Long-Term
Monitoring

Response to EVOS TC Science Panel FY14 Proposal Comments – DRAFT 10-16-13

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LONG-TERM MONITORING/GULF WATCH ALASKA AND HERRING PROPOSALS

*Both Programs are an overall Fund, with two conditional funds, as noted below

1. General Comments

Proposals were lacking in detail, hindering their evaluation. There was not enough information provided for the science panel to evaluate the proposals and offer substantive suggestions. In order to evaluate proposal merits, the science panel wanted to see more detail, including:

- Sampling design, locations and methods, including QA/QC of data collection
- Approach to data analysis including statistical methods and/or relevant contrasts
- Explicit statement of how analyses will answer the major questions
- A discussion of results to date and any adjustments in project design in view of results
- Explicit statement of how individual project results relate to or will be integrated into the broader program
- The proposals should be reviewed as a whole by someone from the group before submission.

The panel, EVOSTC and agency staff will be looking at options for providing brief guidance and/or a form for the programs in advance of proposal drafting and submission to clarify expectations. When EVOSTC staff has a draft form or guidance, we will circulate it to the Team Leads for their feedback. There was also initial discussion regarding reporting which we will also circulate if it is further developed.

LTM and HRM Program Team Lead Response:
We appreciate the detailed review from the EVOSTC Science Panel, and the interest in the ongoing program. We'd like to call your intention to the newly designed Gulf Watch Alaska website (www.gulfwatchalaska.org), designed by Eric Cline, developed by the AOOS team at Axiom Consulting and hosted by AOOS. It is still a "work in progress", but we anticipate it will be a valuable resource for the general public, the Trustee Council, and a variety of stakeholders.

We continue to work with the EVOSTC staff to refine reporting and annual proposal requirements, and our submissions have been made in accordance with the guidance we received. There seems to be a difference of opinion on what was intended with the submitted materials. It appears the materials were reviewed as completely new proposals, rather than the third year work plans from the original, five-year approved programs. Many of the panel's comments were also specifically addressed in our original proposals, the Year 1 annual report and the recent 6-month report.

Several of the Science Panel's comments recommend substantial changes to the previously approved programs. We understand that there are a number of new panel members, and suggest that the Science Panel and the LTM and HRM Programs could mutually benefit by establishing a dialogue between panel members and the program science leads, perhaps through a joint webinar/teleconference meeting that might include some of the project PIs called out in subsequent comments.

Some of the specific issues described by the panel arise because of the program teams' need to report – within a defined page limit - on an integrated program with multiple projects, and the panel's desire to have greater detail on individual projects. Those familiar with the history of the Trustee Council's request for proposals for integrated programs are also familiar with our challenges in creating an integrated program composed of a set of long-standing individual projects with limited funding. Therefore, our report summaries focus on the overall program with individual project details provided in the investigator project summaries. We look forward to finding ways to communicate information in a way that fosters integration and synthesis across the program.

In response to specific issues raised:
a. <u>Sampling design, locations and methods, including QA/QC</u>. Documented sampling protocols are required by all program PIs and are available in a folder on the Gulf Watch Alaska Research Workspace coordinated by Axiom Consulting. Any changes to these protocols must be approved by the Program Management Team and Science Coordinating Committee. We do not have the financial resources to conduct an in-depth review of each protocol nor to provide additional QA/QC for every dataset beyond what is done by the investigators. Since this program is highly leveraged, and depends on monitoring assets supported by multiple federal and state agencies and university partners, we depend on these entities to ensure adequate instrument calibration and data QA/QC, and to document these procedures in the sampling protocols and metadata. We can make these protocols available to the Science Panel if desired. In addition, our science coordinator, Dr. Tammy Neher, reviews and coordinates metadata and data formats at the overall program level.

b. <u>Approach to data analysis including statistical methods and/or relevant contrasts</u>. Detailed statistical analyses vary for each project to address the specific time series, and several of the program scientists have completed or have publications in press that address their analytical approaches (examples include Weingartner, Bishop, and Matkin). We would appreciate clarification from the Science Panel if they are referring to particular analyses with this comment, as data analysis approaches are discussed within the detailed project descriptions. We can then include additional details on data analysis approaches in our year 2 annual report.

c. Explicit statement of how analyses will answer the major questions. One planned topic of our annual Gulf Watch Alaska PI meeting in November 2013 is to discuss all the research questions listed in our original proposal and review preparation of initial results for the February 2015 joint Science Workshop and a journal special issue following the workshop. We can provide that information and a summary of the analytical approaches in our year 2 annual report. We also note that the goals of the Gulf Watch Alaska ecosystem monitoring program are not limited to providing information to address these research questions. These questions were selected to identify some, but not all, of the issues that could be addressed by the Trustee Council's long-term monitoring program. By collecting and providing data to the science community, our goal is also to facilitate significantly more Gulf of Alaska research than can be accomplished within the funding levels of this program alone.

d. Discussion of results to date and any adjustments in project design in view of results. The program is designed as a long-term monitoring program and is in its second year of data collection. The annual and 6-month reports include more detailed descriptions of results to date and adjustments in project design. The Piatt and Arimitsu forage fish project is one example where the project design has been modified based on initial results. We will work with the EVOSTC staff and Science Panel to refine report formats in order to provide the level of detail desired by the Science Panel and to provide our PIs with clear guidance for their report input.

e. Explicit statement of how individual project results relate to or will be integrated into the broader program. Project integration is discussed in our original 5-year proposal, in the Coordination and Collaboration sections for each individual project in the Year 3 work plan submission, and in our annual and 6-month reports. As discussed in the semi-annual report, we are beginning the integration process through the expert opinion-weighted conceptual model development process. We will add to this process through the November 2013 time series workshop that includes a pattern analysis and discussion using trend cards. The products of these two efforts will be used to help inform the synthesis process. We agree that this is an important topic and recommend that the Science Panel and LTM and HRM program team leads discuss this in the near future.

f. Overall review of proposals. The entire package was reviewed by the Program Management Team (program lead, science lead, science coordinator, and administrative lead). We agree that there is still "unevenness" in the depth of information provided in the individual components and look forward to working with EVOSTC staff and Science Panel to refine work plan and report format and content.

2. Physical Oceanography concerns

An overall review by an outside expert in physical oceanography and climate would be useful. In the current round of proposals, the need to describe physical oceanographic forcing was rarely described. Several proposals generally provided vague language, in some cases they cut and pasted text from the overarching and original 2012 proposal.

There is uneven treatment and an apparent lack of collaboration among the four oceanography projects in LTM. The Weingartner (GAK1) and Hopcroft (Seward Line) proposals are well thought out and collaborative. However, Campbell and Doroff proposals should be more collaborative and thorough, including physical measurements; they are also unclear on instrument calibration and data QA/QC. There is no evidence of collaboration with trained physical oceanographers or reference to the PWS sampling stations in the Hopcroft proposal. An overall review of the physical oceanography and climate aspects of LTM (and, to a lesser extent, herring) would be useful.

Outside expert for oceanography review - some suggestions for trained oceanographers who work with biologists include: John Largier, UC Davis/Bodega Marine Laboratory, Steven Bogard, SWFSC-NMFS, and Jack Barth, OSU.

LTM Program Team Lead Response:
While we welcome additional collaborations with other physical oceanography experts, we believe that our program is being well served by the existing investigators. Dr. Weingartner and Dr. Hopcroft serve on the GWA Science Coordinating Committee as leads for the Environmental Drivers component and bring extensive physical oceanography experience to that leadership role. Dr. Campbell (Prince William Sound oceanography project) has considerable experience with cross-disciplinary (physical oceanography and biological) marine research, instrumentation, and instrument calibration. Ms. Holderied (Cook Inlet oceanography project) also is a coastal physical oceanographer. Ms. Doroff (Cook Inlet oceanography project) is the research coordinator for the Kachemak Bay National Estuarine Research Reserve, oversees an extensive long-term water quality monitoring program in Kachemak Bay, is the PI on a project to validate ocean circulation models for the Reserve, and is skilled in communicating science to coastal decision-makers. The GWA team also works closely with Dr. Pegau of the HRM program, who is an experienced physical oceanographer. All GWA PIs interact with each other regularly, and at a minimum via quarterly PI teleconferences, email, an annual PI meeting, and the annual Alaska Marine Science Symposium. In addition to these contacts, team members add additional value to the program through their contacts and collaborations with numerous other programs funded by other entities.

The Year 3 work plan project submissions for the physical oceanography part of the Environmental Drivers component (GAK1 mooring, Seward Line, Prince William Sound, Cook Inlet) did not propose significant changes from the original sampling plan of the 5-year Gulf Watch Alaska program. We followed guidance from Trustee

Council staff prohibiting us from proposing any work that required additional funding from what had been approved for the 5-year program. We did include text from the original proposal for background, but did not completely repeat the original proposal language or information included in the annual and 6-month reports.

The Environmental Drivers component, which also includes Dr. Batten's Continuous Plankton Recorder measurements, was designed to capture seasonal and interannual oceanographic patterns in the major estuaries of Prince William Sound and lower Cook Inlet, as well as across the Gulf of Alaska shelf. The program builds on existing oceanographic time series in all regions, collectively provides information to assess linkages in shelf-estuary conditions, and provides environmental data for investigators in the Benthic and Pelagic monitoring components. We have ongoing collaboration between several of the Environmental Drivers projects, as well as with other component projects, as described in the "Coordination and Collaboration" sections of the proposed work plan and the annual and 6-month reports. A coordinated review of the physical oceanographic (and other) time series data is already part of the agenda for the November 2013 PI meeting and will also be a part of the preparatory work for the February 2015 joint Science Workshop with the HRM program. As mentioned above, all of our projects have sampling protocols that address QA/QC, including instrument calibration. The sampling protocols are maintained on the GWA Research Workspace and can be made available to the Science Panel.

3. Publications

The science panel encourages investigators to publish their results in peer-reviewed journals to make their hard-won results available to wider scientific audience. This encouragement especially applies to young investigators who are establishing their careers. They may quickly become unable to compete for other jobs. We anticipate the FY17 Invitation will include an expectation to publish.

LTM and HRM Program Team Lead Response
We agree with the recommendation to publish results in peer-reviewed journals, and have included references in our reports to several publications already in process. In addition, we have started to work with PIs to develop materials for a special journal issue, which will also support science synthesis efforts prior to the 2015 workshop.

4. Data Management

The science panel is concerned about progress on data management. The data management proposal drew heavily on their old proposal without including sufficient updated evidence of interactions between the programs' PIs and the data management team. In addition, there does not appear to be a data management policy or QA/QC policy created as the programs approach Year Three. In addition, no milestones were reported in the newly submitted proposals, so it was difficult to gauge how much progress had been made in the last two years. Moreover, it was not clear how data would be available for synthesis. The panel recommends that the Council condition funding upon the creation of a credible and detailed data management policy and a QA/QC policy and include clear milestones in for their proposal.

Regarding a QA/QC policy: such a document is a basic need of any data management. We note too that instruments commonly need to be calibrated before and after use to be able to adjust for measurement drift, if it occurs. With two separate data centers operating under the EVOSTC program it is crucial that a high level of QA/QC be maintained. The Science Panel is concerned that adequate attention is not being devoted to this fundamental aspect of data management. It is particularly important that to assemble complete metadata to ensure that long-term data sets can be verified and understood once the current participants have moved on to new positions. For example, EPA and NSF require detailed data management and QA/QC plans as part of all proposals. Large monitoring programs, such as NSF's LTER and oceanographic programs, devote considerable time and effort to addressing these critical needs.

Example: As a specific example, the Ocean Tracking Network (OTN) has four nearly full-time people creating metadata forms that are required to be filled out, submitted and checked for QA-QC before data can be added to the database. Since OTN is currently adding equipment to tracking arrays in PWS, it would be particularly appropriate at this time to arrange communication between senior OTN data managers with EVOSTC program data PIs to ensure that data standards are adequate. As with OTN, and as emphasized in the initial funding of the EVOSTC programs, skilled data management resulting in data that can be relied upon by the scientific community and resource agencies will ultimately determine the long-term success and influence of the programs. The contact at OTN is Bob Branton (bob.branton@gmail.com) or (bob.branton@dal.ca).

LTM and HRM Program Team Lead Response:
As mentioned above, all of the GWA projects have sampling protocols that address QA/QC, including instrument calibration. The sampling protocols are maintained on the GWA's Research Workspace account. In addition, all PIs were required to sign a Program Management Plan, which included a detailed Data Management and Public Access Policy. That policy was developed after review of a multitude of data policies for programs such as GLOBEC, NSF LTERs, NCEAS, North Pacific Research Board's Bering Sea and Gulf of Alaska Integrated Research Programs, PISCO, ORNL (NASA), and TEAM Network.

Because of limited funding for data management services in this proposal (about 7% of total budget), the Program Management Team and Science Coordinating Committee adopted an approach that provide tools for PIs to assist with managing their data themselves. These tools include assistance with writing metadata in ways that follow national standards, and use of the Research Workspace to provide greater data and information access to the entire program team for use in synthesis and analysis activities. We would greatly appreciate more funding and staff to devote to this effort, but the entire program has been encouraged to work within the existing budget limits.

Our approach has been to leverage the resources of the Alaska Ocean Observing System's data management system, which is the only one of its kind with the mission of serving as a regional data assembly center and archive for Alaska ocean and coastal data and information products. All PIs submit their data annually to a private, password-protected GWA account on the AOOS Research Workspace. That data is then available for all program members to access and use for synthesis and analysis activities. At agreed upon times, the most current, QA/QC'd data are "published" from this site into the publicly accessible Gulf of Alaska portion of the AOOS Ocean Portal. We are also developing an automated means to publish this data to a DataONE node and to NOAA's National Oceanographic Data Center.

As with most research and monitoring programs, we have had challenges changing the culture from individuals holding on to their own data on personal computers, to one of more open access and sharing. However, we are making progress, and the investigators see the value in doing so. We have already started making data publicly available and are actively working with our PIs, science coordinator, NCEAS and data management team to further streamline processes for internal data sharing and public access.

We have worked closely with Trustee Council staff regarding annual proposals and reports, and submitted only detail to indicate if there were any major deviations from the approach described in the approved 5-year proposal. However, we realize that the Science Panel would like more detail relating to data management and have provided that detail in two attached documents: Appendix A: LTM Program Data Management Plan (a compilation in one document of text included in the original 5 year approved proposal, reports, the Program Management Plan, and other additional explanatory information) and Appendix B: LTM Program Data Management Services Progress to Date report, which includes attached lists of all the data acquired to date. Please let us know if you would like any additional detail.

5. Attrition of Experienced Personnel

The panel notes that it may be a challenge to replace experienced personnel retiring or transitioning out of the programs, but the need for their expertise remains. To address these changes, the panel suggests that the programs partner their junior PIs with newly recruited, experienced scientists. Where difficulties exist in filling key positions, the panel also suggests strategically tapping outside experts to review projects and provide consultation and setting up a Post-Doc training program for the LTM and Herring projects. As experienced personnel leave the program either through retirement or departure, the salary savings could fund this kind of activity.

Potential Resource - The panel encourages the programs to consider options for developing concepts for postdoctoral programs that can help address these issues. The panel and the programs' internal panels and advisory groups can provide assistance in identifying potential post doc candidates who may be helpful to the programs. Intergovernmental Personnel Assignments and perhaps NRC Research Associate post-docs may also be a source for additional expertise and post-doc work.

LTM and HRM Program Team Lead Response:
We agree on the potential side benefit of long-term research and monitoring programs to provide training opportunities for junior scientists. We have actively encouraged such efforts from the beginning of the program and have a large group of young scientists already working in both programs. Training replacements has focused on those projects where we expect to lose key investigators in the near future. It is not practical to train post-docs in every project to ensure replacements of unexpected losses. However, we would be open to discussing this further with the Science Panel and Trustee Council staff if additional resources are available.

6. Synthesis in Advance of February 2015 Workshop

There is concern from our review of the proposals that the programs are postponing work on synthesis until just before the Workshop. The programs should think through and create a step-by-step route and design for their 2015 synthesis so there is sufficient field time to work on it. This plan should include mechanisms and process. The part of synthesis that involves creation of and testing of models is best done by an iterative process in which modeling is sequentially tested by reference to new data and the models revised accordingly. There was also a suggestion to focus on cross-cutting topical issues, such as acoustics and calibration. PIs with different expertise could be paired to initiate and encourage actual synthetic analyses and presentation in contrast to single PI presentations on isolated projects or topics. Examples for pairings include: disease and physiology, and modeling of herring movements and disease.

LTM Program Team Lead Response: We agree with the Science Panel on the need for advance preparation for the joint Science Workshop. Synthesis-related efforts have been underway since Year 1 of the GWA program, with initial efforts reported in the annual and 6-month reports (Holderied, project 13120114-H and historical data compilation in Jones, project 13120120). As an early tool to promote cross-cutting analyses, the November 2012 PI meeting included cross-disciplinary break-out groups of investigators to assess components for Gulf of Alaska conceptual ecological models (see Conceptual Ecological Modeling project comments for more details). The GWA program has planned a focused, inter-disciplinary time series analysis work session during the upcoming annual PI meeting in November 2013, with an emphasis on coordination for potential scientific journal publications and preparation for the February 2015 Science Workshop. We are inviting scientists from other programs to join in the November work session, including individuals from the HRM program, the North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program, Alaska Department of Fish and Game, and the NOAA National Weather Service. The GWA program team leads believe that the programs would benefit from additional coordination with the Science Panel in advance of the February 2015 Science Workshop and would appreciate a discussion with Trustee Council staff on options for such coordination.

The HRM program is already benefiting from a synthesis submitted in May 2013 regarding the first year of life of herring. This allows the program to build upon that effort in the iterative manner suggested. The potential synthesis topics suggested by the Science Panel are intriguing, but we are limited by the information available and may not have the correct type of information to answer these particular questions. We will examine them more closely to further assess what is feasible.

7. LTM/Gulf Watch Alaska Program 14120114

The science panel appreciates the general approach of the LTM program but feels that more basic information was needed to fully evaluate the potential success of the program. The discussion below includes several projects that are highlighted as examples that would have benefitted from the inclusion of additional information for developing more informative proposals and progress reports. The panel looks for more informative proposals and progress reports in the future. Our goal is to provide feedback that may strengthen the program while it is still in its formative stage of implementation.

*Proposals by Matkin on killer whales, Rice on humpback whales, and Lindeman on benthic monitoring were all praised by the Science Panel for their importance, inclusion of detail, and significant progress.

LTM Program Team Lead Response:
We agree that the GWA program would benefit from additional discussion with the Science Panel and look forward to those discussions. Please also see comments under #1 above. We also appreciate the positive comments on particular report contents from the Science Panel. Please note that the PIs for the humpback whale project are Dr. Straley and Dr. Moran, not Rice. Dr. Rice retired last year, as reported in our March 2013 annual report, and Dr. Lindeberg is the new Pelagic (not Benthic) component lead. Dr. Lindeberg is collaborating with the Benthic group, but Ballachey is the component lead and project lead for project 13120114-R. Drs. Konar and Iken are project leads for Benthic Monitoring project 13120114-L.

8. Program Science Panel and Upcoming 2015 Synthesis

*See also Synthesis in Advance of February 2015 Workshop, above.

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

This is a major problem. Bringing an outside science review into projects makes changes difficult (because of already established long-term monitoring protocols). Some of these aspects should have been established in Year 1 rather than just before a major synthesis workshop in Year 3. The science panel suggests they establish a group that reviews the developed monitoring and integration plans and how they support synthesis.

Regarding the Program's Science Panel: What is its status? Their influence and guidance is not apparent; guidance, integration is needed. The LTM Program's internal science panel should be already composed, constituted and advising by now.

LTM Program Team Lead Response:
The internal Science Coordinating Committee was established at the beginning of the GWA program and has helped coordinate and advise the program from the beginning, as described in program reports and work plans. The timing of the establishment of the external GWA Science Review panel was discussed in detail with the Program Management Team, Science Coordinating Committee, Trustee Council staff and other integrated research program leads. The joint decision was to optimize use of valuable review panel member time at a time when program assessment is most needed, which is leading up to and following the joint Science Workshop in 2015. We anticipate a significant time commitment by the external panel, made up of volunteers, over at least a two year period. We did not expect, and were advised by Council staff not to propose, significant changes to the sampling program during the first 5-year phase of GWA, especially in the first 2 years. Therefore we plan to establish the external Science Review panel before the end of year 2 of the program (February 2014).

The GWA and HRM program leads are concerned that several Science Panel comments indicate potential recommendations for significant changes to GWA monitoring efforts during the current 5-year phase of the GWA program. The program intentionally builds on long-term monitoring efforts funded by the EVOS Trustee Council and other agencies over the past 2 decades. Some adjustments are being made to monitoring programs based on initial results (e.g., forage fish monitoring in PWS, additional coordination of benthic sampling protocols between regions), but we do not anticipate major changes during this 5-year period. If the panel recommends otherwise, that will require additional discussion. We anticipate that the review of the monitoring program and data syntheses planned for the joint Science Workshop will primarily be used to inform planning for the next 5-year phase of the GWA program.

9. Bochenek. Data Management 14120114-D *CONDITIONAL FUND

*See Data Management, above and below, in Herring Program.

LTM Program Team Lead Response: See comments to #4 above.

10. Bishop. Gulfwatch long-term monitoring pelagic component - Long-term monitoring of seabird abundance and habitat associations during late fall and winter in Prince William Sound 14120114-C

The proposed objectives are to characterize the spatial and temporal distribution of seabirds in PWS during late fall and winter and relate the presence of seabirds with prey distributions from hydro-acoustic surveys for identifying winter habitat of seabirds and improving estimates of herring consumption in winter. The panel feels that improved resolution of sampling during summer, when seabirds are nesting and most accurately censused, may be more fruitful than conducting expansive surveys during the winter. Given the overlap of investigators on the summer and winter surveys, we encourage them to consider conducting annual rather than biannual surveys in summer by scaling back winter surveys.

LTM Program Team Lead Response:
We need clarification on the recommendation on seabird surveys, since the Science Panel comments appear to recommend combining two different surveys, one under the Pelagic component (Bishop, 14120114-C) and one under the Benthic component (Kuletz and Irons, 13120114-K). The Bishop project is specifically designed to collect information in late fall and winter to complement other summer seabird monitoring efforts. The Bishop project is also conducted cost-effectively in conjunction with HRM and GWA humpback whale surveys and leverages vessel time provided by those projects. Conducting additional summer surveys under the Kuletz and Irons project would require significantly more funding from the Trustee Council. In addition, as part of the first 5-year phase, we are evaluating our sampling design, both through individual projects (e.g. Coletti, 13120114-F on evaluation of nearshore bird surveys), and in preparation for the 2015 joint Science Workshop.

11. Campbell. Long term monitoring of oceanographic conditions in Prince William Sound 14120114-E

The physical measurements are very important in a project of this kind. There is little evidence that the nuances of the physical oceanography – from instrument calibration, data QA, interpretation of results, and relationships to other similar programs – are in place. There is no reference to or integration with the UA (University of Alaska) physical oceanographers from the Gulf Watch Alaska (GAK1) program or to the physical measurements being made in PWS in the Seward Line program, or the historical physical oceanography conducted by the PWSSC that describes water mass movements from the shelf into Hinchinbrook Entrance and through PWS.

For the moored instrument, calibration is a concern. The proposal states that instruments will be calibrated annually. Typically they should be calibrated before and after each deployment, and the data corrected for drift of the instruments. Has a physical oceanographer been consulted on this? The concern is that the physical data will be assumed to be accurate and will be used for various purposes without adequate QA/QC.

There is not a lot of specificity on how the plankton will be handled, net sizes or other factors. Need further information on target species, and it would be good to show how this relates to Hopcroft's Seward line project, particularly those EVOSTC funded samples taken in PWS, and to Batten's continuous plankton recorder results. There is no evidence of this in the Collaboration and Cooperation section of the proposal.

LTM Program Team Lead Response: As mentioned previously, Dr. Campbell (Prince William Sound oceanography project) has considerable experience with cross-disciplinary (physical oceanography and biological) marine research, instrumentation, and instrument calibration. Details about how plankton are handled, net sizes, and other factors are in the original proposal as well as Dr. Campbell's sampling protocol.

All GWA PIs interact with each other at minimum via quarterly PI teleconferences, email, and an annual PI meeting. PIs such as Dr. Campbell who called out collaborations with parties external to GWA in their work plans did so to emphasize relationships leveraged by GWA. Interactions between and among GWA PIs occur with regularity, as does contact between Dr. Campbell and physical oceanographers both at UA and other institutes. Dr. Campbell is not only highly aware of historic PWSSC oceanographic data collection efforts, but he regularly works with the data collected during those projects.

12. Carls & Lindeberg. Long-term Monitoring: Lingering Oil - Extending the Tracking of oil levels and weathering (PAH composition) in PWS through time 14120114-S

This is one of the few projects presenting data, and it was "refreshing." The hydrocarbon database is important to assess environmental damage in the event of another oil spill, and it may be still relevant to biological assessments of long-term oil impacts and perhaps to re-opener disputes. The PI's indicate that there are not enough funds for complete updating and QA/QC of the database with 1-person/yr effort. If so, arrangements should be made to correct this oversight. If the solution is to request additional funds, then a detailed supplemental proposal should fully justify this request. In general, the science panel requests that fundamental information on the numbers and locations of sampling (both site and tidal elevation) be included in future project proposals and reports to more fully evaluate them.

LTM Program Team Lead Response:
The Science Panel comment indicates that they found the presentation of historical data useful in the work plan proposal as no new data has yet been collected under this project. We suggest this topic be included in a discussion between the GWA leads, Trustee Council staff and Science Panel on format for program reports and work plan submissions. The hydrocarbon database is maintained primarily as an in-kind contribution by the NOAA National Marine Fisheries Service, Auke Bay Laboratory, but could be significantly improved with additional funding. We can submit a detailed supplemental proposal if requested by Trustee Council staff and if additional funds are available. As detailed in the year 3 work plan proposal, the FY 2014 effort in this project will include determination of the specific sites to be sampled in 2015. The site determination will be based, at a minimum, on mussel bed time series started in the early 1990s, beach surveys that were continued up to 2004, and spatial modeling analysis that was initiated in 2008. Regarding the lingering oil surveys, site selection is determined randomly with replacement, in a stratified design based on the degree of initial oiling of shore segments (heavy, moderate, and light oiling). Tidal elevation for these surveys initially ranged from MHHW to +3m but was subsequently expanded to the zero tide line when oil was discovered below the expected threshold. Detailed information on the sampling sites and tidal elevation will be provided when available.

13. Doroff. Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay to understand recovery and restoration of injured near-shore species 14120114-G

The Science Panel agrees that mapping the waters of lower Cook Inlet and Kachemak Bay to understand the effects of intrusions of the Alaska Coastal Current and variation of other currents on phytoplankton and zooplankton distribution and abundance is a valuable part of long-term ecosystem monitoring. Questions arose about the ability to meet this objective with the proposed unbalanced sampling design. Sampling transects 3, 4, 6, and 7 (Kachemak Bay and lower Cook Inlet) will be reduced from quarterly in the first three years of the project to three times in Y4 and twice in Y5 due to budget constraints, thereby limiting the scope of analysis among years. Would a different, but inter-annually consistent, design provide a more powerful, thorough, and rigorous analysis of temporal and spatial variation under these budget constraints? Alternatives might include reducing the: (1) sampling frequency of transects to three times per year throughout the study, (2) the number of stations along transects to maintain quarterly sampling or (3) the number of transects to maintain quarterly sampling. We advise that this sampling plan be carefully re-evaluated and justified.

Concerns were also expressed about the collection and handling of physical measurements – are instruments appropriately calibrated, and how are data handled (QA/QC)? Evidence of collaboration with other physical measurement programs (GAK1, Seward Line) and the relationship to (and use of?) the results of the new Seward Line PWS stations were of interest. Are the physical oceanography measurements in the program designed to take into account the gyre and counter-gyre in Kachemak Bay?

LTM Program Team Lead Response:
We are near the end of Year 2 of the 5-year program, with vessel contracts established through June 2014, and therefore cannot change the sampling design as suggested by the Science Panel, since much of the quarterly sampling has already been accomplished. We agree that it would be preferable to continue quarterly sampling in years 4 and 5 and have leveraged funding from other sources to be able to accomplish more sampling in years 4 and 5 than was originally proposed, while not increasing the requested funding. We reduced the sampling plan to fit within the overall budget limit for the program and still accomplish our primary goals. We decided to conduct quarterly sampling in lower Cook Inlet (in addition to monthly sampling in Kachemak Bay) in the first 3 years to improve assessment of seasonal variability, particularly of fall and winter conditions. We considered conducting less frequent sampling during the year to maintain consistency over 5 years, but determined that collecting data to assess seasonal variability was an important information gap to fill, particularly as we are interested in shelf-estuary exchange (in collaboration with Weingartner and Hopcroft Gulf of Alaska projects), in regional comparisons with Prince William Sound conditions (in collaboration with Campbell project) and in providing environmental data for the Benthic Monitoring efforts (Konar and Iken project) and for harmful algal bloom and ocean acidification research (separate NOAA and ADFG studies). We are fortunate to have captured a range of different forcing conditions (near record versus normal snow pack and normal summer precipitation/temperature versus dry/warm summer conditions) in the first 2 years of the project.

The monthly small boat sampling is maintained for all 5 years. While reducing the number of stations along each transect would not substantially reduce the vessel charter costs (due to length of time to conduct transects and relatively short time for CTD casts alone), we have also evaluated that option. However our initial data results demonstrate that current station spacing is needed to capture the strong horizontal gradients in Cook Inlet oceanographic conditions, particularly as those gradients are important for plankton, marine birds and other species.

As described in the original proposal and year 3 work plan, data QA/QC and instrument calibration for the water quality station instruments is conducted in accordance with the National Estuarine Research Reserve System-wide Monitoring Program, including a secondary review by the national NERR program's Central Data Management office. Additional information on water quality monitoring QA/QC can be found at http://cdmo.baruch.sc.edu/data/qaqc.cfm for Kachemak Bay. For conductivity-temperature-depth (CTD) profiler data, in addition to the processing steps described in the work plan, the final data formats are being coordinated with the data management team for consistency across the different oceanography projects. The Seabird Electronics 19plus profilers are sent to Seabird

Electronics annually for sensor calibration. Additional information on calibration and data QA/QC for the oceanographic data is also available in the project's sampling protocol. The zooplankton data is collected using the same protocols as in the Campbell Prince William Sound project, and Campbell is conducting zooplankton identification and data processing.

As described in the Environmental Drivers overview in the original proposal and referenced in the year 3 work plan, the analysis of data from the first 2.5 years of this project, along with previous oceanographic sampling along the same transects, will be used in conjunction with data from the GAK1, Seward Line, and Prince William Sound oceanography projects to assess temporal and spatial variability in oceanographic conditions. The sampling design was planned to be complementary with the other projects and to build off previous Cook Inlet oceanographic sampling to create longer time series. We are looking forward to discussing results of the first 18 months of sampling in this project with our colleagues at the November 2013 PI meeting and planning synthesis efforts in the coming year. We would also welcome an expanded discussion with Science Panel members who are interested in GWA oceanographic monitoring.

The Science Panel comments refer to the outer Kachemak Bay gyre and counter-gyre identified as potential subtidal circulation patterns by Burbank (1977), which is one of the reasons for sampling along Transect 4 in outer Kachemak Bay. While the GWA project is not funded to measure currents, Doroff and Holderied are involved in separately funded research to deploy drifter buoys in Kachemak Bay and develop an operational National Ocean Service ocean circulation model for Cook Inlet and Kachemak Bay. Those ocean circulation studies will provide new information on Cook Inlet tidal and subtidal circulation patterns and are an example of how we are leveraging other funding to enhance the GWA program.

14. Hollmen. Synthesis and Conceptual Ecological Modeling 14120114-I: *CONDITIONAL FUND

From the CV, there is no evidence that the PI has experience as a synthetic ecological modeler. Her CV and publications suggest that she is more of an avian physiologist. It is unclear how their web-based visualization and data exploration tools differ from those of the data management group and NCEAS. Is there unnecessary duplication? Also, it appears that there are no plans to achieve the objectives until the very end of the 5-yr program. This is not acceptable, as it leaves inadequate time for iterative model evaluation and refinement.

This modeling project is very important to the overall program. However, it lacks evidence of any progress two years into the project and offers no vision of what can and will be done. No milestones have been tied to ongoing costs for this project. The proposals include an integration component but the submissions were boilerplate. More explicit information that sets out a road map is needed, not necessarily a longer submission. The programs are focused on monitoring but the programs should still have forward-thinking research. There should also be an adaptive process that allows the programs to set out a conceptual model, which is continuously updated and refined as its accuracy is challenged by new data and the PIs should develop a collection of reasonable hypotheses.

To address these problems, the panel recommends the formation of a Conceptual Modeling Group, drawn from the programs' existing PIs who are already involved in the programs and known for their synthetic vision: Piatt, Pegau, Weingartner, Hopcroft and Jeep Rice. Examples of synthesis can be found on the Internet, including Chesapeake Bay, George's Bank and Steve Brandt's spatially explicit modeling of habitat quality and fish growth. Daniel Pauly and Tom Okey have been involved in an ECOPATH-ECOISM modeling of the PWS food web.

LTM Program Team Lead Response:
The development of conceptual models to support the synthesis of Gulf Watch Alaska program was initiated 1.5 years ago. The core team working on the modeling task consists of project PI Dr. Tuula Hollmen and collaborator Dr. Suresh Sethi. Dr Hollmen has background and expertise in marine ecology and in decision analysis for resource management, specifically in the development of decision support tools and application of models for natural resource management and monitoring programs. Dr Sethi brings expertise in biometry, applied statistics, and modeling for marine ecosystems and resource management.

The overall goals of the conceptual modeling effort are to develop a conceptual ecological model of the North Gulf of Alaska for the Gulf Watch program that will be used: 1) to represent the current state of knowledge of the North Gulf of Alaska ecosystem to support synthesis of Gulf Watch program efforts; 2) as an iterative tool to demonstrate progress of knowledge throughout the program and learning contributions from the Gulf Watch program, and 3) as a communication tool among scientists, stakeholders, and the general public. Our plan is to accomplish the first conceptual ecosystem model by March 2014, and iteratively update and refine the model throughout the program. The final model will be a product of iterative updates, reflecting ongoing learning from program results. The conceptual models also will provide visualization tools for outreach and education, in coordination with the program's Outreach and Community Involvement Committee. That committee will help to coordinate efforts among modeling, data management, and NCEAS projects to facilitate complementary education efforts and avoid any duplication of effort.

Additional detail is provided as a separate attachment: Appendix C: LTM Hollmen. Synthesis and Conceptual Ecological Modeling 14120114-I, Progress to Date.

15. Kuletz. Continuing the Legacy: Prince William Sound Marine Bird Population Trends 14120114-K

The science panel agrees that continuing the long-term monitoring of marine birds in Prince William Sound (since 1989) is important, given that some species (pigeon guillemots and marbled murrelets) are still declining in oiled areas. We also agree that the high inter-annual variation in numbers of some bird species is problematic, and hence, we question whether maintaining biennial sampling is sufficient to detect trends in recovery. Annual sampling may be needed to better couple variation in bird abundances with ocean conditions, and thereby improve our understanding of factors affecting the recovery of bird populations in PWS; however, it also would increase the budget substantially.

In light of this, we recommend that the PIs review the purpose and goals of sampling and that the sampling frequency be carefully reconsidered, in part by using a power analysis of impacts of alternative survey frequencies.

LTM Program Team Lead Response:
The GWA team agrees that annual sampling would be preferred, but that is not feasible under the current program funding level. Regarding evaluation of the sampling design, we note that the GWA program includes a project (Coletti, 13120114-F) that will analyze historical marine bird survey data to assess the ability to detect trends in nearshore marine bird populations under a variety of survey time frames. The analysis will use over 10 years of historical survey data taken in Prince William Sound since the mid-1990s. The project has been delayed, but is expected to be complete in the summer of 2014 and the results will be used to inform GWA program decisions to recommend alternate marine bird survey frequencies to the Trustee Council.

16. McCammon. Outreach and Community Involvement 14120114-B

This proposal demonstrates a good range of activities, and it is well written and explained. It provides very good elaboration on the level of partnering and how partnerships work. The project has good advisory committees, but could use some evaluation of the impacts of its public educational programs, such as whether they are reaching the intended audience, etc. The budget may be inadequate to support such evaluation costs.

LTM Program Team Lead Response: We agree that evaluation of impacts would be beneficial, and are looking to incorporate in the upcoming year some of the low-cost evaluation tools developed by the COSEE Alaska program. In addition, please visit www.gulfwatchalaska.org, the evolving public website for the program.

Herring Program 14120111

17. Herring Program Advisory Group, academic position suggestion: Some additional expertise that could assist with this group are Tim Essington (UW) and

Alec McCall, SWFSC would also be a good choice for membership. *See also Attrition of Experienced Personnel, above.

HRM Program Team Lead Response:
Thank you very much for the suggestions. Dr. Pegau has been trying to identify a person to replace Ted Cooney on that group. That group includes personnel from NOAA, ADF&G, academia, and hopefully the fishing community. They have been invited to be part of the PI meetings, but need to be more active in reviewing the state of the program now that we are starting to see results and think about next steps.

18. Defining program priorities

There is a basic requirement of the herring program to develop a credible and defensible program/project to assess herring abundance. In practice this means the implementation of a modern stock assessment model. This requirement supersedes all others because virtually all other projects in the herring program, and some in the Gulf Watch program, are dependent on the confidence levels associated with the herring assessments. Such assessment is essential even in the absence of any commercial fishery of in Prince William Sound, because herring abundance will impact so much of the ecology of other species.

Stock assessments usually are done by an agency, such as ADFG, but because of the importance of herring it is reasonable for other experts to develop a state-of-the-art age-structured stock assessment (ASA) model tailored for PWS herring, perhaps to be done cooperatively with ADFG. From the proposals this seems to be happening, but, in the opinion of the science panel, not rapidly enough. The concern with delay is that it will be difficult to fully appreciate many of the ecological processes of Prince William Sound unless there is a reasonable understanding of the abundance of herring. In other worlds, the scientific value of nearly all of the herring projects depends partly on the reliability of the herring assessments.

Typically, an age-structure-assessment (ASA) model requires a 'tuner' or an independent dataset that provides a time-series index of abundance (i.e., to tune the model). For PWS herring there may be only two options: a time series of (i) spawn data or (ii) acoustic data. The problem is complex, because the time series of these two datasets are of differing length. Perhaps there are other data options, but the modelers need to ensure that they understand the strengths and limitations of all the data they use in the model. This is a task that requires experience.

It is important to note that, while acoustic estimates of abundance of herring are commonly used around the world, they seldom are used as stand-alone independent measures of biomass. Instead, they usually contribute time-series data to more complex models that incorporate age structure data and other information. If the available time series data (from spawn or acoustics) are not suitable for an ASA model, then other assessment models or approaches must be considered – and presumably this could involve acoustic approaches, or even simple models based mainly on spawn abundance data. Therefore a firm recommendation of the science panel is that the direction and requirements of the stock assessment process, through ASA models, should be clarified and evaluated as soon as possible.

We wish to further elaborate about why all the other herring projects are secondary in importance to stock abundance estimation. It is because much of the biology and life history of herring is impacted by density-dependent processes and this, in turn, can affect growth, maturation, migration, condition, disease and recruitment – all subjects of the proposals in the herring program. Herring abundance also affects other fauna, especially seabirds and marine mammals. Therefore, the science panel recommendation is that the assessment of herring abundance should get top priority, and proceed as vigorously and rapidly as possible. This is not to say that the other projects are unworthy or should stop - on the contrary. The assessment project, while vital, is among the most scientifically routine of the lot, because it involves the implementation of exiting protocols and methodologies. That does not mean it is simple or easy to do, but it is not a 'hypothesis testing' enterprise in the usual sense. Nevertheless, the products of assessments will provide a basis for better science for almost all of the other projects. The common element on all the other projects, with the possible exception of some acoustics projects, is that they aim to determine why and how herring populations change – physiologically or ecologically. In a sense their value is dependent on the rigor of the herring abundance assessments.

What are the implications of this recommendation?
(1) The project on ASA modeling work should be acknowledged as a priority (even a pre-requisite) among the other herring projects. It needs to be implemented rapidly because its requirements could impact that way that other projects develop, especially acoustic projects.

(2) The immediate implication is that the development of a functional herring ASA model should be proceeding much more rapidly than indicated in the progress report. If this task cannot be implemented in a timely manner, than the herring program should consider other ways of getting this work done.

(3) A longer-term implication is that some of the closely related projects that might provide input data to the ASA, especially some of the acoustic projects, could require modification or reconsideration. If the age-structured model cannot incorporate the acoustic data, as it is presently acquired, then the design of the acoustic programs should be adjusted and re-evaluated. However, this cannot be determined until the ASA model is functional and evaluated.

(4) Once the ASA model is functional, then it should be formally reviewed by 1-2 independent (outside) experts to evaluate its formulation, application and efficacy. Such a review is a common practice and should culminate in a report that

documents the review findings. This report would then provide direction about the data requirements for a reliable ASA model of PWS herring. (Note: this was a recommendation in the 2011 science panel report).

(5) If the fully-developed ASA model cannot provide acceptable results because of the limitations of the input data, then other approaches to herring biomass assessments must be considered. These could include simpler models that rely more directly on acoustics or spawn deposition.

HRM Program Team Lead Response:
We fully agree about the importance of the stock assessment model. Improving that capability is the goal of this program. ADF&G currently has an operational stock assessment model (ASA) that our modeling project has replicated in a form that can be run to determine the Bayesian statistics. The population modeling project is presently examining the value of each of the inputs into that model.

The expanded adult herring biomass surveys along with the proposed aerial survey proposal are designed specifically to improve the quality of the abundance assessments used as inputs to the model. As the Science Panel points out, they are not meant to be hypothesis driven, but are necessary for understanding how the population is changing. We continue to examine the assessment projects to determine if there are ways to make improvements to our approach and if other measures of abundance are more appropriate. The two longest time series of abundance measures/indices are the miles-days of spawn and the acoustic biomass estimates. We are working closely on the issue of how good these inputs are and we are reviewing other forms of input such as aerial biomass estimates and spawn deposition surveys used both in Alaska and elsewhere to determine if they are likely to be able to be implemented and would improve our abundance estimates. Both of the previously mentioned methods have been used in PWS and are being evaluated in the modeling project.

Since you mention the importance of the abundance assessments we hope that you support the addition of aerial surveys in this program. That project is limited and could be expanded if additional funding was available.

Answers to the specific recommendations follow:

1) The existing ASA model run by ADF&G is fully operational and central to the design of the HRM program. The projects addressing objective 1 of the HRM program are specifically designed around the needs of the existing model. The HRM program is looking at other methods of modeling the herring population.
2) Because there is a fully functional ASA model available to the program and we recognize the need to train future researchers, we chose to work this aspect of the program through a graduate student. This is a bit slower than putting a PI directly on the project, but that pace is necessary if the student is to be trained. That student has completed the development of a second fully

functional ASA model with features outside of that used by ADF&G. This project is on track with the original proposed timeline.

3) Both ASA models incorporate the adult biomass estimates that the acoustic project provides. The acoustic biomass estimates have been an input to the model since the late 1990s. We are researching the ability to use acoustic estimates of juvenile populations as inputs to the ASA model, but we are still determining how well we can provide an estimate of potential new recruitment.
4) The operational ASA model has been presented in peer-reviewed publications, which we feel meets the need for independent review. In essence our modeling project is designed to provide an independent review of the ADF&G ASA model and its inputs as you are recommending and was recommended earlier.
5) There will always be a question about what piece of information provides the best measure of herring biomass. Every one of the methods used to provide a measure of biomass has definite sampling issues. We agree that a simpler model may be as accurate as the present version of the ASA model. We will also be exploring more complex models that incorporates the information on life history determined by other projects in this program, such as the disease, energetics and growth projects

19. Inter-project cooperation and communication

The science panel acknowledges and salutes the efforts made to coordinate logistics of field projects, especially following a long period when PIs worked relatively independently on most projects. However we are not convinced that some of the individual projects are as well connected as they should be, in terms of communication among PIs. This comment is based on an apparent lack of connectivity among some of the proposals.

HRM Program Team Lead Response:
Meetings of the PIs within the program and with those of the Gulf Watch Alaska program are held regularly. What appears to be a lack of connection between proposals arises because the single original proposal has been split into several individual projects for your review rather than being presented as a single program. The single program cannot provide as much detail about individual components, and individual components don't show the connectivity of the program as a whole.

20. Project gap: microchemistry

The panel noted that the PWS herring population could have important spatial structure that might go undetected by genetic analysis of microsatellites. This could occur if PWS herring consist of a meta-population with spatially separate sub-populations that, nevertheless, have sufficient genetic exchange to preclude genetic detectable differentiation. Therefore it is important to re-examine this issue because the previous genetic work, conducted more than a decade ago, had a short duration and a limited number of probes. Based on the previous genetic study in Prince William Sound, and similar but more recent genetic analyses of other herring populations in the eastern Pacific, the panel does not anticipate that the current genetic studies will demonstrate new evidence of genetic variation within PWS. Instead these studies will probably provide important confirmatory evidence of a lack of genetic differentiation detectable within different parts of the Sound. Such evidence, however, would not necessarily mean that PWS herring lack any spatial variation.

It is possible that PWS herring constitute a meta-population consisting of several sub-populations that may have spatially distinct life histories for parts of their lives. If so, these populations could have different growth rates, and population parameters. Knowledge of such possible spatial structure is integral to understanding factors affecting the abundance of PWS herring. The absence of such understanding represents an ongoing gap in the program. Such a gap could be addressed by analyses of microchemistry of otoliths. Time spent by herring in different bays within PWS and the surrounding region, could be reflected in the chemical composition of otoliths that can be detected by analyses of microchemistry. This approach would have linkages to several other projects. Thus, the microchemistry approach would provide helpful new insights to ongoing projects while improving linkages among them.

The panel is aware of difficulties associated with previous attempts to examine microchemistry of herring. We acknowledge that microchemistry must be used carefully as a research tool, but point out that it can be a powerful and informative approach when done properly. For this reason we suggest that the herring program could consider the incorporation of this approach. For technical reasons, explained below, we further suggest that the optimal approach would be the examination of otoliths.

Regarding scales vs. otoliths: Herring scales may not be a good tissue for microchemistry, but otoliths may be useful. The main problem with scales is that herring resorb calcium and other minerals from their scales as they mature sexually. The effect does not interfere with annulus formation on scales but it could confound comparisons of putative population groups. This is not a concern for otoliths where, in theory, the chemical signatures are retained unchanged with age/time. The main concern with otolith collections is that they need to be collected and stored carefully prior to analysis. As they dry, otoliths tend to develop hairline cracks that can accumulate extraneous material – which again can confound results.

Potential Resource - The current director of the UAF Alaska Stable Isotope Facility is Matt Woller. He is well respected and is an excellent collaborator. See: http://ine.uaf.edu/werc/asif/

HRM Program Team Lead Response:

This is one of many gaps in the program that we have identified. The program is designed to review and change focus with each 5-year proposal. As you mention, this technique has been applied to herring in PWS with some difficulty. We think it would be most appropriate as a component of a program that examines larval drift, which is one of the potential focal areas for the future. At this point we would prefer to see a small demonstration project funded to ensure we overcome the issues with the previous work. We have been retaining otoliths from the juvenile herring we collect so that we have samples to work with when we have the ability to fund this type of research, but want to also point out that otolith work can be expensive.

