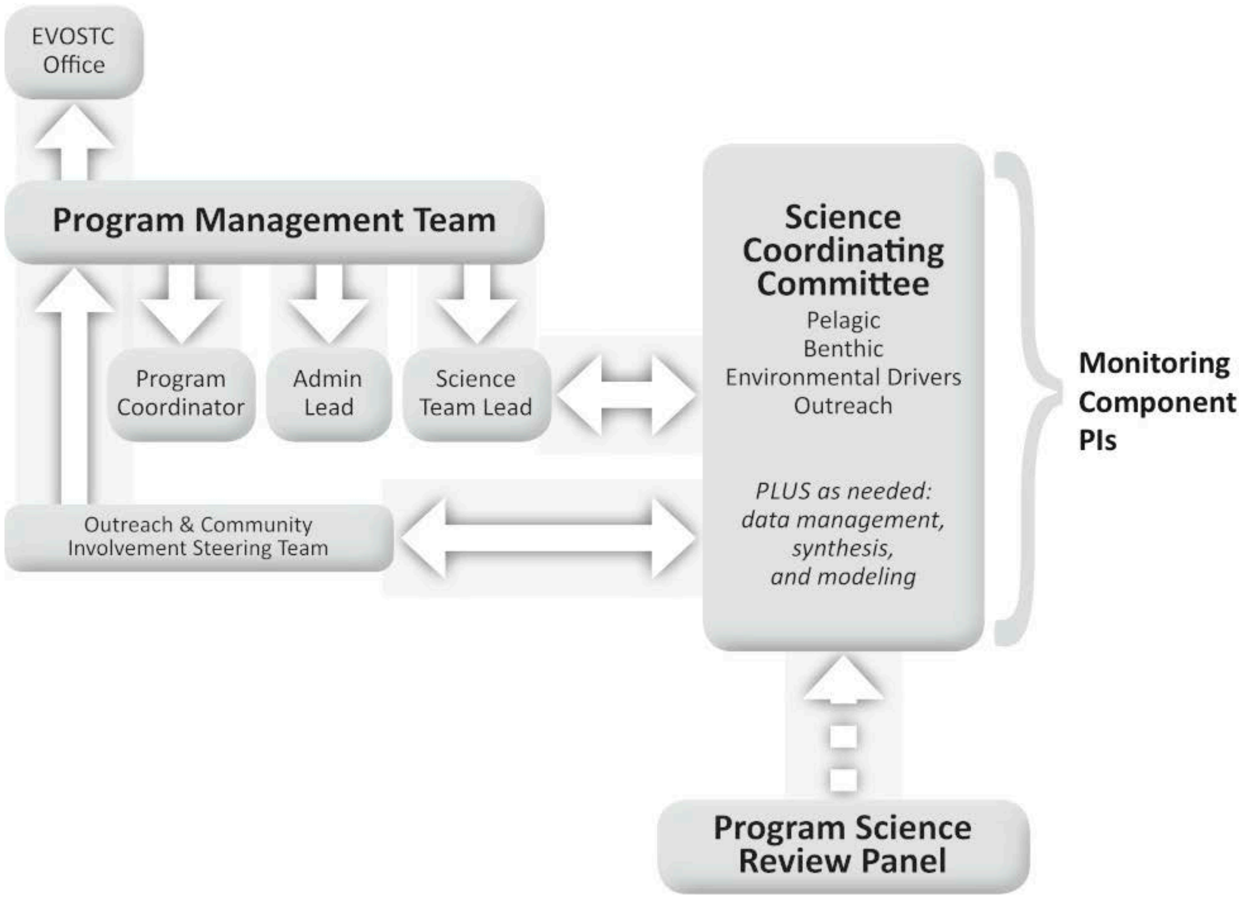

Figure 2. Organizational structure developed for the Gulf Watch Alaska long-term monitoring program funded by the *Exxon Valdez* Oil Spill Trustee Council.

Three additional projects were part of science coordination and synthesis: data management, conceptual ecological modeling, and collaborative data management and holistic synthesis. The data management project provided a common platform for all GWA LTM projects to save and share data and documents, provided data visualization tools, and ensured data from each project were made available to the public (Bochenek et al. 2018). The conceptual ecological modeling project worked across monitoring projects to develop models to explain scientific observations at the ecosystem level (Hollmen et al. 2018). The collaborative data management and holistic synthesis project retrieved and published data from historic EVOSTC-funded projects and developed working groups of scientists, including GWA LTM PIs, to evaluate and synthesize historically collected data. The collaborative data management and holistic synthesis project was a separate solicitation by the EVOSTC that joined the GWA LTM program after its initiation (Jones et al. 2018). Integrated program management projects are listed in Table 1.

Science Coordinating Committee and Science Review Team

We developed two science oversight teams: the science coordinating committee (SCC) and the science review team (SRT).

The SCC was internal to the GWA LTM program and consisted of lead PIs (and alternates) from each of the study components: environmental drivers, pelagic, and nearshore/lingering oil. The SCC's roles included supporting communication between the program management team and the GWA LTM program PIs; providing internal oversight, coordination, and review of program deliverables; supporting data management; and aiding the program management team in program-level decision-making. SCC members also took lead roles in the synthesis workshop and subsequent report initiated in year 3 of the program, and in the special issue initiated in year 5 of the program.

The SRT was external to the GWA LTM program and consisted of eminent scientists with expertise and interest related to northeast Pacific oceanography, pelagic species, and nearshore ecosystems. Volunteering their time, the SRT provided peer review of program deliverables (e.g., work plans, reports, and proposals) and high-level scientific guidance to the program as a whole.

Monitoring Components and Projects

Long-term monitoring projects were grouped by environmental driver, pelagic ecosystem, nearshore ecosystem, and lingering oil components (Table 1). The lingering oil component was a separate part of the EVOSTC's FY12 invitation for proposals and was added to the GWA LTM program after projects were awarded (Bowen et al. 2015, Lindeberg et al. 2018). Monitoring projects, and the objectives and methods of the projects, were selected for inclusion in the GWA LTM program based on the requirements established in the EVOSTC's FY12 invitation for proposals. PIs included in the GWA LTM program were experts in their field of study with knowledge of the northern Gulf of Alaska, the spill, and EVOSTC requirements. Specific information about each project can be found in their respective final reports.

Table 1. Projects associated with the Gulf Watch Alaska long-term monitoring program from 2012 to 2016. Each of these projects contributed to the science coordination and synthesis project.

Project Number	Project Name	Principal Investigator(s)	Lead Agency or Organization[1]
Program Management and Oversight			
16120114-H	Science coordination and synthesis (this project)	Kris Holderied	NOAA KBL
16120114-B	Administration, logistics, and outreach	Katrina Hoffman and Molly McCammon	PWSSC and AOOS
16120114-D	Data management	Rob Bochenek	AOOS and Axiom
16120114-I	Conceptual ecological modeling[2]	Tuula Hollmen	ASLC
16120120	Collaborative data management and holistic synthesis[2]	Matt Jones	NCEAS
Environmental Drivers Component Monitoring Projects			
16120114-A	Continuous plankton recorders	Sonia Batten	SAHFOS
16120114-E	Long-term monitoring of oceanographic conditions in Prince William Sound	Rob Campbell	PWSSC
16120114-G	Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay	Angela Doroff and Kris Holderied	KBRR and NOAA KBL
16120114-J	Seward Line	Russ Hopcroft	UAF
16120114-P	GAK1	Tom Weingartner and Seth Danielson	UAF
Pelagic Component Monitoring Projects			
16120114-M	Long-term killer whale monitoring	Craig Matkin	NGOS
16120114-N	Humpback whale predation on herring	John Moran and Jan Straley	NOAA ABL and UAS
16120114-O	Forage fish distribution and abundance	John Piatt and Mayumi Arimitsu	USGS
16120114-K	Prince William Sound marine bird surveys	Kathy Kuletz	USFWS

Project Number	Project Name	Principal Investigator(s)	Lead Agency or Organization[1]
16120114-F	Ability to detect trends in nearshore marine birds[3]	Heather Coletti	NPS SWAN
16120114-C	Winter habitat use and distribution of marine birds in Prince William Sound	Mary Anne Bishop	PWSSC
Nearshore Monitoring Projects			
16120114-L	Ecological communities in Kachemak Bay	Katrin Iken and Brenda Konar	UAF
16120114-R	Nearshore benthic systems in the Gulf of Alaska	Heather Coletti, Dan Esler, Brenda Ballachey, Jim Bodkin, and Tom Dean	NPS, USGS
Lingering Oil Monitoring Projects			
16120114-Q	Chronic exposure of harlequin ducks and sea otters to lingering oil[3]	Brenda Ballachey and Dan Esler	USGS
16120114-S	Tracking oil levels and weathering (PAH composition) in PWS[3]	Mark Carls	NOAA ABL

1 – Lead agencies and organizations, in alphabetical order, included Alaska SeaLife Center (ASLC), Alaska Ocean Observing System (AOOS), Axiom Data Science (Axiom) Kachemak Bay National Estuarine Research Reserve (KBRR), National Center for Ecological Analysis and Synthesis (NCEAS), National Oceanic and Atmospheric Administration (NOAA) Auke Bay Lab (ABL), NOAA Kasitsna Bay Lab (KBL), National Park Service (NPS), NPS Southwest Alaska Network (SWAN), Northern Gulf Oceanic Society, (NGOS), Prince William Sound Science Center (PWSSC), Sir Alister Hardy Foundation for Ocean Science (SAHFOS), United States Fish and Wildlife Service (USFWS), United States Geological Survey (USGS), University of Alaska Fairbanks (UAF), and University of Alaska Southeast (UAS)

2 – The conceptual ecological modeling project was funded by the EVOSTC for the first 4 years of the GWA program; funding was discontinued for year 5.

3 – These projects were added to the GWA LTM program by EVOSTC staff in year 1 of the program.

GWA LTM Program Implementation

The program management team, with support of the SCC, prepared a program management plan requiring all GWA LTM program actively participate in program activities, such as quarterly and annual meetings and preparing work plans and reports, and meet program expectations, such as data publication requirements and schedules. The program management team and PIs signed the program management plan as a binding contract.

The science coordinator, working at the direction of the program lead, science lead, and administrative lead, performed the following functions to maintain program objectives and milestones:

- Maintained team member distribution lists, calendar, intranet site, and schedule
- Facilitated quarterly team meetings
- Shared pertinent information to all team members and saved permanent program records related to science coordination and synthesis on the program's shared workspace
- Maintained the project website
- Oversaw schedule, preparation, and review of deliverables
- Coordinated with PIs to improve integration of multi-disciplinary monitoring activities within and between geographic regions of the study area

At the start of the GWA LTM program each project prepared standard operating procedures for field data collection and analysis. The science coordinator facilitated the schedule for preparing and submitting standard operating procedures to the shared data management system, and updating the procedures as needed during the five-year period.

During year 2 of the program the program management team participated in a data management workshop with EVOSTC staff, the data management project, and the collaborative data management and holistic synthesis projects. The intent of the workshop was to evaluate technologies used for data management, discuss the roles and responsibilities of the data management project and the collaborative data management and holistic synthesis projects, and ensure the long-term integrity and accessibility of the datasets.

Year 3 of the program included a science synthesis workshop with the EVOSTC. The GWA LTM and HRM programs worked together to present the workshop. The teams developed several cross-disciplinary questions that were addressed through the workshop.

Following the workshop, the science coordinator facilitated the preparation of a science synthesis report submitted to the EVOSTC.

Throughout the five-year period, the science coordinator worked closely with other projects to meet program objectives and the objectives of the science coordination and synthesis project. These activities included coordinating with the data management project on data publication compliance and data exploration tools, the conceptual ecological modeling team on a general conceptual model for the northern GOA ecosystem, participating a working group of the collaborative data management and holistic synthesis project, and coordinating with the administration, logistics, and outreach project on incorporating the latest program findings into outreach activities. Additional activities including facilitating data and information transfer between GWA LTM projects and components, coordinating with the HRM program lead, and assisting in disseminating the latest findings from the GWA LTM program to resource managers and other scientists.

RESULTS

The program management team and SCC were in place within the first quarter of the GWA LTM program. The program management team and SCC coordinated to identify potential members of the SRT based on expertise in marine ecology in the North Pacific Ocean. The SRT was established and briefed in April 2014. The science coordinator began work in September 2012. Following establishment of the program, the science coordination and synthesis team worked to meet each of the project's objectives.

The program management team and SCC developed a program management plan (Gulf Watch Alaska 2012) that outlined the provisions and protocols of the program to "promote development of consistent and seamless team effort for collection and dissemination of data and scientific research results." The plan described the requirements and responsibilities of, among other things the program leadership team, PI coordination, field season planning, internal communications, information and data sharing, data and document retention, annual PI meetings, and reporting.

Objective 1—communication, data sharing, and coordinated field work planning

The science coordinator facilitated communication among the GWA LTM program PIs, supported data sharing, and coordinated with the HRM program and other scientific groups working in the Gulf of Alaska.

Communication

Communication methods employed (e.g., email distribution lists, the intranet site, in-person and teleconference meetings, and shared calendar) helped the program form a cohesive team and link PIs from disparate geographic locations, agencies and organizations, and projects.

GWA LTM program team meetings occurred approximately quarterly from fall 2011 through winter 2017. Spring and summer meetings were teleconferences lasting up to 2 hours. Fall meetings were 2-3-day in-person meetings held in a spill-affected community. Winter meetings were in-person meetings held in Anchorage in conjunction with the Alaska Marine Science Symposium in January, and typically lasted up to 2 hours. The HRM program lead attended GWA LTM quarterly meetings to facilitate communication across the programs. Quarterly meetings had several purposes, which included

- Disseminating information from the program management team to PIs and project team members
- Sharing scientific information among projects
- Collaboration and brainstorming
- Presenting and discussing data management and data visualization tools

Fall and winter meetings, during which project PIs presented annual findings with each other and had opportunities for breakout sessions and side meetings, provided important and rare opportunities for project teams to collaborate in-person.

Teleconference meetings between the program management team and SCC occurred more frequently than program team meetings. These meetings served to guide early development and cohesion of the GWA LTM program, plan larger group meetings and workshops, drive scientific collaboration among the components, and plan publication of program results in a special issue.

The "EVOS Gulf Watch" data management site on the Alaska Ocean Observing System (AOOS) Ocean Workspace (Workspace), developed as part of the data management support project, served multiple functions for the science coordination and synthesis project (Bochenek et al. 2018). From a communication standpoint, the Workspace provided a convenient location for all program team members to access common information such as the program management plan, field-sampling protocols, meeting agendas and notes, workplan and report templates, scientific presentations, and key literature. The science coordinator worked continuously with data management support project team members to improve function and utilization of the Workspace.

Data Sharing

Data sharing among projects and PIs of the GWA LTM program began almost immediately upon creation of the program, facilitated by the communication activities described above.

Soon after the program integrated the monitoring projects, PIs prepared standard operating procedures and shared them with other projects through the Workspace. Sharing enhanced discussions among projects of field and analysis techniques, and project's methods increased in standardization.

Data sharing among projects within and across components resulted in improved program integration and greater ecosystem understanding (see Objective 2).

Coordinated Field Work Planning

The science coordinator developed a graphic representation of each project's field schedule color-coded based on type of sampling (Fig. 3). This graphic was shared among the PIs and posted on the intranet site and program website to facilitate cooperation and collaboration among projects.

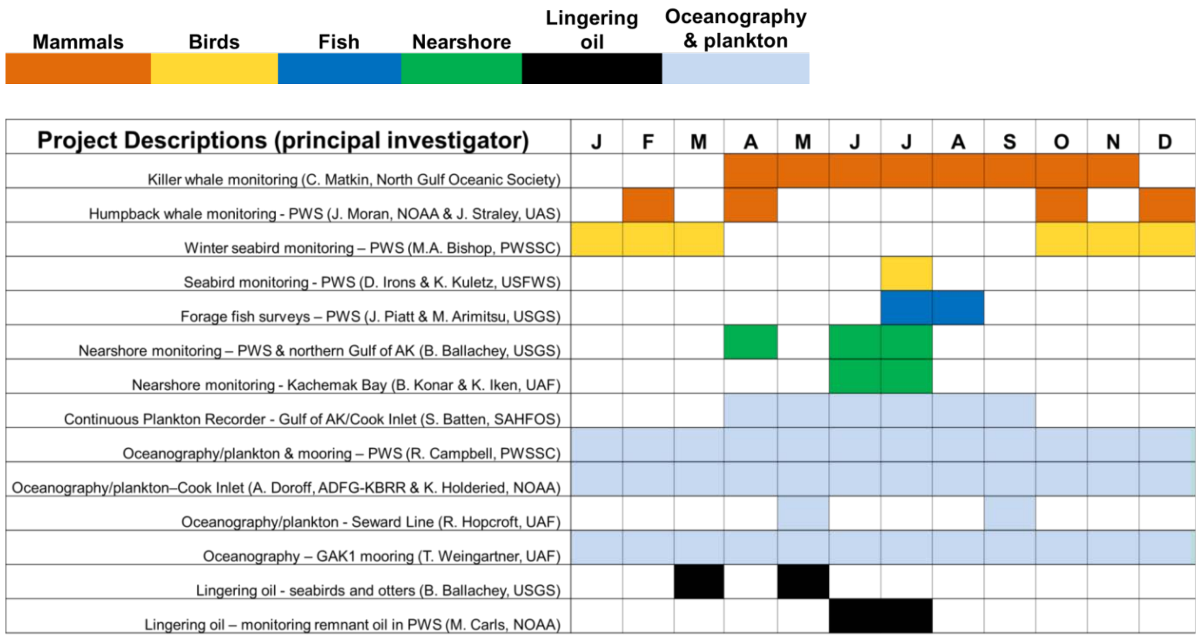

Figure 3. Field sampling schedule for each project and associated principal investigator(s). The legend at top indicates the type of sampling associated with each color in the chart.

Coordinating field work planning among the project teams led to collaboration in numerous ways. The nearshore projects overlapped their field personnel to improve coordination of sampling methods and analyses. Projects such as the Prince William Sound late fall/winter seabird abundance project that relied on ships of opportunity for field sampling collaborated with other GWA LTM projects to conduct field work. Pelagic component projects shared survey platforms to explore hypotheses about marine bird and humpback whale concentration areas near schooling forage fish. Biologists surveying marine birds and mammals participated on environmental driver project cruises (e.g., Seward Line and Cook Inlet-Kachemak Bay) by leveraging funds from other agencies and grants.

Cross-program Coordination with HRM

PIs in the GWA LTM program coordinated with HRM program PIs on field activities, process studies, conceptual ecological modeling, and working groups. Integrated work between the two programs included data sharing by the environmental drivers component projects and collaborative field efforts between the humpback whale, marine birds, and forage fish GWA LTM projects and HRM projects.

The GWA LTM and HRM programs held a joint science workshop in February 2015 during which PIs presented the findings of synthesis reports prepared by each of the programs (see Objective 2). The two programs collaborated on the publication of a special issue on spatial and temporal ecological variability in the northern Gulf of Alaska (see Objective 2).

Coordination with Groups Outside the GWA LTM Program

In addition to data sharing within and across the programs, GWA data were shared with other agencies and research organizations. Program data and associated metadata were made publicly available each year through AOOS's Gulf of Alaska Data Portal (http://portal.aoos.org/gulf-of-alaska.php). At the end of the first 5 years of the program the datasets were assigned digital object identifiers (DOIs) and published on DataOne (Bochenek et al. 2018). Data publication for use by other agencies and research organizations also included historical EVOSTC-funded data synthesis.

Bureau of Ocean Energy Management—The Bureau of Ocean Energy Management (BOEM) approached GWA LTM program PIs regarding their need for oceanography and ecological data in lower Cook Inlet for their proposed Lease Sale 244. With additional funding from BOEM, the lower Cook Inlet-Kachemak Bay oceanography, pelagic, and nearshore projects collected additional data. The lower Cook Inlet-Kachemak Bay oceanography project added transect lines across lower Cook Inlet. USFWS added biologists on lower Cook Inlet-Kachemak Bay oceanographic cruises to record marine bird and mammal observations. The nearshore projects participated in nearshore sampling on the west side of lower Cook Inlet to support BOEM's needs. Oceanography, marine bird and mammal, and nearshore findings from the GWA LTM program were shared with BOEM.

NPRB GOAIERP—GWA LTM program PIs held teleconferences and data sharing discussions with North Pacific Research Board (NPRB) Gulf of Alaska Integrated Ecosystem Research Project (GOAIERP) PIs beginning in 2014 and extending through the remaining years. Collaboration between GWA and GOAIERP proved beneficial to both programs, resulting in development of "trend cards" of GWA LTM program data (Figs. 4-6), scientific discussions of the meanings behind the trends and how the trends relate to other aspects of the Gulf of Alaska ecosystem, and integration of environmental drivers PIs into GOAIERP working group meetings.

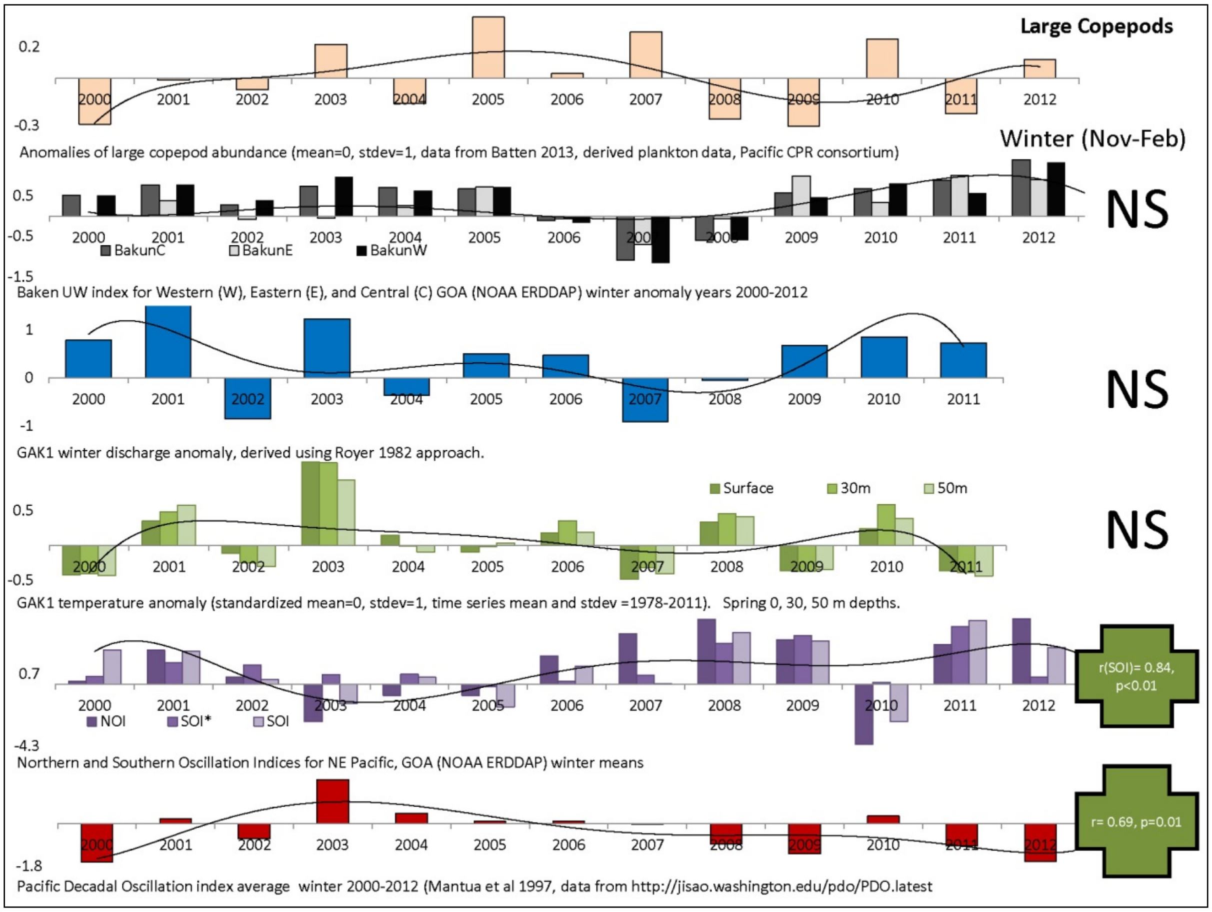

Figure 4. Example of a trend card for large copepod abundance during winter months associated with regional climate index data. This trend card was used during discussions with Gulf of Alaska Integrated Ecological Research Program principal investigators. NS = not statistically significant.