21. Forage Fish

The Science Panel supports the enhanced attention to estimating population abundances of important Forage fish in the Long-term Monitoring/Gulf Watch Project, while noting that the Herring Program will also be sampling forage fishes acoustically and during net tows, such as those planned to ground-truth acoustic signals. Except for herring itself, the early studies of EVOS impacts on the PWS ecosystem unfortunately failed to establish population assessment on any of the forage fishes of known significance to supporting higher-order predators: sand lance, capelin, and eulachon in particular. The Piatt project in LTM/Gulfwatch can serve as the centerpiece study of forage fish to which information gathered by PIs on other projects could be transferred to provide enhanced knowledge of abundances and dynamics of forage fishes.

LTM and HRM Program Team Lead Response: We agree about the importance of forage fish monitoring, and the Piatt project was included in the GWA program for that reason. We expect that the initial results of that project will lead to a fruitful discussion in advance of and during the joint Science Workshop.

This project is in close connection with the HRM program. We are working to find ways so that both programs fill gaps for the other program and ensure we have comparable results. Nearly identical equipment is being used by the forage fish and herring acoustics and validation projects. We are examining what new questions might be addressed by the temporal difference in sampling between the forage fish and herring projects. We have identified the need for additional support for aerial surveys, and would appreciate more discussion on this.

22. Bishop. Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound 14120111-B

Is there any identification of gender in fish upon tagging? If so, more information on male/female schooling/movement behaviors would be very useful to come out of this work.

The results of progress to date were helpful and interesting. Given that the application of the acoustic tag technology to herring appears to be successful, it would be useful to present future results in the context of testable hypotheses –

particularly regarding movements of herring into and out of Prince William Sound. Project Objective 2 is to monitor movement from overwintering to spawning grounds. While the shift from tagging from fall to spring appears to be well justified, the proposal should discuss how this affects achievement of Objective 2 and whether Objective 2 should be revised.

Potential Resource - Because of the departure of Sean Powers from his role as co-PI on this project, the project may need to add a co-PI with experience in acoustic tagging of fish. Several fish ecologists are now using this technology, including Joel Fodrie of UNC and Craig Layman of NC State University.

HRM Program Team Lead Response:
This project was designed as a proof of concept that has resulted in better than anticipated returns. The gender of the fish was identified during tagging. Objective 2 is unlikely to be achieved and the analysis is being revised. The shift in timing of the tagging allowed us to examine how long the fish remained near the spawning grounds (some for nearly two months) and determine when the fish leave and return to PWS. The change in timing shortened the duration that the tags needed to transmit to observe the movement out and into the Sound. The information from the acoustic arrays at the entrances was uploaded in early September and 41 of the 69 fish were observed at the entrances. There was a gap in time between detections and the fish were just starting to be detected again when the data was uploaded.

Since this was a demonstration project, it is now reaching its analysis phase. Dr. Bishop has been funded by NPRB to do other fish tagging work and has a technician with significant experience with acoustic tagging procedures. We feel we have enough expertise to complete the project as described, even without contributions from Dr. Powers.

<u>Re: Bishop – Validation of acoustic surveys using direct capture</u>

It seems that Dr. Bishop is performing a 'service' to the other PI's, but an essential one, especially in the collection of herring samples. For this service the Science Panel applauds her efforts. It would be useful to know, however, how much of the total effort is actually dedicated to acoustic work. This proposal contributes to the cumulative cost of acoustic work in Prince William Sound – so between the three proposals by PI Buckhorn, and this, the total annual effort and cost of acoustic work is significant. This may be appropriate if acoustics has a central role by providing key data for annual abundance estimates.

A general comment: The rationale for this proposal is to validate an acoustic target using a single beam sounder. This is valid in the context of the present program but there may be a more fundamental question that has not been addressed – although it is not directed specifically at this project. Is the acoustic equipment being used the best for the job? If acoustic estimates were used as the ASA tuning index, how would any change(s) in the acoustic surveys (survey protocols, or equipment) affect the temporal integrity of the index? Similar questions were posed in the 2011 Science Panel report.

A different question: There is an interesting excerpt from the proposal: "We recognize that a major deficit in the existing PWS Herring Survey program is the lack of an effective means of validating the acoustic signal. Fortunately, if we can establish through direct capture of ensonified fish that certain patterns in echograms can be interpreted as different year classes of herring, then we may be able to reanalyze historical acoustic measurements to better understand changes in juvenile herring populations."

The suggestion above is that acoustic strength estimates, obtained by field measurements in from this project, could be used to adjust results from past herring surveys. It is not clear who would do this retrospective analysis. Regardless, such a contribution would be welcome - with the caveat that the rationale and methodology must be documented and accessible, preferably in a published report.

HRM Program Team Lead Response:
The acoustic program is dependent on direct capture to provide information about the organisms being ensonified to be able to convert the signal to a biomass measurement. The capture program also provides fish for the energetics and growth, disease prevalence, and genetics projects.

We have converted the technology from a single beam acoustic system to a split beam unit because we realized that the older unit was no longer the most appropriate technology. In theory this should not change the biomass estimate provided by the two units. The practicality is that the error margins on the acoustic estimate caused by survey error are much larger than those associated with the acoustic signal. The changes in survey protocols are something we are examining for their impact on our estimates of juvenile populations. We have not modified the protocols for adult surveys.

The retrospective analysis would be the responsibility of Buckhorn in the acoustic survey projects. The question at hand is if different portions of the pattern can be attributed to different fish assemblages. For instance, are age-0 herring found in schools in the top 15 meters only? We agree about the importance of getting peer reviewed methodology in place.

23. Bochenek. Data Management 14120111-C *CONDITIONAL FUND
*Also see Data Management, above.

Progress is listed as "Data is being archived on the Workspace by investigators in the program..." and "Data from the past two field seasons will be ingested into the data management system. We will continue to refine and expand the information available through the Herring data portal."

Please specify what data have been incorporated. Also, the demonstration of progress is not adequate. More detail is essential. Failing that, this project should be suspended. An inventory of all data proposed to be incorporated eventually into the program should be drawn up and an accounting of progress on incorporating the listed data sets should reported annually, including any changes to the inventory of target datasets.

HRM Program Team Lead Response:
The HRM Program data management approach differs from the LTM program in two respects: the program developed out of a group of earlier herring research projects funded by the EVOSTC, and it is more oriented to hypothesis-driven research than monitoring, with differing data needs.

Data produced from the original suite of herring projects, including the updated herring data acquired from ADF&G, are housed both on the Prince William Sound Herring Data Portal, which is hosted on the AOOS website http://data.aoos.org/maps/pwsherring/ and the AOOS Gulf of Alaska (GOA) portal. The goal is to completely integrate the Herring Data Portal into the overall GOA portal, using a specific tag in the search catalog for EVOSTC herring data and a tag for herring in general. Many ancillary data sets have been ingested and exposed through the AOOS GOA portal.

Project investigators are also using a private account on the AOOS Research Workspace, thus making their data available for synthesis and analysis activities prior to its eventual transition to the publicly accessible AOOS GOA Portal. The project profiles and file structure are still being further developed. Under the HRM program, data have been posted onto the Research Workspace on the following:

- Fish collection by community fishermen
- Aerial survey information
- Herring disease prevalence
- Physical oceanographic data
- Bird observations
- Herring energetics measurements

PIs have prepared additional acoustic survey data, merged the fish predation database, and developed summarizations of the aerial survey data. The zooplankton information has been completed and is ready for submission into the Research Workspace.

Appendix D to this report includes a table of herring data resources acquired and supported through this program and available on the HRM Research Workspace. This table does not include the data already available through the PWS Herring Data Portal or the AOOS Gulf of Alaska portal.

24. Branch. Population Dynamics Modeling 14120111-Q

While this effort may be in the correct direction, the estimation of herring biomass is an integral and very important part of the herring program. Candidly, the Science Panel had expected more progress and more effort than the efforts of a graduate student to be directed at this issue. This comment should not be seen as a criticism of the student, but instead as a deficiency in the effort directed at this important issue.

There is no indication from the proposal that there is any dialogue between the PI and the other herring program PIs and if so, that is a problem that should be addressed. A specific concern is the extent to which acoustic data, or acoustic indices, can be used, as a component of the annual assessments. Similar questions exist about the spawn data. It seems probable that some form of fisheries-independent index would be required to tune the age-structure (ASA) model. If not, then something else might be used, such as a spawn index and if so, that might require a reallocation of resources. Therefore a better understanding of the data requirements for practical development of the ASA model is required. To this end the modelers need to examine and evaluate the strengths and weaknesses of the available data, preferably in collaboration with other PIs in the herring program.

HRM Program Team Lead Response:
This program is on track with the original proposed schedule. Since there is an existing operational ASA model, we feel there is time to allow a student to be developed within this aspect of the program. By developing a new researcher we hope to bring greater focus to the project than can be achieved by the contributions of a PI, and recognize that the initial pace is slower. The current phase of the project is to examine and evaluate the strengths and weaknesses of the available data. We expect that phase will be completed before the start of the FY14 funding.

The modeling project is in communication with the PIs of this program and with ADF&G to understand issues associated with the field measurements. The modeling program has also contributed to development of a new approach to the overwintering energetics model. Those results are included in the final report by Dr. Kline from his PWS Herring Survey Project.

25. Buckhorn. Expanded adult herring surveys 14120111-E

If acoustic information is to be used for annual herring assessments (by ADFG or anyone else) then it would seem reasonable that there were some meaningful communication between the people doing the survey and those doing the assessments (see specific comments on the previous proposal).

Is there a data source, or database on areas that were 'historically surveyed'? If so, what or where is it? Will it be made available to the data synthesis projects? Has there been any effort made to report on these data? Because of PI departures, a very junior, although promising scientist without any peer-reviewed publications, is left alone to execute this project. The Science Panel urges engagement of a more senior experienced partner to help guide and enhance this project.

It is gratifying to see that samples from Kayak Island were made available to geneticists. However, there does not appear to be any reference to this in the genetics proposal.

HRM Program Team Lead Response:
We are in regular communication with ADF&G about all phases of this program. The PWSSC acoustically derived adult biomass numbers have been incorporated into the ASA model since 1995. The data have been used by Dr. Thorne in publications related to PWS herring populations.

There are maps of the areas surveyed each year that show the shift from the Montague Island spawning grounds to the Port Gravina area. There is also a shift in timing of the spawn between the grounds. We are using that information along with ADF&Gs aerial surveys and reports from fishermen to determine the most appropriate time and location for the expanded surveys.

Dr. Thorne is still connected to the acoustic survey projects, albeit he is working hard to become fully retired. He continues to participate in the program in trying to ensure all his previous data is organized in a manner that is easily interpreted and providing expertise to Dr. Buckhorn. He spent the past three years working with Dr. Buckhorn to develop her skills. Dr. Buckhorn is an example of a post-doc transitioning into the program.

The Kayak Island samples were not part of the original proposal. They represent an opportunity to meet the needs of the genetics project, interests of local fishermen, and ADF&G's needs for additional information on that stock. They are meant to be an addition to the originally proposed work and an opportunity to have samples if we are unable to collect fish from multiple spawning stocks within PWS.

26. Buckhorn. Intensive surveys of juvenile herring 14120111-F

There is reference made to the assessment model but there is nothing in the new population dynamics proposal to indicate any meaningful communication between the acoustics work and the developing assessment models. Specifically, is it anticipated that data derived from acoustic surveys will be used as input to the assessment model? If so, it is important that there is an active dialogue among people working on inter-related projects.

This juvenile herring project is predicated on the assumption that it will provide a useful prediction of age-3 recruitment. If there were a commercial fishery this prediction could be especially useful but its value as a predictor would diminish if commercial fisheries for herring were not re-established. In any event such a juvenile index could provide a measure of first year survival, or 'over-wintering' survival, and then this could be useful, especially to the projects concerned with disease and 'condition'.

Please clarify: will the survey design in 2014 match that in 2013? Again, Dr. Buckhorn and the project could benefit greatly by engaging a senior collaborator for this project.

HRM Program Team Lead Response:
This project is designed to develop an index for guiding the prediction of the incoming recruitment of age-3 herring in the ASA model. This need for a recruitment estimate is well established from the modeling aspect of the program, and the desire is to determine if we can improve the estimate using information from the acoustic surveys.

The survey design in 2014 will be the same as in 2013. We will need to reevaluate the design after this year because there are questions about the amount of time required to complete the survey.

27. Butters & Pegau. Outreach 14120111-H

Was there any attempt to coordinate output with Gulf monitoring group? As noted above, the science panel notes that there may be opportunities and requirements for increased communication among PI's within the herring project. A key point is how the different projects relate to each other, especially their connections or inter-dependences. This aspect was not well developed in this (2013) set of proposals. Perhaps this outreach project can assist in this regard?

HRM Program Team Lead Response:
We do compare efforts with the Gulf Watch Alaska group, and a PWSSC staff member serves on the GWA Outreach Advisory Group to help further those connections. We look to the GWA program for new opportunities for outreach, and the GWA program looks at the materials that have been developed for the herring projects in their selection of outreach efforts.

The communication between project PIs in the HRM program have focused on in-person annual PI meetings that are supplemented by a meeting scheduled during the Alaska Marine Science Symposium. We are looking at the GWA model of having quarterly teleconferences as a means to increase communication. We have developed a web diagram showing the connection between the PWS Herring Survey projects and can develop the same for the HRM project. These diagrams are too complex to be of much value for outreach to the general public, but we may be able to develop something simpler and more visual.

28. Guyon. Genetic stock structure 14120111-P

The investigators should re-examine their plans to ensure that the sites of proposed sampling match the broad objectives of the coordinated proposals. We suggest that the greatest value from this work would be a definitive evaluation of the genetic differentiation, or lack of it, within PWS and areas immediately adjacent, such as Kayak Island. It is not clear that one location east and one location west would satisfy questions about stock structure within PWS. If sample size is an issue, perhaps analyzing the samples from Yakutat has lower priority. The Science panel also wonders why there was no reference made to the samples collected from Kayak Island (were these samples of eggs or fish?). Inclusion of these samples would seem to be high priority.

Further, we advise that the investigators take adequate measures to ensure that they are examining fish in spawning condition. Alternately, if it were possible to conduct genetic analyses on late embryos (from spawn samples) as this might be a useful approach.

HRM Program Team Lead Response:
The biggest issue this project faces is the collection of fish from different spawning events. This past year there were large spawn events in the Port Gravina region, but very little reported elsewhere. When the additional spawning events are so small, it takes a lot of effort to be able to respond in a timely manner. This is one of the reasons for the requested aerial support for the program. The Kayak Island samples were not part of the original design because the collection of fish from that area had only happened once before and with great difficulty, so we did not anticipate the opportunity for additional collections. The collection used a very unorthodox method (the fish were found dead in tide pools on the reef), and we will see if additional fish can be collected in this manner using an aircraft. We are focusing our collection on fish that are actively spawning. We will ask the investigators if herring spawn can be used, as it is easier to identify and collect than the adult fish. Those investigators are unavailable to consult with at the time this response is being put together because of the federal government shutdown.

29. Heintz/Pegau. Overwintering, condition, intensive juvenile sampling proposals 14120111-M, 14120111-L

Considerable concern was expressed about the departure of Dr. Kline and the panel endorses Pegau's expressed urgency in finding a suitable replacement. These proposals tackle important issues and they both do a very good job of relating what they do to other projects, especially to the ASA model. These proposals also present well and respond to much of what the panel recommended in 2011.

Over-wintering mortality among herring juveniles has been invoked as an explanation for many things: recruitment variation, spatial variation in herring survival and susceptibility to disease within Prince William Sound, and perhaps more. It is an important topic and there is a rich legacy of work on this by productive researchers in Prince William Sound. It is important that this work receive the continued attention it deserves, including as much synthesis of past work as possible.

With respect to the 2013 proposals: no plan is evident to examine the relationship of the change in energy content to climate and oceanographic conditions during the pre-sampling and overwintering periods. If PIs are truly interested in determining whether the "constraints" are relaxed, then all constraints, including climate/ocean factors must be considered.

As much as possible these projects must be integrated with oceanographic and biological data from LTM, especially because the causes for condition changes are crucial. The project must also be integrated with the herring disease program. The panel suggests that condition be used in experiments with disease challenges including transmission mechanisms.

HRM Program Team Lead Response:
Dr. Pegau also wants to ensure that a replacement for Dr. Kline is found as soon as possible. The rich amount of information of the overwintering energetics is being used to examine the role on survival and has been incorporated into some of the disease susceptibility research. The synthesis of the existing observation is critically dependent on being able to tie the energetic conditions to the oceanographic records. We are using meteorological, physical oceanographic, chlorophyll, and zooplankton information to examine the relationship between condition of herring and the environment. There is growing evidence (see herring scale growth project) that condition and growth may be a good predictor of an individual's ability to survive while being a poor predictor of recruitment. We still believe that there are connections between the oceanographic conditions and recruitment that are not evident from the condition and growth of the herring. One difficulty has been to clearly identify times of good recruitment outside of the four year cycles of the 1980s that may have been caused by herring life history rather than oceanographic conditions.

We believe that we have begun the effort to include condition in aspects of the disease research. One publication (Vollenwieder et al. 2011) looks specifically at the relationship between energetics and *Icthyophonus*:

> *Vollenweider, J. J., J. L. Gregg, R. A. Heintz, and P. K. Hershberger, 2011, Energetic cost of Ichthyophonus infection in juvenile pacific herring (clupea pallasii), Journal of Parasitology Research, doi: 10.1155/2011/926812.*

<u>30. Heinz & Vollenweider- Age at first spawning 14120111-J</u>

The progress report is very brief. Is this statement: "Histology can identify fish that have not previously spawned" based on the results of the analysis of this project or from published papers on this topic? If the former it would be helpful to know more about the criteria used to differentiate between first-time and repeat spawners. Also, the ability to detect age at first spawning from changes in growth rate in field-caught specimens would be a significant breakthrough. However, the proposal does not articulate how age at first spawning would be determined and validated from older fish that had already spawned more than once.

HRM Program Team Lead Response:
Unfortunately, this team was in the field the month leading up to the reports being due and was unable to provide much additional detail. They are unavailable at this time due to the federal government shutdown. The understanding is that they have been using laboratory-reared herring to confirm the ability to detect if a fish has spawned using histological methods. They are attempting to use changes in herring growth based on the herring scales to determine if differences in growth due to energy allocation to reproductive organs can be observed in the scales of fish at the age of observed recruitment. We can provide more information once they are available.

<u>31. Hershberger - Herring Disease Program (HDP) 14120111-K</u>

The Science Panel feels that this is probably one of the most important high-payoff programs within EVOSTC. Funding needs to continue and the incorporation of disease ecology needs to be somehow incorporated into models.

HRM Program Team Lead Response:
At this point the ASA model has disease prevalence as a predictor of mortality. We recognize this is not likely to be the most appropriate application of the disease information, which is why the current focus is on methods to determine the susceptibility of the population.

<u>32. Moffitt - Scales as growth history records 14120111-N</u>

It is probable that the results of this project will provide new perspective about the biological changes that occurred in PWS herring in the mid-1990's. It is essential that the PI develop and explain some quality control rules (and report on them) to ensure that mismatches between the archived scales and size data do not confound the data or results. Also, Table 1 (cited in the text) was not provided.

HRM Program Team Lead Response:
There are several steps for quality control in the selection and scanning of scales. Because of these rules, the older scales have not been scanned. It has been found that the labeling of the older scales was not as easy to tie to the existing databases. A description of the quality control measures will be included in the final report. The missing table is Pegau's fault. It is provided below.

Table 1. Count of production Pacific herring scale images by collection year and count of measured scales by age, sex, and collection year.

		Measurements Count						
		Age 4		Age 5		Age 6		
Collection Year	Production Images count	Male	Female	Male	Female	Male	Female	Total
2012	186					20	17	37
2011	194					30	22	52
2010	193					26	26	52
2009	194					22	27	49
2008	191					30	24	54
2007	191					29	23	52
2006	187					32	27	59
2005	194					29	24	53
2004	174					21	21	42
2003	193					28	26	54
2002	188	31	30	34	27	30	32	184
2001	186	34	31	29	32	30	28	184
2000	188	27	35	39	30	35	36	202
1999	183					27	29	56
1998	181					25	28	53
1997	181					30	30	60
1996	182					27	29	56
1995	183					30	31	61
1994	183					28	27	55
1993	177					24	28	52
1992	164					12	22	34
1991	170					29	27	56
1990	131					23	33	56
1989	183					29	27	56
1988	125					26	31	57
1987	182					29	29	58
1986	180							
1985	99							
Totals	4,963	92	96	102	89	701	704	1,784

Gulf Watch Alaska Long-term Monitoring Program Semi-annual Report

a) **Project Number–** 12120114 and 12120120

b) **Project Title–** Long-term Monitoring of Marine Conditions and Injured Resources and Services

c) **Principal Investigator's Name(s) –** Molly McCammon, Katrina Hoffman, Kris Holderied

d) **Time Period Covered by the Report–** Feb 1-July 31, 2013

e) **Date of Report –** August 30th, 2013

f) **Project Website –** www.gulfwatchalaska.org

g) Summary of Work Performed – The overarching goal of the Gulf Watch Alaska long-term monitoring program is to provide sound scientific data and products that inform management agencies and the public of changes in the environment and the impacts of these changes on *Exxon Valdez* oil spill (EVOS) injured resources and services. To accomplish this goal we are conducting a five-year ecosystem monitoring program in the spill-affected region, which is anticipated to be the beginning of a twenty year effort. Work on the program continues as originally proposed.

The program includes: 1) four monitoring components (environmental drivers, benthic, pelagic, lingering oil); 2) data management services; 3) integrated syntheses of our monitoring program data; 4) data recovery and syntheses of historical data; and 5) science outreach. The long-term monitoring program has six main objectives.

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

The Gulf Watch Alaska program is composed of integrated program management, data services, science synthesis, and outreach efforts (five projects), as well as the 14 ecosystem monitoring projects. Most projects will occur every year, with a note provided below for those projects that will not occur every year.

approve

a) Integrated program management, data services, outreach and science synthesis

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a) Integrated program management, data services, outreach and science synthesis

i) Program coordination and logistics – Prince William Sound Science Center (PWSSC) and Alaska Ocean Observing System (AOOS)
ii) Outreach - AOOS
iii) Data management –AOOS/Axiom Consulting
iv) Historical data management and synthesis – National Center for Ecological Assessment and Synthesis (NCEAS) – EVOS TC Project# 12120120
v) Science coordination and synthesis – NOAA Kasitsna Bay Laboratory (KBL)
vi) Conceptual ecological modeling– Alaska Sea Life Center (ASLC)

b) Environmental drivers monitoring component
   i) Gulf of Alaska mooring (GAK1) monitoring – University of Alaska Fairbanks (UAF)
   ii) Seward line monitoring – UAF
   iii) Oceanographic conditions in Prince William Sound – PWSSC
   iv) Oceanographic monitoring in Cook Inlet – Alaska Department of Fish and Game (ADFG) / Kachemak Bay Research Reserve (KBRR)/ KBL
   v) Continuous plankton recorder –Sir Alister Hardy Foundation for Ocean Science (SAHFOS)
c) Pelagic monitoring component
   i) Ability to detect trends in nearshore marine birds – USNPS Southwest Alaska inventory and monitoring Network (SWAN) – year 1 (no year 2 funding)
   ii) Long-term killer whale monitoring – North Gulf Oceanic Society (NGOS)
   iii) Humpback whale predation on herring – NOAA National Marine Fisheries Service (NMFS) Auke Bay Laboratory
   iv) Forage fish distribution and abundance – U. S. Geological Survey (USGS) Alaska Science Center
   v) Prince William Sound marine bird surveys – U.S. Fish and Wildlife Service (USFWS)
d) Benthic monitoring component
   i) Nearshore benthic systems in the Gulf of Alaska – USGS Alaska Science Center/ USNPS SWAN, Coastal Resources Associates
   ii) Ecological Communities in Kachemak Bay – UAF
e) Lingering oil component
   i) EVOS oil exposure of harlequin ducks and sea otters – USGS Alaska Science Center
   ii) Oil level and weathering tracking – NOAA/NMFS Auke Bay Laboratory

The fiscal year for the overall program, as determined by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), runs from February 1 to January 31 each year. Many agencies have a fiscal year that runs from October 1 to September 30. The Program Management Team and principal investigators will work to accommodate differences in budget years and execute the program with the EVOSTC program year.

Program progress for reporting period:

Most of the work during this reporting period has focused on execution of the monitoring projects and improvement of public data accessibility, cataloging, and publication. We have also worked to develop integrated program synthesis tools and design and revise a program website for outreach. Program administration and management has proceeded as expected. Specific accomplishments related to the program objectives include:

a) Successful completion of planned field work to date with field work for several projects still underway.
b) Cross specialty communication and participation with shared vessel time and staff time between projects and programs to accomplish this year's field work.
c) Documented and published 70 (19%) of the 370 historical, EVOS-funded data sets that have been identified, with an additional 26 data sets (7%) in process of publication.
d) Refined sampling protocol for forage fish data collection that improves sampling efficiency.
e) Development of time-series analysis framework and preliminary synthesis projects, in coordination with NPRB and HRM program principal investigators.
f) Substantial update and expansion of the program website (www.gulfwatchalaska.org), including the addition of a program news section, project summaries and access to the Gulf Watch Alaska program data portal.

Cross-program science synthesis (12120114-H)

A primary objective of the integrated Gulf Watch Alaska ecosystem monitoring program is to improve communication of monitoring information to resource managers and the public through a variety of synthesis products. As part of the synthesis process, we are reviewing findings from previous Gulf of Alaska research and monitoring programs and identifying monitoring data and metrics that could be used to validate previous study results and develop and test new hypotheses. Appendix 1 contains a table with the initial results from this review. We are planning a time series workshop to be conducted in conjunction with our November 2013 principal investigator meeting that will bring together interested scientists from the HRM and NPRB programs to discuss long term trends in ecological data from the Gulf of Alaska. During this reporting period we also coordinated with researchers with the North Pacific Research Board (NPRB) Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP) to investigate use of a "report card" framework (Mueter et al. 2013) as a tool for analyses of long-term Gulf Watch Alaska monitoring data.

The 'trend card' could be used to facilitate the time series analysis discussion, as well as future science synthesis efforts. Trend cards are a visual tool that can help identify data gaps, allow initial investigation of proposed relationships in existing research hypotheses, and generate new hypotheses. The cards provide a means to examine relationships between physical drivers, species population trends and other ecological factors. We will use current and historical data in the Gulf Watch Alaska program, as well as large-scale North Pacific climate indices to develop the trend cards. The cards will be informed by hypotheses and information from the Gulf Watch Alaska conceptual ecological modeling effort, peer reviewed literature and reports from other Gulf of Alaska research and monitoring programs (e.g. Sound Ecosystem Assessment (SEA) program) and recent publications from other integrated programs, such as the NPRB Bering Sea Integrated Ecosystem Research Program (BSIERP). Figures 1 and 2 provide two trend card examples. These trend cards could be used to help address the research questions in our original proposal (McCammon et al. 2012) as well as some of the following hypotheses:

- 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)?
- Alternative hypotheses to explain linkages between environmental conditions and variability in zooplankton communities. The river/lake hypothesis (Eslinger at al. 2001), which is related to the Bakun upwelling index (Bakun 1973), associates changes in the PWS zooplankton community to the degree of upwelling. Alternatively, zooplankton abundances/composition can be driven by nutrient conditions, if the phytoplankton community is nutrient limited. One question might address which of these two hypotheses best explains the variability in plankton communities associated with environmental conditions.

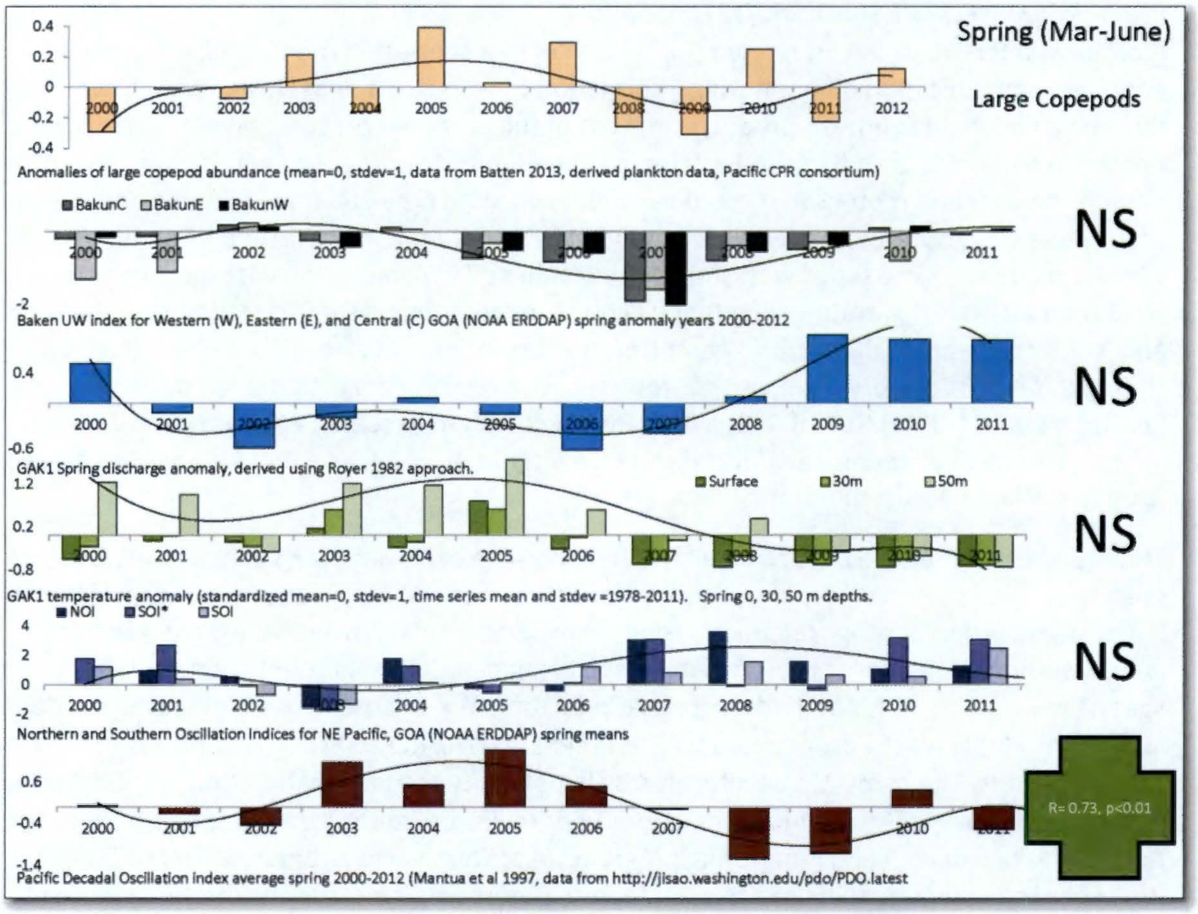

Figure 1. Example of a trend card for large copepod data and selected spring time (March-June). Data are anomalies of values to the full time series average for copepods, upwelling,

discharge, and temperature and the indices for the Northern and Southern oscillation and Pacific decadal oscillation. Significant Pearson correlation coefficients are reported; NS=non-significant.

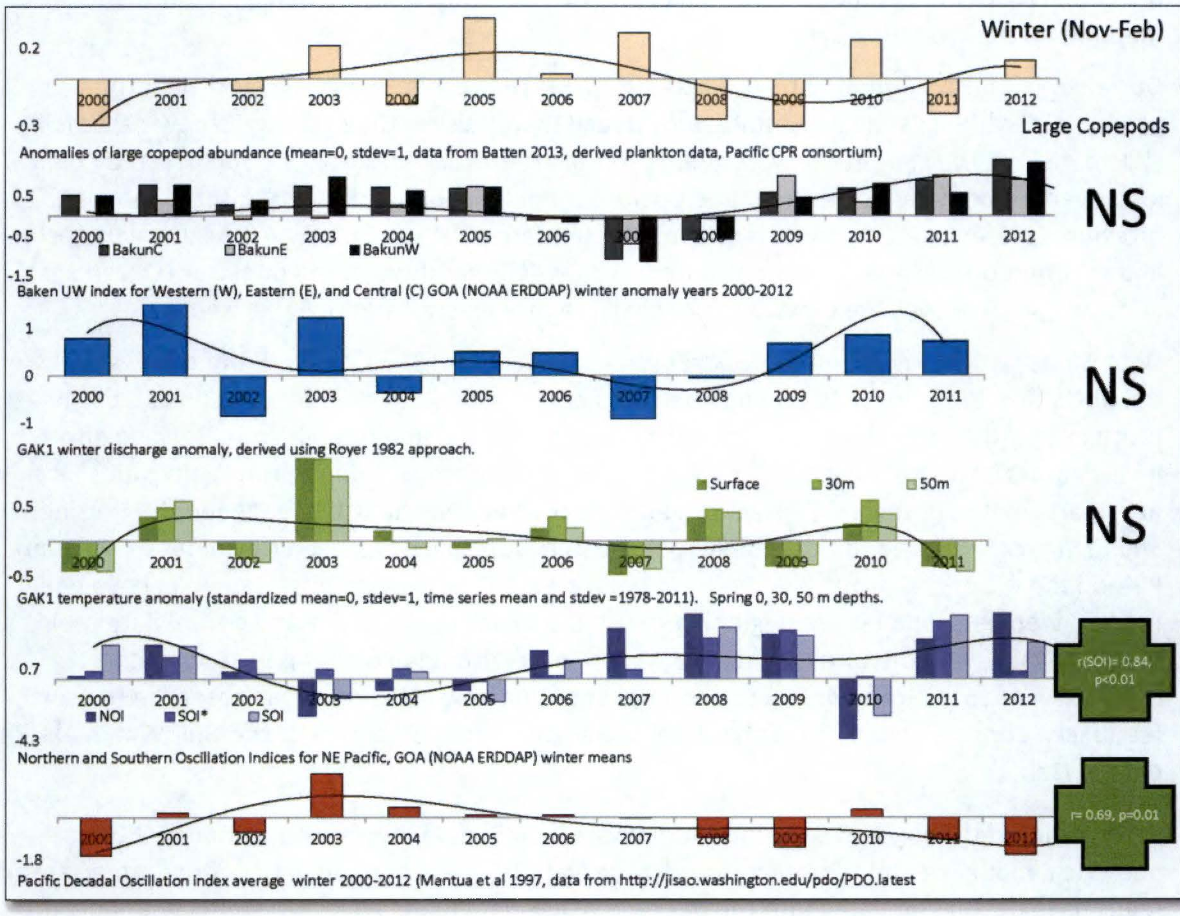

Figure 2. Example of a trend card for large copepod data and selected winter time (November through February). Data are anomalies of values to the full time series average for copepods, upwelling, discharge, and temperature and the indices for the Northern and Southern oscillation and Pacific decadal oscillation. Significant Pearson correlation coefficients are reported; NS=non-significant.

Summary of project level accomplishments:

Program coordination and logistics – Hoffman (PWSSC, 12120114-B): The program successfully submitted the Year 1 annual report and commenced Year 2 of the work, which is proceeding as proposed. Contract management proceeded as expected. We held principal investigator teleconferences in February and July 2013 and had more than seven management team meetings in the reporting period.

Outreach– Molly McCammon (AOOS, 12120114-B): The committee completed all of the products identified as the basic suite of outreach materials for the program: a new name (*Gulf Watch Alaska, The Long-term Monitoring program of the Exxon Valdez Oil Spill Trustee Council),* logo, website domain, PowerPoint and poster templates, pop-up displays, display banners, brochure, presentation folder and bookmarks. In March 2013, a Gulf Watch Alaska slide show and information materials were presented to over 200 members of the public at "Ocean Fest" in Valdez, AK. The website (www.gulfwatchalaska.org) was substantially revised.

Data Management– McCammon/Bochenek (AOOS/Axiom, 12120114-D): From the beginning of the EVOS LTM Program Data Management project investigators have focused on establishing protocols for data transfer and metadata requirements and initiating the data salvage effort. Investigators have met on a regular basis with Matt Jones to coordinate future activities. PIs have participated in several PI meetings and are coordinating activities between the Herring and LTM programs. In addition, the AOOS research workspace has been rolled out to program PIs and their user and group profiles have been created. Several training seminars have been held via webinars, and PIs are beginning to use the system to organize and consolidate their project level data. Software engineers at Axiom have also been working to support the research workspace, resolving bugs and implementing new functionality in response to user feedback. Considerable progress has been made on the development of the Gulf Watch Alaska data portal.

Several hundred Geographical Information System (GIS) data layers, approximately 60 numerical modeling and remotely sensed observational grids and hundreds of real-time sensor feeds have been assimilated into the backend AOOS data management system to support the Gulf Watch Alaska program and complement the datasets produced by Gulf Watch Alaska PIs. Both Gulf Watch Alaska funded research data and these complementary information resources will be seamlessly exposed through the emerging Gulf Watch Alaska/Gulf of Alaska Large Marine Ecosystem data portal scheduled for release in early September 2013 and accessed through the revamped program website: www.gulfwatchalaska.org. This resource will accelerate synthesis efforts by consolidating and organizing critical information products describing the habitat, ecology and physical characteristics of the Gulf Watch Alaska geographical area while simultaneously providing a platform to showcase Gulf Watch Alaska efforts and data products through a publicly accessible geospatial data visualization and catalog system.

Historical data management and synthesis – Jones (NCEAS, 12120120): We have 19% of the data sets that were identified from historical EVOS funding with 7% more in process of publication. NCEAS staff provided training for the Morpho metadata generation tool use and access information for the KNB Metacat portal for data publication to those Gulf Watch program principal investigators who were interested.

Science Coordination and Synthesis – Holderied (NOAA KBL, 12120114-H): During this reporting period we focused on science coordination with principal investigators, creating project level metadata, developing synthesis and visualization tools for integration within the program and public outreach, and assisting with development of the Ocean Workspace, program website and public data portal. Some of the initial program synthesis results are provided above. A full-time science coordinator, Tammy Neher, was hired under contract with NOAA Kasitsna Bay Laboratory in late March 2013 and is working with the program and data management teams on cross-program integration, science synthesis and coordination with outside entities. We have expanded science coordination efforts with the North Pacific Research Board Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), including sharing of retrospective data analyses by Dr. Franz Mueter (University of Alaska Fairbanks). We have also started a new collaboration on salinity data from satellite remote sensing data with the National Centers for Coastal Ocean Science of the NOAA National Ocean Service.

Conceptual Ecological Modeling – Hollmen (ASLC, 12120114-I): Analysis of input from November 2012 PI meeting and development of conceptual models is ongoing. We are currently developing a generic GOA conceptual ecosystem model using input gathered at the November 2012 PI meeting. The output will be a visual diagram representing key linkages based on PI input.

Gulf of Alaska mooring (GAK1) monitoring – Weingartner (UAF, 12120114-P): Field work has been completed on schedule to date and all samples are currently being processed. We have been working on relating long-term Seward sea-level variability to forcing mechanisms. The ultimate goal is to determine if we can use the long-term record in Seward as a proxy for transport in the Alaska Coastal Current. Our major findings are that tides and atmospheric pressure variations (the inverted barometer effect) are largely responsible for sea level variations.

Seward line monitoring – Hopcroft (UAF, 12120114-J): Sampling has been completed on schedule to date and all samples are currently being processed; one cruise is remains for 2013, October. Notable findings from the 2012 season include: upper 100m of along the Seward Line was 0.7°C colder in May than the 15-year mean and the progression of seasonal cycles for plankton was delayed. The spring bloom was partially captured, while the development rates of key zooplankton species were slowed.

Oceanographic conditions in Prince William Sound – Campbell (PWSSC, 12120114-E): Successful surveys of PWS have been conducted to date;with some work still in progress. Testing of the automated moored profiler (AMP) has continued through the summer, 2013 – additional test deployments were done in Nelson Bay and several problems ironed out. Some field challenges have occurred with the AMP profiler communications transmissions; Dr. Campbell is working with the local communications provider to find a solution.

Oceanographic monitoring in Cook Inlet – Doroff (ADFG KBRR) and Holderied (NOAA KBL, 12120114-G): Most of the oceanographic surveys have been completed on schedule to date.

Due to inclement weather in lower Cook Inlet, only the Kachemak Bay transects could be surveyed in February, 2013. We were able to host a U.S. Fish and Wildlife Service bird/mammal observer for all lower Cook Inlet sampling events. CTD data have been processed and are currently being loaded to the Research Workspace and reconfigured for the Axiom data portal. Public presentations were made in Seldovia and Homer, AK in July 2013 on results from the oceanographic monitoring and the use of data for paralytic shellfish poisoning and ocean acidification studies.

Continuous plankton recorder – Batten (SAHFOS, 12120114-A): Plankton surveys have been completed on schedule to date. Sampling is currently underway and has been completed as planned to date. Several sampling events are scheduled to complete the 2013 season.

Ability to detect trends in nearshore marine birds – Coletti (USNPS SWAN, 12120114-F): In mid-September of 2012, we met with subject matter experts to refine approaches and finalize the proposal for the bid process. The resulting proposal was finalized but further delays arose as NPS converted to a new financial system while simultaneously determining how best to deal with sequestration. This resulted in contracts that were not considered time sensitive to be delayed until June / July of 2013 for submission. The contract for analysis has been submitted through NPS contracting and is currently awaiting the bid process. We are anticipating that a contract will be awarded before the end of federal fiscal year 2013 and that a final report will be provided by June 1, 2014.

Long-term killer whale monitoring – Matkin (NGOS, 12120114-M): All surveys have been completed as planned. Final identification and sorting work was completed and the current killer whale photographic reference catalogue is up to date. Plotting and initial GIS analysis of trackline, encounter, and tagging data occurred and was summarized. Analysis of skin and blubber biopsy samples was completed and results analyzed and plotted. A long awaited publication on the life history and population dynamics of the southern Alaska resident killer whale population from 1984-2010 was finalized and accepted for publication by *Marine Mammal Science*.

Humpback whale predation on herring – (NOAA, NMFS Auke Bay Laboratory, 12120114-N): All surveys have been completed as planned. In April 2013, our team conducted a field trip to Prince William Sound Alaska to observe, photograph, and biopsy humpback whales prior to the spring herring spawning. Whales were observed feeding, mainly on schools of spawning herring or layers of plankton. Post survey, all observed photographs identifying individual whales were compared to existing catalogs for possible matches.

Forage fish distribution and abundance – (USGS Alaska Science Center, 12120114-O): We have worked on 2012 data processing, and created metadata in Morpho. These data sets have been loaded to the Research Workspace. We have completed all fish surveys as proposed and in 2013, and conducted exploratory work to investigate the feasibility of incorporating aerial spotting surveys in conjunction with the herring research program.

Prince William Sound marine bird surveys – Irons/Kuletz (USFWS Alaska Region, 12120114-K): Surveys were completed in 2012 as planned. This project had no field work scheduled in 2013, although we analyzed data and presented an oral paper on some of our results: Cushing, D.A., D.D. Roby, K.J. Kuletz, and D.B. Irons. 2013. Changes in abundance of *Brachyramphus* murrelets in Prince William Sound, Alaska, 1989-2012. Pacific Seabird Group Conference, Portland, OR.

Seabird abundance in fall and winter – Bishop (PWSSC, 12120114-C): Seabird observers were onboard cruises with the *Herring and Research Monitoring Expanded Adult Herring* and humpback whale surveys; however, at the request of the Humpback Whale PI, the seabird observer did not participate in the April 2013 *EVOS Humpback Whale* survey because it was a short-term, focused survey for biopsy sample collection. Two papers are accepted pending revisions: Dawson, Bishop, Kuletz and Zuur, "Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska," by the journal *Arctic*. The manuscript: Bishop, Watson, Kuletz and Morgan, "Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska," by the journal *Fisheries Oceanography*. Both of these manuscripts are based on work from EVOS-funded seabird monitoring in Prince William Sound conducted just prior to the beginning of the Gulf Watch Alaska Program.

Nearshore benthic systems in the Gulf of Alaska – Ballachey (USGS Alaska Science Center), Coletti (USNPS SWAN) and Dean (Coastal Resources Associates, 12120114-R): Our field work has been completed with no problems or concerns, and all project components are proceeding on schedule. Interesting findings include the discovery of a live oyster (*C. gigas*) that was found during a sampling trip to Johnson Bay (WPWS) in June 2013. The oyster was presumed to be at least 5 years old due to the perennial seaweeds growing on it as well as its size. Also notable is an overall observed reduction in mussels across our GWA sites that has been observed in data collected through 2012.

Ecological Communities in Kachemak Bay – Iken and Konar (UAF, 12120114-L): Field work for monitoring intertidal communities in Kachemak Bay was conducted successfully. Insufficient low tide level at Bishop's Beach and Bluff Point prohibited us from completing surveys of all tidal levels at those sites. At Bluff Point, an adjacent site to the original (2012) site was sampled in 2013 as that location was more accessible. Notable findings include a strong recruitment event in mussels observed at one site in Kachemak Bay but not others, indicating site-specific dynamics in recruitment, as well as the discovery that clam composition is site-specific in Kachemak Bay, confirming strong local dynamics in various regions of Kachemak Bay.

EVOS oil exposure of harlequin ducks and sea otters – Ballachey (USGS Alaska Science Center, 12120114-Q): Sea otters (n = 60) were captured and sampled in western PWS in summer 2012; blood samples from those otters have been analyzed over the past 6 months for biomarker and health assays using gene expression analyses; a final report is in preparation. Harlequin ducks were captured in PWS in March 2013 and liver biopsies collected for cytochrome P4501A (CYP1A) assays. Previous sampling, through March 2011, had shown higher CYP1A in ducks from oiled areas relative to those from unoiled areas.

Oil level and weathering tracking – Carls (NOAA/NMFS Auke Bay Laboratory, 12120114-S): Sample processing has focused on samples and data that contribute to long-term understanding of conditions in Prince William Sound and along the Gulf of Alaska. Hydrocarbon analyses and biomarker measurements have been completed for Gulf of Alaska samples and we are now writing the report (Irvine *et al*). Measurement of hydrocarbons in three species of shrimp (pink, coonstripe and spot) is underway in the laboratory and will likely consume available processing time for several months.

h) Summary of Work to be Performed–

We are planning the following activities directed to the original program goals during the next six months:

a) Conduct monitoring efforts in accordance with program milestones.

b) Continue to review and add program data and related historic related data to the Gulf of Alaska data portal.

c) Conduct an in-person principal investigator meeting and time series analysis workshop, with a focus on enhancing integration of efforts within the program and with external partners.

d) Continue outreach and information dissemination efforts at community level events, workshops, and scientific meetings and through the revised website.

e) Continue to refine and coordinate sampling methods for specific projects.

f) Continue data assimilation and archiving efforts with the NCEAS programs.

g) Work closely with the Herring Research and Monitoring program to develop the program science synthesis reports and begin planning the 2015 workshop.

Summary of project level plans:

Program coordination and logistics – Hoffman (PWSSC, 12120114-B): Reporting remains on track for FY14 work plans and FY13 semi-annual reports. At the request of EVOSTC staff, we added a proposal for additional FY14 Lingering Oil project funds (PI: Esler) to the overall program. We have scheduled a Gulf Watch Alaska PI meeting for November 13-14, 2013. Where possible, PIs will also attend the Alaska Marine Science Symposium in Anchorage in January 2013. Planning and coordination of the year three synthesis workshop will commence in the last two quarters of FY13.