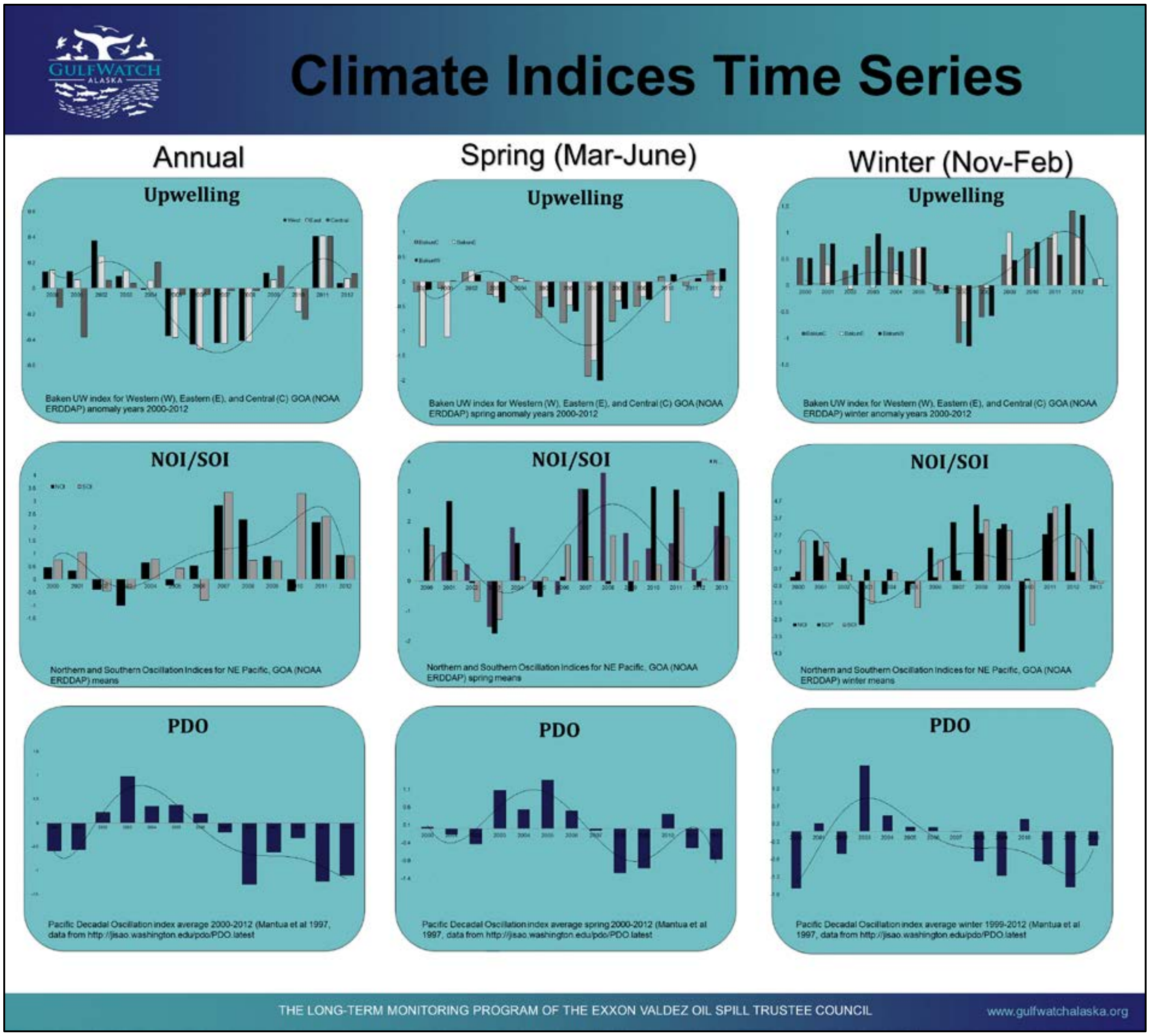

Figure 5. Climate index time series trend card presented as a poster at a workshop with Gulf of Alaska Integrated Ecological Research Program principal investigators.

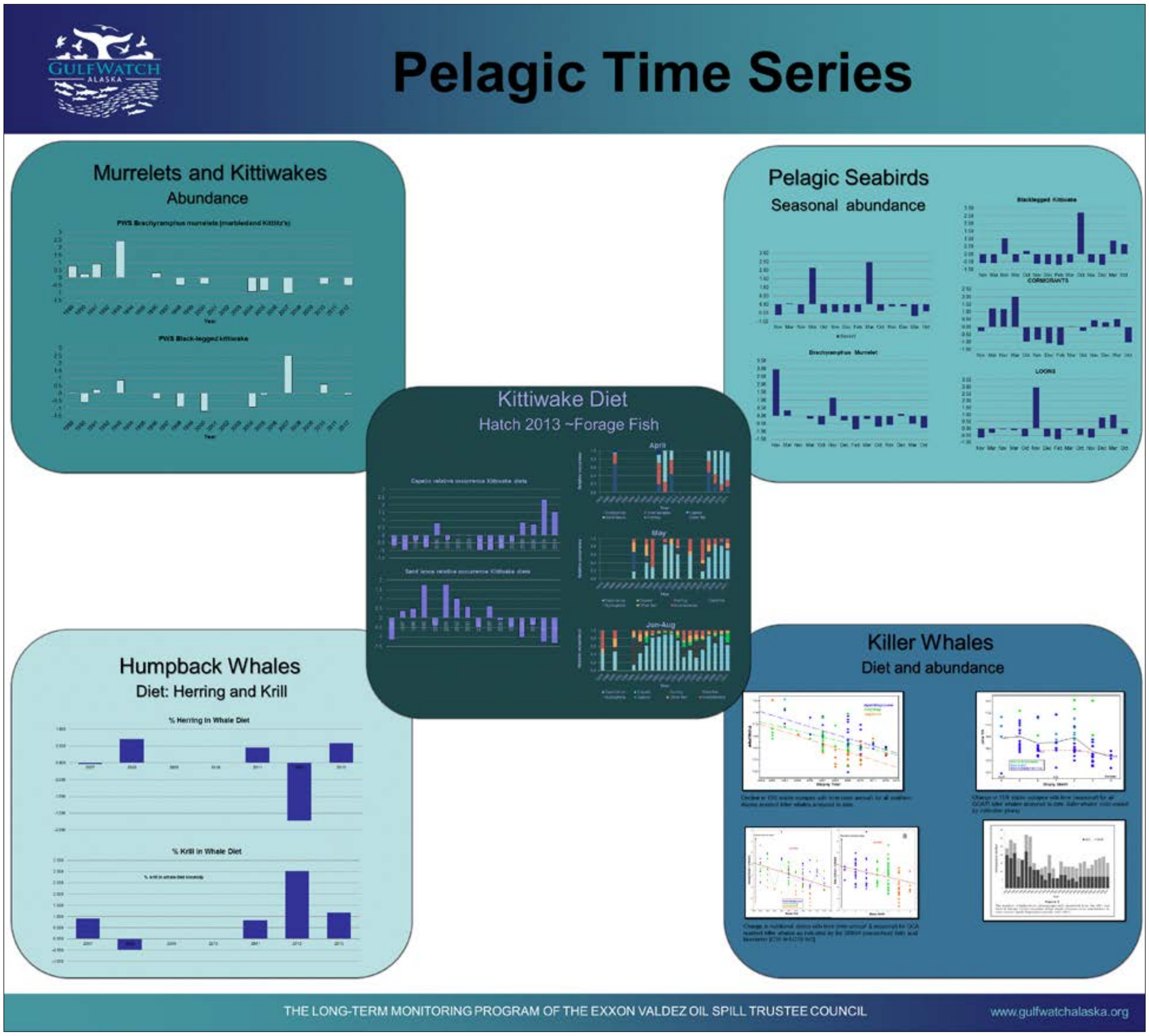

Figure 6. Pelagic component time series trend card presented as a poster at workshop with Gulf of Alaska Integrated Ecological Research Program principal investigators.

Some of the questions and hyphotheses generated from meetings between GWA and GOAIERP PIs include the following:

- Are patterns in species metrics and environmental conditions similar between shelf and off shelf areas and across the Gulf of Alaska (east, west, central)?
- What are some of the potential relationships between injured resources/plankton and environmental conditions?
- What are some of the drivers of variability in nearshore environments (identify temporal and spatial scales of variability, examine patterns of seasonal temperatures, upwelling, wind mixing and correspondence with patterns in metrics

from near shore communities, i.e. species composition, abundance, and distribution)?

- Does the variability in the data (spatial/temporal) reflect a new regime shift of climatic cycles?
- How does PWS track with change in the broader geography?
- Is there predictability in the pulses and what are the drivers?
- Oscillating control (Coyle et al. 2011): are shifts in zooplankton production related to ecosystem shifts in species abundances and community composition favoring pelagic versus benthic communities?
- Match/mismatch (Durant et al. 2007): Two part question- a) does the timing in zooplankton production (community composition and abundances of key prey items) correspond to environmental patterns; and b) are there relationships with availability of specific zooplankton prey and predators that correspond to availability (timing and abundance)?
- River/lake hypothesis (Eslinger at al. 2001): related to the Bakun upwelling index (Bakun 1973), the river/lake hypothesis associates the degree to which upwelling occurs resulting in changes in zooplankton community in PWS; alternatively, zooplankton abundances/composition is driven by phytoplankton composition and is nutrient limited. One question might address which of these two hypotheses best explains the variability in plankton communities associated with environmental conditions.

Common murre die-off—As waters in the Gulf of Alaska warmed during the Pacific warm anomaly, biologists in and out of the GWA LTM program began recording common murre nest failures and dead birds at and near nesting colonies throughout the Gulf of Alaska. A massive die-off occurred in late December 2015 and extended into 2016 and very few common murre colonies had nests during the 2016 nesting season. This event was the largest murre die-off and colony failure recorded and its cause is still under evaluation. Understanding the event is a multi-agency collaborative effort and GWA LTM projects and PIs are contributing data and resources to the investigation (See Bishop 2018, Coletti et al. 2018, and Kaler et al. 2018).

Objective 2—integration of science monitoring results

The GWA LTM program integrated science monitoring results through annual reporting by all projects; coordinating with data management, conceptual ecological modeling, and historic data synthesis; coordinating the science synthesis workshop and report in year 3 of the program; and assisting in the improvement of data integration.

Reporting

The science coordination and synthesis team, in conjunction with the administrative and data management teams, coordinated reporting to EVOSTC and the National Oceanic and Atmospheric Administration (NOAA) (the granting agency for non-trustee organizations). Each project within the GWA LTM program prepared annual reports and submitted them to the science coordinator who facilitated reviews and prepared annual reports for the program based on the project reports. The reports were compiled and submitted to EVOSTC staff through the program management team from the Ocean Workspace. For final reports, the science coordination and synthesis team coordinated internal and peer reviews of the project reports.

In addition, the science coordinator worked with the Prince William Sound Science Center (PWSSC), the administrator of the NOAA grant, to prepare and submit semi-annual reports required under the grant. Non-trustee organizations operating under the NOAA grant included AOOS, Alaska SeaLife Center (ASLC), Kachemak Bay National Estuarine Research Reserve (KBRR), National Center for Ecological Analysis and Synthesis (NCEAS), Northern Gulf Oceanic Society (NGOS), PWSSC, Sir Alister Hardy Foundation for Ocean Science (SAHFOS), and University of Alaska Fairbanks (UAF).

Reports followed template requirements provided by EVOSTC. Contents included current findings and activities, and cross-references to other GWA LTM projects as appropriate. Program reports were a compilation of all project reports. All reports were submitted on schedule.

Data Management and Historic Data Synthesis

The science coordinator worked with the two projects responsible for managing and synthesizing data: data management and collaborative data management and holistic synthesis.

Two projects, data management (proposed as part of the GWA LTM program) and collaborative data management and holistic synthesis (proposed under a different solicitation and added to the GWA program), had specific responsibilities for managing EVOSTC-funded data. The data management workshop held during year 2 of the program resulted in a greater understanding of the roles and responsibilities of each of these projects for hosting, managing, serving, and visualizing EVOSTC-related data. Data collected under GWA (and HRM) were hosted, managed, and served by the platform and system developed by the data management project. Historic EVOSTC-funded data retrieved and archived by the collaborative data management and holistic synthesis project were hosted and managed by that project and when completed were shared to the Gulf of Alaska data portal hosted by the data management project so all publically available EVOSTC data could be searched from one source.

The science coordinator worked with the data management project team and GWA PIs to develop useful ways for GWA team members, resource managers, and the public to view the data and overlay it with other data in the northern Gulf of Alaska. The science coordinator also served on one of the working groups of the collaborative data management and holistic synthesis project to support synthesis of historic data. See Objective 3 for more information on data visualization and publication.

Synthesis Workshop and Report

The science synthesis workshop held with EVOSTC in year 3 of the program, along with subsequent report preparation, represented the first steps toward interdisciplinary synthesis of EVOSTC-funded data, including previously gathered historic data and the two to three years of data collected under the GWA and HRM programs, supplemented by other studies. As part of the workshop, program scientists developed the following cross-disciplinary questions:

1. Are changes in oceanographic conditions in the outer Gulf of Alaska shelf mirrored in the nearshore marine environment and population trends of injured, recovering, and recovered resources?
2. Are population trends of nearshore and pelagic injured, recovering, and recovered species responding similarly to changes in ocean conditions?
3. Is herring and forage fish overwintering success tied to spring and summer productivity and season or year-to-year differences in the zooplankton community?
4. Is herring and forage fish overwinter success associated with winter conditions on the shelf or in PWS?
5. Are variations in seabird abundance and distribution associated with zooplankton stocks and/or oceanographic conditions?
6. What are predation rates of humpback whales and seabirds on PWS herring and other forage fish populations?
7. How do oceanographic patterns compare (and co-vary) between different locations in PWS, Gulf of Alaska shelf, and lower Cook Inlet?
8. What are the spatial patterns and timing of ocean stratification that lead to spring and autumn phytoplankton blooms?
9. How are the timing, intensity, and duration of stratification changing, and what are the consequences?
10. How do zooplankton community assemblages and abundances vary spatially, from year to year, with the timing of the spring phytoplankton bloom, and with water properties (temperature, salinity, and nutrients)?
11. What are the population trends of key pelagic species groups (killer whales, seabirds, humpback whales, and forage fish) in PWS?
12. How can forage fish population trends in PWS be effectively monitored?
13. Are there significant inter-annual changes in the nearshore communities and are they synchronous across the Gulf of Alaska?
14. Have injured resources in the nearshore environment recovered from EVOS? If not, can we identify or rule out other, non-spill related, factors that are constraining their recovery?

The GWA and HRM programs co-presented the workshop and prepared separate reports (Herring Research and Monitoring Team 2014, Neher et al. 2014). Workshop participants included EVOSTC members, staff, and science review panel members; HRM PIs and SRT members; and GWA PIs and SRT members. Select PIs presented brief scientific overviews. All workshop participants discussed the presentations and findings, hypotheses related to the Gulf of Alaska ecosystem functioning, and the synthesis of information. The GWA synthesis report included chapters providing historical context and overview, environmental drivers, variability within the pelagic ecosystem, variability within the nearshore ecosystem, lingering oil monitoring, conceptual models, and program summary and recommendations (Neher et al. 2014).

Key findings from the science synthesis report noted that the Gulf of Alaska has paths of energy transport through two distinct, but connected food webs: a pelagic, offshore environment with most primary production from phytoplankton and a nearshore environment with primary production from macroalgae, phytoplankton and benthic microalgae. Both food webs are driven by environmental conditions, including temperature, salinity, nutrient supply, and solar radiation, that control primary production and biological processes at higher trophic levels. In this section, we describe the key findings and the ecological significance of those results within each of the four program components.

Data collected during oceanographic monitoring at GAK1 from 1970 to present provides evidence for several long-term trends on the Gulf of Alaska shelf over that period, including: 1) an overall warming of shelf water (of nearly 0.8 °C in the upper 100 m over 40 years), with intermittent periods of cooler temperatures; 2) an increase in salinities in deeper waters (> 100 m); 3) a decrease in upper ocean (0 – 100 m) salinities; and 4) increasing stratification. The upper ocean salinity decrease is in agreement with the long-term trend toward increasing freshwater discharge throughout the Gulf of Alaska. Data consolidation efforts within PWS show similar thermal trends on the shelf, but opposite ones inside PWS driven by increased glacial melt. These long-term trends have biological implications as a warming environment should affect the metabolic activities of a host of marine species. The increase in stratification appears to be a response to surface freshening due to increased coastal freshwater discharge, a reduction in wind mixing, and an increase in deep salinity on the shelf; however, the reasons for the deep salinity increase are uncertain. Stratification changes have implications for the magnitude, timing and duration of spring primary production and how that productivity may be reflected in upper trophic levels. These changes have important implications on nutrient availability, ocean acidification, and biological production at all trophic levels through bottom-up forcing.

While coherent patterns in temperature and salinity time series are observed at seasonal, interannual, and decadal time scales within the northern Gulf of Alaska, there is considerable regional variability in environmental conditions at shorter time scales. This variability will also drive spatial differences in species that respond at shorter time scales and raises questions on the space and time scales at which environmental conditions should be monitored to assess linkages to lower trophic levels and subsequent impacts at higher trophic levels. We expect that this may be especially important to understand ecosystem response in years with atypical environmental conditions, such as the unusually warm conditions of 2014. The CPR and Seward Line data show that there is strong evidence of bottom-up forcing. Phytoplankton and zooplankton abundance, timing, and composition are all influenced by the physical environment. Strong interannual variability in physical variables and the plankton, even between adjacent years, is clearly evident. Interannual variability in plankton abundance is much greater than trends in abundance across the time series.

Killer whales – Trajectories of three populations of killer whales demonstrate differing sensitivities to perturbations in this long-lived species. We do not yet know the long-term consequences of EVOS for the declining population (one resident AB pod) that may range from eventual recovery to possible extinction. We note the great value in these data as this is one of the only projects with data collected prior to EVOS.

Humpback whales – Recent removals of herring in PWS by humpback whales approximated the biomass equivalent of the most recent herring fishery harvest (1998). A hotspot (area of consistently high seasonal species aggregations) has been identified in Montague Strait where an influx of whales has been documented in fall and winter as they follow herring. Humpback whale predation in PWS can exert top-down controlling pressure on herring, including competition with fish-eating marine birds and other marine mammals for food, but this may change as prey fields change.

Forage fish – Efforts over the past two decades to document the distribution and abundance of forage fish in PWS and surrounding areas were reviewed. Drawing from these studies, and considering the range of life histories encountered among species of forage fish, a variety of methods were tested and refined into a few efficient procedures for long-term monitoring of multiple species. Some of these methods were developed in mutually beneficial collaborations with other pelagic component studies (e.g., herring, humpback whale, and marine bird surveys).

Marine birds – The strongest spatial pattern of summer marine bird community composition in PWS was related to water depth and distance from shore, paralleling the nearshore-pelagic structure of the marine food web. In PWS, post-spill summer population trends of most offshore birds declined dramatically while most nearshore populations remained relatively stable or increased. This pattern of community change is indicative of changes in the pelagic prey base. Densities of the most abundant marine birds in PWS varied significantly between early and late winter, suggesting multiple surveys are required to quantify the distribution and abundance of wintering populations.

The value of nearshore monitoring is illustrated by two detailed syntheses reported in this document. In the first example, the influence of static or stable attributes of rocky intertidal sites was found to be a significant driver of community structure. In particular, the presence of tidewater glaciers, fetch, and exposure were the main drivers, with substrate providing a less significant contribution for explaining variation in the model. This analysis will allow us to account for variability related to these static attributes in future analyses of dynamic environmental drivers. In the second example, over the period from 2007 to 2013, we have observed a significant reduction in mussel abundance across the Gulf of Alaska. That decline in mussels correlates with changes in sea otter and black oystercatcher diets. Further, the geographic scope of synchronous mussel abundance changes suggests they may reflect changes in the pelagic environment.

In addition to the examples of key findings described above, we continue to collect data on a wide variety of nearshore ecosystem metrics that allow us to address numerous questions. We have observed stable or increasing sea otter abundance in all of our sites since 2007. Also, we have not detected changes in abundance of black oystercatchers or other marine birds over that same time period. There have been notable changes in several intertidal invertebrates and algae, including declines in abundance of several bivalves across the Gulf of Alaska. We looked for, but did not detect, evidence of sea star wasting disease in the north Gulf of Alaska through 2014, in contrast to infected areas further south. Baselines for contaminants in mussel tissues have been established. Data gathered and compiled from all of these studies illustrate how environmental shifts can alter nearshore communities consequently impacting species of focus for conservation and management programs.

Effects of EVOS on some vulnerable wildlife, particularly sea otters and harlequin ducks, were observed for more than two decades. Recent findings indicate that effects of lingering oil on these species are no longer detectable and population status is consistent with recovery as defined by the EVOSTC. However, some oil is known to remain in the environment, although the exact amount is uncertain.

Integration of Multi-disciplinary Monitoring Efforts

One of the outcomes of the synthesis workshop and report was improved coordination between GWA projects.

The two nearshore projects, nearshore benthic communities in the Gulf of Alaska and ecological communities in Kachemak Bay, closely coordinated over the five-year period. Beginning during the first field season, they shared team members and discussed methods to ensure their data were comparable. The projects collaborated on two papers addressing variability within the nearshore ecosystems of the Gulf of Alaska in the Gulf Watch Alaska program's science synthesis report (Chapter 4, Neher et al. 2014). Moving forward, these projects have combined into one.

The projects studying marine birds (Table 1) convened a working group to discuss approaches to analyses of current data, data gaps, and topics for synthesis papers. Outcomes included several papers addressing variability in the pelagic ecosystem of Prince William Sound and identification of data gaps leading to additional program collaboration. The data gaps identified included the lack of potentially important winter abundance data for specific species and the question whether distribution data (clustering) could be used to develop linkages to other species such as forage fish. The projects addressed the data gaps by modifying sampling procedures, and teams identified distribution linkages among species (Chapter 3, Neher et al. 2014).

An outgrowth of the marine bird working group led to collaboration between projects within the pelagic component (PWS late fall/winter seabird abundance, humpback whale monitoring, and forage fish distribution, abundance and body condition) to identify distribution linkages among marine birds, humpback whales, and forage fish. Working together, the projects identified several areas within PWS where marine birds and humpback whales congregate to pursue forage fish prey. Through this collaboration, the projects observed sudden annual changes in spatial distribution patterns that corresponded with the warm water anomaly documented by the environmental drivers component projects. Because of the success of these findings, the wintering marine bird, humpback whale, and forage fish monitoring projects will share a survey platform to conduct field work moving forward.