Outreach – Molly McCammon (AOOS, 12120114-B): The Outreach and Community Involvement Committee will meet to develop Phase II of the program's Outreach and Community Involvement plan. Expected activities include radio shows, lectures, community discovery labs, publications, and science symposia. We will use the Community Based Monitoring (CBM) Best Practices workshop planned by AOOS and Alaska Sea Grant as a forum to help facilitate discussion on potential use of CBM and local and traditional knowledge in the Gulf Watch Alaska Program.

Data Management – McCammon/Bochenek (AOOS/Axiom, 12120114-D): Axiom engineers will facilitate the ingestion of year 2 field season data into the Research Workspace over the next 6 months. The Gulf Watch Alaska data portal will be further cultivated with the addition of multiple datasets.

Historical data management and synthesis – Jones (NCEAS, 12120120): During the rest of this year we plan to continue our data collation efforts, attempting to assemble a complete collection of data sets from the various historical projects. We also will produce data summaries in preparation for our synthesis efforts in years 3-5. We are currently working on finalizing the data catalog by adapting its user interface to match the Gulf Watch Alaska website, extending the search capabilities of the site, and integrating it with DataONE to provide long-term, persistent backup of the data holdings. In the fourth quarter of this grant year, we will begin the process of drafting a call for synthesis working groups to be conducted during years 3-5 of the project.

Science Coordination and Synthesis – Holderied (NOAA KBL, 12120114-H): In the next six months we will plan and conduct the annual in-person principal investigator meeting along with a time series analysis workshop that includes other Gulf of Alaska researchers. We will continue to assist the data management team to develop and test the live data portal. We will coordinate with principal investigators and data management team to make all 2012 project data and metadata available through the data portal and help load 2013 data on the Research Workspace. We will continue development of synthesis products, including trend cards.

Conceptual Ecological Modeling – Hollmen (ASLC, 12120114-I): No changes to the original work plan are expected. Key milestones in the upcoming six months include:

Design draft conceptual models

Gulf of Alaska mooring (GAK1) monitoring – Weingartner (UAF, 12120114-P): We will continue collecting CTD data on a quasi-monthly basis (up to 8 in 2014) and conduct the mooring operations at GAK 1 in March 2014. These are consistent with the approach described in the original proposal and there are no changes in sampling or analytical methods.

Seward line monitoring – Hopcroft (UAF, 12120114-J): Late summer cruise is scheduled for Sept 10-29. Analysis of 2013 samples will continue. Several manuscripts are being prepared for inclusion in an NPRB-led special issue.

Oceanographic conditions in Prince William Sound – Campbell (PWSSC, 12120114-E): No changes in project objectives, procedures or statistical methods, or study area are expected. Slight changes to the profiler deployment are anticipated; it is expected that it will be retrieved in October or November, and redeployed early in January.

Oceanographic monitoring in Cook Inlet – Doroff (ADFG KBRR) and Holderied (NOAA KBL, 12120114-G): In the next six months, we plan to continue monthly oceanography and plankton surveys on the mid-Kachemak Bay transect and to conduct a lower Cook Inlet survey in October 2013. Charter vessel contracts have been established for Cook Inlet sampling in February and April 2014. A data table and relational database structure have been developed for this project and will be coordinated with the data management team and other Gulf Watch Alaska principal investigators. We will provide oceanography and plankton data to the Research Workspace in coordination with the data management and science synthesis teams. Two of the NOAA Kasitsna Bay Lab 2013 Hollings Scholar summer interns will be using and analyzing project data for their senior honors projects during the 2013-2014 academic year at American University and Oberlin College.

Continuous plankton recorder – Batten (SAHFOS, 12120114-A): At this time there are no anticipated changes to the sampling schedule, with the 5th transect set to be sampled mid-

August, and the final transect to be sampled mid-September. Preliminary processing of samples will be ongoing for the remainder of the field season, and processing of remaining samples and QC of the spring samples has commenced and will also now be ongoing.

Ability to detect trends in nearshore marine birds – Coletti (USNPS SWAN, 12120114-F): Because of some unanticipated delays, our timeline for completion of analysis has shifted to a later date. We expect a contract to be awarded by the end of FY 13 and the analyses to be completed by June 2014.

Long-term killer whale monitoring – Matkin (NGOS, 12120114-M): There should be no significant deviance from the proposed basic study plan in the next report period. Some aspects of the plan are based on weather and the presence of specific individual whales and cannot be predicted, but there is no intention to change the project plan at this time.

Humpback whale predation on herring – Moran and Straley (NOAA, NMFS Auke Bay Laboratory, 12120114-N): Three surveys of PWS will be conducted during October and December 2013, and April 2014 to document whale abundance and target prey. An additional whale tagging survey may occur in conjunction with the non-lethal herring sample survey. We will begin working with Dr. Bree Witteveen, who maintains the humpback whale database for Kodiak, Barren and Shumagin Islands.

Forage fish distribution and abundance – Piatt and Arimitsu, USGS Alaska Science Center, 12120114-O): Our primary goal as proposed is to identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long-term monitoring of those indices. After a successful field trial in 2013, we will continue to explore ways to expand the aerial spotting surveys to aid in locating and sampling forage fish schools with hydroacoustics in the Sound. In the coming months we will analyze the hydroacoustic data we collected in conjunction with the Herring Research and Monitoring Program's aerial surveys in July 2013. We will work closely with Scott Pegau to devise a plan that benefits both programs.

Prince William Sound marine bird surveys – Irons/Kuletz (USFWS Alaska Region, 12120114-K): In the next 6 months the seabird biologist will be onboard during three EVOS cruises. Two cruises, scheduled for October and December 2013, are part of the *Humpback Whale systematic surveys*. The third cruise will be the *HRM Juvenile Herring Abundance Index* cruise scheduled for November 2013. In addition to cruises, data analyses are ongoing.

Seabird abundance in fall and winter – Bishop (PWSSC, 12120114-C): In the next 6 months, the seabird biologist will be onboard during three EVOS cruises. Two cruises, scheduled for October and December 2013, are part of the *Humpback Whale systematic surveys*. The third cruise will be the *HRM Juvenile Herring Abundance Index* scheduled for November 2013. In addition to cruises, data analyses are ongoing.

Nearshore benthic systems in the Gulf of Alaska – Ballachey (USGS Alaska Science Center), Coletti (USNPS SWAN) and Dean (Coastal Resources Associates, 12120114-R): We anticipate no changes to the work plan we initially submitted for the nearshore benthic component. We will be adding an additional PI to the project: Dr. Dan Esler, who has served as a PI on the lingering oil studies for almost two decades (including Project 12120114Q & 13120114Q) will be starting a full-time position with the USGS Alaska Science Center in August 2013, and will assume a major role in the Gulf Watch Alaska nearshore benthic monitoring component in addition to continuing with lingering oil studies.

<u>Ecological Communities in Kachemak Bay – Iken and Konar (UAF, 12120114-L):</u> – We will participate in the PI meeting on 14-15 November 2013 in Anchorage. The 2013 data will be prepared for posting on the Research Workspace by December 2013. We are planning on presenting a poster at the Alaska Marine Science Symposium in January 2014. Field work is planned for May 2014 with dates TBD depending on the best low-tide cycle. Sampling in 2014 will include rocky intertidal, seagrass, *Lottia* size-frequency distribution, and *Mytilus* size-frequency distribution. No deviations from the original proposal are expected.

We anticipate continued sample collection and processing of sea otter scats from our long-term monitoring site. We will begin doing visual observations for sea otter prey in fall 2013. Database structures are still being developed and shared with U.S. Geological Survey for the forage observation data.

<u>EVOS oil exposure of harlequin ducks and sea otters – Ballachey (USGS Alaska Science Center, 12120114-Q):</u> We are proposing to resample harlequin ducks in PWS in March 2014 for collection of liver biopsies to be analyzed for CYP1A. A detailed description of the proposed work is provided as a separate Work Plan for Project 14120114Q.

<u>Oil level and weathering tracking – Carls (NOAA/NMFS Auke Bay Laboratory, 12120114-S):</u> The biggest future responsibility is extension of the hydrocarbon time series in Prince William Sound. We are requesting that plans to collect new field samples be delayed by one year, pushing the field effort to 2015. The purpose of the delay is to position the project to best respond to findings from the bioremediation project (Boufadel, 11100836), the lingering oil distribution modeling (Nixon, 12120117), and to consider new findings from Gulf Watch Alaska monitoring.

Appendix 1 Summary of findings from the studies conducted within the Gulf of Alaska, references for those studies and initial list of possible long term monitoring measures that could be used to validate previous study results and test new hypotheses

Findings	**Reference**	**Possible monitoring measures**
2011 anomalous year, early W Gulf of Alaska(WGOA) bloom, no Eastern GOA (EGOA) bloom Low Upwelling(UW) WGOA, low Pacific decadal oscillation (PDO), low spring discharge (Q), high winter Q.	GOAIERP retrospective, Mueter et al 2013	Gulf Watch regions for data· L Cook Inlet, N GOA, Prince William Sound (PWS) Metrics. ChlA/Phytoplankton community, UW, PDO, SOI Spring and winter discharge. Only have off shelf data from N GOA Compare regional variability for GW regions, also delineate off shelf vs shelf from Seward Line (and Continuous Plankton Recorder (CPR) if possible)
GOA-wide: UW strongly, negative (neg) correlation (corr) to winter Q, PDO strong, neg corr to North Pacific index (NPI), Southern oscillation index (SOI) 58% of inter-annual variance in Chlorophyll A (ChlA) production attributable to PDO and UW.	GOAIERP retrospective, Mueter et al 2013	
Variability in ChlA best explained by region	GOAIERP retrospective, Mueter et al 2013	
Upwelling important to shelf production, particularly E. shelf	GOAIERP retrospective, Mueter et al 2013	
Coast wide rockfish growth positive corr w shelf ChlA	Vanessa Von Biela, AKAFS 2012 student presentation	We lack programmatic piece for this in GW Shelf ChlA production can explain variability in fish growth/survival between years (short lived species -i e herring, salmon) Fish life histories related to regions of production. pelagic vs benthic vs neustonic, timing of ontogeny Perhaps can partner with herring program. .for fine scale regional variabilty in growth (i e bays of PWS) Also, pink salmon return data could be useful
Sablefish recruitment increased w higher ChlA production, UW	Brenden Coffin, student thesis in progress	
2011 bad years for pelagic Pcod/pollock, good for Rock/Sable* (neustonic)	GOAIERP retrospective, Mueter et al 2013	
Capelin have nearly disappeared in GOA since later 80s	ADFG small mesh trawl data, Mueter et al 2013 retrospective	Some retrospective work on Capelin would be very helpful to consider what the ecological impacts of losing this species may have been
Physical forces respond to seasonal weather shifts, in particular, long term shifts in the intensity and location of the ALP during winter	GEM	UW, nutrient measures, ChlA and phytoplankton community
Pinks and Plankton reduced nearshore plankton densities lead to dispersion from nearshore and increased predation -reduced survival.	Willette 2001 (SEA work special issue, Fisheries Oceanography)	Pink salmon survival, zooplankton community composition, timing, UW, nutrients, ChlA, phytoplankton community, predator community,

Pinks and Plankton. Zooplankton TYPE is important- reduction in large Calanoids led to increase dispersion from near shore and 5 times greater predation	Willette 2001 (SEA work special issue, Fisheries Oceanography)	other prey sources (i e. forage fishes, large calanoids for pelagic fishes)
Pinks and Plankton. changes in predator community composition more strongly drove changes in survival than did timing of movements (obviously not mutually exclusive).	Willette 2001 (SEA work special issue, Fisheries Oceanography)	
Herring and Pinks: Juvenile herring abundance declines with winter plankton abundance	Cooney et al 2001 (SEA work special issue, Fisheries Oceanography)	Pink salmon, forage fish, and herring size/abundance/energy density, plankton community
Herring and Pinks. Pink salmon predation increases with reduced forage fish abundances	Cooney et al 2001 (SEA work special issue, Fisheries Oceanography)	
Herring and Pinks Age 0 herring and pinks use very different niches Pinks use cool, early bloom near shore habitats dominated by diatoms/calanoids. Age-0 herring use warm, post bloom conditions in late summer/early fall	Cooney et al 2001 (SEA work special issue, Fisheries Oceanography)	
Herring life history (LH). Fall energy content linked to overwintering survival (low feeding in December, fasting)	Norcross et al 2001 (SEA work special issue, Fisheries Oceanography)	
Herring LH: High spatial variability in nearshore rearing habitats prey availability related to physical transport processes for zooplankton. Resulting in high spatial variability in fall energy content	Norcross et al. 2001 (SEA work special issue, Fisheries Oceanography)	
Herring LH timing of herring spawning related to temperature and weather -4 C and calm This has become earlier through time	Norcross et al 2001 (SEA work special issue, Fisheries Oceanography)	Local spawning times, temperatures, and winds/rain/wave action
Herring LH. larval mortality mostly from egg removal, strong storms within weeks after spawning results in high mortality	Norcross et al 2001 (SEA work special issue, Fisheries Oceanography)	
Herring LH larval survival higher in warm winters than cold, lots of *Thysanuessa* and *Metridia* copepods (high energy density) is good	Norcross et al 2001 (SEA work special issue, Fisheries Oceanography)	Herring recruitment, winter temps, zooplankton community/abundance
Plankton in PWS: Large temporal and spatial variability Copepods dominate, Calanus life stage important as are early emergence, catch beginning of phyto bloom, prey for early fish spp	Cooney et al 2001 (SEA work special issue, Fisheries Oceanography)	Plankton communities, Aleutian Low Pressure (ALP)/PDO, UW, SST, herring and salmon survival data

Plankton in PWS. Two conditions A) cold - weak Aleutian Low Pressure (ALP), reduced GOA circulation, negative Sea Surface Temperatures (SST) anomalies, strong CA upwelling B) warm- strong ALP, strong GOA circulation, increased coastal temps and percip, strom intensive -B is good for salmon, perhaps less so for herring	Hollowed and Wooster 1992	
Plankton in PWS. mechanisms- high storms, increased mixing, prolonged phyto bloom, transfer of biomass to pelagic Alt> Calm spring, reduced, warm mixed layer, intense, short bloom, biomass shift to benthos	Cooney et al. 2001 (SEA work special issue, Fisheries Oceanography)	
Plankton in PWS· When large copepods dominate communty in April/June, offsets pink salmon predation	Cooney et al 2001 (SEA work special issue, Fisheries Oceanography)	
Plankton and oceanography· plankton populations vary with nutrient availability and currents that exchange biomass from GOA Early, strong stratification=quick, intense phyto bloom, biomass transfer to benthic. Later, prolonged, stratification due to series of storm events=prolong bloom, biomass transfer to pelagic	Eslinger et al 2001 (SEA work special issue, Fisheries Oceanography)	various measures of biomass (plankton, fish) and community composition, regional measure of stratification, wind, upper circulation, exchange between slope/shelf
90s bottom up forcing drive nutrients, 80s other factors (transfer btwn GOA -'river/lake' hypothesis) drove plankton production	Eslinger et al 2001 (SEA work special issue, Fisheries Oceanography)	
PWS circulation· three factors that influence biomass were examines -surface layer stratification, upper layer circulation, exchange bwtn GOA and PWS	Vaughan et al 2001 (SEA work special issue, Fisheries Oceanography)	

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

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

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

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

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

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

B. Environmental drivers monitoring component

6. Gulf of Alaska mooring (GAK1) monitoring – University of Alaska Fairbanks (UAF)
7. Seward line monitoring – UAF
8. Oceanographic conditions in Prince William Sound – PWSSC
9. Oceanographic monitoring in Cook Inlet – Alaska Department of Fish and Game (ADFG) / Kachemak Bay Research Reserve (KBRR)/ KBL
10. Continuous plankton recorder –Sir Alister Hardy Foundation for Ocean Science (SAHFOS)

C. Pelagic monitoring component

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

D. Benthic monitoring component

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

E. Lingering oil component

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

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

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

FY14 PROGRAM PROJECT PROPOSAL FORM

Project Title: Long term monitoring: Long term monitoring: Program management component – Administration, Science Review Panel and PI Meeting Logistics, and Outreach and Community Involvement

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

Primary Investigator(s): Katrina Hoffman, Prince William Sound Science Center

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

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

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

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

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 30, 2014

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date

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

II. PROJECT DESIGN

A. Objectives

Objective 1 **Fiscal management tasks**

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

The budget assumes that funding to Trustee Agencies is provided directly to that agency and not through PWSSC The PWSSC awards contracts to all non-Trustee organizations involved in this proposal[1], with two exceptions for two co-PIs who are working with Trustee agency projects (Straley from University of Alaska Southeast and Dean from Coastal Resources Associates) Straley and Dean's participation are included as contracts within, respectively, the Moran (NOAA) and Ballachey (USGS) Trustee agency project DPDs and budgets

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

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

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

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

Objective 4 **Travel expenses for Outreach Team**

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

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

Objective 5 **Outreach and Community Involvement**

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

B. Procedural and Scientific Methods

Not applicable

C. Data Analysis and Statistical Methods

Not applicable

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

III. CVs/RESUME

See program appendix

IV. SCHEDULE

A. Project Milestones

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

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

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

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

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

B. Measurable Project Tasks

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

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

V. BUDGET

Budget Form (See attached budget document)

A.2.b Outreach – McCammon (AOOS)

FY14 PROGRAM PROJECT PROPOSAL FORM

Project Title: Outreach and Community Involvement

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

Primary Investigator(s): Molly McCammon, Alaska Ocean Observing System

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

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

Estimated Budget:

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

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

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 30, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date (if applicable)

This component has met all of its milestones thus far by organizing and supporting an Outreach Steering Committee (that includes key outreach staff from AOOS, the PWS Science Center (PWSSC), Kachemak Bay Research Reserve (KBRR), Alaska SeaLife Center, North Pacific Research Board, COSEE Alaska, NOAA, USGS and Alaska Sea Grant), establishing a public website (www gulfwatchalaska org) that is newly revised and updated, developing the first phase of an Outreach and Community Involvement Plan, and implementing the activities described in that plan In addition, program staff briefed the EVOS TC Public Advisory Committee about these activities These activities are closely coordinated with outreach activities sponsored by the EVOS TC Herring Research and Monitoring Program.

II. PROJECT DESIGN

A. Objectives

Objective 1 **Travel expenses for Outreach Team**

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

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

I. Overall Approach

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

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

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

B. Procedural and Scientific Methods

Not applicable

C. Data Analysis and Statistical Methods
Not applicable.

D. Description of Study Area
Outreach and community involvement activities will be completed throughout the EVOS region.

E. Coordination and Collaboration with the Program
Our partner organizations offer significant resources to this effort.
AOOS: AOOS is the only organization in the state with a board made up of all the federal and state resource management agencies and all the marine research entities in Alaska, including the University of Alaska. The AOOS mission is to coordinate and facilitate the gathering and dissemination of ocean and coastal information and data products to meet stakeholder needs in the three Large Marine Ecosystems, including the Gulf of Alaska. AOOS has committed significant resources to its web-based data portal (www.aoos.org) and data products developed in response to stakeholder needs. As part of a national - as well as a global - network of ocean observing systems, AOOS has access to significant national and international resources as well. AOOS will facilitate the outreach/community involvement program, and use its web portal as a key outlet for products to be developed.

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

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

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

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

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

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

IV. SCHEDULE

A. Project Milestones

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

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

B. Measurable Project Tasks

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

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

Depending on results of Day in Our Sound funding appeals, decide on next project activities

V. BUDGET

Budget Form (See attached budget spreadsheet)

FY14 PROGRAM PROJECT PROPOSAL FORM – A.2

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

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

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

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

Estimated Budget:

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$620			

Date: August 6th 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

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

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

B. Summary of Project to Date (if applicable)

During the first few months of the EVOS LTM Program Data Management project investigators have been focused on establishing protocols for data transfer, metadata requirements and initiating the data salvage effort Investigators have been meeting and planning with Matt Jones to coordinate future activities. PIs have participated in several PI meetings and are coordinating activities between the Herring and LTM programs. In addition, the AOOS ocean workspace has been rolled out to PIs and their user and group profiles have been created Several training seminars have been held via webinars and PIs are beginning to use the system to organize and consolidate their project level data Software engineers at Axiom have also been working to support workspace, resolving bugs and implementing new functionality in response to user feedback Significant progress has been made on the Gulfwatch Data Portal to be released in September, 2013

II. PROJECT DESIGN

A. Objectives

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

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

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

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

B. Procedural and Scientific Methods

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

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

The AOOS data management group is currently developing a web base platform for PIs to manage project level data sets and author metadata System development is currently funded through internal AOOS funds in additional to dedicated funding from the Prince William Sound Science Center The AOOS Ocean Workspace will provide a web based platform for PIs to post and share data sets and rapidly author metadata The system will be enabled with security authentication in order to limit access to LTM investigators, project managers and administrators The system will also provide PIs with tools to generate metadata profiles which comply with national standards Initially, this system will focus on authoring FGDC metadata formats including tools for authoring the biological extension for taxonomic classifications and measurements The software development phase of this application was initiated in March 2011 An initial beta release/testing of this system will commence in August 2011 with a planned release date of October 1st, 2011 This platform will provide LTM investigators and project managers with a transparent view of data collection and metadata authoring progress in addition to providing a framework for data integration It is envisioned that this platform will function as the primary vehicle to facilitate data transfer, metadata generation and archiving for the entire LTM project data management lifecycle. This proposed effort will provide a user base and focused environment for the expansion and refinement of this project level data management system

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

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

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

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

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

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

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

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

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

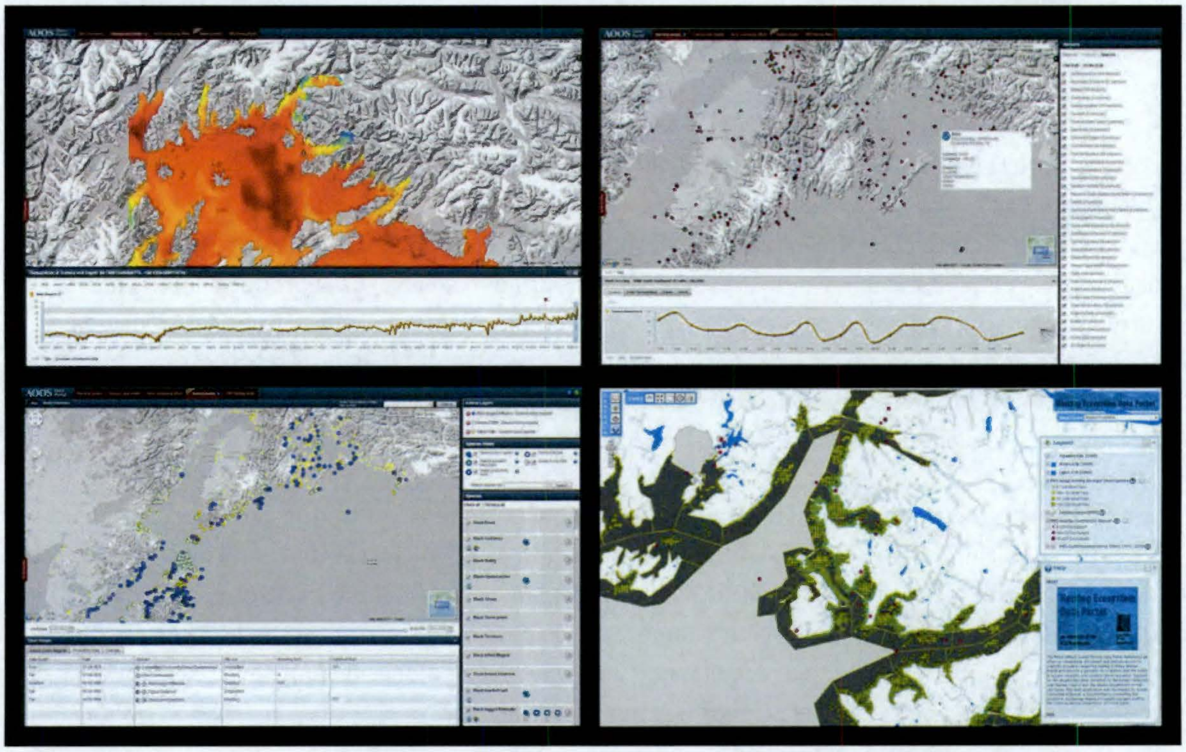

Figure 1. Screenshots of existing AOOS data management and visualization systems which are available at http://data.aoos.org. At the top left is a screenshot of the AOOS model explorer displaying a ROMS circulation model of Prince William Sound and an ocean temperature point source time series extraction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

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

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

C. Data Analysis and Statistical Methods

The overarching strategic plan for the AOOS data system involves implementing an end-to-end technological solution which allows data and information to be channeled and distilled into user-friendly products while simultaneously enabling the underlying data to be assimilated and used by the emerging external data assembly systems. The following diagram (Figure 2) details the four logical technical tiers of the approach. At the base

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

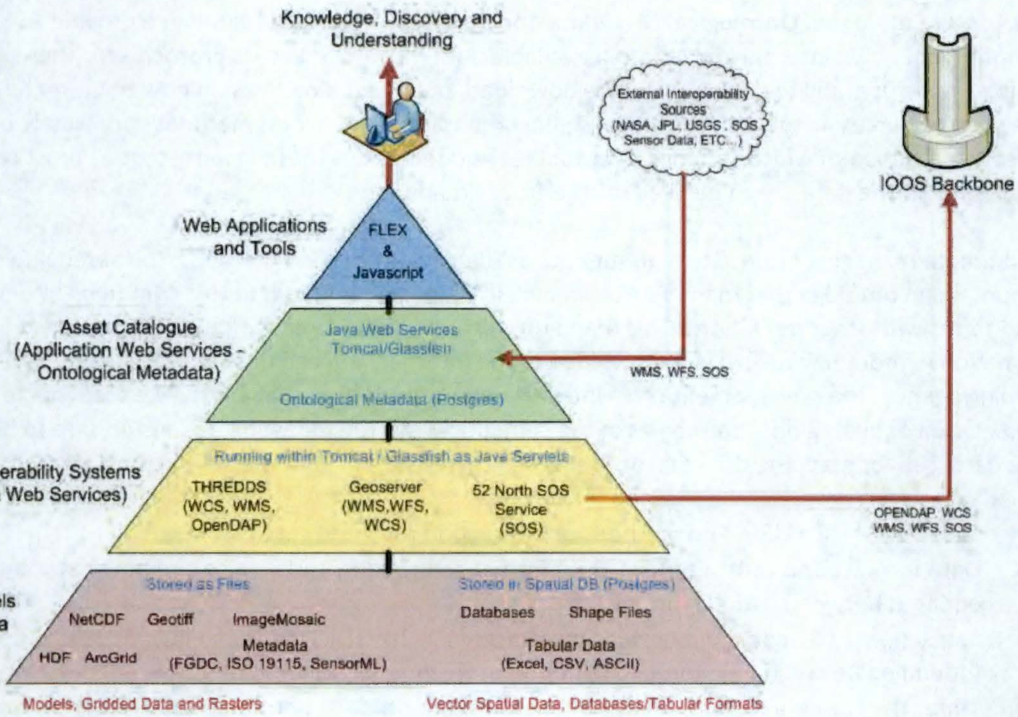

Figure 2. Data knowledge pyramid detailing the flow of data through logical technology tiers so that it can be consumed by users to enable discovery and understanding about the ocean environment.

Tiers are discussed in technical detail below.

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

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

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

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

  - **Source** – Service URLs and methods of interaction for these services
  - **Data formats and return types** – Data format returned by the service and how data can be equated between various formats
  - **Space (x, y, z)** – Spatial dimensions of dataset (1D, 2D, 3D) Upper and lower spatial bounds (bounding box or cube) stored in common projection (EPSG 4326)
  - **Time (t)** – For data resources with a time component. document time span, whether time corresponds to a single moment or if it is representative of a time period If data is in discrete periods, document individual available periods
  - **Taxonomy** – Taxonomic data mapped to International Taxonomic Information System (ITIS) codes
  - **Parameter** – Parameter(s) and units in the data resource and how they map to internally defined universal terms For example Datasets SST, AVHRR, and Sea_Surface all contain parameters that map to internal universal term Sea Surface Temperature.

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

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

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

D. Description of Study Area

The majority of this project will involve consolidating existing data, metadata, and other electronic resources related to herring in Spill Affected Area Specific areas of focus include those areas in PWS, Lower Cook Inlet, and Kodiak where herring fisheries currently do, or historically did occur. The north, east, south, and west bounding coordinates of this area are 59.767, -145 837, 61 834, and -154.334

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "Long-Term Monitoring of Marine Conditions and Injured Resources and Services" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring PWS Herring Research and Monitoring proposal submitted by the Alaska Ocean Observing System This project is also highly coupled with the proposed data management component of the EVOS Herring Research and Monitoring program

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

1 AOOS – (500k to AOOS DM) Alaska oceanographic data management effort Supports open source, standards based data system that serves up and archives real-time sensor feeds, models & remote sensing data, GIS data layers, and historical datasets. Data system developed on interoperability

concepts and meets NOAA Integrated Ocean Observing System standards and protocols for streaming data feeds to national data assimilation centers. Data Management Committee chaired by Dr. Phil Mundy provides ongoing advice, prioritization and direction to the team at Axiom Consulting & Design. AOOS board is made up of federal and state agencies, and major marine research institutions in the state that have committed to data sharing The AOOS board has committed to supporting a statewide data system for as long as AOOS exists Federal funding is stable, although we would like to see it increase. In the event AOOS was to end, all data and data products would be transferred to the University of Alaska

2 PWSSC – PWSSC Data Management Project ($50K to AOOS DM) – Project involves the creation of a prototype data management system for use by PWSSC staff to manage, track, document via metadata and visualize oceanographic and biological data being collected at the center. Project will utilize a stack of open source technologies and protocols with the overall goal of creating a packaged solution for research organizations to better manage and document their data resources This project is to function as the pilot application for the AOOS project level data management system (Ocean Workbench).

3 Northern Forum/USFWS Seabird Data System – ($50K)Project involves the creation and population of a series of new seabird metric databases (diet and productivity) and integrating these new databases with legacy seabird databases (species distribution and abundance at seabird colonies, pelagic species distribution and abundance, USGS seabird monitoring databases and NPRB's North Pacific Seabird Diet Database). Modern spatially explicit, web based data entry interfaces have and continue to be developed to assist researchers existing in distributed agencies to contribute their historic and current seabird metric data into standard data structures. Project will result in vastly increasing the amount and quality of seabird species distribution, diet and other seabird data available for use in retrospective analysis and management Though data includes areas around all of Alaska, most available data is located in GOA and PWS

4 AOOS – 3-year funded partnership (~$200K to ADF&G) with ADF&G Division of Commercial Fisheries to develop data sharing and transfer to make commercial fisheries data more accessible, and to allow ADF&G researchers greater access to oceanographic data. Project builds upon an effort funded by the Moore foundation to develop improved data management capacity and salmon fishery management tools for the PWS fisheries.

5 AOOS – collaborator with Alaska Data Integration Working Group – an initiative with the Alaska Climate Change Executive Roundtable – to develop protocols for serving up project data to increase data sharing among federal and state agencies

6 AOOS and NOAA – initiatives to develop data sharing agreements with private sector, including oil & gas companies.

7 Cook Inlet Regional Citizens Advisory Council (27K) – contract with Axiom to develop a data management system for their oceanographic and contaminants data in Cook Inlet

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

IV. SCHEDULE

A. Project Milestones

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

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

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

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

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

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

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

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

B. Measurable Project Tasks

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

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

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

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

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

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

Y3 4th Quarter (November 1, 14 to January 31, 15)
January Annual Marine Science Symposium

V. BUDGET

Budget Form (attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM – A.3

Project Title: Collaborative Data Management and Holistic Synthesis of Impacts and Recovery Status Associated with the Exxon Valdez Oil Spill (EVOS TC Project #12120120)

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

Primary Investigator(s): Matthew B. Jones, National Center for Ecological Analysis and Synthesis (NCEAS), jones@nceas.ucsb.edu, (907) 957-6509

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

Estimated Budget:
EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 8/27/2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

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

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

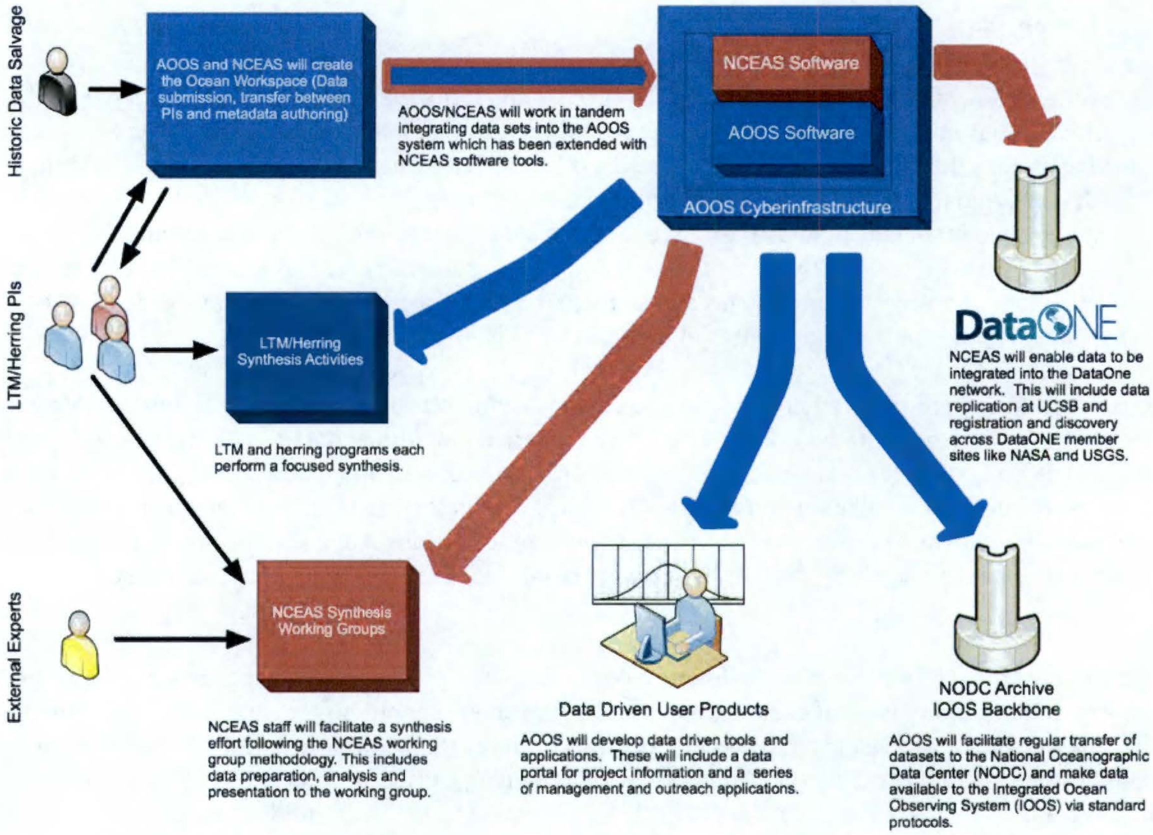

Figure 1. Conceptual description of AOOS/NCEAS/PWSSC collaboration on data management and synthesis activities.

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

B. Procedural and Scientific Methods

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

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

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

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

Objective 2. Consolidate, standardize and provide access to related and historic data sets that are critical for retrospective analysis, synthesis and model development within the LTM and HRM programs
This task will involve isolating and standardizing historic data sets deemed necessary for retrospective analysis by EVOSTC LTM and HRM program synthesis and modeling efforts Early in the effort the EVOSTC LTM and HRM program researcher teams will be engaged to prioritize sources of relevant data deemed of high value for the synthesis effort Data will be prioritized by several metrics including its utility to LTM and HRM program syntheses as well as system-wide synthesis efforts (Objective 7), accessibility of the data, length of time series, scientific importance, quality and precision of the data storage format, and the cost of obtaining the data (digitization can be expensive) All data acquired through efforts of this project will be merged into the AOOS data system for long term archival and access
LTM PIs have already developed a preliminary list of historical data sources under their stewardship which could be of potential value to the LTM program and synthesis effort (see Table 2 in LTM data management proposal), as well as those data PIs would be interested in getting access to are currently unaware of sources (Table 3 in LTM proposal) AOOS funding leverages numerous data sets available through the AOOS website and data system, including the herring and PWS ecosystem data sets that were standardized and made available through the actions of the PWS Herring Portal Project (EVOS Project 070822, 080822 and 090822)
Although data capture will be a collaborative effort, we expect to roughly divide activities into three focal sets of data 1) LTM and HRM data sets that are newly collected under these projects (AOOS focus), 2) Other EVOSTC project data sets, both current and historical, that lay outside of the LTM and HRM projects (NCEAS focus), and 3) external data sets from other funding groups (joint NCEAS and AOOS focus depending on source)

Objective 3. Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM and HRM efforts
AOOS will take the lead on these efforts, as described in the data management DPDs for the LTM and HRM programs The AOOS data team will work with project investigators to develop web-based data driven tools based upon prioritization and direction from agency managers, outreach staff and user groups. Effective data summarization and visualization exposes problems, manifests trends, and allows for high-level comparisons with other sources of information Data visualization products are also ideal tools to communicate information to

audiences with varying degrees of familiarity in meaningful and easily understandable ways NCEAS will provide input and expertise into development of these tools

Objective 4. Organize, integrate, analyze, and model the 20-year historical data from EVOSTC-funded projects in the spill area in preparation for LTM and HRM program and NCEAS working group synthesis efforts
The current AOOS plan is to emphasize the capture of historical data from previous studies related to the Exxon Valdez oil spill during the first two years of the project, as well as to prepare the system to receive the monitoring data generated during this project NCEAS will collaborate with the AOOS team in order to collate, summarize, visualize, and integrate these historical data in order to prepare them for synthesis and analysis NCEAS has developed a group of scientific programmers who specialize in assisting in cross-cutting analysis and modeling, and we will employ one of these scientific programming specialists along with a graduate student assistant to collate, standardize, integrate, summarize, and visualize the data needed for synthesis activities. Digital, graphical and visualization products generated by NCEAS from the 20-year historical datasets will be used for the cross-cutting synthesis activities of the year three EVOSTC joint workshop between the LTM and HRM programs and for the broader EVOS impact syntheses described in Objective 7. Products from these activities will include data summaries and visualizations from each of the prioritized EVOSTC data sets; quality assurance analyses on input data to resolve issues prior to analysis, integrated data products that resolve methodological differences to combine multiple related primary data sets into long-term, cross-scale derived data products; and analyses of these derived products that illustrate long-term, cross scale aspects of spill impacts and recovery These activities will build upon the LTM and HRM program synthesis and conceptual ecological modeling efforts focused on the monitoring program data. Please see the detailed project descriptions on LTM synthesis (Holderied), LTM ecological modeling (Hollmen), HRM synthesis (Pegau), and HRM modeling for additional information, as well as the synthesis activities in Objective 7 regarding cross-cutting synthesis efforts

Objective 5. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use
The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via EVOS LTM and HRM project activities so that it can be transferred efficiently to long term data archive and storage centers and made available for future use by researchers and other user groups This task will leverage the AOOS cyberinfrastructure, long-term funding and other active data management projects being undertaken by that organization. Data sets produced from the integrated research effort will be served to users by extending existing data access, analysis and visualization interfaces currently supported and under development by the AOOS data management team. AOOS systems have the capabilities to ingest, archive and serve model output, remote sensing and real time/archived sensor data streams, and, as of fall 2011, ingest and archive GIS and project level data AOOS is currently developing a mirror site in Portland, OR to ensure long-term security of its data and software In addition, AOOS has prioritized working with state and federal agencies to ensure long-term access and archiving of agency data and information products

Objective 6. Augment AOOS preservation and interoperability system with other non-IOOS data systems through integration of DataONE services
NCEAS will augment the capabilities of the AOOS data system by incorporating the services that are part of the DataONE data federation[2]. These include open services for writing data and metadata, controlling access to data products as they are populated in the system, and services for replication and preservation of data By using the

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[2] http //dataone org

DataONE service framework, this will also link the AOOS and IOOS system to the DataONE federation, which includes partners such as the U S Geological Survey, Knowledge Network for Biocomplexity and NASA Distributed Active Archive Centers This broader federation will be critical in other stages of the project, especially for access to satellite data during synthesis and analysis activities
In addition, DataONE services include a comprehensive, cross-institutional data preservation model that involves mirroring of data at multiple DataONE participating institutions and continuous active monitoring to ensure data remain valid and that adequate replication is present even in the event of institutional failures. In this project, we will establish the AOOS Asset Catalog as a Member Node in the DataONE network, and thus be able to replicate all EVOS data to DataONE partner institutions to ensure longevity, accessibility, and validity of EVOS data Funding for these replicas will largely be supported through storage already available on the DataONE network (approximately 1 2 petabytes available for replication), although exceedingly large data sets (above ten terabytes) will need to be discussed

Objective 7. Conduct broad synthesis activities on EVOS impacts and recovery as part of whole-ecosystem analysis through NCEAS working groups
Since 1995, the National Center for Ecological Analysis and Synthesis (NCEAS)[3] has been advancing the state of ecological and environmental knowledge through synthetic and collaborative research that aims to discover general patterns and principles based on existing data The premise at NCEAS is that many decades of data have been collected that can be synthesized to produce novel insights into important scientific and societal issues, and that the expertise and information resources necessary to accomplish these syntheses are latent but distributed throughout the science community To promote effective synthesis of environmental data, NCEAS has sponsored and executed more than 450 working groups over 15 years, many of which have had major scientific and policy impacts (e g , changes in habitat conservation plans for endangered species, and creation of marine reserve initiatives based on scientific principles). Sociological studies of the working groups in action at NCEAS have demonstrated major shifts in the culture of synthesis in ecology and gains in collaborative productivity via the working group model at NCEAS (Hackett et al. 2008).

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

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

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

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[3] http //www nceas ucsb edu

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

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

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

Due to data heterogeneity, data discovery is difficult for complex, multidimensional and cross-disciplinary data that will be collected by the LTM and HRM program research teams The AOOS system incorporates a metadata authoring tool that includes extensions for biological metadata. In this project, NCEAS and AOOS will expand on that system and build **Smart Semantic Search Services** that understand the scientific content of data to improve the effectiveness of data searches. The NCEAS team has pioneered a semantic scientific observations model that allows scientists to precisely discover measurements of interest and subset data to only include observations relevant to their studies NCEAS developed the Extensible Observations Ontology (OBOE, Madin et al. 2008) to enable semantic search and access services that facilitate much higher precision and recall than have been possible with traditional metadata-driven systems We will incorporate these semantic search services into the

AOOS Tier 3 asset catalog, and help to develop the catalog so that semantic markup of data on ingest is easily accomplished. Thus, in addition to managing information about data availability and access methods, the asset catalogue will also contain ontologies that map source data descriptions and metadata to a common set of internally stored terms with strict definitions. This mapping will allow users to easily locate related sets of information without having explicit knowledge of the internal naming conventions of each data-providing agency The development of an internal ontology will also enable future endeavors to connect the asset catalogue to global ontologies in the semantic web Because the asset catalogue contains a semantic definition of data sources and maps all known data sources to a common definition, applications can be developed which connect users to vast arrays of data through simple but powerful interfaces

Collaborative Synthesis and Analysis Methods

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

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

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

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

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

Based on the preparatory data analysis and modeling conducted to assemble and integrate the 20-year historical data set with available current data from the LTM and HRM program syntheses (see Objective 4),

[4] Anderson, Cherr, and Peterson, Ecotoxicology of the Gulf Oil Spill A holistic Framework for Assessing Impacts

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

D. Description of Study Area

The study area for this project will include the entire EVOS spill affected area The north, east, south, and west bounding coordinates of this area are 59.767, -145 837, 61 834, and -154 334

E. Coordination and Collaboration with the Program

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

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

NCEAS brings complementary skills to the data management efforts. They have extensive expertise in cyberinfrastructure systems for synthetic environmental science (c f , Reichman et al. 2011, Jones and Gries 2010, Jones et al. 2006) NCEAS has developed software systems supporting long-term data preservation and sharing, is a leader in metadata systems for science data, and is a progenitor of the DataONE[6] interoperability framework to create a global data federation for open access to scientific data NCEAS' focus on project-level data management for highly heterogeneous data allow the management of current and legacy data that are

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[5] http //www nceas ucsb edu/globalmarine

[6] http //dataone org

critical to synthesis but that often are not captured by large-scale agency data systems, such as the EOSDIS program or the IOOS program. Thus, the initiatives at NCEAS for capturing complex but smaller-scale biological and physical data will be an effective complement to the ocean observatory data management systems that are provided by AOOS.

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

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

IV. SCHEDULE

A. Project Milestones

Objective 1. Provide data management oversight and services for EVOS LTM project team data centric activities that include data structure optimization, metadata generation, and transfer of data between project teams
This objective will be addressed by AOOS and NCEAS throughout the entire span of the project and will follow the annual cycle of field data collection and analysis by principal investigators NCEAS milestones will include incorporation of project-specific data management tools into the Ocean Workspace and development of Smart Semantic Search Services for data discovery.

Objective 2. Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development
This objective will be primarily met by AOOS and NCEAS by the fourth quarter of year two of the effort (September 2013) However, AOOS will continue to add data to the system throughout the entire life of the project, and NCEAS will continue to add data as needed by synthesis efforts through year 4.

Objective 3. Develop tools for user groups to access, analyze and visualize information produced or processed by the LTM and HRM efforts.
For AOOS, see milestones in LTM and HRM detailed project descriptions For NCEAS, analysis and visualization tools that are incorporated into the system will be available at the end of year 2 when other software deliverables are produced.

Objective 4. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use.
This objective will be addressed throughout the entire span of the project. The AOOS data system is to serve as the vessel to capture all project level data produced through this effort in addition to those datasets salvaged to inform the historic synthesis effort. This task will be ongoing as long as the program is producing or acquiring additional data.

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

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

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

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

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

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

B. Measurable Project Tasks

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

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

FY14 2nd Quarter

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

FY14 3rd Quarter

FY14 4th Quarter

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

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

February	Assess year 3 datasets and metadata submitted through AOOS

FY15 2rd Quarter

May	Participate in annual HRM program PI meeting

FY15 3rd Quarter

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

FY15 4th Quarter

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

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

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

FY16 4th Quarter

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

V. BUDGET
Budget Form (Attached)

References

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FY14 PROGRAM PROJECT

PROPOSAL FORM - A.4

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

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

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

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

Estimated Budget:
EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 29, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

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

B. Summary of Project to Date

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

II. PROJECT DESIGN

A. Objectives

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

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

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

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

B. Procedural and Scientific Methods

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

<u>Coordination</u>

As described in detail in the summaries for the environmental drivers, benthic and pelagic component plans in Appendix 1 of the proposal submitted by McCammon et al , the monitoring efforts under this program are closely coordinated with existing monitoring by other agencies and research organizations We are working with several program managers and scientists in these monitoring programs as part of the synthesis effort Some are participating as principal or collaborating investigators in the program and others are sharing data and coordinating on monitoring protocols. Some examples include the NPRB GOAIERP, the Alaska Ocean Observing System's GOA programs, National Park Service Inventory and Monitoring Program, Kachemak Bay Research

Reserve System-Wide Monitoring Program, Cook Inlet and Prince William Sound Regional Citizens Advisory Council monitoring programs, U S Fish and Wildlife sea otter surveys, small mesh trawl fishery surveys conducted by NOAA National Marine Fisheries Service (NMFS) and the Alaska Department of Fish and Game (ADF&G) and new oceanographic monitoring to be conducted by the NMFS Kodiak Laboratory.