PIs from the environmental drivers component projects (Table 1) formed a working group to coordinate zooplankton sampling techniques and analytical approaches and develop a consistent format for reporting oceanographic data collected by conductivity, temperature, and depth (CTD) instruments. The projects agreed to a standardized analysis of zooplankton data and to standardized methods to archive and publicize CTD instrument data.

As the baseline of environmental data in the Gulf of Alaska ecosystem, data sharing from the environmental drivers projects to the pelagic and nearshore ecosystem projects was critical to the success of the first five years of the program, especially following the occurrence of the Pacific warm anomaly beginning at the end of 2013 and extending through the remainder of the five-year period.

As each of the oceanographic projects measured warming temperatures and changes in plankton species, the pelagic projects observed changes in species distributions. When a Gulf of Alaska-wide common murre die-off occurred in 2015 and 2016, pelagic and nearshore projects included relevant observations. Updates and presentations on the murre die-off by multiple agencies included data collected from multiple GWA LTM projects as well as data from other agencies and organizations (Bishop 2018, Coletti et al. 2018, Kaler et al. 2018).

In addition, the USFWS leveraged funds from other sources to include biologists on Seward Line and lower Cook Inlet-Kachemak Bay oceanographic cruises. Biologists recorded data on marine birds and mammals observed along cruise transect lines. These collaborations allowed USFWS to compare current data to previously collected data in lower Cook Inlet and Kachemak Bay and to evaluate changes in distribution of marine birds under different climatological patterns along the Seward Line.

The environmental drivers and nearshore components also began collaborating to develop an understanding of how oceanographic measurements affect the nearshore ecosystem. PIs from both components began meeting in conjunction with the annual fall GWA LTM meeting to present and discuss findings and develop methods to correlate data.

The conceptual ecological modeling project also required collaboration and input from all field-based projects in the GWA LTM program. This project is discussed below.

Finally, the collaborative data management and holistic synthesis project developed two working groups (understanding changes in the coastal Gulf of Alaska social-ecological system: analysis of past dynamics to improve prediction of future response to natural and anthropogenic change and applying portfolio effects to the Gulf of Alaska ecosystem: did multi-scale diversity buffer against the *Exxon Valdez* oil spill) that met to collaborate on and discuss historic data collected in response to EVOS. GWA LTM program PIs and SRT members participated on each of the working groups, resulting in knowledge, information, and data sharing. Peer-reviewed publications from these working groups are in press or in preparation (Jones et al. 2018).

Conceptual Modeling

The conceptual ecological modeling project developed a northern Gulf of Alaska conceptual model (Fig. 4) and a series of sub-models (Hollmen et al. 2018). The purpose was to assist with ecological understanding by focusing on various drivers of ecosystem function. The sub-models developed included (1) top-down control of herring by humpback whales; (2) nearshore predator-prey dynamics; (3) ecological linchpin processes, such as the key role of forage fish in ecological processes; and (4) bottom-up environmental forcing by plankton populations. Development of the models required incorporation of data from multiple GWA LTM projects and coordination among projects. Preliminary versions of the models were used to facilitate discussion within the GWA LTM program and for outreach to other scientists and the public.

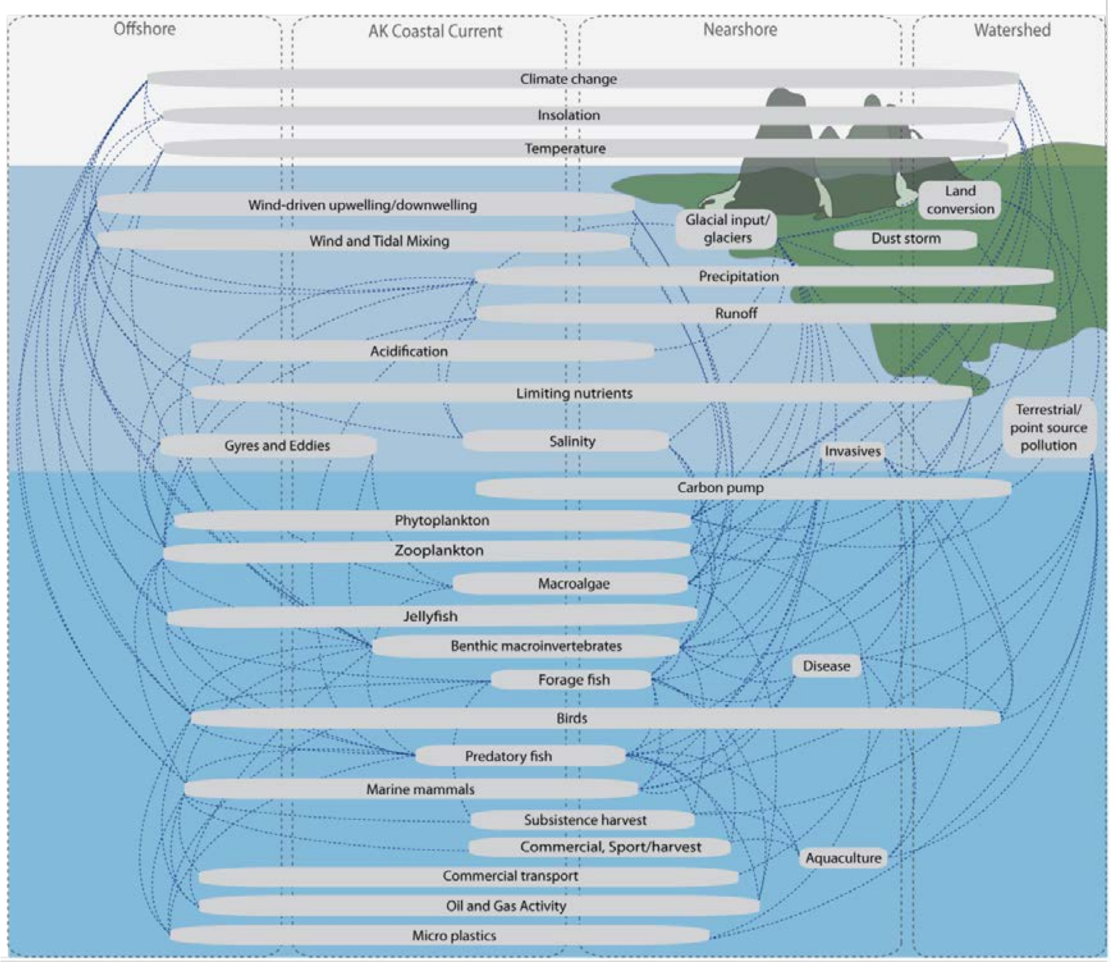

Figure 7. Visual representation of a general consensus conceptual ecological model for the northern Gulf of Alaska.

Objective 3—communication of monitoring information to resource managers and the public

We employed numerous means and tools to communicate monitoring information to resource managers and the public. These included the following: the GWA website, incorporation of program data into resource management reports, presentations and posters at scientific and resource management meetings, scientific publications, data publication, and public outreach. Each of these is discussed below.

Website

We developed and maintained a comprehensive website for the GWA LTM program (www.gulfwatchalaska.org) for outreach to resource managers, the scientific community, and the public. The website provides an overview of the program; overviews of each of the program components; project profiles, including preliminary findings; lists of publications, presentations, and reports; outreach videos, virtual field trips, and photographs; contact information for program PIs, and links to the Gulf of Alaska Data Portal where program data are published annually (see data publication below). We updated the website regularly to include the most recent project and program findings.

Incorporation of data into resource management reports

Numerous datasets from GWA LTM program projects are incorporated into resource management reports. The following examples illustrate how GWA data are being used by federal, state and tribal agencies, as well as the public:

- Oceanography, plankton and humpback whale monitoring data collected in the GWA program are being used by the HRM program investigators and the Alaska Department of Fish and Game to improve herring stock assessment models.
- Killer whale monitoring data are used in NMFS killer whale stock assessment reports for marine mammal species in Alaska.
- Killer whale identification catalogues, guidance, and other data products are used by the tour boat industry in Kenai Fjords National Park, PWS, and Kachemak Bay.
- Humpback whale population and habitat use information were provided to the NOAA NMFS Protected Resources Division for evaluation of changes to the species listing under the Endangered Species Act. Two humpback whale populations (Central North Pacific and North Pacific) were delisted by NMFS during the first five years of the GWA program.
- The states of Alaska and Hawaii used humpback whale monitoring results from the GWA program in petitions to delist humpback whales from the Endangered Species List in US waters.
- Under interagency agreements, oceanography, marine bird and marine mammal observations in lower Cook Inlet were provided to BOEM to inform their environmental assessment for anticipated Cook Inlet oil and gas lease sales. BOEM provided additional financial support to sustain quarterly Cook Inlet shipboard surveys and marine bird observations.
- Seasonal distribution patterns and trends in marine birds detected in the PWS, Seward Line, and Cook Inlet surveys are used by USFWS to inform management approaches for priority species.

- Seabird and whale data are used by Ship Escort/Response Vessel System (SERVS) and other oil spill response training and contingency planning organizations (PWS and Cook Inlet Regional Citizens' Advisory Councils, NOAA Office of Response and Restoration, and Oil Spill Recovery Institute).
- The marine bird survey data (PWS, Seward Line, Cook Inlet) are archived in the North Pacific Pelagic Seabird Database, which has multiple applications in management and conservation actions.
- Sea otter monitoring data are used in USFWS sea otter stock assessment reports for marine mammal species in Alaska and are available for use in management and conservation by state and tribal governments.
- The nearshore component has accumulated baseline data on important nearshore species that previously did not exist for areas across the Gulf of Alaska. These data are available for management and conservation purposes, including risk assessment and remediation in the event of future perturbations. For example, during the eruption of Mt. Redoubt in 2009, nearshore data were used to highlight areas along the coastline that were considered high priority for protection (booms) in the event of a spill from the Drift River terminal oil storage tanks.
- Nearshore baseline data were used to inform development of BOEM's environmental assessment for lower Cook Inlet oil and gas lease sales.
- Nearshore monitoring data are provided to the NPS at regular intervals to assist managers in a variety of decision-making processes as well as through community outreach and interpretation programs. Specifically, the nearshore data are used to produce the NPS State of the Park Reports. These reports are used by park managers to assess the status of important park resources and determine if changes are needed in future management plans.
- Nearshore monitoring has been able to provide information for emerging high priority management needs, such as monitoring for invasive species from marine debris from The Tohoku earthquake and tsunami in Japan.
- Marine bird data are provided annually to the USFWS for migratory bird management applications.
- Data from GAK 1 and the Seward line have been used in over 70 scientific investigations addressing topics in physical and biological oceanography relevant to fisheries management (see GAK 1 website: http://www.ims.uaf.edu/ GAK 1/ and Seward line: https://www.sfos.uaf.edu/sewardline/Publications.html for partial listing of publications).
- Four GWA LTM program projects, GAK1, CPR, long-term killer whale monitoring, and humpback whale predation on herring, contributed data to the Alaska Fisheries Science Center's Alaska marine ecosystem considerations reports and report cards for the Gulf of Alaska (Zador and Yasumiishi 2016). The ecosystem consideration reports and report cards are produced annually for the North Pacific Fishery Management Council, the scientific community, and the public. GAK1 contributes data on freshwater input and CPR contributes information on mesozooplankton biomass and copepod community size.
- The CPR project also contributes information to the Fisheries and Oceans Canada State of the Pacific report (Irvine and Crawford 2013). This series of reports

summarizes results from annual workshops that present and discuss the state of physical and biological resources of Pacific Ocean resources bordering western Canada.

Presentations and posters at scientific and resource management meetings

Scientists presented findings from the GWA LTM program at symposia, workshops, meetings, and conferences throughout the five-year period (Table 1). These presentations furthered scientific understanding of the Gulf of Alaska ecosystem and fostered discussions and collaboration. The complete list of presentations and posters is included in the Other References at the end of this report.

Table 2. Summary of presentations and posters by GWA LTM scientists to scientific audiences at professional conferences and meetings (51 presentations and 56 posters in total).