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

Synthesis

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

C. Data Analysis and Statistical Methods

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

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

1) support coordination between the EVOSTC-funded LTM projects, 2) facilitate coordination with the EVOSTC-funded herring program, and 3) support collaborations with other efforts, including state and federal agency operations and research programs funded by other organizations such as NPRB Please see above sections and the schedule below for details

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

IV. SCHEDULE

A. Project Milestones

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

Objective 1. Improve data sharing and coordinated field work planning between project PIs and other agencies and research organizations

Annual PI meetings to be conducted each year (tentatively in November)
Initial coordinated field work schedule
LTM program update at Alaska Marine Science Symposium each year
Annual LTM proposed work plan submission to be met by August of each year

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

Annual LTM progress report submission to be met by August each year
Initial synthesis of historical data available in digital format from LTM projects to be met by September 2013
Data synthesis report for Year 3 joint workshop to be met by October 2014

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

Development of initial tool
Workshops and Integrated discussion groups held each year.
(see Data Management project description for additional milestones)

B. Measurable Project Tasks

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

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

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM – A.5

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

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

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

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

Estimated Budget:
EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 23, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

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

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

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

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

B. Procedural and Scientific Methods

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

   Development of conceptual ecological models to support synthesis and planning of the long term monitoring program is a multi-phase process. Identification of key components, processes, and functions of the system is a key step involving the PIs of the benthic, pelagic, and environmental components of the project. PI input is elicited at annual PI meetings, workshops focusing on model development, and other interactions with PIs throughout the year. The conceptual models in development reflect the status of the current knowledge of the system, and they will be refined as understanding of the system evolves through the research program. This approach provides out program a tool to demonstrate learning throughout a long term research and monitoring program.

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

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

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

C. Data Analysis and Statistical Methods

The conceptual ecological modeling involves qualitative and quantitative analyses of ecosystem components and processes Information about the system is elicited from PIs to construct the models Analytical and visualization tools and methods include structural and influence diagrams, tabulated data, narratives, spatial maps, and quantitative analyses of PI input Diagrams are used for the development of visualization tools. Data analysis involves synthesis of PI input to develop a generic GOA conceptual ecosystem model, refinement of linkage rating tools to assess state of knowledge and importance of physical and biological processes linking system components, and application of these tools to develop submodels for specific system components We summarize a parsimonious generic GOA conceptual ecosystem model and develop a visual diagram output based on conceptual model diagrams developed by teams of benthic, pelagic, and environmental driver project PIs, representing key linkages based on PI input The generic model serves as a visual representation of current state of our knowledge about structure and function of the GOA ecosystem, and an iterative tool to be updated to demonstrate learning contribution by GWA research We analyze PI input on ecological linkage rating tool exercise from November 2012 PI meeting, summarize results from example submodel from the November 2012 PI meeting, and refine a linkage rating tool applicable to modeling efforts to address a suite of factors related to the strength of linkages, temporal and spatial scales, and state of knowledge Submodels can be further utilized to build linkages between scientific goals and management objectives, using conceptual modeling and tools of structured decision analysis. We anticipate that we are able to initiate the process linking scientific and management objectives during the next year, although the tasks were not specified as a milestone in the original proposal

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

III. CVs/RESUMES- please see appendix 2

IV. SCHEDULE

A. Project Milestones

Objective 1. Develop a conceptual ecological model of the study system

Conceptual ecosystem model: To be met by June 2016

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

B. Measurable Project Tasks

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

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

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

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

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

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

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

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

V. BUDGET

Budget Form (Attached)

Environmental Drivers Monitoring Component (leads – Weingartner & Hopcroft)

FY14 PROGRAM PROJECT

PROPOSAL FORM

Project Title: Long-term monitoring: Environmental Drivers component - Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK 1.

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

Primary Investigator(s): Thomas Weingartner, Principal Investigator, School of Fisheries and Ocean Science, University of Alaska, Fairbanks, AK 99775 (907-474-7993; tjweingartner@alaska.edu)

Abstract:

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

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

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

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

Estimated Budget:

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used: none

Date: August 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

Justification

The purpose of this proposal is to provide long-term monitoring data on the physical oceanography of the Alaska Coastal Current and the northern GoA shelf. The Alaska Coastal Current (ACC) is the most prominent feature of the Gulf of Alaska's shelf circulation. It is a narrow (~40 km), swift, year-round flow maintained by the integrated forcing of winds and coastal freshwater discharge. That forcing is variable and reflected in ACC properties. The current originates on the British Columbian shelf and leaves the Gulf for the Bering Sea through Unimak Pass. Substantial portions of the ACC circulate through Prince William Sound and feed lower Cook Inlet and Kachemak Bay before flowing southwestward through Shelikof Strait. The current controls water exchange and transmits its properties into the fjords and bays between Prince William Sound and the Alaskan Peninsula. The monitoring proposed herein quantifies variability of the Gulf's shelf environment. ACC monitoring provides the broader-scale context for understanding variability in adjacent marine ecosystems and its affect on particular species (e.g., herring, salmon, forage fish). The ACC's variability is transmitted to nearshore habitats around the gulf.

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

The 40-year GAK 1 time series has documented:

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

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

1 Temperature and salinity throughout the water column,
2 Near surface stratification since this affects phytoplankton bloom dynamics,
3. Near and subsurface nitrate supply on the inner shelf, since this important nutrient affects phytoplankton production,

B. Procedural and Scientific Methods

Following past protocols, we propose quasi-monthly (up to 8 per year) CTD measurements and year-long, continuous measurements from a subsurface mooring with temperature and conductivity (T/C) recorders placed at nominal depths of 20, 30, 60, 100, 150, 200, and 250 m We also include 1 - 2 ISUS (*In Situ* Ultraviolet Sensor) sensors at 20 m and at 150 m depth These instruments optically determine nitrate based on the nitrate UV-absorption spectrum. This spectrum is unique for nitrate and it is resolved by the 256-channel ISUS spectrometer and interpreted by an algorithm developed by the Monterey Bay Aquarium Research Institute The 20 m ISUS is within the euphotic zone and complements the fluorometer data. The 150 m ISUS will gauge the annual re-supply of nitrate to this shelf (and also Prince William Sound) through the annual exchange between deep shelf and slope waters. The deep water (and nitrate) is mixed to the surface in winter and is thereby available to phytoplankton at the onset of the spring bloom ISUS sensors appear to provide sufficiently reliable data (± 2 □M) for a whol were provided (and will be maintained) with support from the Alaska Ocean Observing System However, analytical costs for the ISUS data are not covered by this project, so these data will be collected, although support for their analyses has yet to be identified

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

The moored T/C recorders are Microcats (at depths greater than 20 m) and a SeaCat both manufactured by Seabird, Inc Seabird performs pre- and post-calibrations upon which we determine sensor drift (typically ~0 01°C -yr^{-1} and ~0 03, or better, Practical Salinity Unit yr^{-1}). The quasi-monthly CTD casts are collected from a chartered fishing vessel resident in Seward using a portable CTD (Seabird SBE-25) The SBE 25 has an accuracy ~0 01 or better for salinity and 005°C for temperature. Temperature and salinity data are sampled at 15-minute intervals

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

C. Data Analysis and Statistical Methods

The temperature and salinity data analyses are straightforward We will compute standard statistical estimates for each month and depth and compare these with historical data since the thrust of this effort is to quantify interannual variability. We continue to incorporate an integrated discharge time series and air-sea heat fluxes derived from National Center for Environmental Prediction (NCEP) in our analyses of salinity and temperature variability. We have generated the historical heat flux calculations which show that winter heat losses (from the ocean to the atmosphere) are more variable both interannually and at longer periods than summer heat gains. For example, winter heat loss has decreased by nearly 20% since the mid-1970s and this change was reflected in the warming at GAK 1 through 2005 Since that time winter heat loss has increased substantially and returned to values that occurred in the early 1970s. Winter heat loss, in conjunction, with runoff, affects the ocean temperature distribution through spring when many young larvae are emerging to feed (*Janout et al*, 2010). On the other hand summer heat gains appear to be relatively consistent from year to year because this is primarily a function of cloud cover *Royer et al* (2006) contend that summer surface temperatures over the shelf and in Prince William Sound are primarily a function of the stratification They suggest that stronger stratification traps heat in the surface layer and elevates surface temperatures, whereas weaker stratification allows the solar energy to diffuse to greater depths. Within the ACC, stratification is primarily a function of the vertical salinity gradients that we are measuring at GAK 1

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

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

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

IV. SCHEDULE

A. Project Milestones

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

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

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

B. Measurable Project Tasks

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

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

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

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

V. BUDGET

Budget Form (Attached)

Seward line monitoring – Hopcroft (UAF)

FY14 PROGRAM PROJECT PROPOSAL FORM – B.7

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

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

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

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

Estimated Budget:
EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

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

Date: 31 Aug 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

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

Specifically, cruises:

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

B. Procedural and Scientific Methods

Overview

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

General Considerations

For a long-term observation series, one of the most critical requirements is consistency of sampling locations, timing of observations and methodology. We propose to employ the same set of 13 primary and 9 secondary stations along the Seward Line sampled by the GLOBEC program, which extends from the

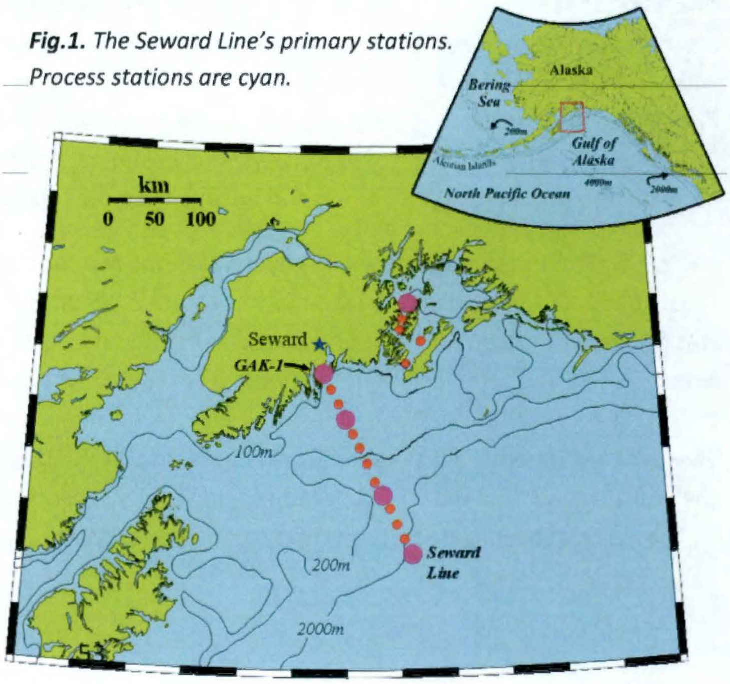

Fig.1. *The Seward Line's primary stations. Process stations are cyan.*

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

Physical, Chemical, and Phytoplankton

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

Nutrient measurements are made post-cruise on frozen samples using an Alpkem Rapid Flow Analyzer (Whitledge *et al*, 1981) and will conform to WOCE standards (Gordon *et al*, 1993). Tests of frozen versus refrigerated samples have indicated no significant difference between storage methods Analytical precision for triplicate nutrient measurements is approximately 0 03-0 05 μmoles kg^{-1} *Chlorophyll a* concentrations will be measured at all stations to calibrate the *in vivo* fluorescence profiles The samples will be collected with the rosette on up-casts Extracted chlorophyll *a* will be determined fluorometrically post-cruise (Parsons *et al.*, 1984).

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

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

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

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

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

Zooplankton

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

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

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

Growth/reproduction (Hopcroft) Ongoing changes in the Gulf of Alaska will likely be a reflection of underlying change in the rates of growth and reproduction experienced by the most dominant components of the zooplankton In the Gulf of Alaska, biomass is seasonally dominated by the large *Neocalanus* spp., although on average they may be exceeded in terms of biomass and production by *Pseudocalanus* species (Coyle & Pinchuk, 2003, 2005). We propose to work with both these species on some cruises, collected using fine mesh nets at 4 stations spaced along the Seward Line, plus one inside the sound, as was done in the GLOBEC program (e.g. Napp *et al.*, 2005, Liu & Hopcroft, 2006) For *Pseudocalanus,* we propose to monitor egg production rate (EPR), because it appears to be generally reflective of somatic growth of prior developmental stages for these species in this ecosystem (Liu & Hopcroft, 2006b, 2007, 2008), and EPR generally reflects the current food climate (Runge & Roff, 2000) For these experiments, 100 females representing a mixture of the *P. mimus* and *P. newmani* are incubated individually in 70 ml flasks, and the number of eggs produced over 2 days by each population is determined (Napp *et al*, 2005). In contrast, *Neocalanus* only spawn at great depth during the winter months, thus we must directly assess the growth rates. In this case, single stages of *Neocalanus flemingeri* are selected and incubated at low densities in 20L carboys (with natural food concentration) for 4-5 days, harvested, preserved, and the increase in stage and size later determined from the samples (Liu & Hopcroft, 2006) If time permits, EPR may also be determined for other important species (e g. *Metridia pacifica* – Hopcroft *et al.*, 2005).

C. Data Analysis and Statistical Methods

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

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D. Description of Study Area

Central coastal Gulf of Alaska & Prince William Sound (see above. 61.0, -149.5, 58 0, -146.0)

E. Coordination and Collaboration with the Program

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

Leveraging: This proposal seeks for EVOS to join the consortium of NPRB, AOOS and NOAA currently funding the line. We propose to add additional sampling (the central sound and Hinchinbrook Entrance) to provide more extensive representation of PWS Full annual costs are ~400K including ship time, thus the 4 members of the consortium should each contribute ~100K per year Substantial cost saving are anticipated in 2013 when NPRB's GOA-IERP program will cover a larger-than-normal share of the annual funding as well as provide larger sampling context throughout the Gulf of Alaska Shelf. The proposal also leverages on the consolidation of historical and contemporary information in the Gulf of Alaska planned through GOA-IERP program

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

IV. SCHEDULE

A. Project Milestones

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

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

Typically

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

B. Measurable Project Tasks

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

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

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT

PROPOSAL FORM – B.9

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

Project Period: February 1 2014 – January 31, 2016

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

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

Estimated Budget:
EVOSTC Funding Requested:

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

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

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

Date: 30 Aug 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

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

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

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

B. Procedural and Scientific Methods

<u>Project approach and logistics</u>

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

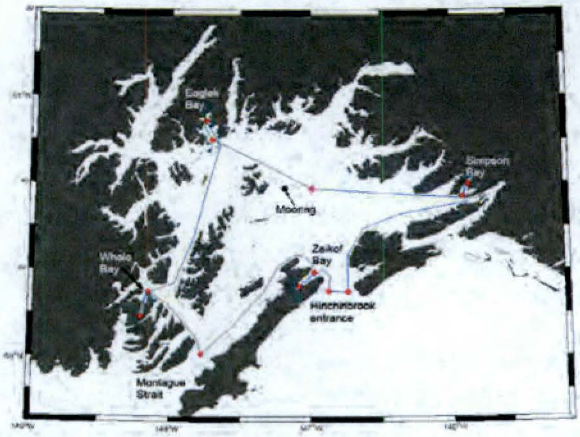

Figure 1. Proposed mooring location, cruise track and station locations visited during vessel surveys.

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

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

Methods

All of the instruments will be calibrated annually, and water samples will be taken with Niskin bottles to validate the observations Water will be filtered through a Whatman GF/F filter (nominal pore size 0 7μm), which will be retained for the extraction of chlorophyll-*a* (Parsons et al 1984), and the filtrate will be retained for the analysis of nitrate, phosphate and silicate Following each cruise, quality assurance checks will be made on all the data collected, and the CTD data will be processed with standard methods, the data and associated metadata will be databased for later analysis and distribution. Zooplankton samples will be subsampled with a Folsom plankton splitter (McEwan et al. 1954), and identified to species and stage under a stereomicroscope.

C. Data Analysis and Statistical Methods

This program will result in a high frequency (~daily) time series in central PWS that will be directly comparable to a complimentary time series taken during the SEA project. It will also continue time series observations of temperature, salinity, chlorophyll fluorescence, turbidity, and nitrate concentration, all as a function of depth, at two locations in each of the SEA bays, as well as four sites representative of open water habitat and water entering and leaving PWS Those data will be used to create temporal sections, using standard methods (e.g Sandwell 1987, Chatfield 1995), which will then be used to describe the changes in oceanographic conditions over time within each of the bays, as well as PWS in general Comparisons will also be made to previous observations (e g. Meunch and Schmidt 1975; Gay and Vaughan 2001) Autocorrelation statistics such as the Mantel test (Smouse et al 1986) will be used to infer decorrelation scales between bays and the open PWS, both spatially between sites and temporally within sites.

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

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

D. Description of Study Area

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

Table 1: Station locations

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

E. Coordination and Collaboration with the Program

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

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

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

IV. SCHEDULE

A. Project Milestones

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

Objective 2. Conduct regular surveys in PWS.

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

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

B. Measurable Project Tasks

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

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

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

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

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

April-June·	*Mooring operational, sample processing ongoing*
April·	*Vessel survey*
June.	*Vessel survey/service mooring*

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

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

V. BUDGET (attached)

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

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FY14 PROGRAM PROJECT PROPOSAL FORM – B.8

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

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

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

Abstract:

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

Estimated Budget:
EVOSTC Funding Requested:

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

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

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 9 August 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

This project is designed to assist in the evaluation of recovery and restoration of injured resources in the foot print of the *Exxon Valdez* oil spill (EVOS). It is important to know if oceanic conditions and changes in the Gulf of Alaska are synchronous with near-shore trends, and monitoring at multiple sites will help discern such relationships. Kachemak Bay, like PWS, has been impacted by the EVOS and has similar physical stressors on near-shore coastal habitat such as land-level changes from the 1964 earthquake and isostatic rebound from melting glaciers. In this project we are continuing oceanographic monitoring data series for lower Cook Inlet (Okkonon et al. 2009) and Kachemak Bay (Murphy and Iken 2013).

B. Summary of Project to Date

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

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

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

II. PROJECT DESIGN

A. Objectives

<u>Project objectives</u>

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

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

4 Improve understanding of water mass movement in Kachemak Bay
   - a Identify surface and subsurface flow and water mass characteristics within Kachemak Bay through measurements of temperature and salinity in historical and present data.
   - b Examine spatial, seasonal and annual changes in the depth and persistence of freshwater lenses in the Bay.
   - c Place an additional YSI data sonde in Bear Cove during the ice-free period to monitor trends in salinity, temperature, and nutrients at the head of the Bay in proximity to clam beds.

5 Determine linkages, and temporal variability in those links, between Kachemak Bay/lower Cook Inlet and the Alaska Coastal Current
   - a Maintain and monitor temperature trends in all sub-bays on the southern side of Kachemak Bay with TiBits temperature loggers
   - b. Analyze data on temperature and salinity signatures that identify Gulf of Alaska water intrusions into Kachemak Bay
   - c. CTD data will be analyzed for spatial, seasonal and annual variability and trends, as well as linkages to oceanographic data from the GAK1 mooring and Seward line and the GoAIERP shipboard sampling along the shelf adjacent to Cook Inlet

6 Examine the short-term variability and track long-term trends in oceanographic and water quality parameters

7 At a subset of stations along each CTD transect, collect water samples for marine plankton Zooplankton samples will be analyzed by Rob Campbell as part of the PWS oceanographic monitoring project Phytoplankton will analyzed by the NOAA Center for Coastal Fisheries and Habitat Research at Kasistna Bay Laboratory and with molecular techniques at our Beaufort Laboratory in North Carolina.

B. Procedural and Scientific Methods

Study Area and Sampling Frequency. We are extending existing time series of oceanographic surveys in lower Cook Inlet and Kachemak Bay (Okkonon et al. 2009, Muphy and Iken 2013) and supplementing an existing water quality monitoring program in Kachemak Bay (Kachemak Bay Research Reserve 2010) with an additional site in Bear Cove during the ice-free months. Surveys will be conducted at stations along transect lines (Figure 1) within Kachemak Bay (Transects 4 and 9) and across lower Cook Inlet (Transects 3, 6 and 7). Kasitsna Bay Laborator and Kachemak Bay Research Reserve small boats will be used for Kachemak Bay sampling and larger chartered boats will be used for Cook Inlet sampling, due to the routine presence of higher sea state conditions in the inlet. Station spacing will be between 400 m and 1 5 km in Kachemak Bay and up to 4 km in Cook Inlet, with closer station spacing near the coast. At the beginning of each transect, the following information is recorded· cruise ID, vessel, date, transect line, wind speed and direction, and sea state Additional information recorded at each station, including station ID, time, position, station depth, event (type of sampling event and sample ID), and comments about the station Oceanographic measurements are made with conductivity-temperature-depth (CTD) profiler casts at each station along Transects 3, 4, 6, 7, and 9 (n=88) and plankton samples are collected at a subset of the stations (n=15) (Figure 1) Transects in lower Cook Inlet and outer Kachemak Bay (Transects 3, 4, 6, and 7) are scheduled for sampling quarterly for the first three years of the study and reduced to three and two sampling periods, respectively, during years four and five of the project due to budget limitations. Transect 9, at mid-Kachemak Bay is scheduled for monthly oceanographic (n=9) and plankton (n=3) sampling throughout the study period

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

Zooplankton Sampling: Zooplankton are sampled with a bongo style plankton net (2 m length of 333 micron mesh with a 60 cm diameter opening (Aquatic Research Instruments)). We conduct a 50m vertical tow with a tow rate of approximately 0 5m/s. A mechanical flow meter (General Oceans Inc. R2030) is attached to one of the two nets to estimate water volume. When the tow is complete, the mesh and cod end are washed down with salt water to concentrate plankton. The plankton sample is retrieved from the net that does not have the flow meter attached to the opening Plankton are transferred to plastic bottles with screw-top lids and preserved with either 3 or 5% formalin solution in the field Preserved samples are shipped to the Prince William Sound Science Center for analysis of species and relative abundance of each species

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

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

C. Data Analysis and Statistical Methods

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

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

D. Description of Study Area

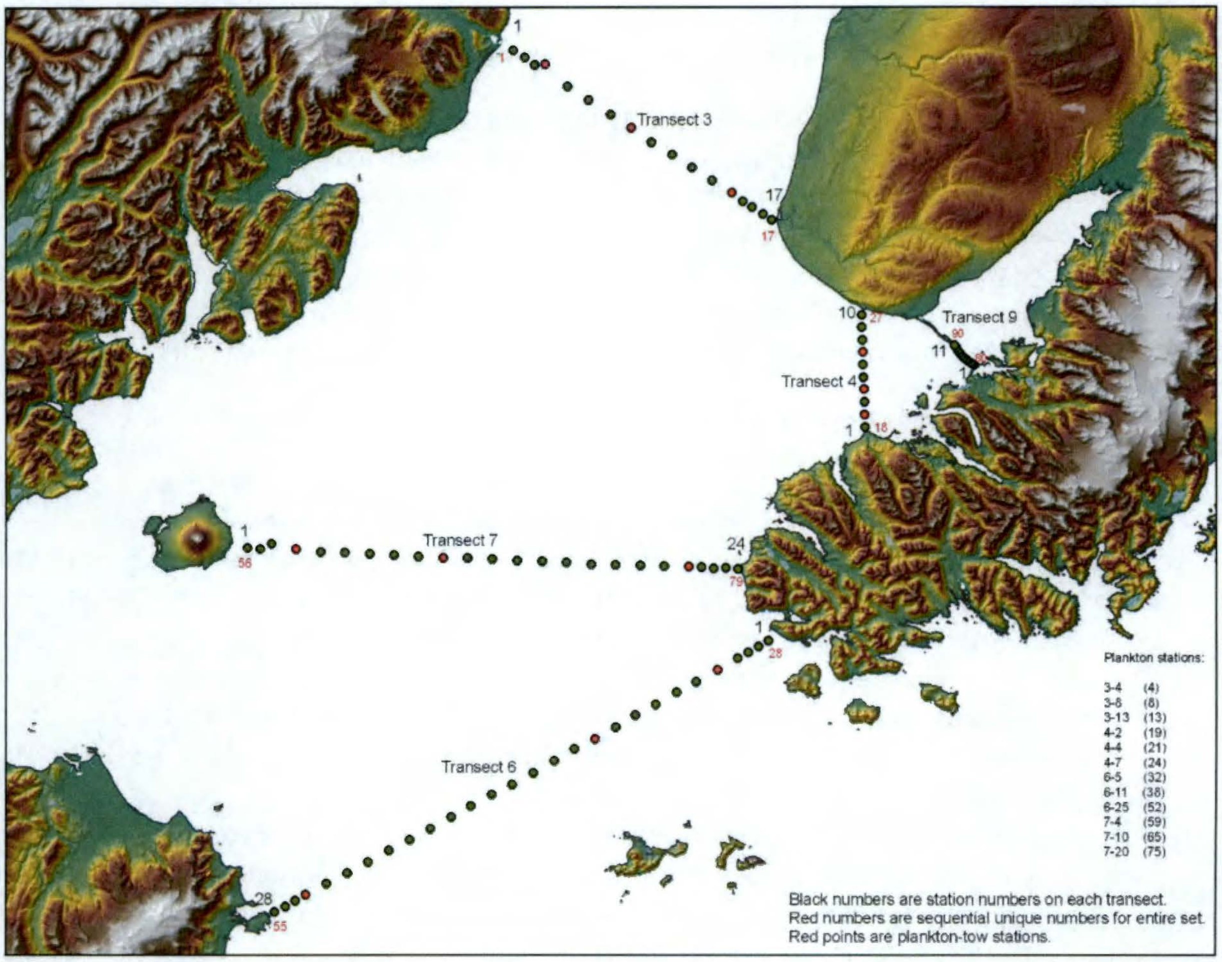

Figure 1. This is the study area for the oceanographic and marine plankton long term monitoring project in Kachemak Bay and lower Cook Inlet, Alaska. Each dot represents an oceanographic profile sampling location; red dots indicate the current sampling stations for marine plankton and water chemistry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

E. Coordination and Collaboration with the Program

The Kachemak Bay Research Reserve provides resources for continuous monitoring of water quality and meteorological data; this proposed project leverages and supplements an existing program. Oceanographic monitoring in Kachemak Bay will combine: 1) continuous data from existing KBRR water quality monitoring stations (YSI sondes measuring temperature, salinity, dissolved oxygen, turbidity, pH) at the Homer and Seldovia harbors; 2) an additional shoreline water quality station to be deployed during ice-free months in Bear Cove (near head of Bay); and 3) small-boat transects of temperature and salinity profiles (CTD) and plankton sampling, conducted by monthly on a transect across from the Homer Spit. Oceanographic monitoring in lower Cook Inlet leverages existing CTD survey data collected along these transect lines as well as four other transects in lower Cook Inlet. The NOAA Kasitsna Bay Laboratory is contributing staff time and in-kind use of small boats and equipment to the project. We are also leveraging support from undergraduate NOAA Hollings Scholars that have 2-month summer internships at Kasitsna Bay Laboratory, with two to three students participating each year Collectively, the proposed near-shore and offshore long-term monitoring will have $155K/year match from the Kachemak Bay Research Reserve and the Kasistna Bay Laboratory, combined

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

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

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

III. CV's/RESUMES- please see appendix

IV. SCHEDULE

A. Project Milestones

Objective 1. Quarterly CTD/marine plankton surveys will be conducted throughout the study area Monthly CTD/marine plankton surveys will be conducted in Kachemak Bay The Kachemak Bay Research Reserve's water quality monitoring program will collect continuous water quality data at 5 stations during ice-free months and 3 stations during heavy icing

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

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

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

B. Measurable Project Tasks

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

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

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

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

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

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

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

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

V. BUDGET
Budget Form (Attached)

Pelagic Monitoring Component (lead – Lindeberg)

FY14 PROGRAM PROJECT

PROPOSAL FORM

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

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

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

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

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

Estimated Budget: $52.7K

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

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

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

Date: July 18, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

From preliminary analysis of NPS data, the current survey design does not provide variance estimates for detecting trends for the identified indicator species with suitable confidence (<0 50) depending on the species We utilized coefficients of variance (CVs) to determine within year as well as across year variation for each species. NPS determined that we may not be adequately surveying for some species possibly because (1) certain species are highly aggregated (2) we are focusing on inappropriate habitat for the species in question, (3) our sample size is too small or (4) the year to year variation in distribution is great enough that we should be conducting replicate surveys within a single season

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

B. Summary of Project to Date (if applicable)

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

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

II. PROJECT DESIGN

A. Objectives

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

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

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

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

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

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

Linkages: This exercise with utilize and link datasets spanning several years within Prince William Sound, Kenai Fjords and Katmai. Focal species include those that have exhibited protracted recovery from EVOS This work would be an interagency effort between NPS, USFWS and USGS to improve the power to detect trends of coastal marine birds across the entire spill area

B. Procedural and Scientific Methods

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

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

See Project Design Section A

C. Data Analysis and Statistical Methods

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

See Project Design Section A

D. Description of Study Area
Where will the project be undertaken? Describe the study area, including if applicable decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e g , 60 8233, -147 1029, 60 4739, -147.7309 for the north, east, south and west bounding coordinates) The formula for converting from degree minute seconds to decimal degrees is· degrees + (minutes/60) + (seconds/3600) so 121°8'6" = 121. + (8/60) + (6/3600) = 121 135

See Project Design Section A.

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

See Project Design Section A.

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

IV. SCHEDULE

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

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

before the end of federal fiscal year 2013 Timelines for objective 3 have been modified based on objective 1's updated date
To be met by September 2013

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

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

B. Measurable Project Tasks

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

FY 14, 1st quarter (February 1 – May 31, 2014)
February, 2014 *Project in progress, no additional funding required*

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)
June 30. *Provide final report with recommendations for continued monitoring.*

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

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

V. BUDGET

Budget Form attached.

FY14 PROGRAM PROJECT

PROPOSAL FORM

Project Title: Long-term Monitoring: Pelagic monitoring component - Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords

Project Period: February 1 – January 31

Primary Investigator(s): Craig O. Matkin, Executive Director, North Gulf Oceanic Society 3430 Main St. St B1 Homer, Alaska 99603 907 299-0677

Abstract:

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

Estimated Budget:

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$23.5			$23.5

Date: 31 July 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

B. Procedural and Scientific Methods

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

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

Survey days and encounter data is logged in an Access database maintained by NGOS and as part of the Gulf Watch Database. Data analysis includes a frame by frame analysis of all digital images, with individual identifications digitally recorded and attached to the photo. Improvement photos of each individual are selected and placed in appropriate folders and used to update catalogue (for NGOS and public access) and provide reference for future identifications The population dynamics data base that lists data on each individual (including newly recruited calves) is updated annually All vessel and encounter tracklines are stored in GIS format, ready for analysis. ARGOS tracklines are also placed in GIS format and initial analysis and mapping completed on an annual basis.

C. Data Analysis and Statistical Methods

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

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

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

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

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

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

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

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

IV. SCHEDULE

A. Project Milestones

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

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

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

B. Measurable Project Tasks

FY14, 1st quarter (October 1, 2013-December 31, 2013)
Workup satellite tag data in GIS format and update databases Lipid/fatty acid, contaminant, stable isotope and genetic analysis.
FY14, 2nd quarter (January 1, 2014-March 31, 2014)
January 23-27 Annual Marine Science Symposium Finish analysis of photographs from fieldwork catalogue, workup satellite tag data in GIS format and update databases. Lipid/fatty acid, contaminant, stable isotope, prey sample and genetic analysis completion.
FY14, 3rd quarter (April 1, 2014-June 30, 2014)
Prepare for April field work Conduct fieldwork in April (10 days) and May- June (10 days)
FY14, 4th quarter (July 1, 2014- September 30, 2014)
Conduct fieldwork in July-August (14 days) and September-November (14 days) Initiate analysis of 2014 data.

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Long-term Monitoring: Pelagic Monitoring Component – Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound

Project Period: Feb 1 – July 31, 2013

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

Collaborating investigator: Terry Quinn (UAF)

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

Estimated Budget:
EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

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

Date: August 9, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date (if applicable)

We have completed three winter field seasons.

II. PROJECT DESIGN

A. Objectives

Objectives·

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

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

Project Integration

We expect strong collaboration between humpback whale, killer whale and seabird components of the pelagic monitoring projects The proposed killer whale monitoring program will opportunistically collect humpback whale data during summers, likewise the observation of killer whales will be documented during winter humpback whale cruises. On some surveys we will be able to provide a berth for a seabird observer

B. Procedural and Scientific Methods

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

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

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

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

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

Estimate predation rates on herring by humpback whales.
The large size humpback whales prevent direct measurement of ingestion rates, therefore estimates of consumption are derived from the allometry between whale size and metabolic requirements The model combines estimates of whale size, metabolic rates, abundance, and diet with estimates of the energy content of overwintering herring to predict consumption We will estimated the potential biomass removed for each location and winter using four different modeling scenarios because of the uncertainty in whale metabolic costs and the numbers of whale present. The different scenarios

represent the range of possible estimates Dividing the total biomass consumed under a given scenario with estimates of herring abundance yields a measure of the intensity of humpback whale predation This ratio, referred to here as predation intensity, is not meant to indicate the actual proportion of the biomass consumed by whales, but rather as an indicator of the scale of whale predation winter under each of the modeling scenarios.

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

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

Humpback whale vessel survey schedule for Prince William Sound.

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

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

Modeling. Quinn et al (2001) and Marty et al. (2003) developed an age-structured assessment model for Prince William Sound that included disease information. Thus the model can be used to evaluate the impact of disease on population abundance, recruitment, and survival. ADF&G uses this model in its annual assessments of herring (S. Moffitt, ADF&G, pers comm.).

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

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

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

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

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

IV. SCHEDULE

A. Project Milestones

Objectives

1) Population estimates of humpback whales through the use of photographic mark- recapture models *To be met September 2015*
2) Monitor the seasonal trends of humpback whales in Prince William Sound relative to prey *To be met September 2015*
3) Estimate inter-annual trends in humpback whale abundance *To be met September 2015*
4) Determine the diet and dietary shifts of humpback whales. *To be met September 2015.*
5) Estimate predation rates on herring by humpback whales *To be met December 2015*
6) Incorporate mortality rates into herring age structure models *To be met January 2016*

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

FFY 14, 1st quarter (October 1, 2013-December 31, 2013)

October	*6 day survey of PWS*
December	*6 day survey of PWS*

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

January	*Annual Marine science Symposium*

February: *6 day survey of PWS*

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

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

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

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

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

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

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

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

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

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

Auke Bay Lab Budget Justification - $ 526K

Personnel Salaries ($8K) – Overtime for Moran

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

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

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

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

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

FY14 PROGRAM PROJECT
PROPOSAL FORM

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

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

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

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al.
In response to a lack of recovery of wildlife populations following the *Exxon Valdez* Oil Spill (EVOS), and evidence of natural background changes in forage fish abundance, there was a significant effort to document forage fish distribution, abundance, and variability in Prince William Sound (PWS) since the 1990's. We propose to adopt some of these earlier sampling techniques, and also incorporate new methods to monitor forage fish in Prince William Sound with fishing and acoustic surveys of forage fish, and to measure indices of forage fish condition.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$209.9	**$202.5**	**$202.5**	**$202.5**	**$150.3**	**$967.6**

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
$339	**$130**	**$130**	**$130**	**$110**	**$839**

Date: August 9, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date (if applicable)
We are operating according to schedule as described in the original proposal

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

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

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

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

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

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

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

C. Data Analysis and Statistical Methods

Abundance indices will be developed for each common forage species from coupled hydroacoustic-trawl surveys. Age distributions will be compared among regions and years using multinomial logit models Size-at-age will be examined using von Bertalanffy growth curves and a two-way analysis of variance for each age with region and capture year as factors Biomass estimates for target species will be calculated annually from ground-truthed hydroacoustic surveys by subarea using geostatistical models We will calculate the echo integral over a given area (mean Nautical Area Scattering Coefficient, NASC, m^2nm^{-2}) using EchoView v 5 3 (Hobart, Tasmania, Australia). Acoustic properties of fish vary among species, and target strengths for the species we capture will be drawn from the published literature Geostatistical modeling of acoustic biomass by station will be done with the 'krige.bayes' routine in the geoR package Abundance indices will be summarized using simple univariate statistics (after transformation where necessary), and changes among years and subareas tested with ANOVA After a sufficient number of years it may be possible to detect significant trends with linear regression To examine the issue of *why* populations may change, we will employ a variety of statistical approaches to examine overall patterns in distribution of fish or apex predators and correlate these patterns with bio-physical features. For example, we will use geostatistical analyses to help interpret spatial patterns of distribution, Principal Components Analysis (PCA) to identify gradients in physical properties, General Linear Models (GLM) and non-linear methods (e g GAMM, gradient boosted regression trees) to assess the relative contributions of different biophysical features in predicting the relative abundance of key forage fish and apex predators Where appropriate, we will use Detrended Correspondence Analysis (DCA) or Non-metric multidimensional scaling (MDS) to characterize community structure and patterns of community response to physical gradients Statistical analyses will be performed using tools available in R (R Core Development Team 2011)

D. Description of Study Area

We will work within Prince William Sound (bounding coordinates· 61.292, -148.74; 61.168, -146 057, 60 273, -145.677, 59.662, -148.238).

E. Coordination and Collaboration with the Program

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

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

IV. SCHEDULE

A. Project Milestones

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

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

To be met by March 2015

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

To be met by September 2016

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

To be met by September 2016

B. Measurable Project Tasks

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

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

February, 2014 — *Project funding available*

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

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

June 2014· — *Upload 2013 data to workspace, update metadata*

July-Aug, 2014· — *Field Sampling*

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

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

November: — *Annual PI meeting*

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)
December 1· *Hydroacoustic data analysis, report writing*

V. BUDGET
Budget Form (Attached)

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

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

Estimated Budget:

EVOSTC Funding Requested:

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

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

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

Date: 22 August 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

McKnight et al. (2008) examined whether marine bird and mammal species designated as injured by the *EVOS* Trustee Council had shown signs of recovery by 2007. Data collected from 1989 to 2007 in the oiled area indicated that common loons (*Gavia immer*) and cormorants (*Phalacrocorax spp.*) are increasing. Numbers of all other injured species are either not changing or are declining in the oiled area. Populations of harlequin ducks (*Histrionicus histrionicus*), black oystercatchers (*Haematopus bachmani*), Kittlitz's murrelets (*Brachyramphus brevirostris*), and common murres *(Uria aalgae)* are showing no trend in the oiled area; pigeon guillemots (*Cepphus columba*), and marbled murrelets (*Brachyramphus marmoratus*), are declining in the oiled areas of Prince William Sound in summer. Pigeon Guillemots are the only bird on the EVOSTC injured species list that is "not recovering". In addition Kittlitz's murrelet is a candidate species under the Endangered Species Act and PWS is one of the few remaining hotspots for it. There are no other surveys done in PWS to get population estimates for marine birds.

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

B. Summary of Project to Date (if applicable)

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

II. PROJECT DESIGN

A. Objectives

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

B. Procedural and Scientific Methods

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

We will continue to use a stratified random sampling design containing three strata. shoreline, coastal-pelagic, and pelagic (Klosiewski and Laing 1994) (Fig 1) The shoreline stratum will consist of waters within 200 m of land. Irons et al. (1988b) divided this stratum, by habitat, into 742 transects with a total area of 820 74 km^2 We will locate shoreline transects by geographic features, such as points of land, to facilitate orientation in the field and to separate the shoreline by habitat (Irons et al. 1988a,b) Shoreline transects will vary in size, ranging from small islands with <1 km of coastline to sections of the mainland with over 30 km of coastline. Mean transect length will be 5 55 km During summer, we plan to survey 212 shoreline transects. All transects were randomly chosen, and the same transects are used each survey (Klosiewski and Laing 1994).

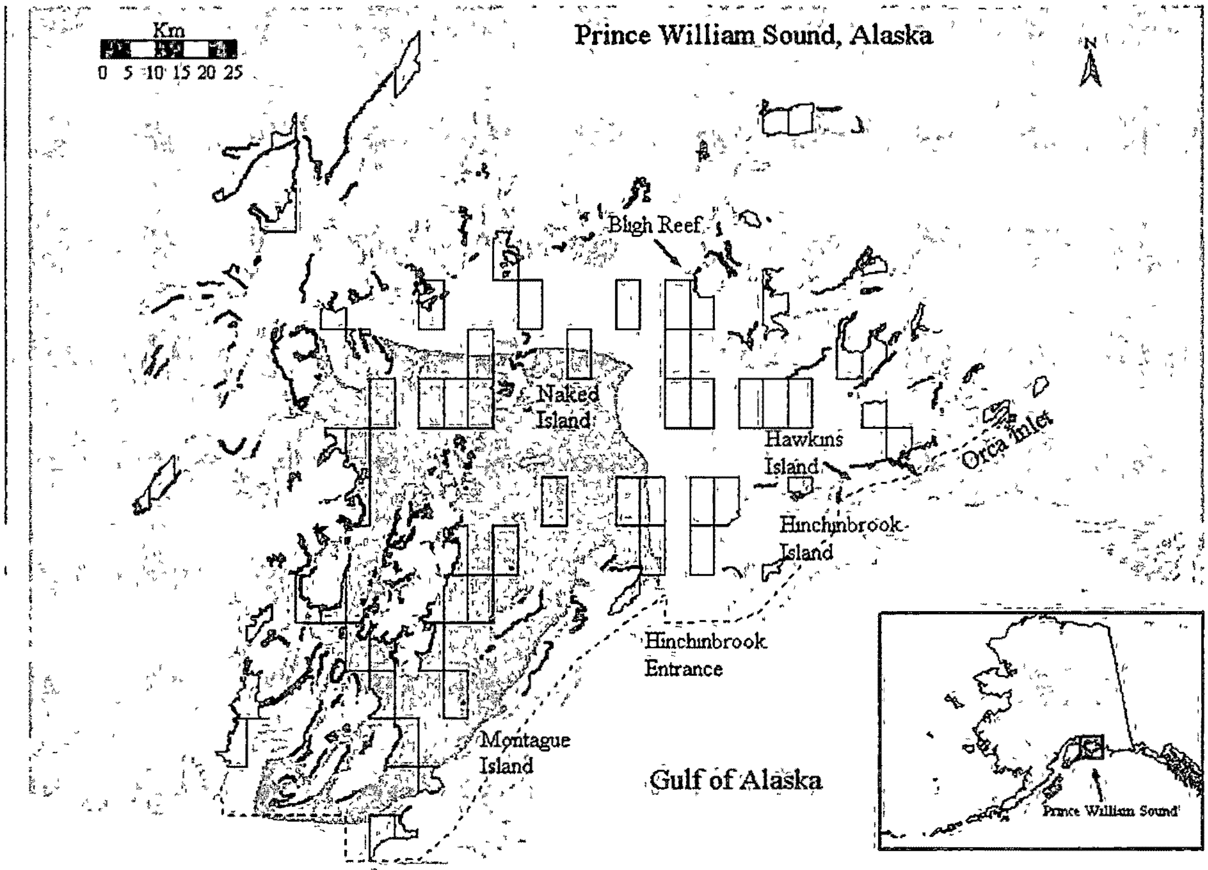

Figure 1. Locations of shoreline transects and pelagic transect blocks in Prince William Sound. Shading denotes the oiled region.

Justification:

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

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

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

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

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

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

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

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

C. Data Analysis and Statistical Methods

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

a) Trends in the oiled region
We will perform a linear regression on log-tranformed population estimates over time (1989 – 2016) in the oiled region of Prince William Sound. Prior to calculating the $\log_{10}$ of each population estimate, we will add a constant of 0.167 to each estimate to avoid the undefined $\log_{10}$ of 0 In all analyses we will use a test size alpha = 0.10 to balance Type I and Type II errors. The reasons for this include: 1) variation is often high and sample sizes low (n = 11 survey years), and 2) monitoring studies are inherently different from experiments and the number of tests being run with a multi-species survey are many, therefore, controlling for the number of tests by lowering alpha levels (e g Bonferroni adjustment) might obscure trends of biological value

Taxa with significant increasing trends in the oiled region will be considered "recovering," while taxa with no trends or significant negative trends will be considered "not recovering

b) Comparing trends between oiled and unoiled regions
We will use the regression technique detailed in (a) to perform regression analyses on population estimates (1989 – 2016) in the unoiled region We will use a homogeneity of slopes test (Freud and Littell 1981) to

compare population trends between the oiled and unoiled zones of Prince William Sound to examine whether species with population estimates of >500 individuals have changed over time. To do this, we must assume that marine bird and sea otter populations increase at the same rate in the oiled and unoiled zones of Prince William Sound. Significantly different slopes would indicate that population abundance of a species or species group changed at different rates.

Taxa showing no difference in trends between the oiled and unoiled regions will be considered "not recovering." Taxa showing significantly greater trends in the oiled region compared with the unoiled region will be considered "recovering." Taxa showing significantly greater trends in the unoiled region compared to the oiled region will be considered to be suffering "continuing and increasing effects."

Overall, a species will be considered "recovering" if it meets the requirements for this category in either the regression analysis within the oiled region or the homogeneous slopes analysis.

To determine optimum survey frequency, we conducted a power analysis to estimate the probability of detecting trends in abundance using linear regression from a given number of samples (Taylor and Gerrodette 1993). We examined our power to detect trends when coefficient of variation (CV) of the population was 0.30 (greater than the mean CV from previous surveys for 73% of the injured species; Fig. 2) and when the CV = 0.13 (the mean summer CV for *Brachyramphus* murrelets, an injured species. Models of seabird population growth predict most species increase no more than 12% per year (Nur and Ainley 1992), so we used 10% for our comparisons. With CV=0.30 the probability of detecting an average annual change of 10% would be 92% with the 10 surveys completed to date (Fig. 2).

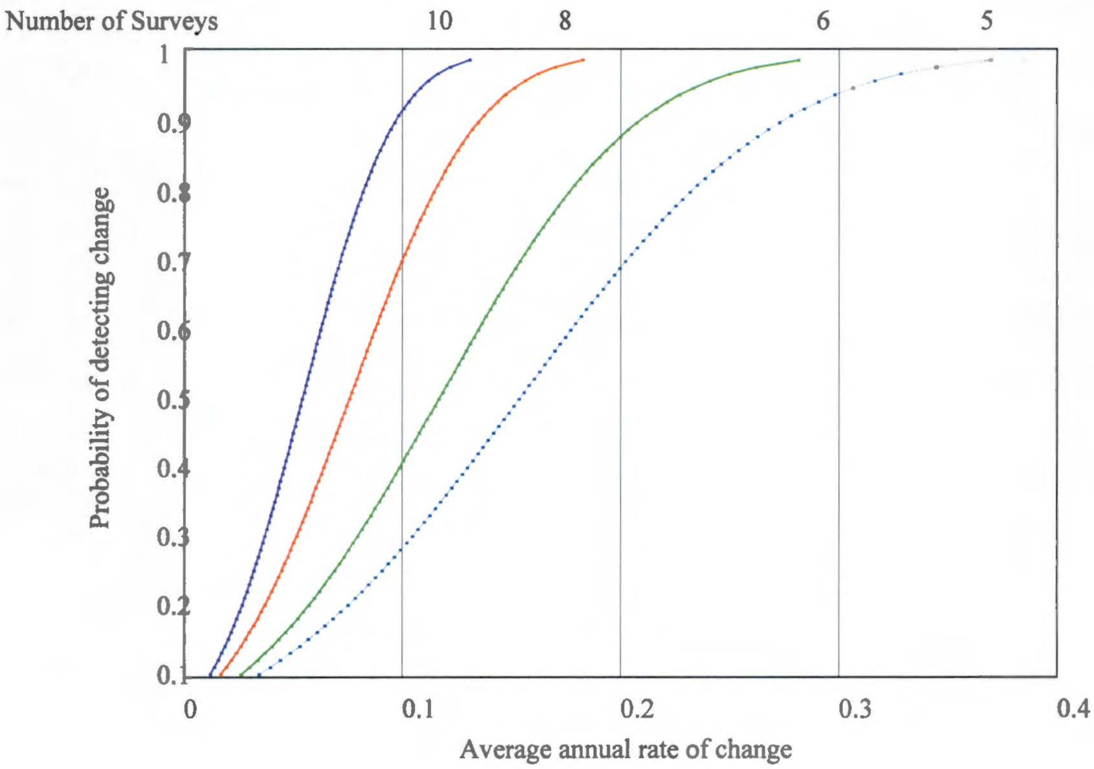

Figure 2 Estimated power based on numbers of surveys (5, 6, 8, and 10) conducted to detect a trend in marine bird populations in Prince William Sound when the CV = 0 30

D. Description of Study Area
Our study area includes all waters within Prince William Sound and all land within 100 m of shore (Fig. 1). We exclude Orca Inlet, near Cordova, Alaska and the southern sides of Montague, Hinchinbrook, and Hawkins Islands (Klosiewski and Laing 1994).

E. Coordination and Collaboration with Other Efforts
See above, Linkages.

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

IV. SCHEDULE

A. Project Milestones

Objective 1.

To determine population abundance, with 95% confidence limits, of marine bird populations in Prince William Sound during July 2014 in both oiled and unoiled regions, as well as in Prince William Sound as a whole, in order to assess population trends in the years following the EVOS. *To be met by April 2015.*

B. Measurable Project Tasks

FY 14, 1st quarter (February 1 – May 31, 2014)
Hire project personnel
Prepare for Field Season

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)
Prepare for Field Season
Conduct field work
Submit annual report

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

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)
Report writing
Attend Annual PI Meeting

V. BUDGET
Budget Form (Attached)
Please complete the budget form for each proposed year of the project

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Gulfwatch long-term monitoring pelagic component - Long-term monitoring of seabird abundance and habitat associations during late fall and winter in Prince William Sound.

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

Primary Investigator(s): Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova

Collaborators: Kathy Kuletz, Ph.D. US Fish & Wildlife Service, Anchorage; John Moran, Auke Bay Lab, NOAA, Juneau; Michelle Buckhorn, Ph.D. & Richard Thorne, Ph.D. Prince William Sound Science Center.

Abstract: This project is a component of the integrated Gulfwatch Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et.al. The vast majority of seabird monitoring in areas affected by the *Exxon Valdez* oil spill has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful. However, late fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels reduced, day length shorter and water temperatures colder. Of the seabirds that overwinter in PWS, nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered (marbled murrelet, Kittlitz's murrelet and pigeon guillemot). Here we propose to continue to monitor from 2012 through 2016 seabird abundance, species composition, and habitat associations using multiple surveys (up to 5 surveys per season) during late fall and winter. The data will improve our predictive models of seabird species abundance and distribution in relation to biological and physical environmental factors. In addition, by monitoring the top-down forcing by seabirds, a major source of herring predation, this project will complement the suite of *PWS HRM* studies, including improved mortality estimates for herring population models. This project is part of the pelagic component within the integrated *Gulfwatch LTM program* submitted by McCammon et. al. Our project uses as observing platforms the vessels associated with the *LTM Humpback Whale surveys* and *PWS HRM Juvenile Herring Abundance Index* as well as the *Extended Adult Herring Biomass Surveys* and integrates the seabird observations with those studies.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$51.7	**$78.6**	**$80.9**	**$83.4**	**$86.3**	**$380.9**

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

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 31, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

Seabirds spend most of the year widely dispersed. At higher latitudes, late fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels reduced, day length shorter and water temperatures colder. Consequently daily energy requirements increase (Fort *et al.* 2009) and birds have to forage for a large proportion of daylight hours (Daunt *et al.* 2006). Wind and sea state are known to affect surface-feeding seabirds in particular (Dunn 1973, Taylor 1983) but diving birds can also be impacted (Harris and Wanless 1996, Piatt and Van Pelt 1997, Frederiksen *et al* 2008)

Of the seabirds that overwinter in Prince William Sound (PWS), nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered (marbled murrelet, Kittlitz's murrelet and pigeon guillemot Nevertheless, the vast majority of seabird monitoring in areas affected by the Exxon Valdez oil spill has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful Long-term monitoring of seabirds in PWS during winter is needed to understand how post-spill ecosystem recovery and changing physical and biological factors are affecting seabird abundance and species composition, as well as their distribution and habitat use

Changes in the timing of biological events, geographic range and/or relative abundance of species, community structure, and system productivity can be indications of a changing ecosystem (Parmesan 2006). For example, a recent 10-year monitoring effort along the transition zone between the California Current and the Gulf of Alaska documented significant increases in seabird species diversity and relative abundance during the nonbreeding season that corresponded with a possible regime shift to cooler conditions (Sydeman et al. 2009).

In December 2004, we began monitoring seabird abundance and distribution in PWS during late fall and winter months. Initially our surveys were concurrent with hydroacoustic surveys for adult herring in northeast PWS. Beginning in March 2007, we expanded our winter survey efforts to other areas of PWS under EVOS Project 070814. Since then surveys have been conducted concurrent with either juvenile herring hydroacoustic surveys or with humpback whale surveys Results from seven cruises conducted over two winters found consistent trends and species-distinct patterns in distribution Habitat association modeling revealed that winter climate conditions may influence these distribution patterns (Dawson et al. *in review*) When we examined distribution at a fine- scale (1 km) using data from seabird transects with concurrent fish data, we found a positive association between presence of seabirds and predictable fish prey fields (Bishop et al. 2010) Furthermore, our consumption model of herring predation quantified the potential impacts of such prey association by seabirds during the winter Our model shows that seabirds consume ~3-10% of the total adult herring biomass during each winter and underscores the importance of further examination of top-down forcing (Bishop et al., *in review*)

Post-spill ecosystem recovery and changing physical and biological factors all have the potential to affect PWS seabird populations Here we propose to continue to monitor seabird abundance and habitat associations using multiple surveys during late fall and winter. While this proposal encompasses a five-year period, we would foresee this project continuing over a 20-year period in order for ecosystem changes to be detected

B. Summary of Project to Date. Between October 2011 and July 2013, a seabird observer participated in eight cruises associated with three EVOS-funded projects. Gulfwatch *Humpback Whale systematic surveys* (n = 5), Herring and Research Monitoring *Juvenile Herring Abundance Index* (n = 1), and Herring and Research Monitoring *Expanded Adult Herring Surveys* (n = 1). Two cruises associated with the whale surveys were conducted pre-award (Oct 2011 and Dec 2011), but we believed an observer onboard was critical to maintaining our time series Both herring projects have only had one cruise to date, and a seabird observer has participated in each of those cruises In 2013, the late winter humpback whale survey was moved from February to April, and was dedicated to obtaining biopsy (genetic) samples within a small geographic area A seabird observer was not placed on this cruise, because of the limited opportunity to conduct transects. Preliminary data from the first six cruises was included in the February 1, 2012 – January 31, 2013 annual report, submitted in February 2013. We continue to use the same methodology on our cruises that we have used since November 2007. That includes a 300m transect width (150 m each side), and recording all observations into dLog software Data analyses is ongoing Data is stored in the form of a Microsoft access database Metadata for the project is currently available. We continue on track to meet our milestones, all of which have completion dates in 2016

II. PROJECT DESIGN

A. Objectives

This project is part of the pelagic component of the Long-term Monitoring of Marine Conditions and Injured Resources and Services There are two primary research goals for the pelagic team population monitoring of key species groups, and understanding the energy flow through the pelagic ecosystem with key measurements Objectives of this study include

1) Characterize the spatial and temporal distribution of seabirds in PWS during late fall and winter
2) Relate seabird presence to prey fields identified during hydroacoustic surveys
3) Identify critical biological and physical habitat characteristics for seabirds across PWS within and between winters
4) Utilize increased temporal sampling resolution to improve our estimates of consumption of herring by seabirds during the winter

The monitoring of top down forcing by seabirds and whales, the largest predators on herring, will complement the suite of *PWS Herring Research & Monitoring* studies, including insertion of key data into the population modeling of herring In addition, this project will provide information on the wintering ecology of several seabird species injured by the oil spill that can be used to help restore and/or conserve their populations

B. Procedural and Scientific Methods

This study will be a continuation of systematic late fall and winter seabird surveys begun in 2007 by Bishop and Kuletz. Up to five surveys will be conducted between October and early April Depending on the vessel of opportunity used, surveys will either be coupled with the or with surveys associated with the *PWS Herring Research and Monitoring* including *Juvenile Herring Abundance Index* in November and *Expanded Adult Herring Surveys* in late March/early April), as well as the *Gulfwatch LTM Humpback Whale systematic surveys* (October, December, and possibly a third whale survey)

All surveys will employ established U.S. Fish and Wildlife Service protocols that have been adapted for GPS-integrated data entry programs (USFWS 2007) One observer will record number and behavior of birds and marine mammals occurring along a strip transect width of 300 m (150 m both sides and ahead of the boat, in distance bins of 50m) Additionally, any noteworthy observations will be recorded out to 1 km either side Observations will be recorded into a GPS-integrated laptop computer using the program Dlog (Ford Consulting, Inc , Portland OR). This GPS-integrated program provides location data at 20-sec intervals and for every entered observation program In addition, sea conditions including sea surface temperature (as indicated on the vessel's fish finder) and weather can be entered and tracked on site by the observer

Seabird transects that are coupled with hydroacoustic fish surveys will occur in four to eight select bays in PWS. Seabird transects will also be conducted when the boat is in transit during daylight hours Seabird surveys conducted onboard humpback whale surveys will follow specified routes from northeast to southwest PWS At the end of first 5 years of the long-term monitoring (September 2016), this study will have data sets from broad-scale coverage of PWS ranging from 4 to 10 years

C. Data Analysis and Statistical Methods

Density (birds • km^{-2}) of each seabird species will be calculated for each km of survey trackline. We will use all surveys conducted since 2007 to describe the seasonal patterns of abundance and distribution Seabird observations will be mapped using ArcView GIS. Temporal variability in bird density will be addressed at inter- and intra-annual scales

The November and late March/early April seabird transects will be conducted concomitant with hydroacoustic fish surveys The November *Juvenile Herring Abundance Index* survey will take place in the four bays (Simpson, Eaglek, Zaikof, Whale) surveyed in the 1990's as part of the EVOS-sponsored Sound Ecosystem Assessment (SEA) program Locations of the expanded adult herring surveys are not yet defined Data on fish biomass (kg/m2) by depth will be available for each trackline Composition of fish schools will be made available by the *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture,* a separate project that is part of the *PWS Herring Research & Monitoring* program We will combine acoustic survey data on prey composition with a suite of additional independent variables shown to be relevant to seabird predation (eg , school density, school area, species composition and size structure, water depth, depth to school, depth below each school, and distance from shore [Kuletz 2005, Ostrand et al 2004, 1998; Day and Nigro 2000]) We will use logistic regression to determine the role of these covariates on the presence of seabirds (Maniscalco et al 1998, Manly et al 1993). Model selection criteria (eg , AIC, GCV) will be chosen according to the most effective model framework (eg , GLM, GAM)

We will model seabird abundance and distribution in relation to biological and physical environmental factors. While the prey field data will be available from the *PWS Herring Research and Monitoring* cruises, seabird abundance surveys will cover both the herring and LTM humpback whale cruises Seabird abundance data are typically zero-dominated therefore hurdle models will be applied whereby data are analysed initially as presence-absence, followed by a separate analysis of presence-only data (Boucher and Guillén, 2009, Zuur *et al.* 2009) Hence, the first analysis will determine which covariates are driving the presence and absence of birds, while the second analyses will focus on covariates driving the abundance of birds when they were present GIS will be used to determine covariates such as distance to shore, water depth, distance to eelgrass beds, distance to kelp beds, and slope Locations of coastal kelp and eelgrass beds will be obtained from the ShoreZone database (NOAA Fisheries 2009), and slope from the Alaska Ocean Observing System bathymetry grid Other covariates including sea surface temperature, year, and month will also be examined For the presence-absence data a binomial generalised additive mixed model (GAMM) will be used. For presence-only data we will use a GAMM. For a detailed description of the proposed statistical methods see Zuur *et al.* (*in press*).

Late fall and early winter plankton tows will be conducted in October and November each year in PWS as part of the *Gulfwatch LTM Long term monitoring of oceanographic conditions in Prince William Sound* Surveys will be conducted in the four bays (Simpson, Eaglek, Zaikof, Whale) surveyed in the 1990's as part of the EVOS-sponsored Sound Ecosystem Assessment (SEA) program. In addition, plankton surveys will include the major entrances to PWS. We will examine zooplankton data to see if there are linkages to seabird hotspots observed during October, November and December cruises

To describe the relationship between seabird densities and zooplankton biomass and herring biomass in PWS we will run linear regressions, using zooplankton and herring survey data provided from their respective projects For each bird species, a best model for explaining variability in bird densities will be determined using a general linear model. A natural log or square root transformation of the dependent variable will be used when appropriate to improve the fit of the model to the data The relationship between date, densities of each seabird species observed, and food abundance (zooplankton or herring biomass) will be evaluated by bay (the four SEA bays and the four additional bays), and in the case of herring biomass, by transect

Current seabird survey data provide little information regarding the residence times of most seabird species in Prince William Sound from November through March. Our recent efforts to quantify herring consumption by seabirds utilizes the best available data about such residency and estimates seabird consumption based on a daily energy budget projected over each species winter residency period (Bishop et al , *in review).* The increased temporal resolution of sampling in the current proposal will enable us to include direct observations of seabird presence throughout the season to improve upon the current data Refined data for each species will be used to update the residence time parameter in our current consumption model, thereby improving estimates of seabird consumption of herring during winter.

D. Description of Study Area

The pelagic component of the *Gulfwatch LTM* project, including this project and the *Humpback Whale Intensive Surveys* includes all of Prince William Sound Seabird observations associated with the *PWS Herring Research & Monitoring Juvenile Herring Abundance Index* will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays These bays also cover four different quadrants of the Sound The *PWS Herring Research & Monitoring Juvenile Herring Abundance Index* and the *Expanded Adult Herring Surveys* will include other bays based on the results from the synthesis and aerial surveys, respectively

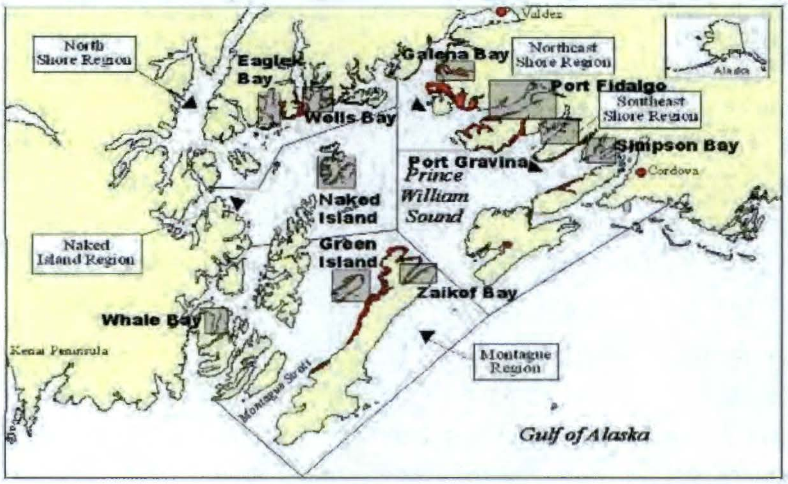

Figure 1. Study area, Prince William Sound. Hi-lighted in gray are the four SEA bays (Whale, Zaikof, Eaglek, and Simpson), as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with the Program

This project is a component of the integrated *Gulfwatch Long-term Monitoring of Marine Conditions and Injured Resources and Services* submitted by McCammon *et al.* Our proposed long-term monitoring program is composed of several components (Environmental Drivers, Pelagic and Benthic Monitoring), with a series of projects in each component lead by principal investigators from a number of institutions. The seabird project, headed by Dr. Mary Anne Bishop, is part of the pelagic monitoring component and shares research vessels associated with the *LTM Humpback Whale Systematic Surveys*, also part of the pelagic monitoring component. In addition, this seabird project is highly integrated with the *PWS Herring Research & Monitoring* program, and shares research vessels with the two projects in this program (see below).

This project builds on previous seabird data sets. Since 2004, winter seabird surveys have been performed on vessels conducting hydroacoustic surveys for adult herring (5 cruises, 2004-2006) and juvenile herring (10 cruises, Nov 2007 – Mar 2012). Cruises between Nov 2007 and Mar 2012 have been part of EVOS Projects 070814 and 10100132-H. In addition, seabird surveys were performed on vessels conducting Humpback Whale surveys (6 cruises, 2007-2009) as part of EVOS project 070804.

This long-term seabird monitoring project uses as observing platforms vessels associated with three different projects. Cruises begin in Cordova, and therefore the staff member would not need to travel. One seabird observer (PWSSC staff) will be onboard all cruises associated with the *Gulfwatch LTM Humpback Whale systematic surveys* (Oct, Dec, Feb, years 1-4). In addition, a seabird observer (PWSSC staff) will be onboard surveys associated with *PWS Herring Research and Monitoring.* Specifically the observer will be onboard *Juvenile Herring Abundance Index* surveys (Nov yrs 2-5) and the *Expanded Adult Herring Surveys* (late March/early Apr yrs 2-5). When not conducting daytime seabird surveys, observers assist the other projects, including helping to process the nighttime herring catch and helping identify humpback whales. Seabird observations from this project will be shared and integrated into the whale and herring surveys. In addition, information on herring, other fish and zooplankton prey fields around whale foraging areas, juvenile herring schools and adult herring schools will be used for the seabird analyses.

Information from this project will feed into the *North Pacific Pelagic Seabird Database,* a database that is maintained by US Fish & Wildlife Service and USGS. This database is currently being integrated into a single database that will be available over the internet through an ARC/IMS

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

IV. SCHEDULE

A. Project Milestones

Objective 1.	Characterize the spatial and temporal abundance of seabirds in PWS during late fall and winter. *Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016*
Objective 2	Model species abundance and distribution in relation to biological and physical environmental factors *Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016.*
Objective 3.	Assess seabird habitat associations within and between winters *Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program by August 2016.*
Objective 4	Relate species composition and distribution to prey fields *Data analyses incorporating data collected through April 2016 will be completed by July 2016 and incorporated into Gulfwatch LTM program report by August 2016.*
Objective 5	Identify critical marine habitats used by seabirds during late fall and winter *Data analyses incorporating data collected through April 2016 will be completed by August 2016 and incorporated into Gulfwatch LTM program report by August 2016*

B. Measurable Project Tasks

FY 14, 1st quarter (February 1 –Apr 30, 2014)	
Feb	Project funding available
Feb	Submit annual report
late Mar/early Apr	Field cruise. *LTM* seabird survey in conjunction with *PWS Herring* extended adult biomass cruise
late winter	Field cruise. *LTM* humpback whale cruise (if a whale survey, seabird survey will also occur)
Apr	Analyze data
FY 14, 2nd quarter (May 1, 2014- Jul 31, 2014)	
May-Jul	Analyze data
Jul	Report writing (mid-year report, FY 2015 workplan)
FY 14, 3rd quarter (Aug 1, 2014- Oct 31, 2014)	
Aug	Submit report, workplan
Aug-Oct	Analyze data
Oct	Field cruise· *LTM* humpback whale and seabird surveys

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)	
Nov	Field cruise. *LTM* seabird survey in conjunction with *PWS Herring* juvenile abundance index
Nov	Annual PI meeting
Dec	Field cruise. *LTM* humpback whale and seabird surveys

Jan	Alaska Marine Science Symposium
Jan	Report writing

V. BUDGET (Attached)

Benthic Monitoring Component (lead – Ballachey)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Gulf Watch Alaska: Long-Term Monitoring: Nearshore Benthic Ecosystems in the Gulf of Alaska

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

Primary Investigator(s):

Brenda Ballachey, James Bodkin, Daniel Esler, Kim Kloecker, Daniel Monson, Ben Weitzman
USGS Alaska Science Center, 4210 University Drive, Anchorage, AK 99508
Thomas Dean, Coastal Resources Associates, Inc., 5190 El Arbol Drive, Carlsbad, CA 92008
Heather Coletti, Michael Shephard , Southwest Alaska Inventory & Monitoring Network
National Park Service, 240 W. 5th Avenue, Anchorage, AK 99501
Mandy Lindeberg, NOAA/NMFS Auke Bay Laboratory, 11305 Glacier Hwy, Juneau, AK 99801
Angela Doroff, Kachemak Bay Research Reserve, 95 Sterling Highway, Suite 2, Homer, AK 99603

Abstract: We propose to continue the long-term nearshore marine monitoring program which has been ongoing in the GOA since 2006, supported by the National Park Service-Southwest Alaska Network and the US Geological Survey, and supported by the Gulf Watch Alaska project since 2012. The sampling design consists of three primary sampling locations in nearshore habitats in the central GOA region, including Prince William Sound (PWS), Kenai Fjords National Park (KEFJ), and Katmai National Park (KATM). Additionally, we will coordinate with nearshore sampling ongoing in Kachemak Bay as part of the Gulf Watch Alaska project. In western PWS, KEFJ and KATM, we plan to continue sampling at established sites on an annual basis through 2016. In eastern and northern PWS, we plan to continue sampling at established sites in alternate years, with eastern PWS scheduled for 2014. Monitoring includes measurements of water quality (temperature, salinity), intertidal invertebrates and algae, sea grasses, sea otters, black oystercatchers, and surveys of marine birds and mammals. The monitoring also includes measures of nearshore ecosystem productivity, predator-prey dynamics, and stable isotope and contaminant analyses.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$282.4	**$304.1**	**$331.9**	**$309.6**	**$331.9**	**$1,559.90**

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
$25.0	**$73.0**	**$73.0**	**$73.0**	**$73.0**	**$317.0**

Date: August 12, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

The nearshore is considered an important component of the Gulf of Alaska ecosystem, including the region affected by the *Exxon Valdez* oil spill (EVOS), because it provides·

- A variety of unique habitats for resident organisms (e g sea otters, harbor seals, shorebirds, seabirds, nearshore fishes, kelps, seagrasses, clams, mussels, and sea stars)
- Nursery grounds for marine animals from other habitats (e g crabs, salmon, herring, and seabirds).
- Feeding grounds for important consumers, including killer whales, harbor seals, sea otters, sea lions, sea ducks, shore birds and many fish and shellfish
- A source of animals important to commercial and subsistence harvests (e g marine mammals, fishes, crabs, mussels, clams, chitons, and octopus)
- An important site of recreational activities including fishing, boating, camping, and nature viewing
- A source of primary production for export to adjacent habitats (primarily by kelps, other seaweeds, and eelgrass).
- An important triple interface between air, land and sea that provides linkages for transfer of water, nutrients, and species between watersheds and offshore habitats.

Also, the nearshore is broadly recognized as highly susceptible and sensitive to both natural and human disturbances on a variety of temporal and spatial scales For example, observed changes in nearshore systems have been attributed to such diverse causes as global climate change (e.g. Barry et al. 1995, Sagarin et al. 1999), oil spills (e g Dahlmann et al. 1994 Peterson et al 2001, 2003), human disturbance and removals (e g. Shiel and Taylor 1999, Murray et al. 1999), and influences of invasive species (e.g Jamieson et al 1998) Nearshore systems are especially good indicators of change because organisms in the nearshore are relatively sedentary, accessible, and manipulable (e g. Dayton 1971, Sousa 1979, Peterson 1993, Lewis 1996). Also, in contrast to other marine habitats, there is a comparatively thorough understanding of mechanistic links between species and their physical environment (e.g. Connell 1972, Paine 1994, Estes and Duggins 1995) that facilitates understanding causes for change

Perhaps most important with respect to the goals of the Gulf Watch Alaska Long-term Monitoring program, the nearshore is the one habitat within which it is most likely that we will be able to detect relatively localized sources of change, tease apart human-induced from natural changes, and provide suggestions for policies to reduce human impacts. Because many of the organisms in the nearshore are sessile or have relatively limited home ranges, they can be geographically linked to sources of change with a reasonable degree of accuracy

Finally, the nearshore is critically important because it was without doubt the habitat most impacted by the 1989 EVOS, and is known to be a persistent repository for oil that could be linked to continued injury to species that reside there (especially, sea otters and harlequin ducks; Peterson et al. 2003, Short et al 2004, 2007) In addition, the majority of the species or services that have been listed by the EVOS Trustee Council as either "not recovered" or "status of recovery unknown" reside in or are associated with the nearshore. Thus, monitoring within the nearshore system provides the opportunity to continue to assess progress toward recovery, and to identify and possibly ameliorate other human induced disturbances

Following several years of planning, a restoration and ecosystem monitoring plan for the nearshore marine ecosystems affected by the EVOS in the Gulf of Alaska (GOA) was completed (Dean and Bodkin 2006) Within this plan it was recognized that (1) restoration of resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the Gulf, and (2) causes of changes independent of the oil spill are likely to occur in the GOA during the 21st century, and are likely to result from a number of different agents (e g normal environmental drivers, global climate change, shoreline development and associated inputs of pollutants). Further, in order to effect restoration of injured resources it is essential to separate EVOS-related effects from other sources of change. It was also recognized that changes are likely to occur over varying temporal and spatial scales. For example, global climate change may result in a gradual change in the nearshore community that occurs over decades and has impacts over the entire GOA. On the other hand, impacts from shoreline development will likely be more episodic and more local Thus, one challenge of designing a monitoring program was to detect changes occurring over widely varying scales of space and time, and from various causes. To this end, a conceptual framework for monitoring in the nearshore was designed with the following elements

1) Synoptic sampling of specified physical and biological parameters (e g temperature, salinity, and eelgrass cover) over the entire GOA
2) Sampling of a variety of specified biological and physical parameters (e g. abundance and growth of intertidal organisms, abundance of selected birds and marine mammals) within specified areas spread throughout the GOA, these are referred to as intensive sites. The focus is on species injured by the EVOS, in particular species not recovered or whose status relative to recovery is uncertain.
3) Sampling of a smaller suite of selected biological and physical parameters (e g. the abundance and growth of intertidal organisms, and contaminant levels in mussels) at additional sites, referred to as extensive sites.
4) Conduct of shorter-term studies aimed at identifying important processes regulating or causing changes within a given system or subsystem (e g, stable isotope analyses of nearshore species)

The monitoring plan developed for the EVOSTC was revised and adopted by the National Park Service's Vital Signs Long-Term Monitoring Plan, Southwest Alaska Network (SWAN), and implemented in Katmai NP (KATM) in 2006 and in Kenai Fjords NP (KEFJ) in 2007. In 2010, EVOS Project 10100750 funded the US Geological Survey to implement the long-term nearshore monitoring plan in western Prince William Sound (WPWS), providing for monitoring of the nearshore environment, sea otters, nearshore sea birds (including black oystercatchers), and intertidal kelps, seagrasses and invertebrates In 2011, the EVOS Gulf Watch Alaska Project (12120114) was initiated to continue and expand the long-term nearshore monitoring, in combination with studies of pelagic systems and environmental drivers The Gulf Watch Alaska Project is working in concert with the NPS-SWAN program and the USGS, the work described herein is a continuation of the nearshore benthic monitoring effort implemented over the past decade by those agencies.

B. Summary of Project to Date (if applicable)

To date, as part of the Gulf Watch Alaska project, we have conducted two full years of nearshore monitoring at KATM, KEFJ, and WPWS (intensive sites), and all goals of that sampling have been met We have also established study sites in eastern PWS (EPWS, sampled in 2012) and northern PWS (NPWS, sampled in 2013) to be sampled biannually (extensive sites). We propose to continue a long-term restoration and ecosystem monitoring program these locations through 2014 (and longer depending on study continuation). We plan to continue the integration of SWAN and USGS programs with the Gulf Watch Alaska project

II. PROJECT DESIGN

A. Objectives

The overall objectives of the proposed research are:

1. Long-term monitoring of a suite of nearshore benthic species at multiple locations across the Gulf of Alaska
2. Continued restoration monitoring in the nearshore in order to evaluate the current status of injured resources in oiled areas.

To accomplish these objectives, we have a list of tasks, presented in Table 1.

Table 1. Components of the proposed nearshore benthic monitoring plan and five year schedule

COMPONENT	2012	2013	2014	2015	2016
Western PWS, intertidal invertebrates and algae	x	x	x	x	x
Western PWS, kelps and sea grass	x	x	x	x	x
Western PWS, black oystercatchers	x	x	x	x	x
Western PWS, contaminants/water quality	x				
Western PWS, sea otter carcass recovery	x	x	x	x	x
Western PWS, sea otter foraging observations	x	x	x	x	x
Eastern PWS, intertidal invertebrates and algae	x		x		x
Eastern PWS, kelps and sea grass	x		x		x
Eastern PWS, contaminants/water quality	x				
Northern PWS, intertidal invertebrates and algae		x		x	
Northern PWS, kelps and sea grass		x		x	
Northern PWS, contaminants/water quality		x			
Katmai NP, intertidal invertebrates and algae	x	x	x	x	x
Katmai NP, kelps and sea grass	x	x	x	x	x
Katmai NP, black oystercatchers	x	x	x	x	x

Katmai NP, sea otter carcass recovery	x	x	x	x	x
Katmai NP, sea otter foraging observations	x	x	x	x	x
Kenai NP, intertidal invertebrates and algae	x	x	x	x	x
Kenai NP, kelps and sea grass	x	x	x	x	x
Kenai NP, black oystercatchers	x	x	x	x	x
Kenai NP, sea otter carcass recovery	x	x	x	x	x
Kenai NP, sea otter foraging observations	x	x	x	x	x
PWS, sea otter aerial survey	x		x		x
Kenai NP, sea otter aerial survey		x		x	
Katmai NP, sea otter aerial survey	x		x		x
Kachemak Bay, sea otter aerial survey	x		x		x
PWS Nearshore marine bird survey (under Pelagic component)	x		x		x
Katmai nearshore marine bird survey	x	x	x	x	x
Kenai nearshore marine bird survey	x	x	x	x	x
Stable isotope analysis of selected nearshore species(4-5 areas/yr)	x	x	x	x	x
Tasks conducted under Project 11120114-L:					
Kachemak Bay, intertidal invertebrates and algae	x	x	x	x	x
Kachemak Bay, sea otter carcass recovery	x	x	x	x	x
Kachemak Bay, sea otter foraging observations	x	x	x	x	x

B. Procedural and Scientific Methods

Standard operating procedures (SOP's) for all data to be collected have been fully developed as part of the preparation and implementation of nearshore monitoring in KATM. KEFJ, and WPWS. The *Nearshore Restoration and Ecosystem Monitoring Program* (Dean and Bodkin 2006) and the *National Park Service SWAN Nearshore Monitoring Program* (Dean and Bodkin 2011) include protocols that provide justification, background, objectives, goals, an overview of the monitoring and sample design, the fundamental analytical approach, and description of operational requirements. The SOP's provide the details of each data collection procedure, their relations to one another, and how they can be integrated to provide understanding of causes of change that will be detected. Protocols are also available on the NPS project website http.//science.nature.nps gov/im/units/swan/monitor/nearshore.cfm

(Note: Protocols for 1) sampling of mussel beds, 2) sampling of soft sediments, and 3) sampling of sea grass beds and in review and not yet available on the website but drafts are available from H Coletti or B. Ballachey)

Brief description of Tasks from Table 1 (refer to SOPs on Project Website for detail):

1. Collection of sea otter skulls for determination of age-at-death.

Surveys will be conducted in western PWS in late April of each year to collect sea otter carcasses for determination of ages-at-death to be used in describing annual survival. In Katmai and Kenai, surveys for carcasses will be conducted opportunistically during the June/July field work. In Kachemak Bay, a coalition of the Center for Alaska Coastal Studies, the Homer Marine Mammal Stranding Network, and the USFWS have been and will continue to conduct systematic beach walks to recover sea otter and bird carcasses, and marine debris.

2 Annual collection of sea otter diet data

Data will be obtained through direct observation of foraging sea otters using high powered spotting scopes and a stratified random sampling design.

3. Aerial surveys of sea otter abundance.

Estimates of sea otter abundance and distribution will be obtained through detection-corrected standardized aerial surveys using a stratified random sampling design

4. Sampling of intertidal invertebrates and algae.

Estimates of the abundance intertidal algae and invertebrates, and sizes of invertebrates, will be obtained from annual sampling along permanent transects and quadrats (5 sites per block, including rocky, soft sediment, and mussel transects) using a stratified random sampling design. Sampling will include mussel collection for gene expression analyses, as a potential indicator of ecosystem health

5. Sampling of sea grasses.

Estimates of sea grass abundance will be obtained through at sea surveys conducted in close proximity to each of the 5 sites per block

6. Diet and productivity of black oystercatchers

Black oystercatcher nests on transects associated with each of the intensive sites will be monitored annually in June/July for productivity, and shell litter will be collected to determine diet (prey items and sizes).

7. Stable isotope analysis of selected nearshore species.

Stable isotope analysis will be used to (1) trace the dominant sources of primary producer carbon that fuels nearshore marine food webs, and (2) characterize the trophic interactions between primary and secondary *consumers within the nearshore. These data will provide a baseline of information that will be important in assessing now and in the future the role human activities and natural processes play in determining the structure and function of nearshore ecosystems in the GOA.*

C. Data Analysis and Statistical Methods

Data analyses and statistical methods used to evaluate changes in the nearshore environment are detailed in Dean and Bodkin (2006) and Dean et al. (2008), and also presented in the SOPs as described above In general we will examine trends in each metric over time within each location, differences among locations over time, and interactions between time and locations (i e , the extent to which changes within each location track changes across locations over time) through regression and information-theoretic (IT) criteria (Burnham and Anderson 2002, 2004) Competing hypotheses (models) will be selected a priori and those models will be ranked based on their relative support (AIC values). These analyses will help to sort out effects of small scale sources of change (e g , effects of oil in PWS or other location specific impacts such as logging activities) from larger scale sources of change (e g , those due to climate change that are occurring over the entire GOA)

D. Description of Study Area

The proposed work will be conducted in the Gulf of Alaska, in the area bounded by the following coordinates. -144.410, 61.480, NE corner, -145 600, 57 030, SE corner; -155.800, 57.300, SW corner, -156.030, 61.800, NW corner (decimal degrees, NAD 83 Albers).

E. Coordination and Collaboration with the Program

A primary goal of the proposed nearshore monitoring effort is to evaluate the recovery status of resources in PWS that were injured by the EVOS Our ability to assess the restoration of resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the Gulf We will continue evaluation of EVOS injured resources and services (recreational, subsistence, and passive use), to determine when populations may be considered recovered, and where applicable, to foster recovery of those resources by identifying and recommending actions in response to factors limiting recovery. The NPS-SWAN program for nearshore monitoring along the KATM and KEFJ coasts was initiated in 2006, and has been collecting information similar to the data sets that have been used to assess recovery of injured resources in PWS (including monitoring implemented under EVOS Project 10100750), and under the Gulf Watch Alaska project, we have united the NPS-SWAN and USGS monitoring efforts The addition of the study area in Kachemak Bay (Gulf Watch Alaska component 14120114-L), where monitoring has been ongoing for approximately a decade (although methods have varied from those used in PWS), will further enhance our ability to assess recovery We will also integrate information gained on injured resources collected under project component 11120114-Q (lingering oil studies)

Sea otters are a focus species for restoration monitoring, as the population in western PWS was severely impacted by the EVOS, and in areas where shorelines were most heavily oiled, sea otters had not recovered to pre-spill abundance by 2009 (Bodkin et al. 2002, 2011, Monson et al. 2000, 2011) Data to be collected as part of the proposed monitoring will contribute to existing long-term data sets from PWS and other regions, including survey data on sea otter abundance since 1993, carcass data on sea otter ages at death since 1976, and sea otter foraging data since the mid-1970s

As productivity in the nearshore is strongly influenced by physical oceanographic processes, it will be a priority to evaluate whether or not changes that may be noted in the nearshore systems are reflected in either oceanographic conditions or in synchronous changes in pelagic species and conditions that are being measured as part of Gulf Watch Alaska The geographic scale of our study (GOA-wide) will provide greater ability to discern both potential linkages across these diverse components, as well as among the study areas within the nearshore, allowing us to evaluate relations and changes in the nearshore resources We will incorporate data on annual and seasonal patterns measured in the Environmental Drivers component as well as data from the Pelagic study components One component of the overall Gulf Watch Alaska project of particular importance to the nearshore is surveys of nearshore marine birds, which will be accomplished in PWS through the Marine Bird Population Trends monitoring component (representing a further long-term data set; see Irons et al. 2000) and at KEFJ and KATM by the NPS-SWAN program in collaboration with Gulf Watch Alaska

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

IV. SCHEDULE

A. Project Milestones

Objective 1. Long-term monitoring of a suite of nearshore benthic species at multiple locations across the Gulf of Alaska *To be met by September 2014, for the 2014 field season*

Objective 2. Continued restoration monitoring in the nearshore in order to evaluate the current status of injured resources in oiled areas *To be met by September 2014, for the 2014 field season.*

B. Measurable Project Tasks

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

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

February, 2014	*Project funding available*
April/May, 2014	*Carcass surveys, PWS*

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

June- July, 2014	*Conduct field work, PWS, KATM, KEFJ*
August, 2014	*Upload 2013 datasets to GWA server*

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

September-November, 2014	*Data analyses, all project components*
September-November, 2014	*Stable isotope analyses of selected nearshore species*
November 2014	*Attend annual PI meeting, Anchorage*

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

December 2014-January2015	*Report preparation*
January 2015	*Attend Alaska Marine Science Symposium, Anchorage*

V. BUDGET

Budget Form attached

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FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Long-term monitoring: Benthic monitoring component - Long-term monitoring of Ecological Communities in Kachemak Bay: a comparison and control for Prince William Sound

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

Primary Investigator(s): Brenda Konar and Katrin Iken (UAF)

Co-operating Investigator: Angie Doroff (KBNERR)

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. As part of this component, we monitor rocky intertidal, seagrass and clam gravel beach systems as well as the sea otter abundance and diet in Kachemak Bay. This component is complementary to work being conducted under this program in Prince William Sound and Katmai.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$48.1	$48.2	$48.1	$48.1	$47.4	$239.8

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 30, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

Justification

Many protocol similarities exist between the monitoring that is currently being done in Prince William Sound (EVOSTC Project 10100750) and that which is being done in Kachemak Bay. By continuing this monitoring in both areas, comparisons can be made between the two regions and Kachemak Bay may be able to be used as a control for Prince William Sound if another spill were to occur. Historical data exist in both areas, making future comparisons of trends even more valuable

Project Concept

This project will evaluate ecological communities in Kachemak Bay. Following protocols established for Prince William Sound, we will monitor sea otter abundance, diet and carcasses, seabird carcasses, marine debris, abundance and distribution of rocky intertidal plants and invertebrates, abundance and size frequency of clams and mussels on gravel beaches, and selected environmental parameters in Kachemak Bay. All protocols have been established and are described for Prince William Sound These same protocols as will be used in this study. These Kachemak Bay data will be compared with those being collected in Prince William Sound and may be able to act as a control if an oil spill were to occur in the Sound again. The data will also be comparable to data being collected in Kenai and Katmai National Parks (National Park Service SWAN Nearshore Monitoring Program) using the same methods as used in Prince William Sound.

B. Summary of Project to Date (if applicable)

The project is ongoing since two years (2012, 2013). The second year (2013) of field sampling has just been completed and data are currently being entered from field notes, analyzed and formatted for database entry. Field sampling will be continued in 2014 and 2015 and data synthesized in 2016. It is expected that the project will continue for an additional 15 years after 2016.

II. PROJECT DESIGN

A. Objectives

7) Determine trends in sea otter abundance
8) Determine the diet and dietary shifts of sea otters
9) Determine trends in sea otter and seabird mortality
10) Determine trends in marine debris.
11) Determine trends in the abundance and distribution of rocky intertidal plants and invertebrates
12) Determine trends in the abundance and size frequency of clams and mussels on gravel beaches.
13) Determine trends in selected environmental parameters and relate them to #1-6 above.

The field work for this proposal will completed annually for four years and followed by a year of data synthesis (year 5), with the outlook of continuing this pattern of monitoring for up to 20 years

B. Procedural and Scientific Methods

Rocky intertidal sampling consists of visual estimates of percent cover of algae and sessile inverts in 10 replicates (1x1 m^2) along 50 m transects in the high, mid, low and -1 m intertidal strata Mussels are collected along the mussel bed extent from 10 randomly distributed 25x25 cm2 quadrats and length of all mussels is measured. Length of at least 100 *Lottia persona* is measured at each rocky study sites. Seagrass is sampled with 10 replicates (50x50 cm^2) for seagrass shoot counts and percent cover of all vegetation and substrate. Clams are collected from ten randomly placed 0 125 m^3 excavations of the sediment and sieved over 1 cm^2 mesh Temperature is measured at each rocky site using data loggers

Sea otter scat is being collected at a long-term site in Little Tutka Bay (Kachemak Bay) during the winter months. Each scat sample is sorted by prey type and assigned a percentage frequency method using a 1 – 6 ranking (1 = 1 – 5%; 2 = 5 – 25%; 3 = 25 – 50%; 4 = 50 – 75%; 5 = 75 – 95%; 6 = 95 – 100%) Visual foraging observations are conducted with a high-power telescope (Questar field model 50x) Methods follow previously established protocols for visually identifying prey and estimating prey size

C. Data Analysis and Statistical Methods

Intertidal community data are analyzed using multivariate statistics, including hierarchical clustering, non-dimensional scaling and analysis of similarity. Size-frequency distributions are plotted for spatial and temporal comparisons. To summarize the categorical data on sea otter diet from scat samples, the median value for each category are used and then averaged by the monthly collection period

D. Description of Study Area

Study sites are within Kachemak Bay, lower Cook Inlet.

E. Coordination and Collaboration with the Program

Project Logistics

For this project, Brenda Konar and Katrin Iken will provide overall project management They also will oversee the rocky intertidal and gravel beach portion of this study. This will include working with student field assistants, conducting the field work (including some collections of environmental parameters) and completing analyses Angie Doroff will complete the sea otter foraging observations component of this project and will oversee some of the environmental parameter collections. The USFWS has tentatively committed to conducting sea otter abundance surveys (confirmation anticipated when 2011 federal budgets are determined). The Center for Alaska Coastal Studies, the Homer Marine Mammal Stranding Network, and the USFWS have been and will continue to conduct systematic beach walks to recover dead birds, sea otters, and marine debris

Project Integration

We expect strong collaboration between all components of this project with the Prince William Sound, Katmai and Kenai components (all nearshore monitoring with similar data collection methods) and the Oceanographic component Data sharing is integral to the success of this program. This project will be integrated with two University of Alaska field courses that are taught by Konar and Iken at the Kasitsna Bay Lab. Students will get valuable experience and training from participating in this project and the project will benefit from having these students

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

IV. SCHEDULE

A. Project Milestones

Objective 1. Monitor intertidal communities in Kachemak Bay.
To be done annually from 2012-2016

Objective 2 Monitor sea otter diet annually in Kachemak Bay
To be done annually from 2012-2016.

Objective 3. Synthesize temporal (annual) patterns in intertidal communities and sea otter diet in Kachemak Bay
To be met by September 2016.

B. Measurable Project Tasks

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

February-April, 2014 *Plan field sampling on intertidal communities, conduct monthly sea otter scat sampling*

May-June 2014 *Conduct field sampling on intertidal communities and sea otter diet*

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)
July 30 *Enter data from field sampling, continue sea otter sampling*
August 30 *Preliminary data analysis, reporting (6-month report)*

FY 14, 3rd quarter (September 1, 2014-November 30, 2014)
November 30 *Additional data analysis, project presentation at annual PI meeting*

FY 14, 4th quarter (December 1, 2014 – January 31, 2015)
January 31 *Report writing, prepare presentation at scientific conference (Alaska Marine Science Symposium)*

V. BUDGET
Budget Form (Attached)

Lingering Oil Monitoring Component (lead – Ballachey)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Long-term Monitoring: Lingering Oil - Evaluating Chronic Exposure of Harlequin Ducks to Lingering *Exxon Valdez* Oil - 14120114-Q

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

Primary Investigator: Daniel Esler, US Geological Survey, Anchorage, desler@usgs.gov

Co-Investigator: Brenda Ballachey, US Geological Survey, Anchorage, bballachey@usgs.gov

Study Location: Prince William Sound, Alaska

Abstract: This Lingering Oil project is associated with Gulf Watch Alaska, the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services funded by the EVOSTC. Harlequin duck populations in PWS were injured as a result of the *Exxon Valdez* oil spill, with evidence for both immediate acute mortality and longer term injury from chronic exposure to oil spilled in 1989. A series of EVOSTC projects have examined exposure of harlequin ducks to lingering oil as a factor constraining recovery, using the cytochrome P4501A biomarker, CYP1A. Harlequin ducks showed elevated CYP1A in oiled areas from 1998 through 2011 relative to unoiled areas, which was interpreted to indicate continued exposure to residual oil over that period. Data from March 2013 indicated that CYP1A induction was similar between oiled and unoiled areas, suggesting that exposure to lingering oil had ceased by that time, 24 years after the spill. As recommended in previous iterations of this body of work, we propose to re-sample harlequin duck CYP1A in March 2014 to confirm 2013 findings and substantiate our conclusion that exposure to lingering oil has abated. This work contributes to understanding of the timeline and process of recovery of injured species, as well as the nearshore ecosystem, generally.

Estimated Budget: $121.3K
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$187.4		$111.3*			$298.7*

(Funding requested must include 9% GA)
***This is a change from the full program proposal for the five years of the project approved by the Council.**
Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$10.0			

Date: August 8, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

Sea duck populations in western PWS were injured as a result of the *Exxon Valdez* oil spill, with evidence for both immediate acute mortality and longer term injury from chronic exposure to oil spilled in 1989. A series of EVOSTC projects have addressed population demographic endpoints including abundance, habitat use, and survival rates (Rosenberg and Petrula 1998, Esler et al 2002, McKnight et al. 2006, Esler and Iverson 2010, Iverson and Esler 2010) as well as sampling to monitor ongoing exposure to lingering EVO using the cytochrome P4501A (CYP1A) biomarker (Trust et al 2000, Esler et al. 2010, Esler et al 2011).

As described below, a time series of CYP1A data has been collected describing exposure of harlequin ducks to lingering *Exxon Valdez* oil. The work proposed here requests continuation of this unprecedented evaluation of the timeline of population recovery and exposure following a catastrophic oil spill This work is critical for confidently evaluating the duration and process of population recovery of a particularly vulnerable wildlife species.