Year	Venue	Number Presentations	Number Posters
2013	Alaska Marine Science Symposium	1	5
	Alaska Forum on the Environment	1	
	Pacific Seabird Group	2	
	PICES		1
2014	Alaska Marine Science Symposium	5	7
	American Fisheries Society	1	
2015	Alaska Marine Science Symposium	3	9
	American Fisheries Society	2	1
	Kachemak Bay Science Conference	3	
	Coastal & Estuarine Research Federation	1	
	Pacific Anomalies Science and Technology Workshop 1	2	
	Pacific Seabird Group	2	
	PICES	1	
	Oil Spill and Ecosystem Conference	1	
	Southern Killer Whale Health Meeting	1	

Year	Venue	Number Presentations	Number Posters
	Society for Marine Mammals Conference		2
2016	Alaska Marine Science Symposium	4	17
	Pacific Anomalies Science and Technology Workshop 2	1	4
	Ocean Sciences Meeting	1	2
	Oil Spill & Ecosystem Science Conference	2	
	Large Whale Unusual Mortality Event Workshop	1	
	Alaska Bird Conference	3	
	National Marine Animal Health Stranding Network Conference	1	
	MCEAS	1	
	Pacific Seabird Group		1
2017	Alaska Marine Science Symposium	5	6
	ICES/PICES	2	
	Pacific Seabird Group		1
	The Wildlife Society	1	
	Canadian Conference for Fisheries Research	1	
	Sea Duck Conference	2	

Scientific publications

GWA LTM scientists contributed to more than 30 peer-reviewed scientific publications utilizing data from the GWA LTM program during the first five years of the program. Publications include journal articles, book chapters, and a special issue published jointly with the HRM program. The first five years of the GWA LTM and HRM programs culminated with publication of a special issue in the journal Deep Sea Research, Part II, entitled "Spatial and Temporal Ecological Variability in the Northern Gulf of Alaska: What Have We Learned Since the *Exxon Valdez* Oil Spill?" Leaders from both GWA LTM and HRM programs served as guest editors for the special issue. PIs submitted manuscripts for the special issue during summer and fall 2016. Peer reviews of special issue manuscripts began in late fall 2016.

Manuscripts are currently in the final stages of revision and acceptance. Depending on final acceptance, between 5 and 15 GWA papers will be included in the special issue.

The complete list of GWA LTM program publications is included in the Other References section at the end of this report.

Data publication

GWA LTM program data and associated metadata were made publicly available each year through AOOS's Gulf of Alaska Data Portal (http://portal.aoos.org/gulf-of-alaska.php). At the end of the first 5 years of the program, the datasets were assigned DOIs and published on DataOne (see data management project final report, Bochenek et al. 2018). Data publication for use by other agencies and research organizations also included historical EVOSTC-funded data synthesis.

To facilitate use of the data on the portal, Axiom, the GWA LTM data manager, and the science coordinator provided training to GWA program PIs, other scientists, and the public on how to access the data and perform visualizations with individual and multiple datasets (Fig. 7).

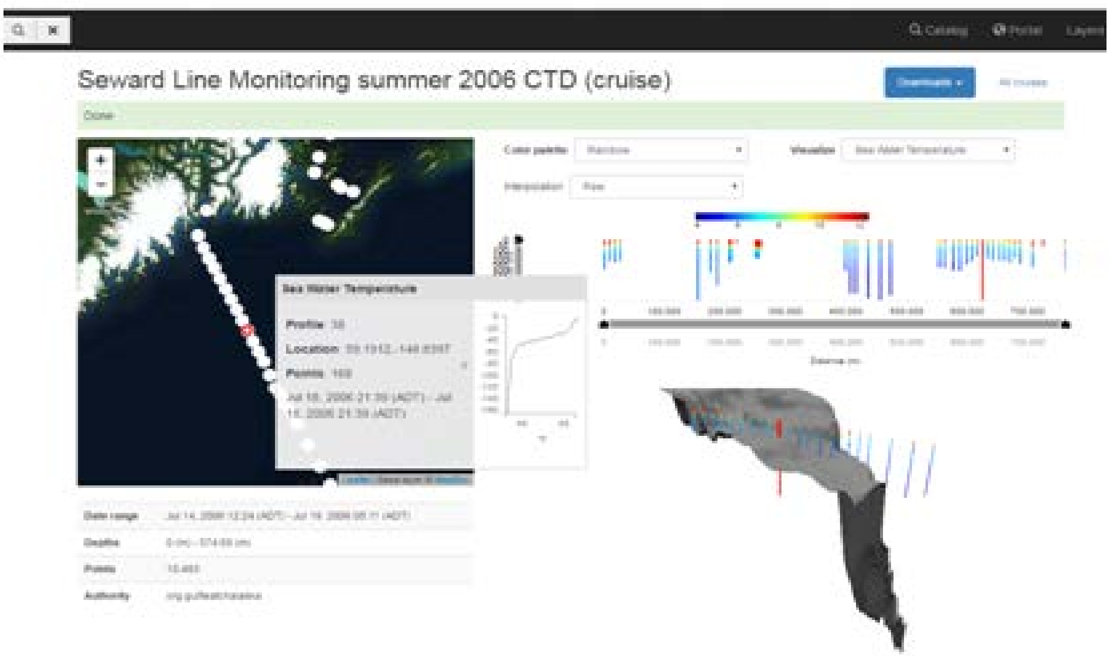

Figure 8. Example of data visualizations developed for the Gulf of Alaska data portal. This visualization shows conductivity, temperature, and depth (CTD) data from the Seward Line project in the Gulf of Alaska data portal, including spatial and temporal data parsing, vertical profiles, and linear interpolation for various oceanographic parameters.

Public outreach activities

The science coordinator worked closely with the outreach team to ensure current scientific results from projects were incorporated into outreach materials. Specific activities included the following:

- Supporting website (www.gulfwatchalaska.org) development to focus on science that is understandable by a general audience and guiding website updates as new findings became available
- Assisting with two-page profiles prepared for each project which provided information about the project PIs and answered the questions why, where, how, and what are we sampling
- Helping coordinate scientific presentations by GWA LTM PIs to communities as part of lecture series and festivals, discovery labs, classroom visits, webinars, and workshops
- Supporting development and presentation of discovery labs conducted by the Kachamek Bay Research Reserve that presented experiments and activities related to the GWA projects and findings in the Gulf of Alaska and attracted both residents and visitors
- Coordinating and producing videos and field notes about the work of various GWA LTM projects
- Facilitating Delta Sound Connections articles about GWA LTM project findings published each year and distributed throughout PWS and the Copper River Delta, including cruise ships, ferries, airports, visitor centers and other locations
- Reviewing drafts of a five-panel traveling exhibit depicting an overview of the GWA LTM program and each of the program's components, currently on display at the Alaska SeaLife Center
- Supporting and reviewing materials for virtual field trips developed by the Alaska SeaLife Center blending interviews with GWA LTM scientists with lesson plans for middle-school students; one virtual field trip featured the four program components and the work and careers of GWA scientists and the second, called The Bloom and the Blob, compared seasonal patterns of ocean conditions in the Gulf of Alaska and implications for food webs

The program coordination, logistics, and outreach final report (Hoffman and McCammon 2018) provides details on outreach activities.

DISCUSSION

The science coordination and synthesis project tied together all the projects in the GWA LTM program and facilitated collaboration, data management and synthesis, and outreach. As the nexus for all aspects of the program, the science coordinator was the key to program success. The science coordination and synthesis project met each of its objectives.

The science coordinator tracked milestones and deadlines and ensured they were met; facilitated communication, data sharing, and field work planning among GWA LTM projects and with other agencies and research organizations; helped improve integration of monitoring results across the GWA LTM program; coordinated with the SCC, SRT, and HRM program lead; and improved communication of monitoring information to resource managers and the public.

Throughout the five-year period, PIs eagerly participated in quarterly program meetings and readily shared information about their projects. Fall and winter in-person meetings facilitated by the science coordinator became opportunities for scientists to share findings and discuss themes emerging from the data. Component teams began scheduling side meetings for additional coordination, including cross-component meetings.

PIs coordinated with each other to share data and preliminary findings, discuss field work timing and collaborative efforts. Funds were leveraged from outside sources to extend field data collection and add additional components to survey cruises. For instance, biologists participated in oceanographic cruises to collect data on marine bird and mammals simultaneous to oceanographic data.

In particular, the science coordinator was instrumental in the on-time and integrated delivery of annual reports and work plans to EVOSTC and semi-annual reports to NOAA, preparation of the science synthesis report, accurate integration of GWA data into outreach materials, coordinated data management, productive quarterly PI meetings, inclusion of the GWA SRT into the program, collaborative working relationship with the HRM program, and successful publication of the Deep Sea Research Part II special issue on the ecology of the Gulf of Alaska.

The Pacific warm anomaly, or Blob, was a significant event that occurred within the first five years of the GWA program. Every scientific project in the GWA LTM program recorded observations directly associated with the phenomenon (e.g., warm temperatures, changes in nutrients and plankton, species distribution changes, a common murre die-off). Having the GWA program in place during this period allowed scientists across multiple disciplines to begin to put the pieces in place and tell the story about the Blob sooner than if the projects had been individually siloed.

The GWA program management team learned to be adaptive during the first five years of the GWA program, made adjustments, and will continue to adapt during the next five years of the LTM program. The team learned the importance of dedicating staff to the overall running of the program. Having one person dedicated to science coordination and synthesis was important for success, but turned out to not be enough because day-to-day coordination of a large program with 20 projects and more than 40 team members required dedicated attention that detracted from a focus on synthesizing data. To this end, the GWA program management team chose a modified program management team structure in the subsequent five years (FY17-21), whereby a program coordinator is added to reduce program administrative duties so that the science coordinator can focus on data collection, integration, and synthesis.

The program management team also realized the need for a person devoted to data management for such a large program with diverse sources and types of data. Mid-way through the five-year period a dedicated data manager was added to the data management project, which resulted in improved data delivery and publication.

CONCLUSIONS

Including a project dedicated to coordination and synthesis is valuable and necessary for the program to achieve its objectives. The science coordination and synthesis project should continue for the duration of the LTM program. While dedicating a project and one person to science coordination and synthesis was one of the keys to the success of the GWA LTM program in the first five years, the size and complexity of the program (20 projects and more than 40 team members) required the science coordinator to focus more on program coordination than science coordination. The program management team also noted that the skills associated with program coordination and science coordination may differ. To this end, the program management team recommends a modified program management team structure in the subsequent five years and splitting the science coordinator into two positions, a program coordinator and a science coordinator. The science coordinator will focus on cross-project and cross-program data synthesis and analysis and will collaborate with resource managers and other research programs to ensure the relevance and use of GWA LTM program data and scientific products as the program's time-series increases. The program coordinator will support the science coordinator and GWA LTM projects, including internal team collaboration, EVOSTC and NOAA deliverables, team meetings, SRT coordination, and outreach activities. Separating the roles of science coordinator and program coordinator in the future will help the program achieve its objectives to a higher degree.

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Esler, D., J. Bodkin, B. Ballachey, D. Monson, G. Esslinger, K. Kloecker, S. Iverson, K. Miles, and L. Bowen. 2014. 25 years after the Exxon Valdez oil spill: Recovery timelines of harlequin duck and sea otter populations. Alaska Marine Science Symposium, Anchorage. Presentation.

Esler, D. 2015. Injury and recovery of sea otters and harlequin ducks following the *Exxon Valdez* oil Spill: a quarter-century perspective. Presentation to Prince William Sound Regional Citizens' Advisory Council, Anchorage. Presentation

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

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

Esler, D., L. A. Sztukowski, D. H. Monson, S. A. Sethi, H. A. Coletti, B. P. Weitzman, K. A. Kloecker, and T. E. Hollmen. 2016. Barrow's goldeneye demographic responses to changing mussel conditions on wintering areas: A conceptual model exercise. Alaska Bird Conference, Cordova. Presentation.