B. Summary of Project to Date

As part of EVOSTC Restoration Project 070808, harlequin ducks were examined for lingering exposure to residual *Exxon Valdez* oil. This work demonstrated that harlequin ducks continued to show biomarker evidence of elevation of cytochrome P4501A in oiled areas through 2009, which was interpreted to indicate exposure to *Exxon Valdez* oil up to 20 years after the spill (Esler et al. 2010) More recent work (EVOSTC projects 11100808 and 12120114-Q) indicated that. (1) degree and incidence of elevated CYP1A in oiled areas was reduced in 2011 relative to previous years, and (2) in 2013, there was no evidence of elevated CYP1A in oiled areas The 2013 sample was the first since the spill in which no difference between oiled and unoiled areas was evident, which in turn indicated that oil exposure had ceased by 24 years after the oil spill. Additional sampling proposed here for 2014 will evaluate the validity of the conclusion that harlequin ducks are no longer exposed to residual Exxon Valdez oil.

II. PROJECT DESIGN

A. Objectives

<u>Project Concept</u>

In this study, we propose to sample harlequin ducks in PWS for biomarker assays in March 2014 to evaluate recovery status by measuring the degree of continued exposure to lingering oil. As described above, this continues a time series of quantification of CYP1A induction that started in 1998 In this instance, the primary goal is to evaluate whether findings in 2013, indicating abatement of exposure to lingering *Exxon Valdez* oil, are supported, which would lend strong support to the conclusion that harlequin duck populations have recovered, based on the criteria for recovery of the species established by the EVOSTC

Objective 1. Sample harlequin ducks in oiled and unoiled areas of PWS for CYP1A analyses to evaluate continuing exposure to lingering *Exxon Valdez* oil.

B. Procedural and Scientific Methods

Methods will replicate those from previous work (Trust et al. 2000, Esler et al. 2010) to facilitate time series comparisons In brief, we will capture harlequin ducks in several areas that were oiled during the *Exxon Valdez* oil spill, including Bay of Isles, Herring Bay, Crafton Island, Lower Passage, and Green Island, as well as at nearby unoiled northwestern Montague Island. In each area, at least 20 harlequin ducks will have small (< 0.5g) liver biopsies taken while under general anesthesia. Biopsies will be frozen in liquid nitrogen immediately and will be maintained in a frozen state until laboratory analysis at UC Davis by collaborators Liz Bowen, Keith Miles, Jack

Henderson, and Barry Wilson). CYP1A induction will be determined by measuring hepatic 7-ethoxyresorufin-*O*-deethylase (EROD) activity, which is a catalytic function principally of hydrocarbon-inducible CYP1A enzymes

C. Data Analysis and Statistical Methods

For harlequin ducks, data analysis will follow that of Esler et al (2010) and will evaluate average differences in EROD between oiled and unoiled areas, accounting for any effects of age, sex, or mass. Also, the incidence of elevated exposure, defined as two times the average EROD activity on unoiled areas, will be compared between oiled and unoiled areas. Finally, these data will be incorporated into time series evaluations to document the timeline of exposure to lingering *Exxon Valdez* oil.

D. Description of Study Area

This project will focus on harlequin ducks in western PWS Captures will target birds in Bay of Isles, Herring Bay, Crafton Island, Lower Passage, and Green Island (all areas that were oiled in 1989), and at nearby unoiled northwestern Montague Island to provide a reference sample These sites are those that have been sampled over the entirety of the time series of harlequin duck CYP1A data.

E. Coordination and Collaboration with Other Efforts

This project is coordinated with the Gulf Watch Alaska long-term monitoring program funded by the EVOSTC A primary goal of the monitoring effort is to evaluate the recovery status of resources in PWS that were injured by the EVOS, and measuring biochemical indices of exposure in harlequin ducks, a species recognized to have protracted recovery from the spill, directly supports that goal. This project will continue biomarker studies that were initiated in 1998 in western PWS, supported by the EVOSTC, and methods used will conform to those from earlier studies

III. CVs- please see appendix 2

IV. SCHEDULE

A. Project Milestones

Objective 1. Harlequin duck sampling in oiled and unoiled areas of PWS, for CYP1A analyses, to evaluate continuing exposure to lingering oil of ducks captured in oiled areas *To be met by March 31, 2014.*

Measurable Project Tasks

FY 14, 1st quarter (February 1, 2014-April 30, 2014)
Plan for March captures
Arrange lab analysis of samples
Harlequin duck capture, PWS
Shipping of harlequin duck liver biopsies

FY 14, 2nd quarter (May 1, 2014-July 31, 2014)
Laboratory analyses of harlequin duck liver biopsies
Initiate analysis of laboratory data of EROD activity of harlequin ducks

FY 14, 3rd quarter (August 1, 2014-October 31, 2014)
Complete data analyses
Prepare report and submit to EVOSTC

FY 14, 4th quarter (November 1, 2015-January 31, 2015)
Attend meeting of LTM PI's, Anchorage
Attend Annual Marine Science Symposium, Anchorage

References:

Esler, D , T. D. Bowman, K Trust, B E Ballachey, T A. Dean, S C. Jewett, and C. E O'Clair. 2002 Harlequin duck population recovery following the Exxon Valdez oil spill: progress, process, and constraints Marine Ecology Progress Series 241. 271-286.

Esler, D., and S. A. Iverson 2010 Female harlequin duck winter survival 11 to 14 years after the *Exxon Valdez* oil spill Journal of Wildlife Management 74.471-478

Esler, D., K. A Trust, B. E Ballachey, S. A. Iverson , T. L. Lewis, D. J. Rizzolo, D. M. Mulcahy, A K. Miles, B R. Woodin, J. J. Stegeman, J. D Henderson, and B. W Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the Exxon Valdez oil spill. Environmental Toxicology and Chemistry 29 1138-1145.

Esler, D., B. E. Ballachey, K A. Trust, S. A. Iverson, J. A. Reed, A K. Miles, J D. Henderson, B W Wilson, B. R. Woodin, J. R. Stegeman, M. McAdie, and D. M Mulcahy 2011. Cytochrome P4501A biomarker indication of the timeline of chronic exposure of Barrow's goldeneye to residual *Exxon Valdez* oil. Marine Pollution Bulletin 62:609-614

Iverson, S A., and D. Esler. 2010 Harlequin duck population dynamics following the 1989 Exxon Valdez oil spill. assessing injury and projecting a timeline to recovery. Ecological Applications 20·1993-2006.

McKnight, A., K. M Sullivan, D B. Irons, S W. Stephensen, and S Howlin 2006. Marine bird and sea otter population abundance of Prince William Sound, Alaska. trends following the *T/V Exxon Valdez* oil spill, 1989-2005. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Projects 040159/050751), U.S Fish and Wildlife Service, Anchorage, Alaska.

Rosenberg D. H. and M J Petrula. 1998. Status of harlequin ducks in Prince William Sound, Alaska after the *Exxon Valdez* oil spill, 1995-1997 *Exxon Valdez* oil spill restoration project final report, No. 97427. Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage, Alaska.

Trust, K A , D Esler, B. R Woodin, and J J Stegeman 2000. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. Marine Pollution Bulletin 40: 397-403

V. BUDGET
Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM

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

Project Period: February 1, 2014 – January 31, 2017

Primary Investigator(s): Mark Carls & Mandy Lindeberg, NOAA/NMSF Auke Bay Laboratories, 907-789-6019, mark.carls@noaa.gov

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et al. This project fills three needs: understanding exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by measurement of geochemical biomarkers (triterpanes, hopanes, and steranes). The objectives are 1) to determine oil quantity and weathering in 12 PWS beaches 25 years post spill (with repeats every 5 years thereafter), 2) provide supplementary support analyses for other long-term monitoring collaborators, 3) maintain and expand the hydrocarbon database, and 4) produce annual, final, and published reports. The subset of PWS beaches to be monitored are those where sequestered oil is expected to linger for decades. At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s, (2) beach surveys that were continued up to 2004, and spatial modeling analysis that was initiated in 2008.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$19.6	$13.1	$8.7*	$169.2*	$6.5	$217.1

(Funding requested must include 9% GA) ***Funds originally requested for FY15 are now being requested in FY14 due to a shift in sampling dates, because the majority of the funds will be needed (in FY15). The FY14 request is equal to the value originally approved for FY15. This transposition of funding year requests results in no net effect on the total budget. See Part B, Summary of Project to Date for a detailed explanation.**

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 9, 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

Intertidal areas in western Prince William Sound were extensively coated with Exxon Valdez oil[1]; oil still remains in many beaches[2-3], presumably with declining impacts on intertidal invertebrates such as mussels[4-5], and also predators such as sea otters and harlequin ducks[6-9]. . This project would revisit approximately 12 of the worst case sites to continue the long term data set that tracks oil quantity and weathering composition in the contaminated sediments, and establish long term oil monitoring sites that would be re-sampled every 5 years over the next 20 years.

This project fills three needs understanding exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by triterpane, hopane, and sterane measurement. Understanding exposure doses is important to injured species, and this would complement biochemical biomarker evidence (cytochrome P4501A induction) of lingering exposure on sea otters and harlequin ducks (Ballachey, Esler) Understanding oil loss over time is important for understanding full recovery of the habitat; in Alaska, this time course is apparently longer than in lower latitude environments. This study would complement and extend previous work, and would complement the remediation studies by Boufadel in 2011-12 as well as the Irvine study outside of PWS in 2011-12 The study will retrospectively explore geochemical biomarkers (triterpanes, hopanes, and steranes) in Exxon Valdez oil samples collected over time for comparison with contemporary results (including the Boufadel study) To avoid confusion, please note that two very different topics are labeled 'biomarkers,' in the literature, the geochemical biomarkers previously noted and biochemical evidence of change in living animals, hence we use the term geochemical for the former and biochemical for the latter We recognize, however, that these oil compounds were originally produced by plants

B. Summary of Project to Date (if applicable)

- In general, hydrocarbon concentrations in Prince William Sound were low in 2012, ≤ 4 ng/g wet weight in mussel tissue (n=8) and ≤ 28 ng/g wet weight in sediment (n = 7; Payne et al)
- Some beaches remain heavily contaminated; hydrocarbon concentrations in bioremediation beaches (Boufadel et al) were high, $4\ 1 \times 10^4$ to $8\ 0 \times 10^6$ ng/g wet weight
- Hydrocarbon composition in 2012 bioremediation samples was consistent with Exxon Valdez oil
- New forensic modeling approaches with geochemical biomarkers provide definitive identification of stranded oil decades after stranding. Geochemical biomarkers have been measured in Exxon Valdez source oil and samples collected by Boufadel et al. Similar analysis of other source oils in PWS (Monterey crude oil, coal, Constantine Harbor) are not yet complete.
- Oil remains biologically available at some Gulf of Alaska locations (Irvine et al)
- The hydrocarbon database is undergoing a major overhaul, involving extensive data additions, record checking, and structure updates. This requires more than 1 person-year effort, well above the funded amount.
- Determination of oil quantity and weathering (composition) at 12 PWS beaches was scheduled for 2014, we suggest it be delayed until 2015 along with an appropriate shift in yearly funding

II. PROJECT DESIGN

Concept

Continue monitoring a subset of beaches in Prince William Sound where sequestered oil is predicted to linger for long periods of time (decades) At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s[10], (2) beach surveys that were continued up to 2004[2], and spatial modeling analysis that was initiated in 2008[11] Sampling techniques will allow extension of time series data (where they exist), detailed examination of hydrocarbons present (including PAHs, alkanes, and geochemical biomarkers), verification of hydrocarbon source, weathering state, and estimation of the amount of remaining oil at specific sites In addition to sediment samples, mussel tissue will also be examined for hydrocarbon loads to determine if PAHs are biologically available without sediment disturbance (such as that created by foraging activities) A limited number of passive samplers may be deployed in pits dug for sampling purposes to demonstrate the potential for biological exposure if (or when) sediment is disturbed.

Chemical analyses will be upgraded to include geochemical biomarker data (terpanes, hopanes, and steranes); these compounds are the most recalcitrant compounds to biodegradation and weathering, and will yield a more complete picture of the biodegradation/weathering that has occurred over the last 25 plus years and the future 20 years. Geochemical biomarker data have not been collected in the past but are being incorporated in the remediation studies of 2011. We will analyze new samples, but also re-analyze samples collected in the past that are still stored and compliment the future sampling, plus Exxon Valdez source oil In addition, geochemical biomarkers will be measured in a limited number of other known (stored) sources (Constantine Harbor, coal, and Monterey oil) for comparison and contrast with Exxon Valdez oil.

Lastly, to ensure integration between projects and with past monitoring, we will analyze a limited number of sediment samples collected from the intertidal monitoring project (e g from sea otter pits) and maintain the hydrocarbon database including new entries of all new sampling.

Future intentions. The periodic sampling (every 5 years) should be extended for three more cycles, ending on year 40 of the post spill era

A. Objectives

1 Determine quantity and weathering state at 12 beaches in PWS, in 2015.
   a. Year 1 (2012) Begin Retrospective analysis of geochemical biomarkers in Exxon Valdez oil, weathered Exxon Valdez oil, and other potential source oils in Prince William Sound (Constantine Harbor, coal, and Monterey oil).
   b Year 2 (2013). Continue geochemical biomarker retrospective analyses
   c. Year 3 (2014). Determine specific subset of beaches to be sampled in 2015. Continue geochemical biomarker retrospective analyses. Draft a geochemical biomarker report (and paper)
   d Year 4 (2015). Major field sample collection effort
      i Visit 10-12 beaches, collect sediment samples for PAH concentration and weathering profiles
      ii. Using random quadrats, measure the quantity of oil on specific beaches to estimate the quantity present
      iii Collect mussels near oil patches to determine bioavailability in tissues.
      iv. Place a limited number of passive samplers in disturbed areas to model oil bioavailability resultant from foraging activity assuming sufficient funding and interest among other Gulfwatch investigators. Pair these with samplers deployed without disturbance
   e. Year 4, 5. Begin and end the chemical analyses of samples collected in primary field effort, using state of the art GCMS, with geochemical biomarkers included.

2 Supplemental support analyses. Support on-going intertidal projects with chemical analyses, such as determining PAH levels in sea otter pits or prey items. This will integrate with the sea otter and harlequin duck biochemical biomarker measurements in those studies 10-20 samples per year depending on requests from other Gulfwatch investigators.

3. Database: Maintain and add new data to the hydrocarbon database.
   a Add new information to hydrocarbon database. (This database contains data from all NRDA hydrocarbon samples from 1989 to present, including numerous data sets from investigators outside ABL)
   b Prepare a complete FOIA package (100% of the chemical analyses have been FOIAed in the past, and these data will likely also be FOIAed

4. Products. prepare annual and final reports as needed; supply collaborators with appropriate data (e.g. sea otter pit data to sea otter PI) Prepare synthesis manuscript summarizing environmental progress after 25 years

B. Procedural and Scientific Methods

1 Chemical analyses: Standard operating procedures developed at the Auke Bay Laboratories for hydrocarbon analysis will be used for all sample analyses. These have resulted in numerous peer-reviewed publications.

2 Beaches will be randomly drawn from the identified group of oiled beaches (n = 12).

3 Beach segments will be up to 100 m long. Sampling by quadrat will be random across beaches, divided by upper, middle, and lower tide intervals, all based on past studies.

4 Beaches will be accessed by charter boat during spring or summer months during one cruise. Passive samplers will be deployed at the front end of the cruise and picked up at the back end

<u>Project integration</u>

5 This project continues hydrocarbon analyses started prior to 1989 in Prince William Sound and recorded in a hydrocarbon database that encompasses multiple agencies, collection sites, and matrices This database has been maintained by Auke Bay Laboratory (ABL) personnel since the time of the Exxon Valdez oil spill.

6 The major field sampling of 2014 will use methods developed in earlier studies and will conform to those methods for intercomparison over time.

7 This project will complement "effects" studies by including some sampling/analyses specifically targeted to those projects, and will complement the remediation studies of Boufadel (same analyses with geochemical biomarkers included), and will complement the tracking study by Irvine outside of PWS.

<u>Project Logistics:</u>

8 Major field effort in PWS in 2014 will be on a local charter, consisting of a field crew of up to 6 people Federal personnel will lead the cruise effort, although some contract labor will likely be used for the labor intensive beach surveys. Laboratory logistics (chem labs, GCMS) will be at the Auke Bay Laboratories in Juneau Alaska Senior staff will conduct the instrumental analyses, but processing effort will be by contractors.

C. Data Analysis and Statistical Methods

The basic statistical approach is regression analysis of time series data Regression fits and slopes provide evidence for significant change (or not) and direction of change. To assess the usefulness of fitted regressions we compare the observed ANOVA F-ratio to the critical F[12]. Knowledge of measured background levels provide an assessment of when a beach may be considered recovered (or at least indistinguishable from background levels) A third approach to understanding the data is source identification; we use several published PAH source models[13-15], have recently written a more robust version of one of these, and have developed biomarker source models as a result of Selendang Ayu studies. These models provide insight as to sample condition and independent assessment of whether or not samples match background conditions. We also map hydrocarbon distributions to understand geographic and temporal changes using ArcMap. Spatial variation at the beach level is addressed by replicate sampling and by random and composite sampling. Two examples of hydrocarbon time series are illustrated below to demonstrate these tools.

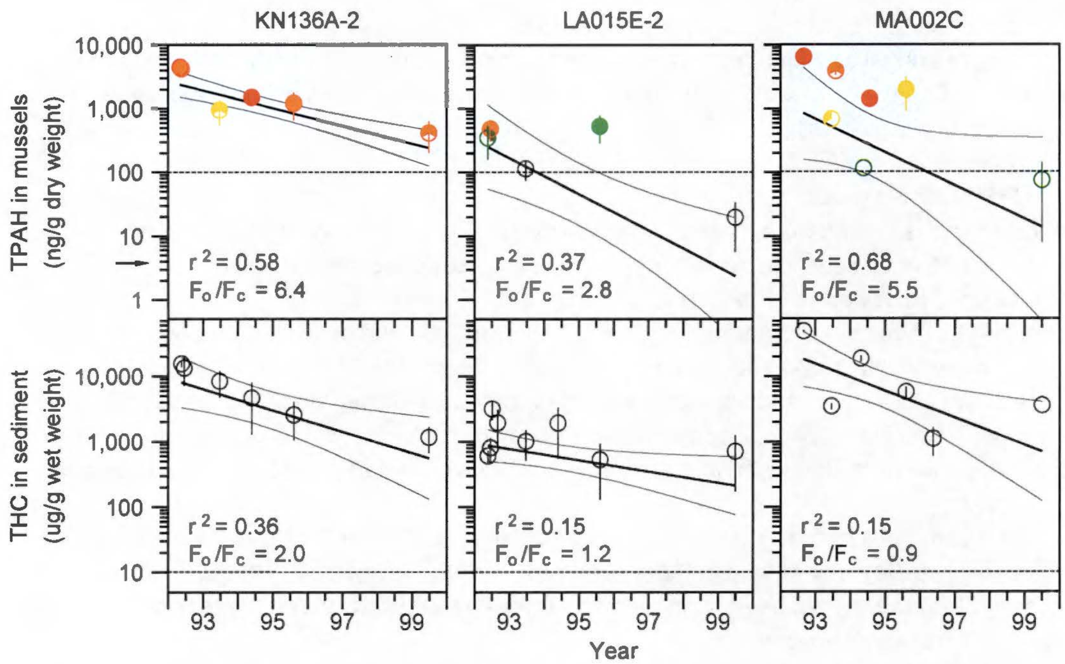

Fig. 1. Example mean (±SE) total polynuclear aromatic hydrocarbon (TPAH) concentrations in mussel tissue and total petroleum hydrocarbons (THC) in underlying sediment, 1992-1999, an extension of Carls et al. (2001). Exponential regressions are bounded by 95% confidence bands. Horizontal dashed lines indicate above-background concentrations. Arrows indicate the upper 95% confidence bound for TPAH in reference mussels (3.8 ng/g dry weight). See Fig. 2 for color and symbol fill keys; THC hydrocarbon source information cannot be determined from THC data.

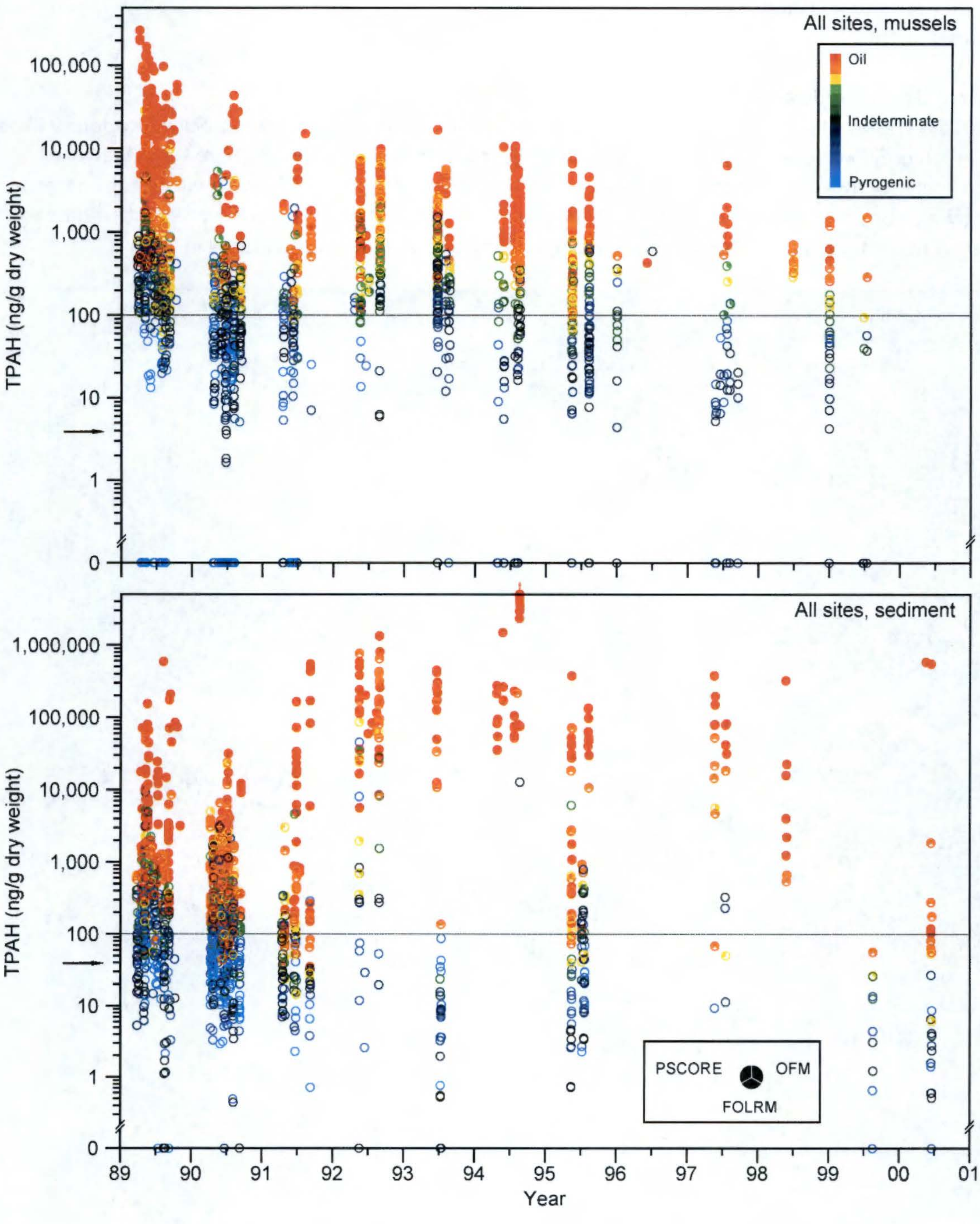

Fig. 2. Total PAH concentrations in mussels and sediment from all sites in Prince William Sound. Symbol fill indicates identification of *Exxon Valdez* oil by components of the consensus model; a non-parametric model (PSCORE; Carls 2006), an oil-fingerprint model (OFM; Bence and Burns 1995), and a first-order loss-rate model (FORLM; Short and Heintz 1997). Symbol colors are based consensus scores. Above-background estimates are

indicated with horizontal dashed lines; arrows indicate the upper 95% confidence bounds for TPAH in reference mussels and sediment.

D. Description of Study Area

The study area is western Prince William Sound (see following figure for an overview); specific locations will be chosen based on previous research. The subset of beaches monitored will be those where sequestered oil is predicted to linger for long periods of time (decades). At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s[10], (2) beach surveys that were continued up to 2004[2], and spatial modeling analysis that was initiated in 2008[11].

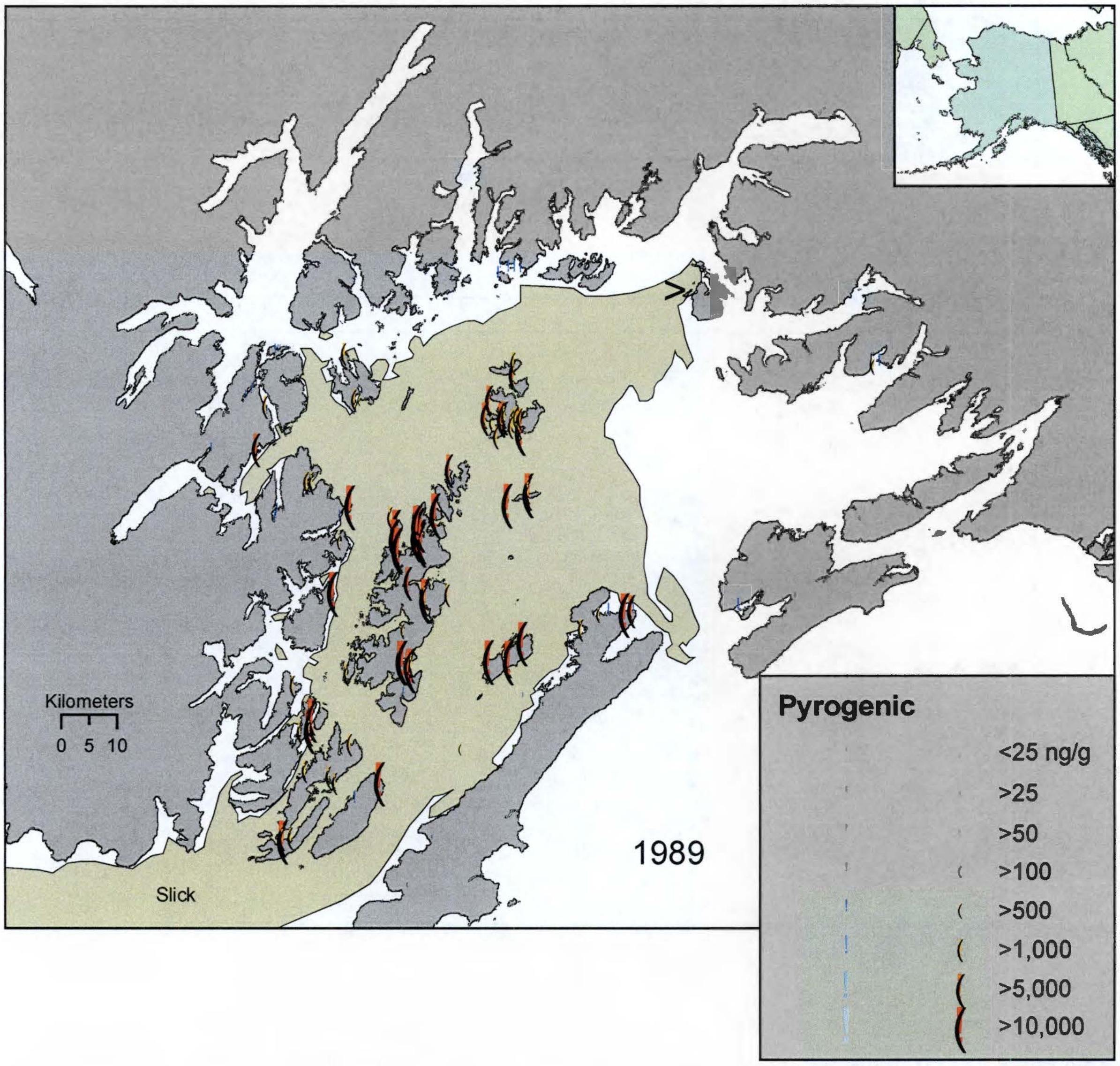

Fig. 3. Composition and concentration of PAHs in mussels in Prince William Sound after the Exxon Valdez oil spill. Orange - red symbols are petrogenic.

E. Coordination and Collaboration with the Program

This project provides a chemical frame of reference for other studies in PWS and the Gulf of Alaska, including 1) an understanding of exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by triterpane, hopane, and sterane measurement. Understanding exposure doses is important to injured species, and this complements biochemical biomarker evidence (cytochrome P4501A induction) of lingering exposure on sea otters and harlequin ducks (Ballachey; Esler). Understanding oil loss over time is important for understanding full recovery of the habitat, in Alaska, this time course is apparently longer than in lower latitude environments. This study complements and extends previous work, and complements the remediation studies by Boufadel in 2011-12 and the Irvine study outside of PWS in 2011-12

III. CVs/RESUMES- please see appendix 2

IV. SCHEDULE

A. Project Milestones

Objective 1. Determine oil quantity and weathering in 12 PWS beaches 25 years post spill.
To be met by September 2016 (Field work completed in 2014, measurements completed in 2016, analyses and manuscript completed in 2016)

Objective 2. Supplemental support analyses.
To be met yearly as information is requested by other long-term monitoring collaborators

Objective 3 Maintain and add new data to the hydrocarbon database
Primary database update to be met by October 2013. Additions to the data base to be met yearly

Objective 4. Prepare annual and final reports
To be met annually. A synthesis manuscript is expected in 2016.

B. Measurable Project Tasks

FFY 14, 1st quarter (Feb 1, 2014-Apr 30, 2014)
February *Design 2015 field study*

FFY 14, 2nd quarter (May 1, 2014-Jul 31, 2014)
June *Draft biomarker report*

FFY 14, 3rd quarter (Aug 1, 2014-Oct 31, 2014)
September

FFY 14, 4th quarter (Nov 1, 2013-Jan 31, 2014)
December *Complete biomarker paper*
January *Annual Marine Science Symposium, meetings*

V. BUDGET
Budget Form (Attached)

FY14 PROGRAM PROJECT PROPOSAL FORM

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

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

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

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

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
$61.3	$63.1	$64.9	$67.1	$61.3	$63.1

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$94.7			

Date: July 30th 2013

I. NEED FOR THE PROJECT

A. Statement of Problem

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf and crosses the slope into the open Gulf of Alaska, providing a record of taxonomically resolved near-surface zooplankton and large phytoplankton abundance over wide spatial scales. Many important species, including herring, forage outside of Prince William Sound for at least some of their life history (salmon, birds and marine mammals for example) so an understanding of the productivity of these shelf and offshore areas is important to understanding and predicting fluctuations in resource abundance. Our sampling transect extends from the inner part of Cook Inlet, onto the open continental shelf, across the shelf break and into the open Gulf of Alaska in a continuous fashion (Figure 1), enabling us to identify where the incidences of high or low plankton are and whether the whole region is responding in a similar way to meteorological variability. Evidence from CPR sampling over the past decade suggests that the regions are not synchronous in their response to ocean climate forcing.

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

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

B. Summary of Project to Date (if applicable)

Note that in FY 2012 funding was provided under EVOS project 10100624, not the Gulf Watch Alaska project. Sampling has continued each year, on six transects per year, usually April to September as planned. In 2012 there were some sampling issues with the loss of the CPR instrument in August (likely due to collision with a large piece of submerged debris). The final 6th transect was sampled in October after new gear had been shipped out for September. Sampling through 2013, the first year funded under this contract, has gone smoothly to date and sample processing is underway.

II. PROJECT DESIGN

A. Objectives

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

<u>Project Integration</u>

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

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

B. Procedural and Scientific Methods

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

C. Data Analysis and Statistical Methods

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

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

Our methodology has remained unchanged since the survey's inception so comparisons with historical CPR data are straightforward. Comparisons with other plankton sampling are more problematic as each sampling system has a bias of some sort caused by, for example, mesh size, depth of sampling, taxonomic resolution. However, by using indices such as anomalies and pooling taxa to create functional groups useful comparisons can be made. Such work was undertaken during project 10100624 and will continue here

D. Description of Study Area

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

E. Coordination and Collaboration with the Program

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

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

IV. SCHEDULE

A. Project Milestones

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

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

B. Measurable Project Tasks

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

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

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

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

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

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

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

November.	Attend annual GWA PI meeting

December.	Processing and initial analysis of samples collected in summer/fall 2014 will be completed.

V. BUDGET

Budget Form (Attached)

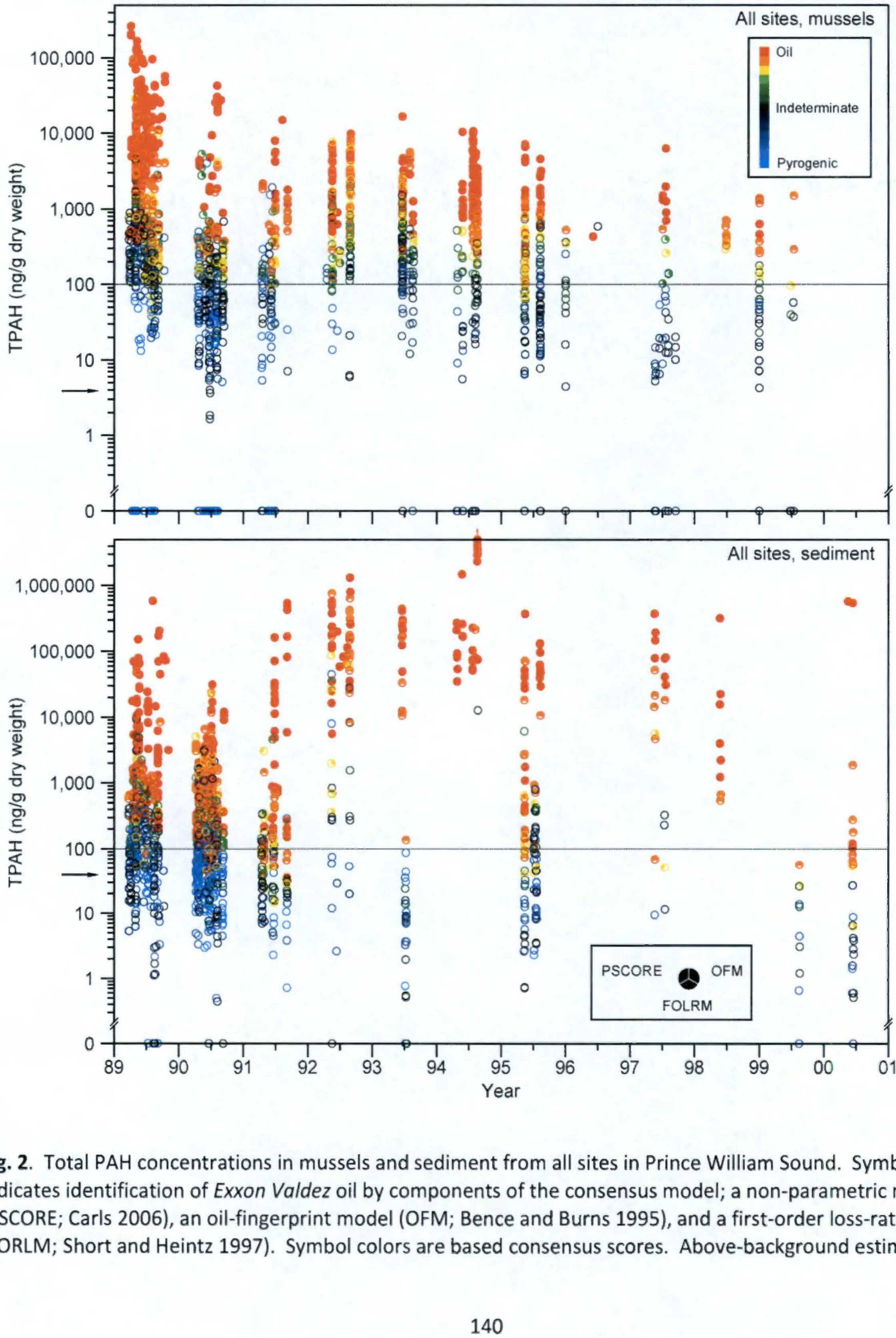

Fig. 2. Total PAH concentrations in mussels and sediment from all sites in Prince William Sound. Symbol fill indicates identification of *Exxon Valdez* oil by components of the consensus model; a non-parametric model (PSCORE; Carls 2006), an oil-fingerprint model (OFM; Bence and Burns 1995), and a first-order loss-rate model (FORLM; Short and Heintz 1997). Symbol colors are based consensus scores. Above-background estimates are

indicated with horizontal dashed lines; arrows indicate the upper 95% confidence bounds for TPAH in reference mussels and sediment.

D. Description of Study Area

The study area is western Prince William Sound (see following figure for an overview); specific locations will be chosen based on previous research. The subset of beaches monitored will be those where sequestered oil is predicted to linger for long periods of time (decades). At least three predictive data sets will be considered in determining which beaches are monitored: (1) mussel bed time series started in the early 1990s[10], (2) beach surveys that were continued up to 2004[2], and spatial modeling analysis that was initiated in 2008[11].

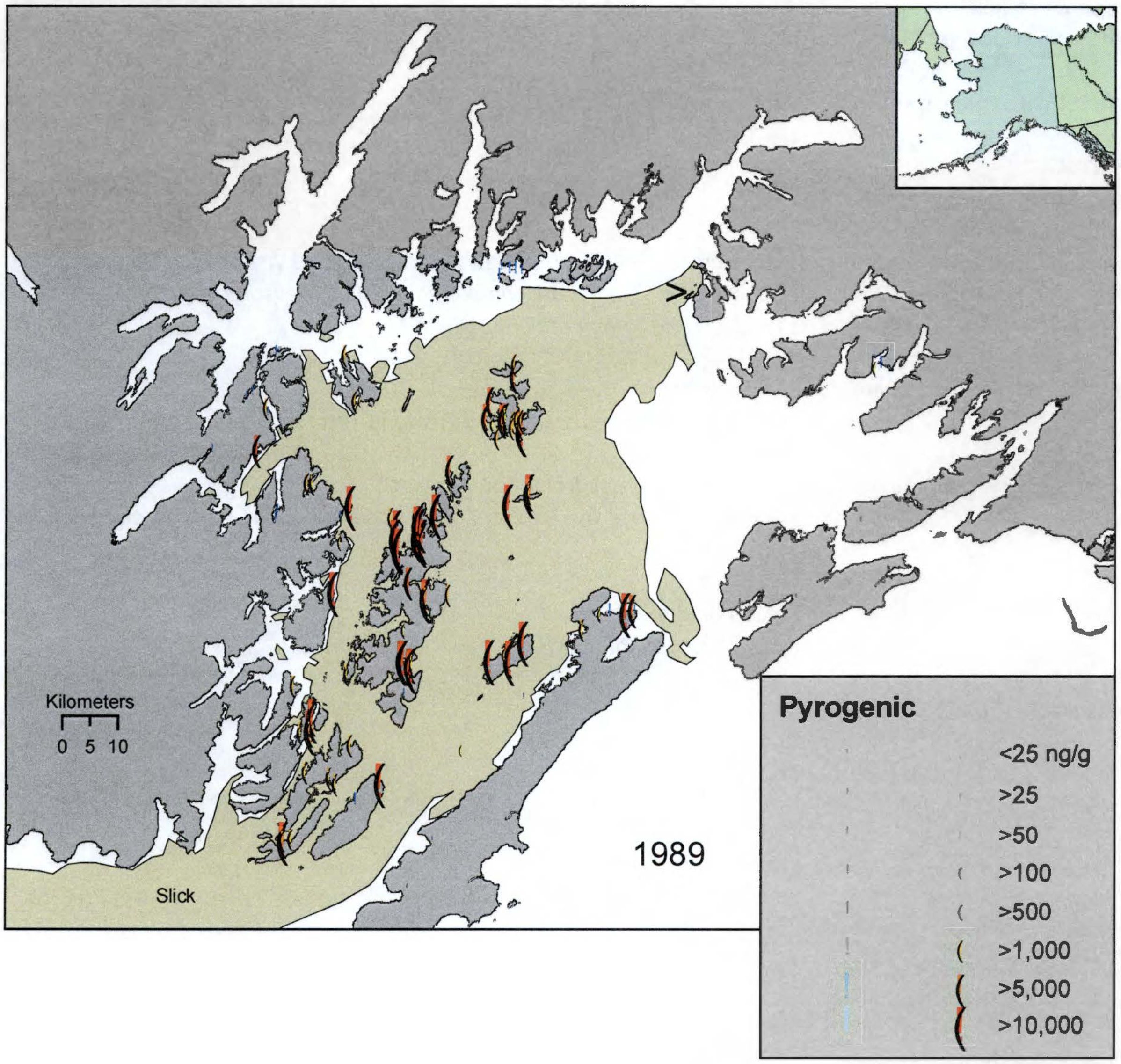

Fig. 3. Composition and concentration of PAHs in mussels in Prince William Sound after the Exxon Valdez oil spill. Orange - red symbols are petrogenic.

E. Coordination and Collaboration with the Program

This project provides a chemical frame of reference for other studies in PWS and the Gulf of Alaska, including 1) an understanding of exposure levels (past and present) for species such as mussels, intertidal invertebrates, sea otters, and harlequin ducks, (2) understanding the natural degradation of quantity and composition of PAH over a long time course, and 3) definitive long-term source identification by triterpane, hopane, and sterane measurement Understanding exposure doses is important to injured species, and this complements biochemical biomarker evidence (cytochrome P4501A induction) of lingering exposure on sea otters and harlequin ducks (Ballachey; Esler) Understanding oil loss over time is important for understanding full recovery of the habitat; in Alaska, this time course is apparently longer than in lower latitude environments This study complements and extends previous work, and complements the remediation studies by Boufadel in 2011-12 and the Irvine study outside of PWS in 2011-12

III. CVs/RESUMES- please see appendix 2

IV. SCHEDULE

A. Project Milestones

Objective 1. Determine oil quantity and weathering in 12 PWS beaches 25 years post spill
To be met by September 2016. (Field work completed in 2014, measurements completed in 2016, analyses and manuscript completed in 2016)

Objective 2. Supplemental support analyses
To be met yearly as information is requested by other long-term monitoring collaborators

Objective 3 Maintain and add new data to the hydrocarbon database
Primary database update to be met by October 2013. Additions to the data base to be met yearly.

Objective 4. Prepare annual and final reports
To be met annually A synthesis manuscript is expected in 2016.

B. Measurable Project Tasks

FFY 14, 1st quarter (Feb 1, 2014-Apr 30, 2014)
February — *Design 2015 field study*

FFY 14, 2nd quarter (May 1, 2014-Jul 31, 2014)
June — *Draft biomarker report*

FFY 14, 3rd quarter (Aug 1, 2014-Oct 31, 2014)
September

FFY 14, 4th quarter (Nov 1, 2013-Jan 31, 2014)
December — *Complete biomarker paper*
January — *Annual Marine Science Symposium, meetings*

V. BUDGET
Budget Form (Attached)

GOAR

Gulf of Alaska Keeper

5933 E 12th Avenue
Anchorage, Alaska 99504

Updated Progress Report and Prospective Funding

Project Number: 12120116
Project Title: Gulf of Alaska Keeper Tsunami Debris Cleanup Project
PI Name: Chris Pallister
Time period covered: May 8 through September 30, 2013
Date of Report: October 2, 2013
Report prepared by: Chris Pallister
Project website: goak.org

Gulf of Alaska Keeper's (GoAK) cleanup crew began cleaning PWS beaches May 8, targeting Japanese Tsunami Marine Debris (JTMD). 17 landing craft loads of debris were hauled to Whittier where the debris was then transported by Alaska Waste to Central Alaska Recyclers' facility in Anchorage for sorting. Non-recyclable items were then sent on to the Anchorage landfill. During this project, over 68 tons or approximately 700-cubic yards of debris were removed from beaches throughout PWS and along the northeast corner of Montague Island. That is approximately 700-cubic yards of debris. Over 300 miles of targeted beaches were cleaned in this EVOSTC-funded effort.

approve

The GoAK cleanup crew, ranging between 8 and 13 workers, spent 78 days cleaning beaches for EVOSTC in PWS. Two volunteer crews from Japan joined our cleanup crew for one week each, One Japanese crew worked inside PWS in May and another cleaned on the northeast corner of Montague Island in July. Two volunteer Japanese crews intend to again join the cleanup project in the summer of 2014. Nine volunteers also spent 8 days cleaning 14 marine debris monitoring sites within PWS.

With the exception of a few miles around the tip of Zaikof Point at the northeast corner of Montague Island, all of this shoreline had been cleaned by GoAK within a few years of the arrival of JTMD. Most of the volume of the debris collected on previously cleaned beaches consisted of Styrofoam, urethane foam, other construction insulation foam, large aquaculture buoys, drums, fuel jugs, and other types of plastic containers. Many thousands of Japanese plastic bottles were also recovered during this cleanup.

The density of debris collected on shorelines within inner PWS was a fraction of the debris removed from the shoreline around Zaikof Point on Hinchinbrook Entrance. Over half of the debris collected for EVOSTC this season came from just a couple of miles of shoreline near Zaikof Point. The volume of debris in that area exceeds 300-cubic yards or 30 tons per mile. That is considerably higher than the 20 tons we had estimated. At least 50% of the total debris volume is JTMD, but as the JTMD is relatively lightweight, it is only about 15 to 20% of the total weight of debris removed, the balance being derelict fishing gear and many other kinds of plastic debris. GoAK expended as much effort cleaning a couple of miles around Zaikof Point as they did the other 300 miles within PWS this season.

The 14 PWS marine debris monitoring sites conclusively demonstrated that foam JTMD continued to wash onto PWS beaches over the winter of 2012/2013. The total amount of debris

Gulf of Alaska Keeper
5933 E 12th Avenue
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The 14 PWS marine debris monitoring sites conclusively demonstrated that foam JTMD continued to wash onto PWS beaches over the winter of 2012/2013. The total amount of debris on the monitoring sites decreased by about a third compared to the previous year, but the amount of foam debris remained extraordinarily high, over 25% of the total debris by weight and, of course, much higher by volume. However, we saw very little new foam debris washing onto the beaches during the summer.

As predicted by tsunami debris distribution modeling, since the spring of 2013 we have seen a significant increase of heavier debris such as drums of chemicals washing onshore this season. That trend is more apparent on Gulf of Alaska shorelines such as outer Montague Island and the Kenai Peninsula. Numerous 55-gallon steel drums had Japanese labels on them. We now have several stashes of unknown chemicals awaiting proper disposal. ADEC hazardous-material personnel inspected and removed several drums containing hazardous chemicals that GoAK found on Peak Island. The stashed drums and containers of acid, numerous petroleum products, and unknown chemicals will need to be removed by proper authorities.

A full 55-gallon of an unknown chemical that washed up on northeast Montague Island during the last week of September 2013.

2013-2014 Funding

In addition to the EVOSTC funding for the PWS cleanup this summer, GoAK received in July a $1,000,000 Alaska Legislative grant for JTMD removal. That grant was split with Island Trail Network (ITN) for Kodiak Island area cleanup work and Airborne Technologies, Inc. (ATI) for Southeast Alaska cleanup work. GoAK received $366,000 of the Legislative grant to utilize on the northeast Montague Island cleanup and also in the Gore Point region. GoAK has expended approximately $216,000 of that grant and will utilize the balance of $150,000 to assist with the Barren Island project if necessary. If not needed on the Barrens, we will use it to continue working on northeast Montague Island next summer. However, because the debris density on the Barrens has increased substantially since the tsunami, we anticipate using the Legislative grant funds on that project However, we and our partners intend to again approach the Legislature for additional funding to help support the Montague Island, Kodiak Island and Southeast Alaska cleanup projects in 2014. It is entirely speculative, but we hope to obtain the same level of funding from the Legislature in 2014 as we did this year.

GoAK would use additional Legislative funding to continue the Montague project. We believe that cleaning the northern three-fifths of Montague Island's Gulf of Alaska shoreline is critically necessary to prevent JTMD from refloating and being dispersed throughout PWS. Because the debris density is so high on the Gulf of Alaska side of Montague Island, and the beaches so remote and rugged, the cost of cleaning that shoreline is now approaching $100,000 per mile including debris transport and disposal costs. Unfortunately, nearly 70 miles of heavily fouled shoreline remain there to be cleaned. Consequently, legislative support for this costly but critical project is essential.

In addition to the remaining Legislative grant balance, GoAK has also been awarded a $25,000 grant from the Chugach Forest Service RCAC to help with fuel and debris disposal related costs for cleanup work in PWS, including outer Montague Island, in the summer of 2014. We also received the same Forest Service grant this summer.

Additionally, GoAK and its partners ITN and ATI have also been qualified to submit proposals in response to ADEC cleanup project RFPs. GoAK would likely use its share of any ADEC funding to assist with the challenging Montague Island project.

Therefore, in addition to the EVOSTC funding requested for 2014, GoAK also has $150,000 in Legislative funding and $25,000 from the Chugach Forest Service available. The level of additional funding from ADEC or the Legislature is unknown at this time. GoAK anticipates also receiving $246,120 in matching funds, including in-kind donations such as volunteer work and cash donations from private donors, to help with the Barren Islands cleanup.

Alaska Legislative Cleanup Project

In addition to the PWS and Montague cleanup work for EVOSTC this summer, GoAK also cleaned beaches with the Alaska Legislative grant at Gore Point, Windy Bay, Chugach Bay, Elizabeth Island, and Summer Cove on the Kenai Peninsula. Under that same grant, GoAK also removed debris from 2 miles of Montague Island shoreline working south from where the

EVOSTC northeast Montague Island project terminated. The cleanup crew spent 35 days working on the Legislative funded project in 2013, 20 of those on outer Montague Island.

The debris collected during the Legislative project on northeast Montague was consolidated but not removed as was done for the EVOSTC project further north. As we worked south, the collected debris became increasingly more difficult to remove from the shore. Instead, the collected debris was cached in large Super Sacks, or in large bundled piles, so that it can later be easily removed by helicopter. There are over 200 Super Sacks, and about 50% more bundled loose debris such as floats, buoys, large drums, and boat parts, cached in safe locations along 2 miles of shoreline. That is approximately 65 tons of debris. This debris, along with additional debris collected next season, will be removed in the fall of 2014 utilizing a helicopter and a large barge. The debris density on the Gulf of Alaska side of Montague Island is so high that it makes little sense to attempt to transport it in countless, and expensive, relatively small loads.

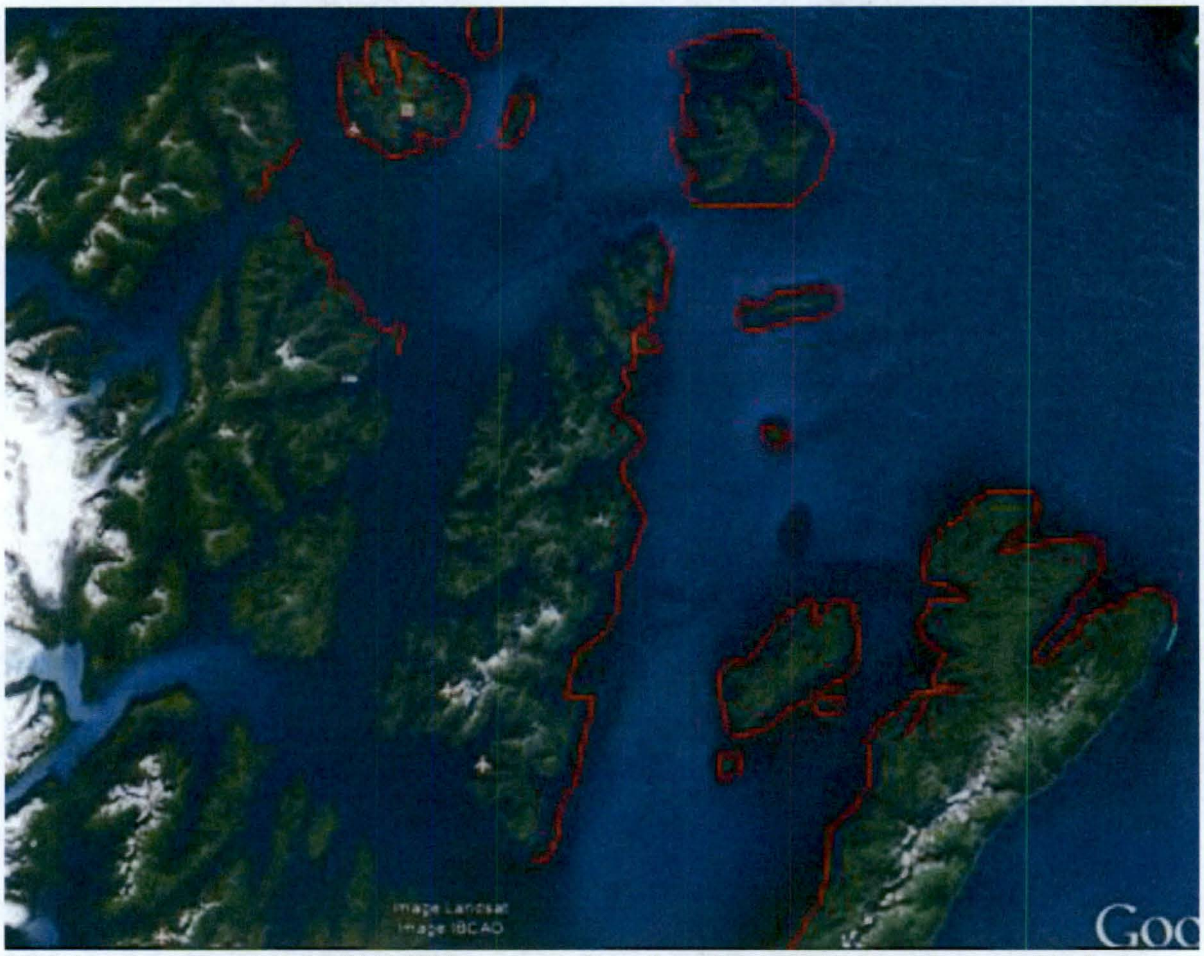
In several locations, where the beaches are very narrow and subject to severe storm surf washing over them, we moved the consolidated debris by helicopter to a safe staging point. On many beaches along the rugged northern two-fifths of eastern Montague Island, it is nearly impossible to land a helicopter. It is also extremely difficult to land workers onshore by skiff or inflatable without perfectly calm seas, so once ashore it is important to maximize cleanup efforts. Hence, we decided that debris consolidation was the most efficient and the safest cleanup methodology. We also reduced risks to workers by avoiding transferring tons of debris from slippery, rocky, surf-driven beaches.

Super Sacks being consolidated September 30 in a secure Montague Island staging area


Nets and line being transferred to the staging area


Super Sack pile on northeast Montague Island

Cleaned for EVOSTC
Cleaned for Alaska Legislature



PWS shorelines cleaned during 2013 JTMD cleanup. Shorelines also cleaned but not shown on this chart include those on northern and eastern Latouche Island, the southwest corner of Elrington Island, and all of the Axel Lind Island, Little Axel Lind Island and Bald Headed Chris Island beaches.

The following photos show some of the marine debris removed and cleanup work done during the summer of 2013.

Derelict dock with encased hazardous chemical drums removed from Naked Island

Cutting up and removing derelict boat hull from Naked Island


Street marker from Japanese tsunami zone found on Naked Island


Load of tsunami debris removed from Green Island

JTMD Styrofoam on Zaikof Point, Montague Island

Tsunami debris collected on Zaikof Point


Transferring JTMD on Zaikof Point


Japanese building components in Rocky Bay, Montague Island

A pile of JTMD and other debris on Zaikof Point

One of numerous steel drums found during the 2013 cleanup

Gulf of Alaska Keeper

EVOSTC

Harbor Protection and Marine Restoration

Marine Debris Removal Grant

Barren Islands Amendment

By Chris Pallister

Team Leader

907-345-0166

chris@goak.org

September 10, 2013

Table of Contents

Background Information

In early 2012, Gulf of Alaska Keeper (GoAK) commenced work on a multi-year marine debris cleanup, **EVOSTC Project #12120116, Contract # IHP-12-057**. During the summer of 2012, the EVOSTC-funded cleanup work focused on removing decades of built-up deposits of marine debris from southwest Prince William Sound (PWS) beaches. In 2013, pursuant to an amendment to the original contract, GoAK removed Japanese Tsunami Marine Debris (JTMD) from targeted shorelines in PWS and delayed the proposed Barren Islands cleanup by one year. The Chart 1 illustration on page 4 is of the shorelines proposed for the PWS JTMD cleanup in 2013 and the Chart 2 illustration on page 5 is of the PWS shorelines actually cleaned in 2013, including the southeast portion of Knight Island that is currently being cleaned.

One of 16 loads of JMD removed from PWS in 2013

Tsunami Debris Collector Areas within PWS
Continuous Heavy Tsunami Debris Field outside PWS

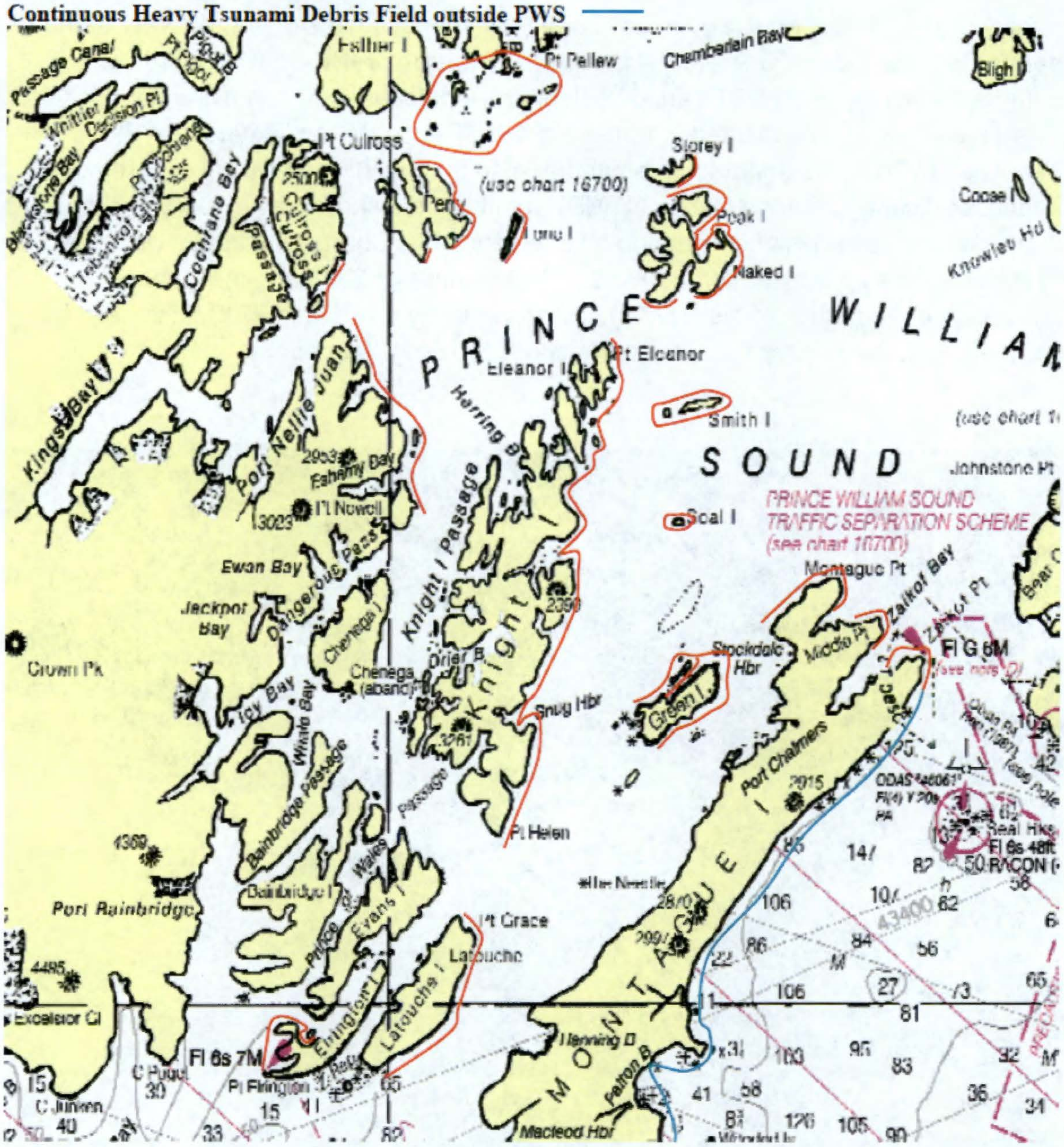


Chart 1. PWS shorelines proposed for 2013 cleanup

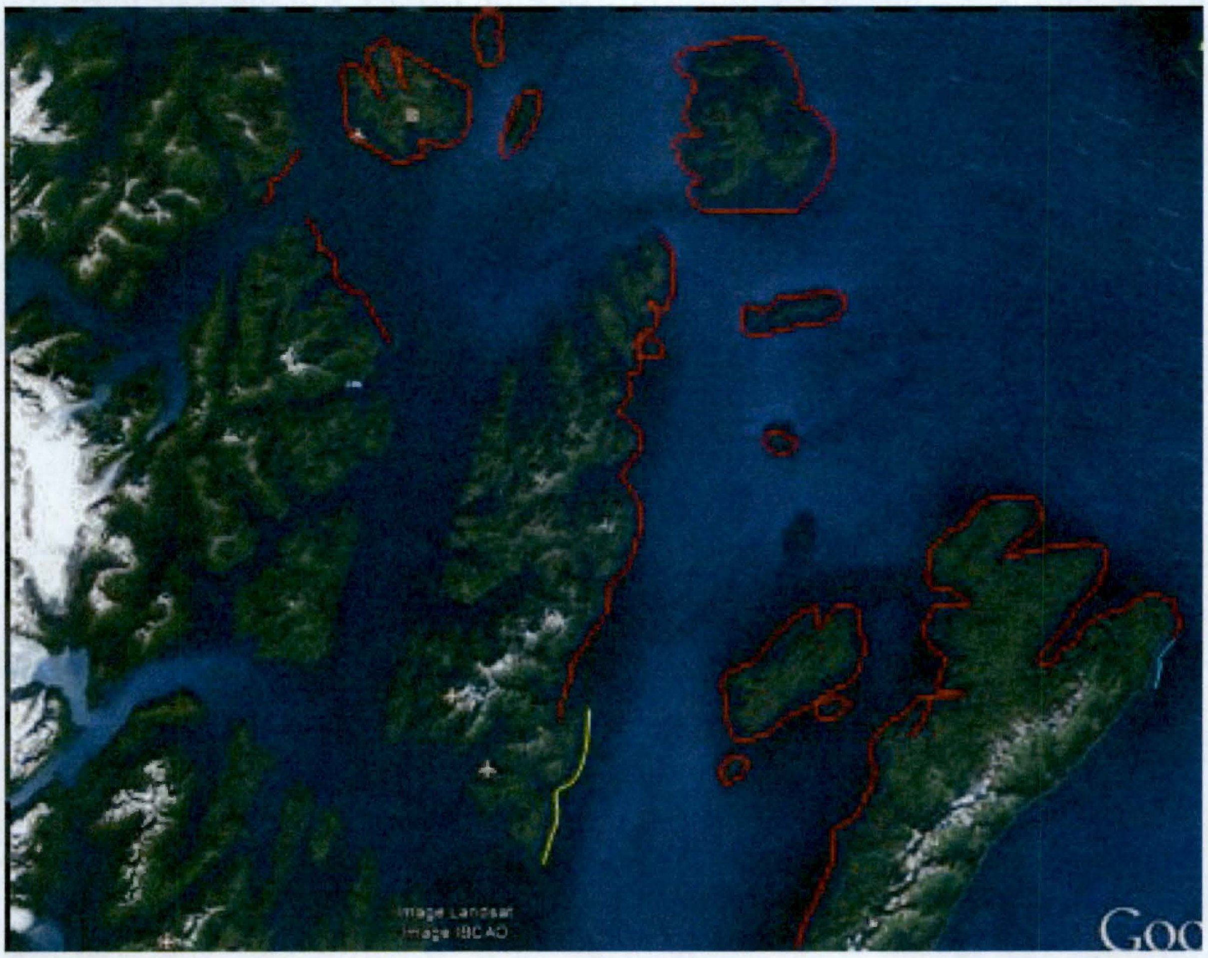


Chart 2. PWS shorelines cleaned during 2013 JTMD cleanup. Not shown on this chart, north and eastern Latouche Island and the southwest corner of Elrington Island have also been cleaned.
Cleaned for EVOSTC
Being Cleaned for EVOSTC
Cleaned for Alaska Legislature

As can be seen from a comparison between the two charts, the actual cleanup deviated somewhat from the proposed cleanup. That is because we only cleaned where we found significant tsunami debris deposits. 16 landing craft loads of debris comprising 640-cubic yards or over 64 tons of JTMD were removed from over 300 miles of PWS shoreline. A complete report on the 2013 JTMD cleanup will be submitted when the GoAK crew completes cleanup operations at the end of September. With the successful completion of the PWS JTMD cleanup, Gulf of Alaska Keeper proposes to turn cleanup focus once again upon the Barren Islands.

2014 Amended Barren Islands Marine Debris Removal Project

Gulf of Alaska Keeper (GoAK) originally proposed this marine debris cleanup project as a portion of a multiyear marine debris cleanup proposal to the Trustee Council. That proposal was submitted and approved before the full extent of impacts from the March 2011 Japanese earthquake and tsunami became apparent in Alaska In response to the influx of Styrofoam, urethane foam, and other Japanese tsunami marine debris (JTMD), GoAK submitted an amended proposal to the Trustee Council which delayed the Barren Island cleanup project one year. GoAK instead spent the 2013 season removing JTMD from impacted PWS shorelines GoAK started the 2013 PWS JTMD cleanup May 8 and will finish cleaning beaches there toward the later part of September

While JTMD continued to wash up on PWS beaches during the winter of 2012/2013, and will likely continue to do so for years, the immediate threat to shorelines within PWS from the massive volume of foam tsunami debris has been substantially abated. GoAK has successfully removed most of the foam debris from inner PWS However, Montague Island's Gulf of Alaska shoreline has an immense quantity of foam debris littering its beaches Refloated debris from the northern three fifths of that shoreline still poses a direct threat to inner PWS beaches GoAK received a grant from the Alaska Legislature to remove JTMD from high priority beaches. We are using part of the legislative grant to clean a small portion of the northeast Montague shoreline to prevent, as much as is possible, refloated debris from entering and again fouling inner PWS shorelines In addition to the 2013 cleanup work on northeast Montague Island, a portion of the legislative funding will be used in the summer of 2014 to help with the Barren Islands cleanup project

GoAK has also been selected by the Alaska Department of Environmental Conservation as a contractor eligible to submit cleanup proposals for ADEC marine debris projects, including the projects supported with Japanese funds gifted to the U.S for JTMD response Funding GoAK obtains from ADEC, and with their approval, will first be applied to cleaning outer Montague Island, particularly the northern beaches that have the potential to send refloated debris into PWS

Barren Islands 2014 Marine Debris Project Narrative

Now that shorelines within PWS have been cleared of JTMD, we propose removing marine debris from the Barren Islands during the summer of 2014. Since this proposal was originally submitted, two winters of JTMD accumulation have occurred on the Barrens. Consequently, there is significantly more debris, particularly tsunami related foam debris. Small foam debris is labor intensive to remove and, because of that and the increased volume of debris, GoAK anticipates a 20% increase in the man hours necessary to complete this cleanup. However, we are not requesting an increase in funding from the Council for this project, but instead plan to utilize small teams of volunteers to assist with the job GoAK's $366,800 request for EVOSTC funding for this project remains the same as in the original proposal

The Barren Islands are situated about 20 miles southwest of Elizabeth Island, at the southwest end of the Kenai Peninsula, across Kennedy Entrance Southwest from the Barren Islands, it is about another 20 miles across Stevenson Entrance to Shuyak Island at the north end of the Kodiak Island archipelago Ushagat Island is the western most and largest of the Barren Islands Ushagat Island is about 7 miles east to west and 3.5 miles north to south. West and East Amatuli Islands, about 3 and 2-miles long respectively, are several miles to the east of Ushagat Island and are significantly smaller than Ushagat Island. Nord, Sud and Sugarloaf Island, between ½ and 1-mile long each are the three remaining "major" islands in the group, however there are numerous small unnamed islets in the area.

The Barren Islands are part of the Alaska Maritime National Wildlife Refuge They comprise an ecologically rich, but sensitive environment. MD cleanups in this area will be closely planned and coordinated with Refuge staff GoAK has initiated permitting for the cleanup project

Ushagat Island has several long sections of shoreline uninterrupted by headlands that combined total approximately 5 miles in length These beaches for the most part are heavily fouled by marine debris (MD), especially those beaches armored with drift logs In those shoreline areas with lowlands beyond the beaches, particularly on the island's north side, MD has been driven far onshore. In some areas, large amounts of debris are found hundreds of yards beyond the tideline. Large quantities of MD have also washed over beach berms and been deposited in two sizable lakes on the island's north side.

In addition to the stretches of low-profile continuous beach on Ushagat Island, there are approximately another 12 miles of rocky shoreline pocketed with numerous MD collector areas Most of these discontinuous collector beaches are heavily fouled with MD. These shorelines will be quite difficult to clean because most of them will need to be accessed by skiff Cleanup personnel will generally not be able to walk from one collector pocket to the next. The balance of the remaining 8 to 10 miles of coastline on Ushagat Island is steep with few debris-catchment areas and will need little cleanup effort

Most of the low beaches on Ushagat Island have MD deposits nearly comparable to the massive MD deposits Gulf of Alaska Keeper removed from Gore Point, where 20 tons of plastic MD were removed from just a single third-of a-mile shoreline. That particular Gore Point beach took a 7-man professional cleanup crew, with the assistance of 5 volunteers, one month to clean The beaches on Ushagat Island, and the other Barren Islands, are not quite as badly fouled as those at Gore Point, but they are more extensive and even more difficult to access in many circumstances As such, cleaning shorelines in the Barren Islands will be very difficult and time consuming We estimate that it will take a ten-person crew with rotating 6-person teams of volunteers 62 days to thoroughly clean the beaches in this area

The Barren Islands sit at a convergence of strong storms, currents, and tides The Alaska Coastal Current approaches the islands from the east Strong tidal currents from Cook Inlet and Shelikof Straits surge around the islands. Storms hit the islands in the summer cleanup season primarily from the southwest to the southeast, but can come from any quarter. There are only two good anchorages for cleanup support vessels, one each on the north sides of East and West Amatuli Islands Generally, when not working on either East or West Amatuli Island, crew vessels will need to move to the lee side of an island for protection The lack of secure anchorages will require a considerable amount of effort and time to move crews to beach work sites Careful daily on-site attention to, and consideration of, actual and forecasted weather conditions will determine crew placement and work schedules

Marine debris will be collected by hand and smaller items placed in large garbage bags The garbage bags and larger debris items will then be moved to accessible staging sites and placed in large Super Sacks At the end of the season, the Super Sacks will be lifted by a helicopter onto a large barge anchored offshore. **In a departure from the original proposal, the debris will likely then be transported out of Alaska along with debris collected on outer Montague Island and from other cleanup projects along the Gulf of Alaska.** We are currently working with other cleanup groups to coordinate the debris transport effort.

GoAK's plan for cleaning this sensitive area includes housing the cleanup crews on a 54-foot support vessel in order to limit human impact on the area There will be no onshore camps in the Barren Islands Workers will be shuttled to and from shore on a daily basis. All cleanup-generated waste and trash will be stored onboard and transferred to Homer for proper disposal. A 32-foot landing craft will be used for transferring MD from accessible beaches and providing logistical support for the project. A 45-foot landing craft will be used to transfer crew over longer distances to cleanup beaches and to move gear and debris. Four inflatable skiffs will also be used access beaches, ferry crew, and to collect and consolidate debris.

The shoreline in the Barren Islands is rocky, largely unprotected, and subject to strong currents There are only a few areas where a large landing craft could approach the shore safely. For that reason, GoAK plans to use the same cleanup methodology successfully employed on the Gore Point cleanup Crews, using only hand tools, will collect debris in garbage bags A small landing craft can access many of the beaches and will be used to consolidate debris for later shipping. The garbage bags of MD will be moved to accessible locations for helicopter slinging. The garbage bags will be placed in Super Sacks which will be cached until the end of the cleanup season A helicopter will then sling the Super Sacks of MD onto a large landing craft or barge The MD will then be shipped to a recycler and/or landfill for disposal All salvageable items, such as fishing floats, fuel drums, etc., will be given to commercial fishermen or any other entities that might want them

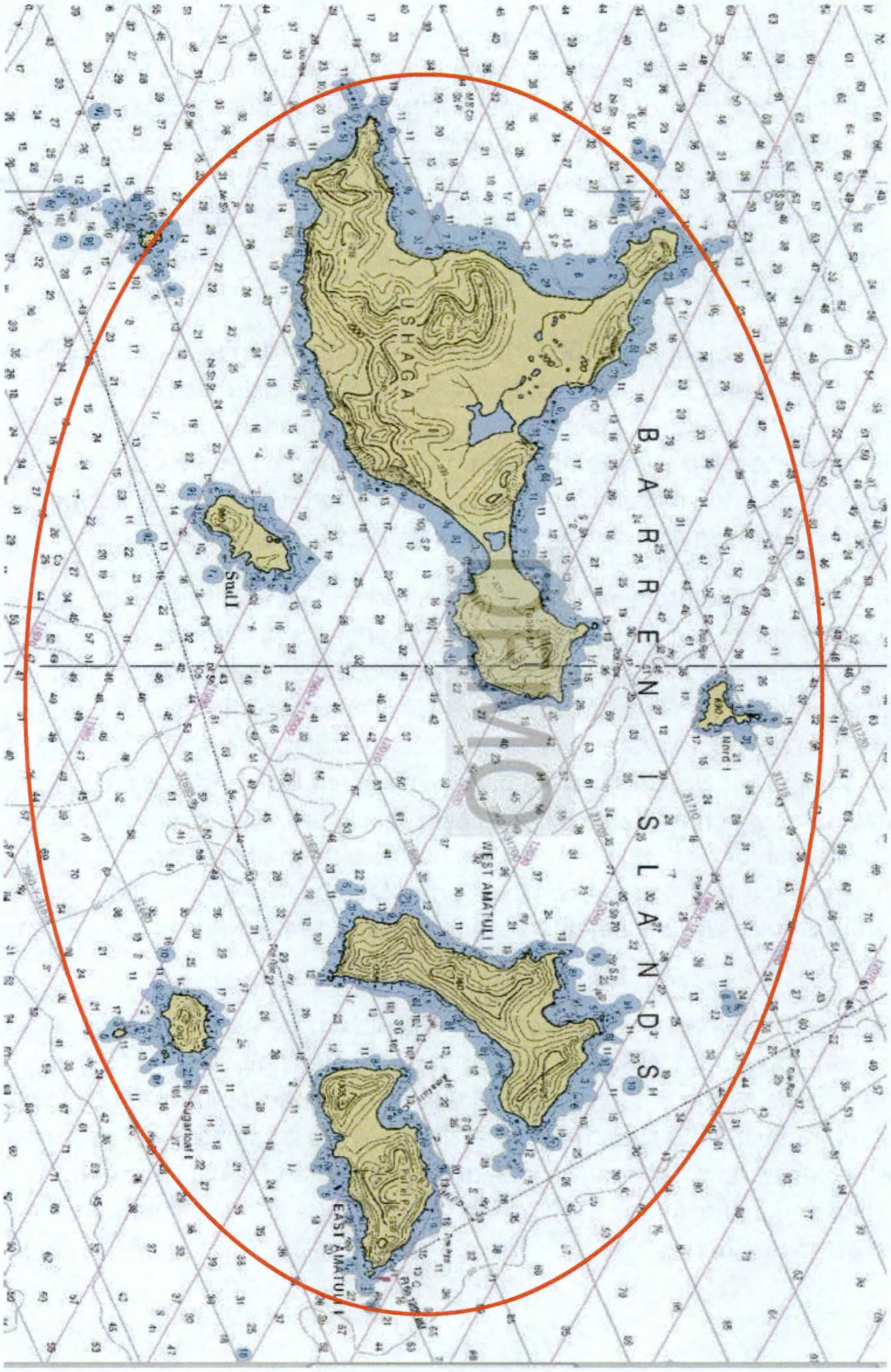
GoAK anticipates that between 80 and 100 tons of primarily plastic marine debris will be removed from between 20 and 25 miles of coastline in the Barren Islands over the duration of this project The width of the shoreline cleaned will vary from approximately 25 yards on steeper beaches up to several hundred yards inland on the low profile, low elevation beaches At least 2.6 million square yards of coastal habitat will be cleaned during this project and as much as 4 4 million square yards could be cleaned.

In addition to the Barren Island professional cleanup effort, GoAK will have teams of volunteers working along with our crew. Two 6-man contingents of Japanese volunteers will work in the field with the GoAK crew for two weeks each Other local volunteers will also join the cleanup team. They will assist cleanup efforts on northeast Montague Island and also on the Barren Island project. By using teams of volunteers for the Barren Islands project, we anticipate reducing the cleanup timeline by 6 days, from 80 days to 74 days, which will reduce crew costs However, after experiencing the difficult access conditions for cleanup crews on the northeast end of Montague Island, conditions which are very similar to those on the Barren Islands, GoAK decided a larger and faster crew boat is necessary to safely transport crew and volunteers in the Barren Islands Hence, the increase in vessel costs

GoAK will also take 8-10 volunteers and 3 donated vessels out for 7 days to re-clean 14 MD monitoring plots throughout PWS. Eight volunteers will also help clean 3 Gore Point monitoring beaches over a 6-day period. GoAK will also participate in an ongoing MD toxicity research project on Elizabeth Island at the southwest tip of the Kenai Peninsula. Three volunteers will spend two weeks traveling to and collecting samples from fish, water, and sediments in a coastal salmon rearing lake and outlet stream severely polluted by marine debris.

Barren Islands 2014 Project Charts

Projected 2014 marine debris cleanup area



Ushagat Island, Barren Islands

Heavy continuous MD deposits

Moderate to heavy continuous MD deposits

Heavy MD deposits in concentrated pockets

West and East Amatuli Islands, Barren Islands

Heavy continuous MD deposit

Heavy MD deposits in concentrated pockets

Barren Islands Cleanup FY 2014 Budget

Budget Category (e g personnel, supplies, contractual, etc)	EVOSTC Funds	Matching Contributions	Total Expense	Nature (cash or in-kind) And Source of Match
Personnel -CCF (public outreach) -Volunteer Cleanup -Volunteer Research	 1,500 00 0 00 0 00	 0 00 92,250 00 8,600 00	102,350 00	 Cash-EVOSTC In-kind-Volunteer labor In-kind-GoAK/UAA/WM labor
Travel -Volunteer transport	 0 00	 1,300 00	1,300 00	 In-kind-Volunteers
Equipment -Vol cleanup vessels -Super Sacks	 0 00 00 0	 103,000 00 5,250 00	108,250 00	 In-kind - vessel owners In-kind - GoAK
Supplies -Watermaker filters -Garbage bags -Volunteer food	 0 00	 500 00 900 00 5,120 00	6,520 00	 Cash-GoAK In-kind – ALPAR In-kind - volunteers
Contractual -Contract Crew - - -Work Vessels w/fuel -Debris Disposal -Liability Insurance -MD Monitoring leaders	 0 00 0 00 69,300 00 296,000 00 0 00 0 00 0 00	 150,000 00 2,700 00 0 00 0 00 13,000 00 8,000 00 3,500 00	542,500 00	 Cash–AK Legislature Cash–private donors Cash-EVOSTC Cash-EVOSTC Cash-private donors Cash-private donors Cash-Private donors
Accounting/Bookkeeping	0 00	2,000 00	2,000 00	Cash- GoAK
Total	366,800 00	396,120 00	762,920 00	

Barren Islands 2014 Removal Budget Narrative

Gulf of Alaska Keeper (GoAK) proposes to expend over a 74-day project a total of **$762,920** to remove marine debris from the Barren Islands coast. Of the total projected cost, **$366,800** would be from **EVOSTC** funds and **$396,120** from **matching** funds The matching funds would be comprised of a $150,000 Alaska Legislature marine debris grant, $27,200 in private donations, $2,500 cash from GoAK, and $216,420 of in-kind donations. For the past 6 years, GoAK's cash donations have averaged approximately $25,000 and in-kind donations $225,000 for marine debris projects in the oil spill footprint area

Personnel

In past years GoAK organized and conducted large volunteer cleanups in the Exxon oil spill footprint area, primarily in PWS and the Gore Point region Up to 100 volunteers with 12 vessels spent four days each season cleaning beaches Now that the more accessible beaches have been cleaned and only difficult remote shoreline remains to be cleaned, GoAK has turned to utilizing small groups of volunteers that work with our crew for up to two weeks each We will have volunteer groups with us through much of the 2014 season, two of them from Japan In addition, each summer, GoAK uses 8 volunteers and 3 vessels to re-clean 14 marine debris monitoring sites in PWS and 3 at Gore Point Volunteers and GoAK board members donate over 4500 hours to these projects annually, an in-kind donation worth **$92,250** GoAK and researchers from the University of Alaska Anchorage and the College of Williams and Mary will also donate 420 field hours, an in-kind donation worth **$8,610**, to a marine debris toxicity research project centered on Elizabeth Island during the summer of 2014 **$1,500** would be expended on CCF instructors for the CACS public outreach program

Travel

Volunteers for the different GoAK marine debris projects pay their own transportation costs to and from the project departure point. Volunteers also pay Whittier tunnel fees and parking fees where they join GoAK vessels, an in-kind donation of **$1,300** annually.

Equipment

In-kind donations

Total contractual costs include an in-kind **$88,000** donation of private vessel time and an in-kind **$15,000** donation of charter vessel time

The Barren Islands cleanup project will require that debris be loaded into Super Sacks so that a helicopter can sling the debris from the beach onto an offshore barge or landing craft GoAK will donate 350 Super Sacks to the project, an in-kind donation of **$5,250** All other marine debris tools and equipment will be provided by GoAK

Supplies

Water filtration supplies of **$500** will be purchased by GoAK Volunteers will provide their own food, an in-kind donation of **$5,120** ALPAR will donate **$900** worth of garbage bags

Contractual

Cash

In July 2013, GoAK received an Alaska Legislature grant of which **$150,000** will be used for the Barren Islands cleanup project The Alaska Legislature grant combined with the **$366,800** requested from EVOSTC and **$27,200** from private donors will pay for cleanup related insurance ($8,000), disposal costs ($13,000), pay for two individuals for 7 days to clean 14 marine debris monitoring beaches with 8 volunteers, collect the data and to produce the monitoring reports and analysis ($3,500), large vessel lease for 6 days to collect cached marine debris for disposal ($24,000); helicopter lease for two days to transfer debris from Barren Islands beaches to large vessel ($35,000), contract for 3 cleanup support vessels and 4 skiffs The support vessels include a 45-foot landing craft for moving crews to work sites and hauling debris, a 32-foot landing craft for collecting and transferring debris to collection sites, a 54-foot crew quarter vessel, and also 4 12-foot inflatable skiffs with outboards for beach access, garbage transfer, and crew transport (all with fuel for $4,000 per day for 74 days=$296,000), cost of contract crew of 10 people to clean beaches in the Barren Islands ($3000 per day for 74 days=$222,000).

Accounting/Bookkeeping

GoAK will pay an accountant **$2,000** to do the bookkeeping and accounting associated with this project.

Indirect, Management, Travel and Profit

There are no additional indirect, management, travel, or profit charges for the Barren Islands project.

Pigeon Guillemot

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NATIONAL FISH AND WILDLIFE FO
GRANT AGREEMENT

PROJECT: 0101.12.028373 (Seabird Restoration in Prince Willi

PROPOSAL ID: 28373

NFWF RECIPIENT: Northern Forum, Inc.

RECIPIENT TYPE: Non-profit Corporation

PERIOD OF PERFORMANCE: June 1, 2011 to December 30, 2016

PROJECT DESCRIPTION: Restore population of seabirds at Naked Island group, Prince William Sound, through eradication of introduced mink. Project will result in recovery of pigeon guillemots population and other seabirds.

NFWF AWARD: $1,050,300

FUNDING SOURCE	**CFDA NUMBER**
National Fish and Wildlife Foundation Non-Federal Funds	N/A

NON-FEDERAL MATCH REQUIREMENT: $1,397,300

FEDERAL MATCH REQUIREMENT: N/A

The National Fish and Wildlife Foundation (NFWF) agrees to provide the NFWF Award to the NFWF Recipient for the purposes of satisfactorily performing the Project described in a full proposal titled "Seabird Restoration in Prince William Sound (AK)" and incorporated into this grant agreement by reference. The NFWF Award is provided on the condition that the NFWF Recipient agrees that it will raise and spend at least $1,397,300 in matching contributions on the Project. Project must be completed, with all NFWF funds and matching contributions spent, during the Period of Performance as set forth above.

NATIONAL FISH AND WILDLIFE FOUNDATION
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NFWF RECIPIENT CONTACT INFORMATION

Recipient Name:	Priscilla Wohl
Recipient Address:	716 West 4th Avenue, Suite 100 Anchorage, AK 99501
Recipient Phone:	907-561-3280
Recipient Fax:	907-561-6645
Recipient Email:	pwohl@northernforum.org

NFWF CONTACT INFORMATION

NFWF Grants Administrator:	Michelle Olson
NFWF Address:	1133 Fifteenth Street, NW Suite 1100 Washington, DC 20005
NFWF Phone:	202-857-0166
NFWF Fax:	202-857-0162
NFWF Email:	michelle.olson@nfwf.org

NFWF PROCESS

Matching Contributions.

Matching Contributions consist of cash, contributed goods and services, volunteer hours, and/or property raised and spent for the Project. Matching Contributions for the purposes of this Project must meet the following three criteria: 1) Matching Contributions must be non-federal in nature and not presented as match to any other federal program(s), 2) Matching Contributions must be committed directly to the Project and must be used within the Period of Performance as identified on page 1 of this grant agreement, and 3) Matching Contributions must be voluntary in nature. Funds presented for fulfillment of mitigation, restitution, or other permit or court-ordered settlements are not eligible

Documentation of Matching Contributions.

1 Cash, Goods and Services, and/or Property The NFWF Recipient must report to NFWF as a part of the final report, the Matching Contributions received by the NFWF Recipient and expended in connection with the Project. The match report must include the name and address and contribution amount of any donor who contributes $500 or more to the Project. Fair market value of donated goods and services, including volunteer hours, shall be computed as outlined in the OMB Circulars

2. Property. The NFWF Recipient may have a third party donor submit a letter to NFWF, documenting the fair market value and date of a Matching Contribution and stating that the donation is non-Federal, voluntary, and intended to qualify as a Matching Contribution. A letter provided to document a donation of real property must be accompanied by an appraisal by a certified appraiser; a letter provided to document rental of equipment or space must list three comparable rentals in the location of the Project.

The NFWF Recipient must retain detailed time records for contributed services and original receipts and appraisals of real property and comparable rentals for other contributed property at its place of business in the event of an audit of the NFWF Recipient as required by applicable Federal regulations.

Restrictions on Use of Funds.

No Funds provided by NFWF pursuant to this grant agreement or Matching Contributions may be used to support overhead/indirect costs, litigation expenses, lobbying activities, terrorist activities, or activities in violation of the Foreign Corrupt Practices Act

Payment of Funds.

To receive funds, the NFWF Recipient must provide NFWF with: 1) an original executed copy of the grant agreement, 2) a Payment Request from the NFWF Recipient requesting payment; and 3) any required financial and programmatic reports Failure to provide information required by this grant agreement may delay payment. NFWF Recipient may request funds by submitting a Payment Request to the NFWF Grants Administrator via email, mail, or fax. NFWF Recipient may request advance payment of funds prior to expenditure provided: 1) NFWF Recipient demonstrates an immediate need for advance payment; and 2) NFWF Recipient documents expenditure of advanced funds on the next required financial report to NFWF. Approval of any advance payment of funds is made at the sole discretion of NFWF, based on an assessment of the NFWF Recipient's needs. In all other cases, funds are disbursed on a reimbursable basis. NFWF reserves the right to retain up to twenty percent (20%) of funds until submission and acceptance of the final reports.

Interim Programmatic Reports
The NFWF Recipient will submit an interim programmatic report to NFWF based on the reporting schedule below The interim programmatic report shall consist of written statements of Project accomplishments since Project initiation, or since the last reporting period, and shall be uploaded via NFWF's Easygrants system.

Annual Financial Report.
An annual financial report detailing cumulative receipts and expenditures made under this Project is required annually, due on October 31st of each year of the grant term. In the annual financial report, the NFWF Recipient must report the amount of NFWF Funds expended during NFWF's fiscal year (October 1 – September 30). The NFWF Recipient must enter a justification when there is a difference between the amount disbursed by NFWF and the amount expended by the grantee. Failure to submit an annual financial report in a timely manner will delay payment of submitted payment requests

Final Reports
No later than 90 days after the completion of the Project, the NFWF Recipient will submit 1) a final financial report accounting for all Project receipts, Project expenditures, and budget variances (if any) compared to the approved budget; 2) a final programmatic report summarizing and evaluating the accomplishments achieved during the Period of Performance; 3) a representative number of photographs depicting the Project; and 4) copies of any publications, press releases and other appropriate products resulting from the Project. The final reports should be uploaded via NFWF's Easygrants system. Any requests for extensions of the final report submission date must be made in writing to the NFWF Grants Administrator and approved by NFWF in advance.

Reporting Due Dates.

June 1, 2012	Interim Programmatic Report
October 31, 2012	Annual Financial Report
June 1, 2013	Interim Programmatic Report
October 31, 2013	Annual Financial Report
June 1, 2014	Interim Programmatic Report
October 31, 2014	Annual Financial Report
June 1, 2015	Interim Programmatic Report
October 31, 2015	Annual Financial Report
June 1, 2016	Interim Programmatic Report
October 31, 2016	Annual Financial Report
March 30, 2017	Final Programmatic Report
March 30, 2017	Final Financial Report

Amendments.
During the life of the Project, the NFWF Recipient is required to inform the NFWF Grants Administrator of any changes in contact information or in the Project scope of work, as well as any difficulties in completing the Project by the end of the Period of Performance, or in submitting reports by their due dates. If the NFWF Recipient determines that the amount of the budget is going to change in any one budget category by an amount that exceeds 10% of the Award, the NFWF Recipient must seek approval from the Grants Administrator. Amendment requests should be initiated by the NFWF Recipient upon determination of a deviation from the original grant agreement. However, NFWF may initiate the amendment if NFWF determines an amendment is necessary. Amendment requests are to be submitted via NFWF's Easygrants system.

Termination.
Failure by the NFWF Recipient to comply with any material term of this grant agreement shall be deemed to be a default in this grant agreement and constitute cause for NFWF to terminate this grant agreement by written notice to the NFWF Recipient and to pursue any legal remedy to which NFWF may be entitled

The NFWF Recipient may terminate this grant agreement by written notice to NFWF. In the event of termination of this grant agreement prior to Project completion, the NFWF Recipient shall immediately (unless otherwise directed by NFWF in its notice if NFWF initiated the termination) undertake all reasonable steps to wind down the Project cooperatively with NFWF, including but not limited to the following:

a. Stop any portion of the Project's work that is incomplete (unless work to be completed and a different date for termination of work are specified in NFWF's notice)
b Place no further work orders or enter into any further subawards or subcontracts for materials, services or facilities, except as necessary to complete work as specified in NFWF's notice.
c. Terminate all pending Project work orders, subawards, and subcontracts for work that has not yet commenced.
d With the prior written consent of NFWF, promptly take all other reasonable and feasible steps to minimize and/or mitigate any damages that may be caused by the failure to complete the Project, including but not limited to reasonable settlements of any outstanding claims arising out of termination of Project work orders, subawards, and subcontracts
e. Deliver or make available to NFWF all data, drawings, specifications, reports, estimates, summaries, and such other information and material as may have been accumulated by the NFWF Recipient under this grant agreement, whether completed or in progress
f. Return to NFWF any unobligated portion of the Award.

REPRESENTATIONS, CERTIFICATIONS, AND OTHER STATEMENTS GENERAL

Binding Obligation.
This grant agreement has been duly executed by a representative of the NFWF Recipient with full authority to execute this grant agreement and bind the grant agreement to the terms hereof. After execution by the representative of the NFWF Recipient named on the signature page hereto, this grant agreement will represent the legal, valid, and binding obligation of the NFWF Recipient, enforceable against the NFWF Recipient in accordance with its terms.

Assignment; Subawards and Subcontracts.
The NFWF Recipient may not assign this grant agreement, in whole or in part, to any other individual or other legal entity without the prior written approval of NFWF. The NFWF Recipient may not provide subawards nor enter into subcontracts without the prior written approval of NFWF Subawards and subcontracts with known parties disclosed in the proposal budget are deemed to be approved.

Unexpended Funds
Any funds provided by NFWF and held by the NFWF Recipient and not expended at the end of the Period of Performance will be returned to NFWF within ninety (90) days after the end of the Period of Performance

Additional Support.
In making this Award, NFWF assumes no obligation to provide further funding or support to the NFWF Recipient beyond the terms stated in this grant agreement

Publicity and Acknowledgement of Support.
The NFWF Recipient agrees to give appropriate credit to NFWF and any Funding Sources identified in this grant agreement for their financial support in any and all press releases, publications, annual reports, video credits, dedications, and other public communications regarding this grant agreement or any of the project deliverables associated with this grant agreement. The NFWF Recipient must obtain prior NFWF approval for the use of the NFWF logo and any public information releases concerning this Award.

Posting of Final Reports
The NFWF Recipient gives NFWF the right and authority to publicize NFWF's financial support for this grant agreement and the Project in press releases, publications and other public communications. The NFWF Recipient hereby acknowledges its consent for NFWF and any Funding Source identified in this grant agreement to post its final reports on their respective websites. In the event that the NFWF Recipient intends to claim that its final report contains material that does not have to be posted on such websites because it is protected from disclosure by statutory or regulatory provisions, the NFWF Recipient shall so notify NFWF and any Funding Source identified in this grant agreement and

clearly mark all such potentially protected materials as "PROTECTED," providing an accurate and complete citation to the statutory or regulatory source for such protection.

Website Links

The NFWF Recipient agrees to permit NFWF to post a link on any or all of NFWF's websites to any websites created by the NFWF Recipient in connection with the Project.

Evaluation.

The NFWF Recipient agrees to cooperate with NFWF by providing timely responses to all reasonable requests for information to assist in evaluating the accomplishments of the Project for a period of five (5) years after the date on which the final financial and programmatic reports are provided.