Esslinger, G. G., H. A. Coletti, J. L. Bodkin, D. H. Monson, B. E. Ballachey, T. A. Dean, and D. Esler. 2017. Contrasting demography and behavior among sea otter populations in the northern Gulf of Alaska. Alaska Chapter of The Wildlife Society Annual Meeting, Fairbanks. Presentation.

Esslinger, G. G., H. A. Coletti, J. L. Bodkin, D. H. Monson, B. E. Ballachey, T. A. Dean, and D. Esler. 2017. Trends and equilibrium density vary among sea otter populations in the northern Gulf of Alaska. Sea Otter Conservation Workshop, Seattle. Presentation.

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

Heflin, B., M. L. Arimitsu, J. Piatt, S. Schoen, and E. Madison. 2016. Seabird and forage fish response to contrasting cold and warm years in Prince William Sound, Alaska. Pacific Seabird Group meeting, Honolulu. Poster.

Heintz, R. A., and M. G. Carls. 2016. Persistent Alaska North Slope crude oil: A quarter century of weathering. Ocean Sciences Meeting, New Orleans. Presentation.

Hoffman, K. 2012. Long-term monitoring program funded by the *Exxon Valdez* Oil Spill Trustee Council. Status report to the EVOSTC Public Advisory Commission, Anchorage. Presentation.

Hoffman, K. 2013. Have you seen them? The scientists of Gulf Watch Alaska. Ocean Fest, Cordova and Valdez. Presentation.

Holderied, K. 2013. Gulf Watch Alaska. Alaska Forum on the Environment, Anchorage. Presentation.

Holderied, K. 2013. Gulf Watch Alaska. Gulf of Alaska research program meeting, Anchorage. Presentation.

Holderied, K. 2013. Gulf Watch Alaska. Presentation to the Bureau of Ocean Energy Management, Anchorage. Presentation.

Holderied, K. 2015. How connected are Kachemak Bay and the Gulf of Alaska? And why it matters. Kachemak Bay Science Symposium, Homer. Presentation.

Holderied, K. 2016. Gulf Watch Alaska program overview. Prince William Sound Science Center Lecture science night lecture series, Cordova. Presentation.

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

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

Holderied, K., and D. Hondolero. 2016. Oceanographic and ecosystem response to the 2013-2015 Pacific Warm Anomaly in Kachemak Bay Alaska. Pacific Anomalies Workshop 2, Seattle. Poster.

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. Coastal and Estuarine Research Federation Conference, Portland, OR. Poster.

Holderied, K., R. Hopcroft, T. Weingartner, S. Batten, R. Campbell, S. Danielson, and A. Doroff. 2015. 2014-2015 Oceanographic Anomalies in the Gulf of Alaska. Pacific Anomalies Workshop 1, Seattle. Presentation.

Holderied, K., M. McCammon, K. Hoffman, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner. 2014. Gulf Watch Alaska ecosystem monitoring highlights from the 2013 season. Alaska Marine Science Symposium, Anchorage. Poster.

Holderied, K., M. McCammon, K. Hoffman, B. Ballachey, R. Hopcroft, M. Lindeberg, T. Weingartner, and T. Neher. 2014. 2013 Gulf Watch Alaska ecosystem monitoring highlights. Alaska Marine Science Symposium, Anchorage. Presentation.

Holderied, K., T. Neher, M. McCammon, K. Hoffman, M. Lindeberg, R. Hopcroft, T. Weingartner, B. Ballachey, H. Coletti, and D. Esler. 2016. Using integrated ecosystem observations from Gulf Watch Alaska to assess the effects of the 2014/2015 Pacific warm water anomaly in the Northern Gulf of Alaska. Ocean Sciences Conference, New Orleans. Poster.

Holderied, K., M. McCammon, K. Hoffman, B. Ballachey, T. Weingartner, M. Lindeberg, and R. Hopcroft. 2015. Gulf Watch Alaska – Monitoring the pulse of the Gulf of Alaska's changing ecosystems: Alaska Marine Science Symposium, Anchorage. Presentation.

Hollmen, T., and S. A. Sethi. 2013. Development of conceptual ecological models to support the Gulf Watch Alaska long-term monitoring program. PICES-2013, Nanaimo, British Columbia, Canada. Poster.

Hollmen, T., and S. A. Sethi. 2015. Conceptual models are flexible tools for research planning, prioritization, and communication. Alaska Marine Science Symposium, Anchorage. Presentation.

Hondolero, D. 2015. Kachemak Bay phytoplankton and harmful algal bloom patterns. Kachemak Bay National Estuarine Research Reserve Harmful Algal Bloom Workshop, Homer. Presentation.

Hondolero, D. 2015. Monitoring Phytoplankton in Kachemak Bay and lower Cook Inlet. Kachemak Bay Science Conference, Homer. Presentation.

Hondolero, D., and K. Holderied. 2016. Monitoring Phytoplankton in Kachemak Bay, Alaska. Alaska Marine Science Symposium, Homer. Poster.

Hondolero, D., K. Holderied, C. Pickens. 2014. Bloom and bust: Monitoring phytoplankton populations in Kachemak Bay. Alaska Marine Science Symposium, Homer. Poster.

Hondolero, D., S. Kibler, M. Vandersea, W. Litaker, and K. Holderied. 2015. Effects of Stratification and nutrient limitation on phytoplankton blooms in Kachemak Bay. American Fisheries Society, Alaska chapter meeting, Homer. Presentation.

Hopcroft, R. 2016. Plankton and oceanography. Prince William Sound Science Center community lecture series, Cordova. Presentation.

Hopcroft, R., and K. Coyle. 2014. Measuring the pulse of the Gulf of Alaska: 16 years of oceanographic observations along Seward Line, and in Prince William Sound. Alaska Marine Science Symposium, Anchorage. Presentation.

Hsu, B., M. A. Bishop, K. J. Kuletz, and R. Thorne. 2012. Linking hydroacoustic surveys for juvenile herring with winter seabird distribution in Prince William Sound. Alaska Bird Conference, Anchorage. Presentation.

Iken, K., and B. Konar. 2014. Strong local dynamics of intertidal communities in Kachemak Bay – a Gulf Watch Alaska program. Alaska Marine Science Symposium, Anchorage. Poster.

Iken, K., B. Konar, D. Esler, B. Weitzman, H. Coletti, D. Monson, B. Ballachey, T. Dean, and J. Bodkin. 2017. Spatial variability in mussel size frequency distribution in the Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Poster.

Klinger, T. 2014. What can we learn from long-term monitoring of intertidal habitats? Discovery lab public lecture, Homer. Presentation.

Kloecker, K. 2014. Women in science. Anchorage Public Schools presentation, Anchorage. Presentation.

Kloecker, K. A., D. H. Monson, B. Robinson, H. A. Coletti, B. E. Ballachey, and D. Esler. 2017. Correlates between sea otter diet and prey energetics in a mussel-specialist population. Sea Otter Conservation Workshop, Seattle. Presentation.

Konar, B., K. Iken, H. Coletti, T. Dean, and D. Monson. 2015. Influence of static habitat attributes on variability in rocky intertidal communities of the central Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Poster.

Konar, B., K. Iken, H. Coletti, T. Dean, D. Esler, B. Weitzman, K. Kloecker, and M. Lindeberg. 2017. Trends in intertidal seastar abundance and diversity across the Gulf of Alaska: looking for effects of seastar wasting. Alaska Marine Science Symposium, Anchorage. Poster.

Konar, B., S. Vanderwaal, and M. Rogers. 2015. Testing the use of unmanned aircraft systems for intertidal surveys—proof of concept. Alaska Marine Science Symposium, Anchorage. Poster.

Kuletz, K. J., D. A. Cushing, R. R. Hopcroft, S. L. Danielson, and E. A. Labunski. 2017. Running hot and cold: Shifts in seabird distribution in the northern Gulf of Alaska under different temperature regimes, based on Seward Line surveys, 2017-2015. Alaska Marine Science Symposium, Anchorage. Poster.

Kuletz, K., and E. Labunski. 2012. What's up and what's down: Seabird surveys in Kachemak Bay. Kachemak Bay Science Symposium, Homer. Presentation.

Kuletz, K., E. Labunski, M. Renner, and M. Bishop. 2013. The murrelet in winter –a review of marbled murrelet post-breeding distribution with a focus on Alaska. Pacific Seabird Group, Portland, OR. Presentation.

Kuletz, K. and J. Piatt. 2011. The plight of the 'glacier murrelet': What do receding glaciers have to do with the Kittlitz's murrelet? Wildlife Session, 'Classrooms for Climate' symposium, Chugach National Forest and University of Alaska Anchorage. Presentation.

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

Lindeberg, M. R. 2015. Seaweeds, fishes, monitoring and more! Prince William Sound Science Center and Cordova Night Lecture Series, Cordova. Presentation.

Lindeberg, M. R. 2016. Lingering oil in Prince William Sound: What we know, past and present. Prince William Sound Regional Citizens Advisory Council Meeting, Anchorage. Presentation.

Lindeberg, M., M. Arimitsu, M. A. Bishop, D. Cushing, R. Kaler, K. Kuletz, C. Matkin, J. Moran, J. Piatt, and J. Straley. 2016. Response to top predators and prey to changes in the marine environment: Gulf Watch Alaska's pelagic monitoring program. Alaska Marine Science Symposium, Anchorage. Poster.

Lindeberg, M., K. Holderied, D. Aderhold, K. Hoffman, M. Arimitsu, H. Coletti, and R. Hopcroft. 2017. Gulf Watch Alaska: Results from five years of ecosystem monitoring in the northern Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Presentation.

Lujan, S., S. D. Newsome, H. Coletti, V. von Biela, D. Monson, B. Ballachey, and J. Bodkin. 2014. Importance of micro- vs. macro-algae to Alaska marine invertebrates. Western Society of Naturalists, Tacoma. Presentation.

Madison, E., J. Piatt, M. Kissling, D. Douglas, M. Arimitsu, E. Lance, K. Kuletz, G. Drew, and E. Cooper. 2012. Post-breeding movements of Kittlitz's Murrelet from the Gulf of Alaska and Aleutian Islands to the Arctic. Pacific Seabird Group, Oahu. Presentation.

Marcotte, E., and M. Lytle. 2015. Sea otter diet in Kachemak Bay 2015. Oral presentation in fulfillment of thesis research credits. University of Alaska, Kachemak Bay campus, Homer.

Marshall, K., A. Beaudreau, B. Brenner, M. Hunsicker, A. O. Shelton, and E. Ward. 2017. Twenty-five years after the *Exxon Valdez* oil spill: a synthesis of climatic, anthropogenic, and ecological drivers of Gulf of Alaska communities. Alaska Marine Science Symposium, Anchorage, AK. Presentation.

Matkin, C. 2014. Killer whale predation. Killer Whale Wildlife Wednesday, Juneau. Presentation.

Matkin, C. 2015. Alaskan killer whales from Ketchikan to the Pribilofs. UAA Lifelong Learning Class. Lecturer.

Matkin, C. 2015. Killer whales. Discovery lab public lecture, Kachemak Bay Research Reserve, Homer. Presentation.

Matkin, C. 2015. Latest killer whale research findings. Kenai Fjords Tourboat Operators Meeting, Seward. Presentation.

Matkin, C. 2015. Population dynamics of Alaskan killer whales. Southern Resident Killer Whale Health Meeting, Seattle. Presentation.

Matkin, C. 2016. Killer whales. KPC/UAA Biology Class, Homer. Guest lecturer.

Matkin, C. 2016. Migrations: A closer look at killer whale movements. Alaska SeaLife Center, Seward. Presentation.

Matkin, C., and E. Bradfield. 2016. A history of the threatened AT1 killer whale population. State University of New York. Presentation.

Matkin, C., D. Herman, G. Ellis, E. Saulitis, D. Burrows. 2014. Are recent changes in dietary patterns of southern Alaska resident killer whales leading to nutritional stress? Alaska Marine Science Symposium, Anchorage. Poster.

Matkin, C. O., and E. L. Saulitis. 2014. Into great silence. Week-long Seminar, St. Catherine University, Minneapolis. Presentations.

Matkin, C. O., and E. L. Saulitis. 2014. Into great silence. ORCA program for pre-college students, Everett, WA. Presentations.

Matkin, C. O., and E. L. Saulitis. 2014. Into great silence. Southern Resident Killer Whale Symposium, Friday Harbor. Presentations.

Matkin, C. O., G. W. Testa, G. M. Ellis, and E. L. Saulitis. 2015. Is the fate of southern Alaska resident (SAR) killer whales (*Orcinus orca*) tied to salmon? Life history and population dynamics of SAR killer whales. Alaska Marine Science Symposium, Anchorage. Poster.

McCammon, M., and K. Holderied. 2013. Gulf Watch Alaska: Ecosystem monitoring … at the intersection of spilled oil and climate change. Alaska Forum on the Environment, Anchorage. Presentation.

McCammon, M., K. Hoffman, K. Holderied, T. Neher, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner. 2015. Gulf Watch Alaska: Monitoring the pulse of changing ecosystems in the Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Presentation.

McCammon, M., K. Hoffman, K. Holderied, T. Neher, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner. 2015. Gulf Watch Alaska: Monitoring the pulse of changing ecosystems in the Gulf of Alaska. Coastal and Estuarine Research Federation Conference, Portland, OR. Presentation.

McCammon, M., K. Hoffman, K. Holderied, T. Neher, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner. 2015. Gulf Watch Alaska: Monitoring the pulse of changing ecosystems in the Gulf of Alaska. Kachemak Bay Science Conference, Homer. Presentation.

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

Mearns, A. J., K. McLaughlin, R. Campbell, J. Bodkin, T. Dean, B. Ballachey, and J. Harper. 2013. Joint effort adds 24th year to long-term rocky intertidal photo-monitoring of western Prince William Sound. Alaska Marine Science Symposium, Anchorage. Poster.

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. Alaska Marine Science Symposium, Anchorage. Poster.

Monson, D. H., B. P. Weitzman, K. A. Kloecker, D. Esler, L. A. Sztukowsi, S. A. Sethi, H. A. Coletti, and T. Hollmen. 2017. Understanding trophic relationships of sea otters and their effects on demographic attributes. Sea Otter Conservation Workshop, Seattle. Presentation.

Moran, J. 2012. Impact of humpback whale predation on Pacific herring populations in the Gulf of Alaska. Advisory Panel to the Western Pacific Fishery Management Council, Honolulu. Invited speaker.

Moran, J. 2012. Impact of humpback whale predation on Pacific herring populations in the Gulf of Alaska. 154th Meeting of the Western Pacific Fishery Management Council, Honolulu. Invited speaker.

Moran, J. 2012. Impact of humpback whale predation on Pacific herring populations in the Gulf of Alaska. Managing for Recovery of the North Pacific Humpback Whales, Honolulu. Invited speaker.

Moran, J. 2014. Living in a humpback world. How does an increasing humpback whale population affect humans? Prince William Sound Science Center weekly lecture series, Cordova. Presentation.

Moran, J. 2014. Living in a humpback whale world. University of Eastern Finland, Finland. Guest lecturer.

Moran, J. 2014. Challenges of photo ID during the Alaskan winter. Wildlife Photo-ID Workshop, Joensuu, Finland. Invited speaker.

Moran, J. 2015. Fisheries anomalies in the Gulf of Alaska, 2014 and 2015 highlights. Gulf of Alaska 2015 Anomalies Workshop, Anchorage. Presentation.

Moran, J. 2015. Sea birds as indicators of humpback whale prey. Juneau Marine Naturalist Symposium, Juneau. Presentation.

Moran, J. 2016. Hawaii's humpbacks: What are they doing in Alaska? Whale Tales event, Kapalua, Maui, Hawaii. Invited speaker.

Moran, J. 2016. Impacts of a recovering humpback whale population. University of Alaska Southeast guest lecture, Juneau. Guest lecturer.

Moran, J., K. Boswell, and J. Straley. 2017. Humpback whales ruin a perfectly good overwintering strategy for Pacific herring in Alaska. PICES - Drivers of Dynamics of Small Pelagic Fish Resources, Victoria, British Columbia, Canada. Poster.

Moran, J., M. O'Dell, D. Dickson, J. Straley, and M. L. Arimitsu. 2017. Seasonal distribution of Dall's porpoise in Prince William Sound, Alaska. Alaska Marine Science Symposium. Anchorage. Poster.

Moran, J., and J. Straley. 2016. Missing herring: Water temperature, relocation or dinner? Alaska Marine Science Symposium, Anchorage. Poster.

Moran, J. R., J. M. Straley, and M. Arimitsu. 2015. Humpback whales as indicators of herring movements in Prince William Sound. Alaska Marine Science Symposium, Anchorage. Poster.

Neher, T. H., K. Holderied, M. McCammon, K. Hoffman, T. Weingartner, R. Hopcroft, M. Lindeberg, and B. Ballachey. 2016. Gulf Watch Alaska: Monitoring the pulse of the Gulf of Alaska's changing ecosystems. Alaska Marine Science Symposium, Anchorage. Poster.

Neher, T., M. McCammon, K. Hoffman, K. Holderied, B. Ballachey, R. Hopcroft, M. Lindeberg, and T. Weingartner. 2016. 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. Presentation.

Olsen, D.W. 2012. Killer whales of Alaska. KPC/UAA Biology Class, Homer. Guest lecturer.

Olsen, D. W. 2012. Killer Whales of Kenai Fjords National Park. Kenai Fjords National Park Service Interpreter Training, Seward. Presentation.

Olsen, D. W. 2013. Killer Whales of Coastal Alaska. Juneau Naturalist Symposium, Juneau. Presentation.

Olsen, D. W. 2014. Killer Whale Culture in Alaska. Juneau Naturalist Symposium, Juneau. Presentation.

Olsen, D. W. 2014. A comparison of satellite telemetry and photographic surveys in determining important foraging habitat for resident killer whales in the Gulf of Alaska. Alaska Coastal Rainforest Center Brown Bag Series, Juneau. Presentation.

Olsen, D. W. 2014. A comparison of satellite telemetry and photographic surveys in determining important foraging habitat for resident killer whales in the Gulf of Alaska. American Fisheries Society Annual Meeting, Juneau. Presentation.

Olsen, D. W. 2014. Killer whales of Alaska. UAS Biology Class, Juneau. Guest lecturer.

Olsen, D. W. 2014. Killer whale culture in Alaska. Wildlife Wednesday Series, Juneau. Presentation.

Olsen, D. W. 2015. Shifting hotspots: Core habitat use for resident killer whales in the Northern Gulf of Alaska. American Fisheries Society Student Chapter, Juneau. Presentation.

Olsen, D. W. 2015. Killer whale culture in Alaska. Seward Guide Training, Seward. Presentation.

Olsen, D. 2016. Family habits are hard to break: Killer whale culture in Prince William Sound. Prince William Sound Science Center community lecture series, Cordova. Presentation.

Olsen, D. W. 2016. Killer whale culture in Alaska. UAS Biology Class, Juneau. Guest lecturer.

Olsen, D. W. 2016. Killer whale culture in Alaska. KPC/UAA Biology Class, Homer. Guest lecturer.

Olsen, D. 2016. Killer whale culture in Alaska. Prince William Sound Science Center community lecture series, Cordova. Presentation.

Olsen, D. 2016. Killer whale culture in Alaska. Science after the spill: How are our ecosystems changing? Homer. Presentation.

Olsen, D. W. 2016. Mom knows best, killer whale culture in PWS. Prince William Sound Regional Citizens' Advisory Council, Anchorage. Presentation.

Olsen, D. W., C. M. Matkin, and R.D. Andrews. 2015. Shifting hotspots: Seasonal and pod-specific use of habitat by resident killer whales in the Northern Gulf of Alaska. Society for Marine Mammalogy Biennial Conference, San Francisco. Poster.

Olsen, D. W., C. M. Matkin, and R. D. Andrews, R.D. 2016. Shifting hotspots: Seasonal and pod-specific use of habitat by resident killer whales in the Northern Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Poster.

Pegau, W. S., M. L. Arimitsu, and M. Collins. 2015. Aerial surveys provide age-1 herring and forage fish indices for monitoring in Prince William Sound. Alaska Marine Science Symposium, Anchorage. Poster.

Piatt, J., G. Drew, M. Arimitsu, E. Madison, K. Kuletz, S. Zador. 2015. The glacier murrelet of Beringia: Pagophilia in the age of global warming. Pacific Seabird Group, San Jose. Presentation.

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

Renner, H., K. Kuletz, D. Irons, R. Kaler, L. Labunski, J. Parrish, H. Burgess, B. Bodenstein, J. Piatt, S. Schoen, and M. Renner. 2016. The murre die-off. Alaska Marine Science Symposium, Anchorage. Presentation.

Robinson, B. H., L. M. Phillips, and A. N. Powell. 2016. Accelerated energy intake increases survival of black oystercatchers broods. Alaska Bird Conference, Cordova. Presentation.

Savage, K., B. Witteveen, J. Moran, S. Raverty, K. B. Huntington, D. Fauquier, K. Wynn, F. VanDolah, P. Cottrell, M. Migura, and A. Jensen. 2016. 2015 Gulf of Alaska Large Whale Unusual Mortality Event. National Marine Animal Health and Stranding Network Conference, Shepardstown. Presentation.

Schaefer, A. 2016. Winter seabirds of PWS. Prince William Sound Science Center community lecture series, Cordova. Presentation.

Straley, J., and J. Moran. 2016. Bird killers of Prince William Sound: A foraging strategy used by humpback whales to detect schooling fish. Alaska Marine Science Symposium, Anchorage. Poster.

Sztukowski, L. A., D. H. Monson, D. Esler, S. A. Sethi, H. A. Coletti, B. P. Weitzman, K. A. Kloecker, and T. E. Hollmen. 2017. Nearshore marine consumer responses to changing prey conditions: Combining quantitative and qualitative model input into a conceptual framework. Alaska Marine Science Symposium, Anchorage. Presentation.

Sztukowski, L. A., S. A. Sethi, and T. E. Hollmen. 2016. Mesoscale ecosystem processes in the Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Poster.

Traiger, S. B., and B. Konar. 2015. Effects of glacial discharge on recruitment and succession in kelp bed communities. Alaska Marine Science Symposium, Anchorage. Poster.

Traiger, S. B., B. Konar, A. Doroff, and L. McCaslin. 2015. Distinguishing sources of foraging pits using pit dimensions and shell litter in nearshore substrates. Alaska Marine Science Symposium, Anchorage. Poster.

Ward, C. L., R. E. Blake, M. Hunsicker, A. O. Shelton, A. Hollowed, E. Harvey, and O. L. Petchey. 2017. From local to regional: spatial scaling of long-term diversity and stability in the Gulf of Alaska groundfish community. Canadian Conference for Fisheries Research, Montreal, Canada. Presentation.

Weitzman, B. P., A. K. Fukuyama, G. Shigenaka, H. A. Coletti, T. A. Dean, J. L. Bodkin, K. A. Kloecker, G. G. Esslinger, D. H. Monson, D. Esler, B. Konar, K. Iken, and B. E. Ballachey. 2016. Happy as a clam? Variation in bivalve abundance throughout the northeastern Pacific. NPS Centennial Science Symposium, Fairbanks. Presentation.

Weitzman, B. P., D. Esler, H. A. Coletti, B. Konar, T. A. Dean, J. L. Bodkin, K. Iken, A. K. Fukuyama, G. Shigenaka, and D. Lees. 2017. Can you dig it? Patterns of variability in clam assemblages within mixed-sediment habitats across the Gulf of Alaska. Alaska Marine Science Symposium, Anchorage. Presentation.

Zador, S., S. K. Gaichas, and S. Kasperski. 2016. Linking ecosystem processes to communities of practice through commercially fished species in the Gulf of Alaska. MSEAS 2016: Understanding marine socio-ecological systems: including the human dimension in Integrated Ecosystem Assessments, Brest, France. Presentation.