Arbitration.

All claims, disputes, and other matters in question arising out of, or relating to this grant agreement, its interpretation or breach, shall be decided through arbitration by a person or persons mutually acceptable to both NFWF and the NFWF Recipient. Notice of the demand for arbitration shall be made within a reasonable time after the claim, dispute, or other matter in question has arisen. The award rendered by the arbitrator or arbitrators shall be final. The terms of this provision will survive termination of this grant agreement.

Indemnity.

The NFWF Recipient shall indemnify and hold harmless NFWF, any Funding Source identified in this grant agreement, their respective officers, directors, agents, and employees in respect of any and all claims, injuries, losses, diminution in value, damages, liabilities, whether or not currently due, and expenses including without limitation, settlement costs and any legal or other expenses for investigating or defending any actions or threatened actions arising from or in connection with the Project. The terms of this provision will survive termination of this grant agreement

Choice of Law/Jurisdiction

This grant agreement shall be subject to and interpreted by the laws of the District of Columbia, without regard to choice of law principles. By entering into this grant agreement, the NFWF Recipient agrees to submit to the jurisdiction of the courts of the District of Columbia. The terms of this provision will survive termination of this grant agreement.

Compliance with Laws.

In conducting its activities relating to the Project, the NFWF Recipient agrees to conduct all such activities in compliance with all applicable Federal, State, and local laws, regulations, and ordinances and to secure all appropriate necessary public or private permits and consents. The terms of this provision will survive termination of this grant agreement.

Insurance.

The NFWF Recipient agrees to obtain and maintain all appropriate insurance against liability for injury to persons or property from any and all activities undertaken by the NFWF Recipient and associated with this Award in any way The terms of this provision will survive termination of this grant agreement.

REPRESENTATIONS, CERTIFICATIONS, AND OTHER STATEMENTS RELATING TO FEDERAL FUNDS

The NFWF Recipient must read and understand certain Federal regulations, including but not limited to, those identified below which may be located on the Internet at <www.whitehouse.gov/omb/circulars/index html>. If a NFWF Recipient does not have access to the Internet, it should ask its NFWF Grants Administrator for copies Many Federal agencies have agency-specific regulations that govern the issuance of awards and subawards with their funds; it is the obligation of the NFWF Recipient to review and comply with any such regulations issued by its Federal agency Funding Source(s).

If the NFWF Recipient is a non-profit organization, it will need to understand and comply with (i) OMB Circular A-110 "Uniform Administrative Requirements for Grants and Agreements With Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations" and, (ii) depending on what kind of organization it is, either (a) OMB Circular A-21 "Cost Principles for Educational Institutions" or (b) OMB Circular A-122 "Cost Principles for Non-Profit Organizations," in addition to other applicable Federal regulations.

If the NFWF Recipient is a State, Local or Tribal Government, it will need to understand and comply with OMB Circulars A-102 "Grants and Cooperative Agreements with State and Local Governments" and A-87 "Cost Principles for State, Local, and Indian Tribal Governments," in addition to other applicable Federal regulations

A-133 Audits.

If the NFWF Recipient is any type of U.S organization and it expends an aggregate of $500,000 or more from all Federal sources in a fiscal year, it is subject to a special kind of audit as detailed in OMB Circular A-133 "Audits of States, Local Governments, and Non-Profit Organizations," which it will need to understand and comply with, in addition to other applicable Federal regulations

Interest

Any interest earned in any one year on Federal funds advanced to the NFWF Recipient that exceeds $250 must be reported to NFWF, and the disposition of those funds negotiated with NFWF.

Subcontractor Lobbying.
The NFWF Recipient agrees, to the best of his or her knowledge and belief, that:
a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement
b. If any funds other than Federal appropriated funds have been paid or will be paid to any person influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
c. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly

Subcontractor Debarment and Suspensions.
The NFWF Recipient shall enter into no contract or subcontract using Federal funds provided by NFWF with any party listed on the General Services Administration's Lists of Parties Excluded from Federal Procurement or Nonprocurement Programs in accordance with Executive Orders 12549 and 12689 (Debarment and Suspension).

Disclaimers.
Payments made to the NFWF Recipient under this grant agreement do not by direct reference or implication convey NFWF's endorsement nor the endorsement by any other entity that provides funds to the NFWF Recipient through this grant agreement, including the U.S. Government, for the Project. All information submitted for publication or other public releases of information regarding this grant agreement shall carry the following disclaimer:

"The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government or the National Fish and Wildlife Foundation."

Davis-Bacon Act.
If applicable to the Project, the NFWF Recipient shall be subject to the provisions of the Davis-Bacon Act (40 U.S.C. 276a to a-7) as supplemented by Department of Labor regulations (29 CFR part 5, "Labor Standards Provision Applicable to Contracts Governing Federally Financed and Assisted Construction").

Rights to Inventions.

If applicable to the Project, the NFWF Recipient shall abide by the provisions of 37 CFR Part 401 (Rights to Inventions Made by Non-Profit Organizations and Small Business Firms Under Government Grants, Contracts, and Cooperative Agreements) and any implementing regulations issued by the Federal agency(ies) that provide funds for this grant agreement.

SIGNATURES

IN WITNESS WHEREOF, the parties have executed this grant agreement, intending to be bound legally.

National Fish and Wildlife Foundation

____

Gerry Vans
Vice President, Operations

____

(Date)

Northern Forum, Inc.

________________________________ ________________________________

(Signature) (Name and Title)

____

(Date)

FINAL ENVIRONMENTAL ASSESSMENT
DECISION NOTICE
FINDING OF NO SIGNIFICANT IMPACT

POTENTIAL RECOVERY OF PIGEON GUILLEMOT POPULATIONS

NAKED ISLAND GROUP, PRINCE WILLIAM SOUND,

CHUGACH NATIONAL FOREST, ALASKA

October 2013

Prepared by:

U.S. Fish and Wildlife Service

U.S. Forest Service,
Chugach National Forest

U.S. Animal and Plant Health Inspection Service
Wildlife Services

GAP Solutions, Inc.

For:

The *Exxon Valdez* Oil Spill Trustee Council

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PREFACE

This document represents the Final Environmental Assessment, Decision Notice, and Finding of No Significant Impact for evaluating the potential for recovering the pigeon guillemot (*Cepphus columba*) population at the Naked Island group, Prince William Sound, Chugach National Forest, Alaska. It is important to restore the pigeon guillemot population at the Naked Island group as it was the most important breeding location in Prince William Sound. American mink (*Neovision vision*) are the primary predator responsible for the decline in the pigeon guillemot population at the Naked Island group. Control of predatory mink is feasible and will restore pigeon guillemot populations. Environmental impacts of predatory mink control are not significant. The public and other interested parties provided their comments and ideas during public scoping and at the draft Environmental Assessment phase. Alternative B: Proposed Action-Control of Predatory Mink was selected as the preferred alternative. By implementing the preferred alternative, the pigeon guillemot population will be restored 20 years after project initiation.

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

On March 24, 1989, the oil tanker Exxon Valdez ran aground at Bligh Reef resulting in the release of at least 44 million liters of Prudhoe Bay crude oil into Prince William Sound (PWS; Figure 1). Oil spread to the southwest through the PWS and into the northern Gulf of Alaska. An estimated 500 to 1,500 pigeon guillemot (*Cepphus columba*) in PWS were immediately killed due to oil exposure (Piatt and Ford 1996). Ten to 15 percent of the pigeon guillemot population within the entire spill area, an estimated 2,000 to 6,000 birds, died from acute oiling (EVOSTC 2010). The Naked Island group (Naked, Storey, and Peak islands), located within PWS (Figure 1) were one of the first areas to be oiled (Oakley and Kuletz 1994). Evidence indicates that pigeon guillemot were exposed to and negatively affected by residual oil for at least a decade after the spill (Golet et al. 2002). By 2004 there was no longer an indication of pigeon guillemot exposure to residual oil from the Exxon Valdez Oil Spill (EVOS; Bixler 2010).

As a result of the Exxon Valdez Oil Spill (EVOS), the State of Alaska, the federal government, and Exxon Corporation entered into "the Agreement and Consent Decree (Consent Decree), as approved by the court on October 8, 1991 (A91-082-CIV)", to ensure restoration of injured resources and resources dependent services due to the oil spill The Consent Decree provided that money paid to the Governments would only be used for certain purposes, which included to "plan, implement, and monitor the restoration, rehabilitation, or replacement of Natural Resources, natural resources services,...injured as a result of the Oil Spill..." The EVOS Trustee Council established a list of resources that suffered population-level injuries due to the spill and developed specific, measurable recovery objectives for each injured species. The pigeon guillemot is on that list. Studies were completed in 2010 (see Most Recent Research and Studies section, Chapter 1) to address the lack of population recovery of pigeon guillemot.

The Naked Island group is particularly important because it was historically the main pigeon guillemot breeding location in PWS (Sanger and Cody 1994). One fourth of all pigeon guillemot nests in PWS in 1989 (just after the spill) were located at the Naked Island group, although the islands constitute only about two percent of the total shoreline in PWS (Bixler et al. 2010). Restoration of pigeon guillemot at the Naked Island group to the 1989 levels could result in a substantial PWS-wide population increase. The Naked Island group is also the site where researchers and managers have the most information and have investigated mechanisms regulating pigeon guillemot populations in PWS. Data on population size, nesting success, and diet of pigeon guillemot has been collected at the Naked Island group for 15 years between 1978 and 2008.

Predation by American mink (*Neovison vison*) (hereafter referred to as mink) appears to be the primary factor limiting pigeon guillemot population recovery at the Naked Island group (Irons et al. 2013). Mink predation on eggs and chicks in nests and adults combined with the decline due to EVOS has likely suppressed pigeon guillemot populations at the Naked Island group. Other seabirds have also been affected. Parakeet auklets (*Aethia psittacula*), tufted puffins (*Fratercula cirrhata*), and horned puffin (*Fratercula corniculata*) declined from about 1,400 breeding birds to approximately twelve (Bixler 2010). Prior to the EVOS the Naked Island group supported the highest number of nesting pairs of parakeet auklet in PWS

Available evidence and modeling indicate that reducing mink predation on eggs, chicks and adults would result in a measureable increase in the breeding population and productivity of pigeon guillemot.

To assess potential methodologies for recovery of pigeon guillemot within the oil spill area, the EVOS Trustee Council authorized Project 11100853, *Pigeon Guillemot Restoration Research in PWS; providing an opportunity to restore the population of pigeon guillemot at the Naked Island group* Preparation of this Environmental Assessment (EA) represents the first phase of implementing Project 11100853. The EVOS Trustee Council, comprised of three state and three federal trustees, has provided funding for this EA. Once a preferred alternative is selected with potential funding partners, the EVOS Trustee Council and the National Fish and Wildlife Foundation would review the project for implementation funding.

PURPOSE OF ACTION

The purpose of the action is to remove pigeon guillemot from the EVOS Trustee Council "not recovering" list by restoring the current ≤100 pigeon guillemot population at the Naked Island group (Irons pers. comm.) to the 1,000 adult/breeding birds observed after the 1989 EVOS. Recovery at the Naked Island group would effectively recover pigeon guillemot in PWS.

Mink are the primary predator responsible for pigeon guillemot declines at the Naked Island group and Alternative B: Proposed Action-Control of Predatory Mink (Chapter 2) requires a mink population reduction. Progress toward the recovery of pigeon guillemot, as defined by the EVOS Trustee Council, is expected to be measureable three years after project initiation. Recovery is anticipated to be slow during initial implementation of the Proposed Action, as pigeon guillemot recruited into the population requires three to four years to become sexually mature and adults may not breed each year (De Santo and Nelson 1995). Initial signs of recovery would be recognized by observing sustained or increasing pigeon guillemot productivity from current levels and an increase in the number of nesting birds. Productivity is defined as the number of young pigeon guillemot produced yearly from each nest (Table 1). It is anticipated that pigeon guillemot populations would be "recovered" in approximately 15 years after mink reduction has been completed (five years).

The EVOS Trustee Council has three definitions for the status of injured species: "not recovering", "recovering", and "recovered" (EVOSC 2010).

- Not Recovering: Resources that are "Not Recovering" continue to show little or no clear improvement from injuries stemming from the oil spill. Recovery objectives have not been met. Pigeon guillemot numbers at the Naked Island group are ≤100 adult/breeding birds (2013) compared to 1,000 birds in 1989 after the EVOS.

- Recovering: Recovering resources are demonstrating substantive progress toward recovery objectives, but are still adversely affected by residual impacts of the spill or are currently being exposed to lingering oil. When productivity at the Naked Island group is sustained or increasing from 0.5 chick/nest surviving, pigeon guillemot would be considered "recovering", as stipulated by the EVOS Restoration Plan 2010 Update Injured Resources and Services.
- Recovered: Recovery objectives have been met, and the current condition of the resource is not related to residual effects of the oil spill. Pigeon guillemot would be considered "recovered" when 1,000 adult/breeding birds are present at the Naked Island group, a number comparable to the 1,000 adult/breeding birds observed after the 1989 EVOS. The PWS pigeon guillemot population would also be "recovered" when the total population at the Naked Island group has reached 1,000 adult/breeding birds.

Table 1. Expected Results for Proposed Action-Control of Predatory Mink and No Action-Current Management Alternatives. (Modeling utilized a base of 100 adult/breeding birds as an initial starting point.)

Timeline* (following project initiation)	Pigeon Guillemot Status*	
	Proposed Action – Control of Predatory Mink	No Action-Current Management
Year 1 (2014)	*Not Recovering* (~100 adult/breeding birds compared to ~1,000 adult/breeding birds in 1989)	*Not Recovering* (~100 adult adult/breeding birds) compared to ~1,000 adult/breeding birds in 1989
Year 3 (2017)	*Recovering* Chick productivity increases to 0.5 chicks and adult/breeding birds increase up to 10% from ~100 (baseline) to ~110 observed three years after project initiation	*Not Recovering* Chick productivity of <0.5 chicks/nest static or declining and adult/breeding birds declining from the ~100 (baseline) to ~70
Year 5 (2019) Note: Corresponds to completion of mink reduction.	*Recovering* Chick productivity remains at 0.5 chicks/nest or higher and adult/breeding birds increase to 10-30% from ~100 (baseline) to ~110 to ~130	*Not Recovering* Chick productivity of <0.5 chicks/nest and adult/breeding birds declining to ~55
Year 10 (2024)	*Recovering* Chick productivity remains at 0.5 chicks/nest or higher and adult/breeding birds increase to 250 or more	*Not Recovering* Chick productivity of <0.5 chicks/nest and adult/breeding birds declining to ~30
Year 15 (2029)	*Recovering* Chick productivity remains at 0.5 chicks/nest or higher and adult/breeding birds increase to 500 or more	*Not Recovering* Chick productivity of <0.5 chicks/nest and adult/breeding birds declining to ~30
Year 20 (2034)	*Recovered* Chick productivity remains at 0.5 chicks/nest or higher and adult/breeding birds increase to 1,000 or more	*Not Recovering* Chick productivity of <0.5 chicks/nest and adult/breeding birds decline to ~18

*Timeline and milestones for observing "not recovering", "recovering", and "recovered" pigeon guillemot status as defined by the EVOS Restoration Plan 2010 Updated Injured Resources

NEED FOR ACTION

The number of pigeon guillemot breeding at the Naked Island group has declined from approximately 1,000 adult/breeding birds pre-EVOS in 1989 to about 100 post-EVOS in 2008; a 90 percent decline (Bixler et al. 2010). Other PWS pigeon guillemot populations, excluding the Naked Island group, declined 22 percent during the same period (Irons et al. 2013; Bixler et al. 2010). The Naked Island group had 47.8 pigeon guillemot observed per kilometer of shoreline in 1990 and 0.96 in 2008 (Bixler et al. 2010, Irons et al.2013).

Pigeon guillemot is the only marine bird species listed as "not recovering" on the EVOS Trustee Council's Injured Resources List, and shows no indication of population recovery. An EVOS Trustee Council objective is to pursue alternatives to actively shift the population status toward full recovery. Research and several studies to address the lack of population recovery of pigeon guillemot were completed in 2010. Pigeon guillemot recovery would allow the EVOS Trustee Council to remove this bird from its "not recovering" list and added to the "recovering" list and eventually to the "recovered" list.

The primary limiting factor for pigeon guillemot recovery at the Naked Island group appears to be mink predation (Irons et al. 2013). Reduction of mink is critical to the success for "recovering" pigeon guillemot at the Naked Island group and in PWS.

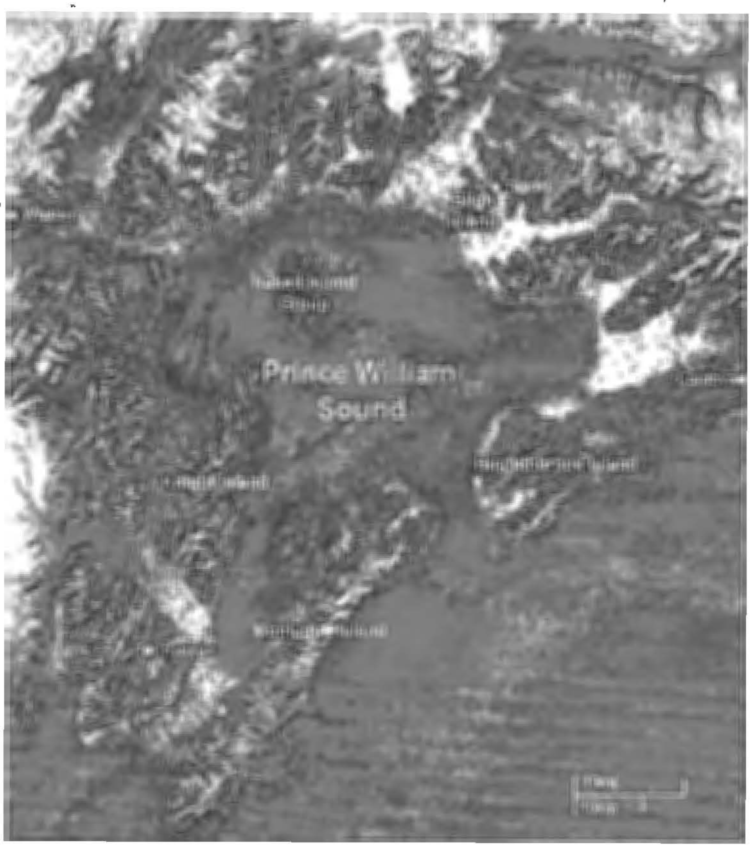


Figure 1. Prince William Sound, Alaska.

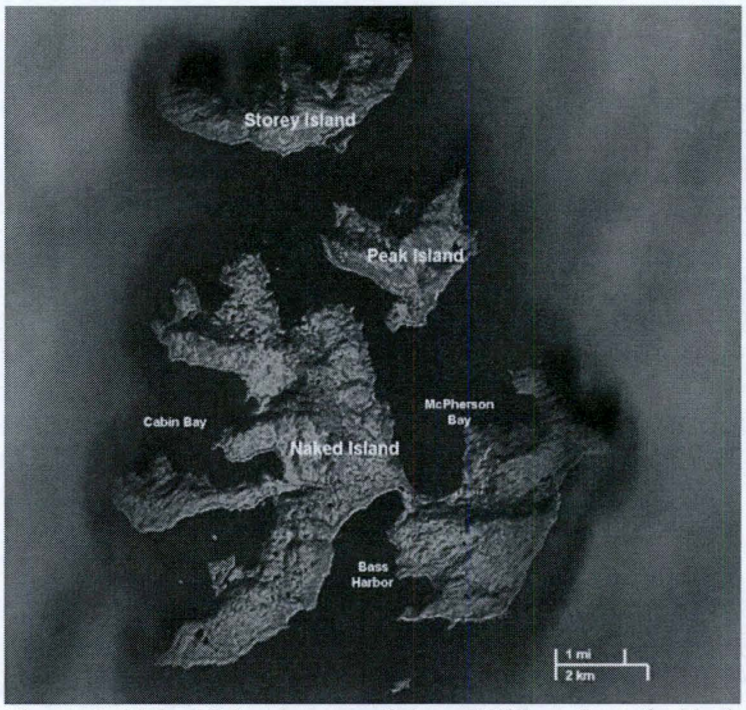


Figure 2. Naked Island group, Prince William Sound, Alaska.

BACKGROUND

Importance of Naked Island group

The Naked Island group was one of the most important historical breeding and rearing locations for seabirds in PWS (Bixler et al. 2010). From the early 1970s until the EVOS in 1989, the Naked Island group supported some of the highest densities of breeding pigeon guillemot (93.2 birds/km^2) as well as parakeet auklet (23.8 birds/km^2), tufted puffin (39.2 birds/km^2), and horned puffin (6.0 birds/km^2) on approximately 100 km of shoreline as compared with the remainder of PWS, which encompasses approximately 5,000 km of shoreline (Isleib and Kessel 1973; Table 2). While the purpose of the Proposed Action is the recovery of pigeon guillemot, it is important to understand the benefit to other seabirds as a result of removing predation by mink.

Table 2. Seabird densities of randomly selected transects at the Naked Island group (NIG) and Prince William Sound (PWS).

Period or Year	Pigeon Guillemot birds/km^2		Parakeet Auklet birds/km^2		Tufted Puffin birds/km^2		Horned Puffin birds/km^2	
	NIG	PWS	NIG	PWS	NIG	PWS	NIG	PWS
1970's *	93.2	15.5	23.8	1.9	39.2	9.6	6.0	3.6
1990 *	34.4	1.78	5.1	0	59.0	0.2	3.2	0.1
1998*	27.3	1.74	8.4	0	37.6	0.4	3.0	0.2
2010*	2.6	1.51	0	0	0	0.1	0	0.1

*Dywer et al. 1976, Oakley and Kultez 1979, and Cushing et al.2012

Population Decline

Declines in numbers of pigeon guillemot at the Naked Island group were concurrent with the onset of sightings of and predation by mink. No predation of pigeon guillemot nests was observed in 1978, but by the late 1990's at least 60 percent of pigeon guillemot nests and 10 percent of adult/breeding pigeon guillemot were depredated by mink (Irons et al. 2013, Bixler 2010, and Bixler et al. 2010). Mink were identified as a predator of pigeon guillemot at the Naked Island group by:

- snaring mink entering pigeon guillemot nest cavities (Irons et al. 2013).
- confirmation that bite wounds were the cause of chick death and that these wounds were consistent with the inter-canine width of mink (generally nine to11 mm) (Irons et al. 2013).
- identification that the method of death is consistent with mink predation, i.e., bite wounds on the head and neck, decapitation of the bird, and caching of carcasses (Irons et al. 2013).

Pigeon guillemot, like many other seabirds, produces few offspring and their populations are sensitive to even small decreases in adult survival. The rate of egg and chick predation increased during the 1990s and caused the majority of nest failures during this period. By 1998, at least 60% of monitored guillemot nests and 4.5% of breeding adults at those nests were killed by mink (Bixler et al 2010).

Aside from river otter (*Lontra canadensis*) and mink, no other mammalian predators including American marten (*Martes americana*) and weasel (*Mustela ssp.*) have been documented on the islands, despite extensive trapping efforts. River otter have been documented on the islands since at least 1908 (Heller 1910) and have been known to depredate a limited number of pigeon guillemot nests (Oakley and Kuletz 1979, Ewins 1993, Hayes 1995, Oakley and Kuletz 1996).

River otter access nests by digging into them and the disturbance is obvious and easily distinguishable from mink. No such disturbance was detected in depredated nests since 1989, suggesting that the recent observed predation events can only be attributed to mink (Bixler et al. 2010).

Other predators of pigeon guillemot exist. Corvids have been observed in the vicinity of pigeon guillemot nests at the Naked Island group, but have not been observed entering a nest cavity (Irons et al. 2013). A few adult pigeon guillemot beaks have been found in bald eagle (*Haliaeetus leucocephalus*) nests, but bald eagles cannot access the pigeon guillemot nest cavity (Oakley and Kuletz 1979, Hayes 1995, Oakley and Kuletz 1996).

Pigeon guillemot nest in talus and rock crevices and are susceptible to ground based predation. Mink are the only known ground-based predator occurring at the Naked Island group, except for river otter. Little predation of seabirds by river otter has been observed at the Naked Island group (Irons, pers. obs.).

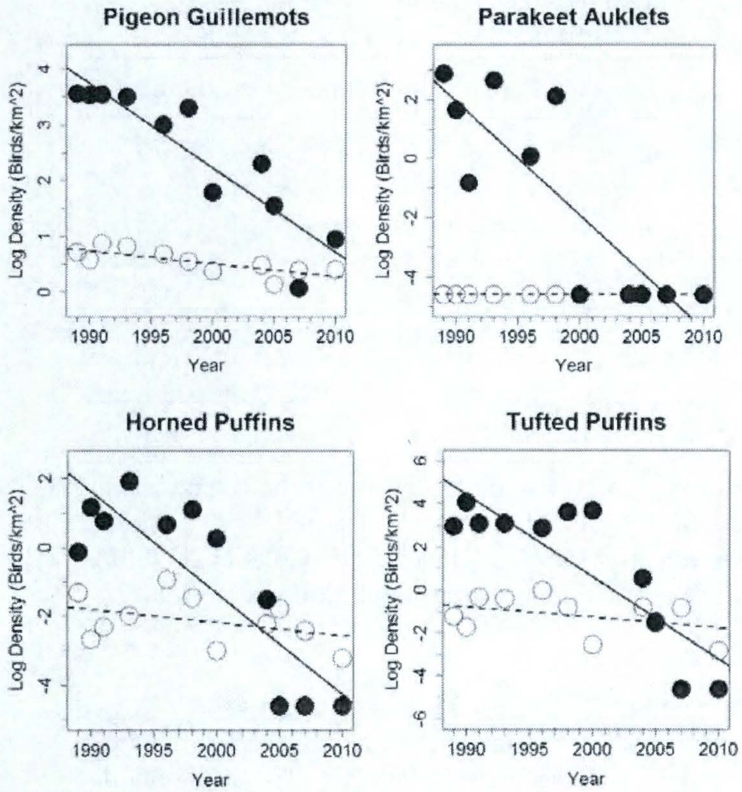
Mink and Seabird Populations

In 1978 when little pigeon guillemot predation by mink occurred at the Naked Island group, birds nested mainly in three different habitats: crevices on cliff faces; overhanging soil at a cliff top, and under boulders at the base of a cliff, or amidst rocks on a cliff edge. Mink could access most nests in overhanging soil at a cliff top and nests under boulders at the cliff base or amidst rocks on a cliff ledge, but mink were not able to access crevice or cliff face nests easily. Most nests in the habitat easily accessible to mink were gone by 2008 and remaining nests occurred in habitat difficult for mink to access (Table 3.). These results provide evidence that mink predation is responsible for the pigeon guillemot decline at the Naked Island group.

While recovering pigeon guillemot is the purpose of the Proposed Action, it is important to show the benefit to other seabirds as a result of removing predatory mink from the Naked Island group. By comparing trends in seabird numbers susceptible to mink predation, those nesting trends in seabirds not susceptible to mink predation at the Naked Island group and the rest of PWS, indicate that an increase in mink likely caused pigeon guillemot and other seabirds to decline.

Densities of seabirds susceptible to mink predation were much higher in 1989 at the Naked Island group than in the rest of PWS. From 1989 to 2008 the seabird densities declined sharply at the Naked Island group, while declining only slightly in the rest of PWS (Figure 3). Initial densities and trends in densities of seabirds not susceptible to mink predation are similar at the Naked Island group and the rest of PWS (Cushing et al. 2012, Cushing unpubl. data). These data support the premise that in 1989, few mink were at the Naked Island group compared to the rest of PWS and mink numbers increased over the next several years at Naked Island group, but changed little in the rest of PWS. Likewise, the increase in mink caused pigeon guillemot and other bird species (whose nests are susceptible to mink predation) to decline significantly at the Naked Island group as compared to the birds in the rest of PWS.

Species With Nests Susceptible to Mink Predation



Species With Nests Not Susceptible to Mink Predation

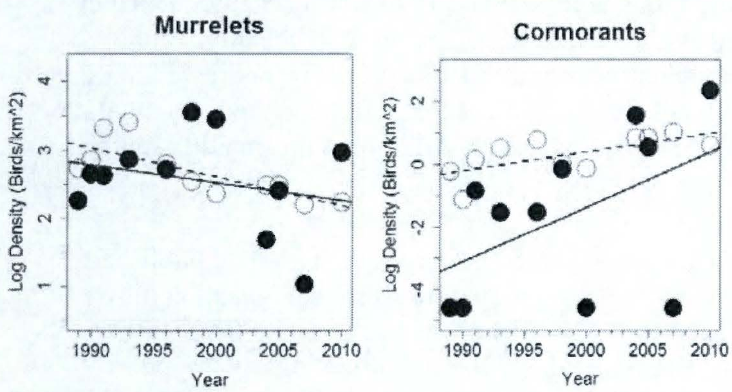


Figure 3. Comparison of population trends from 1989 to 2010 for species of fish-eating seabirds, with nests are susceptible to mink predation, and with nests are not susceptible to mink predation at the Naked Island group (filled circles) and the remainder of PWS (open circles). Data are from EVOS Trustee Council-funded, PWS-wide surveys of a random sample of 25 percent of the shoreline transects. (Note: negative values on the natural log scale indicate that densities were less than one bird/km^2 (Cushing et al. 2012).

Table 3. Number and percent of active pigeon guillemot nests in different nest site types at the Naked Island group, Prince William Sound, Alaska in 1978 and 2008.*

Year	1978		2008	
Nest Type	Number	Percent	Number	Percent
In a crevice on a cliff face	52	35.6	15	88.2
In overhanging soil at a cliff top	58	39.7	2	11.8
Under boulders at the base of a cliff or amidst rocks on a cliff ledge	36	24.7	0	0.0
Total	146	100.0	17	100.0

*Reproduced from Bixler et al (2010)

Mink predation was not a recorded cause of pigeon guillemot nest failure at the Naked Island group during studies in the late 1970's and early 1980's. However, by the mid-1990's mink predation on pigeon guillemot nests was frequently recorded (Hayes 1995, Golet et al 2002). The population of pigeon guillemot has declined at a dramatic rate, and mink are the major reason for this population decline.

Mink are native to the Gulf of Alaska ecoregion (ADF&G 2006). Genetic analysis of populations in PWS (Fleming and Cook 2012) indicates mink at the Naked Island group are of the same or very close lineage to mink found in PWS. Fleming and Cook (2010) also regarded the Knight Island Archipelago, as the primary source of mink at the Naked Island group. Neither mink nor their predation was noted until mid-1990, although studies of pigeon guillemot were ongoing at the Naked Island group since the late 1970's (Hayes 1995, Golet et al 2002). As definitive data are not conclusive, ADF&G considers mink to be native to the Naked Island group. Whether or not mink are native or introduced will not be addressed in this EA. However, what is clear is that the population of pigeon guillemot has declined at a dramatic rate, and mink are the major reason for this population decline. Additional information can be found at Irons et al. (2013).

Theoretical projections of the mink population at the Naked Island group, based on published values on reproduction and survival in other systems, suggested that mink colonization most likely preceded the EVOS and may have been followed by a decline as a result of the spill, although no study was done to confirm this (Ben-David 2012a, b). Simulations also support the hypothesis that a recovery of the mink population in the late 1990's, which coincided with low numbers of nesting seabirds, led to increase in predation rates by these carnivores (Ben-David 2012a, b). This is supported by the observation that the highest predation rates on pigeon guillemot nests occurred in 1998 (Irons et al. 2013). Mink forage at sites with shallower tidal slopes, with mostly bedrock, and protected from wave action, mostly during low tides when large areas of shallow rock-pools are exposed (Ben-David et al. 1996).

MODELING

The potential changes in the growth of the pigeon guillemot population at the Naked Island group were modeled in an effort to inform the decision-making process. Two management alternatives were modeled: Alternative A: No Action-Current Management; and Alternative B: Proposed Action-Control of Predatory Mink.

A stochastic Leslie matrix model after Golet et al. (2002) and Bixler et al (2010) was used to project pigeon guillemot population growth under these two alternatives at the Naked Island group. Modeling is based on a 100 adult bird initiation point. The following equation was used to project the growth rate of the pigeon guillemot population:

(λ): $\lambda = ((PF * FX * PA\ 2) + (NX * PA)) / NX$

Where,

λ = annual population growth rate
PF = annual sub-adult survival rate
FX = number of offspring produced
PA = age-constant annual adult survival
NX = initial population size

The details of the model and justification are found in Appendix C.

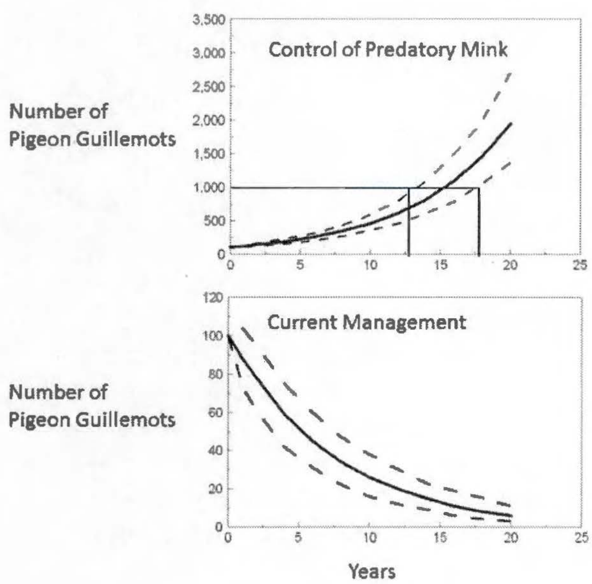


Figure 4. Results of stochastic Leslie matrix modeling of the changes in the pigeon guillemot population at the Naked Island group for the Proposed Action-Control of Predatory Mink and No Action-Current Management Alternatives (Fleming and Cook 2010). Pigeon guillemot productivity varies in a monotonic fashion across the two model scenarios. The graphs start with

the year after the actions were completed.

Under the Proposed Action-Control of Predatory Mink alternative, the model projecting pigeon guillemot population growth assumes minimal mink predation (~2 nests depredated per year). Pigeon guillemot population is projected to be recovered at 1,000 adult/breeding birds in about 13-18 years after reduction of mink have been completed. Please note that fifteen years is being used as an average.

The No Action-Current Management alternative represents no control of mink and a predation rate based on the empirical predation rate during the 1990s (Bixler et al. 2010). The result would be a continued reduction in the pigeon guillemot population to less than 100 birds. Any remaining pigeon guillemot would nest in limited areas inaccessible mink.

DECISION FRAMEWORK

U.S. Fish and Wildlife Service

The Department of Interior (DOI), U.S. Fish and Wildlife Service (USFWS) is the lead agency responsible for preparing this EA, as defined in 40 CFR 1508.16, as well as developing the National Environmental Policy Act (NEPA) analysis and findings. The USFWS has a responsibility for evaluating possible impacts on Federal trust resources (birds, mammals, etc.) in accordance with applicable Federal law. The USFWS's Chief of Migratory Bird Management is responsible for any decision document once a preferred alternative is selected.

U.S. Forest Service

The U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) is authorized by applicable Federal law and regulations to administer the management of natural resources, including fish and wildlife habitat, wilderness, and recreational resources on the Chugach National Forest. The Naked Island group is within the Chugach National Forest, Glacier Ranger District and within the Nellie Juan-College Fiord Wilderness Study Area.

The Forest Supervisor is the Responsible Official. The Forest Supervisor is responsible to ensure that action alternatives are consistent with the 2002 Chugach National Forest Revised Land and Resource Management Plan, as amended, including maintaining the character of the Nellie-Juan- College Fiord Wilderness Study Area which was designated in 1980. The Forest Supervisor's decision would be documented in a Decision Notice and if the proposed action is selected as the preferred alternative, would specify measures to implement actions proposed on National Forest System land and would issue a special use permit for project implementation.

Animal and Plant Health Inspection Service – Wildlife Services

The USDA Animal and Plant Health Inspection Service-Wildlife Services (APHIS-WS) mission is to provide Federal leadership and expertise to resolve wildlife conflicts. APHIS-WS is recognized as having the authority and expertise to conduct wildlife damage management activities on federally administered lands and would implement field operations under a funding agreement. The APHIS-WS Western Regional Director would sign a decision document based on selection of the preferred alternative.

Alaska Department of Fish and Game

The Alaska Department of Fish and Game (ADF&G) has the responsibility and authority to provide for the sustainability of all fish and wildlife in Alaska, regardless of land ownership or designation, unless specifically preempted by Federal law. If the proposed action is selected as the preferred alternative, the ADF&G would assist the USFWS in consulting with those State entities necessary to gain authorization for a predator control program. The ADF&G is responsible for issuance of applicable permits.

EVOS Trustee Council

The Trustee Council is providing partial funding for this project and would determine whether to fund the proposed action, if it is selected as the preferred alternative. There are three State and three Federal trustees, including ADF&G, the Alaska Department of Environmental Conservation, the Alaska Department of Law, the National Oceanic and Atmospheric Administration, the USDA, and the DOI.

Cooperating Agencies

The USFWS, USFS, and APHIS-WS are cooperating agencies for preparation of this EA.

LEGAL/ADMINISTRATIVE REQUIREMENTS

Wilderness Study Area

The Naked Island group is located within the congressionally designated Nellie Juan-College Fiord Wilderness Study Area (Alaska National Interest Lands Conservation Act (ANILCA) Section 702. USFS Alaska Region and Chugach National Forest policy directs management of the area to maintain wilderness character. The Nellie Juan-College Fiord Wilderness Study Area is managed to maintain and protect the existing (1980) wilderness character in the western half of PWS until Congress acts on permanent wilderness designation or releases the area from Wilderness Study Area designation. A Minimum Requirements Decision Guide is being prepared that would define the minimum required activity necessary to meet the objectives of the proposed action.

Roadless Area Conservation

The Naked Island group was part of a Roadless Area Review and Evaluation (RARE II area) in 1978 and the Chugach Forest completed an inventory of unroaded areas as part of the national process (USDA 2002). There are no roads on any of the islands at the Naked Island group and none are proposed. No tree removal or other vegetation manipulation is proposed with this action.

2002 Revised Land and Resource Management Plan, Chugach National Forest

The Revised Forest Plan (USDA Forest Service 2002), as amended, provides a framework that guides the Chugach National Forest's day-to-day resource management operations. It is reviewed and revised approximately every 15 years. The Naked Island group is managed under the Recommended Wilderness management prescription. During preparation of this EA, the two alternatives are designed to be consistent with the 2002 Revised Forest Plan (USDA 2002). The USFS prepared a Forest Plan Consistency Checklist (part of administrative record) to ensure that all Forest Plan standards and guidelines were considered and/or integrated into the design of the project or were incorporated as mitigation measures. The Recommended Wilderness Management Area is managed to maintain and protect the existing wilderness character. The ecological desired conditions stipulate that the area would be largely unaffected by human activity and dominate the area. The Recommended Wilderness Management prescriptions allow for treatments or measures to be taken on exotic animals to minimize impacts on ecological processes.

MOST RECENT RESEARCH AND STUDIES

Considerable pigeon guillemot research has been conducted in PWS, particularly since the EVOS in 1989. Most recently, three reports, building upon prior research and studies have been completed. These reports represent the most recent information on the pigeon guillemot population at the Naked Island group as well as predation by mink. Please refer to these reports for more detailed presentation of data, analysis, and findings. Lastly, please refer to the Literature Cited section for a complete listing of all materials used during preparation of this EA.

Why Aren't Pigeon Guillemot in PWS, Alaska Recovering from the *Exxon Valdez* Oil Spill? Kirsten S. Bixler. A THESIS. Submitted to Oregon State University the requirements for the degree of Master of Science. July 2010.

Exxon Valdez Oil Spill: Restoration Project Final Report. Pigeon Guillemot Restoration Research in PWS, Alaska Restoration Project 10070853 Final Report. Kirsten S. Bixler, Daniel D. Roby, David B. Irons, Melissa A. Fleming, and Joseph A. Cook. November 2010.

MtDNA and Microsatellite DNA Provide Evidence of Fur Farm Ancestry for American Mink Populations in PWS. Melissa A. Fleming and Joseph A. Cook. February 2010.

CHAPTER 2: ALTERNATIVES, INCLUDING THE PROPOSED ACTION

INTRODUCTION

This chapter describes two alternatives, **No Action** and the **Proposed Action**. Alternative B: Proposed Action-Control of Predatory Mink was selected as the preferred alternative as a result of the environmental planning process. Ten other alternatives were considered and rejected. Rationale for their not being considered further is provided. Under either alternative, the Naked Island group would remain as part of the Chugach National Forest and managed under State and Federal regulations for currently permitted public uses, including trapping, hunting, wilderness recreation, and other activities. The Naked Island group would continue to be managed as a wilderness study area to maintain and protect the existing wilderness character. While there would be a temporary presence, all precautions would be taken to use minimum tools and prevent natural and cultural resource impacts.

ALTERNATIVE A: NO ACTION – CURRENT MANAGEMENT

No management action to control or reduce mink would be taken under this alternative. Nesting pigeon guillemot would still persist at ≤100 birds, greatly reduced from the 1,000 adult/breeding birds observed prior to the 1989 EVOS (see Table 1) and other seabirds would still persist at the Naked Island group but in greatly reduced numbers. Pigeon guillemot would remain on the EVOS Trustee Council "not recovering" list for PWS.

Cost of Alternative A

No new additional costs.

ALTERNATIVE B: PROPOSED ACTION- CONTROL OF PREDATORY MINK

The purpose of the action is to remove pigeon guillemot from the EVOS Trustee Council "not recovering" list by restoring the current ≤100 pigeon guillemot population at the Naked Island group (Irons pers. comm.) to the 1,000 adult/breeding birds observed prior to the 1989 EVOS and recover pigeon guillemot in PWS.

Mink are the primary predator responsible for pigeon guillemot declines and will be removed from a 500 m buffer around current and potential (past) nesting pigeon guillemot colonies (Figures 5 and 7). Up to 250–300 mink may be removed during this five year effort. Management actions will begin in January (with snow covering the ground) and be completed by May for up to five years. Trapping will occur prior to the arrival of breeding birds and only very limited and discrete actions will occur after mid to late May, when peak numbers of pigeon guillemots are present (Kuletz and Oakley 1994) to avoid disturbance to mating and nesting birds.

Nests will be monitored for a five year period each breeding season, June to August, to determine reproductive success parameters, brood size, and predation rates by mink as part of this action. All accessible burrows would be checked initially in early June to determine if egg(s) are present. Beginning late in incubation, nests will be checked every 5-10 days. Nest checks will terminate when nestlings fledge or it has been positively determined that the nesting attempt failed.

At-sea surveys of pigeon guillemot population size will be monitored as part of an ongoing and separate effort from this action. Birds will be counted in late May or early June. Pigeon guillemot at-sea survey methodology and design will remain identical to that of post spill surveys conducted by the U. S. Fish and Wildlife using small boats. Birds will be recorded on either side, ahead of, and above the vessel and within 100 m of shore.

After three years, chick predation by mink will be greatly reduced or eliminated. Pigeon guillemot productivity will increase to 0.5 chicks fledged per nest or greater and nesting bird numbers will be stable or begin to increase slightly to 10 percent. After five years of reducing mink populations it is expected that the pigeon guillemot will increase the current 100 breeding birds (model baseline) to ~110 to ~130 birds, allowing for a population of ~250 or more birds by year 10 and attainment of ~1,000 breeding bird objective by year 20 or earlier (see Table 1).

Mink abundance will be assessed by numbers of tracks observed in the area, by catch per unit effort (number caught per trap-night), or by the use of bait stations with track plates or cameras placed along island shoreline. As mink numbers decline the catch per unit effort will decline. Mink fur samples will be taken for possible future DNA analysis. Age, sex, and diet from stomachs and perhaps, stable isotopes of mink would be assessed. This information would be collected and analyzed to provide a greater understanding of pigeon guillemot and mink in PWS.

Carcasses of mink will be frozen and placed in a tamper-proof container and removed from the island every two to four weeks. Carcasses will be donated to research organizations for additional genetic and other study or to permanent archives in public museums or universities, whenever feasible. There is also the opportunity to provide carcasses to Native Alaskans for their cultural programs. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.) Carcasses that are taken off island but cannot be salvaged for donation may be disposed of in a city landfill.

No tree removal or vegetation manipulation is proposed with this action. No exotic plants or animals will be introduced. All project and personal equipment will be cleaned prior to transport into PWS. Mainland storage/staging areas of equipment would avoid weeds, like common dandelion (*Taraxacum officinale*) or slugs (*Onchidiacea* and *Soleolifera*). All personnel will clean equipment (boots, packs etc.) prior to transport to PWS. Sites will be surveyed throughout the project for invasive species.

If after five years pigeon guillemot are "not recovering" because of mink predation, the program would be reevaluated. A new environmental planning effort may be considered and other alternatives considered. A proposed action could be developed to address the depredation of pigeon guillemot by mink and include a new environmental analysis.

If after five years pigeon guillemot are "recovering" and there is no mink predation, the recovery of pigeon guillemot would be documented by a separately funded, ongoing 15-year, boat-only based pigeon guillemot population monitoring program to enumerate and track pigeon guillemot numbers breeding at the Naked Island group. This monitoring program will be established and funded through the EVOS Long Term Monitoring Program.

Mink Removal Methods

Trapping

Trapping would be the primary method used to reduce mink and would occur for a five year period through a three to five month effort each January to May, a period of heavy snow and the mink mating season (Bones et al. 2007). Trapping activities will cease by mid to late May when peak numbers of pigeon guillemots are present and courtship begins (Kuletz and Oakley 1994). Lethal body grip traps will be the principal trap type. Approximately 100-500 traps will be placed in groups of one to five within 500 m of nest sites and checked daily, weather permitting. Traps will be secured with a wire to deadwood, rocks, roots, or trees less than 50 years old no greater than five inches in diameter. Trap wires will be attached loosely to the trees to prevent any tree damage. Bait, likely herring, will be purchased or caught and stored in tamper-proof containers.

The precise timing of trapping will be determined by evaluating data collected during trapping (e.g., trapping success, trapped animal sex and age class). If the specified objective is not being achieved, restoration methods or actions could be altered as per agreement with all parties involved.

The Association of Fish and Wildlife Agencies (AFWA) best management practices will be utilized to determine trapping methods. Trapping efforts will be monitored throughout the active trapping period to ensure maximum trapping effectiveness and to minimize or eliminate non-target take. APHIS-WS will implement the management program under a funding agreement with the USFWS. An estimated nine to 12 experienced wildlife specialists will conduct mink removal efforts for the project duration. Protocols and methodologies for mink removal will be agreed upon by USFWS and APHIS-WS, prior to implementation.

Shooting

Firearms, using non-toxic ammunition, could also be used to remove mink. Shooting is a highly species-specific method, as positive identification is made prior to shooting. Shooting would be conducted primarily from January to May, prior to the first week of June when maximum numbers of pigeon guillemot occur (Oakley and Kuletz 1994). Firearms with sound suppression would be used to remove mink from around the breeding colonies after pigeon guillemot arrive, if required.

Dogs

Dogs, trained for hunting mink, and their handler may be used on separate occasions to locate trap-shy mink. Dogs would be monitored and leased or under voice control of their handler at all times, when not kenneled. Dogs would be kenneled on land or on a boat. Dog food would be kept in a tamper-proof container. Dog feces would be transported off-site.

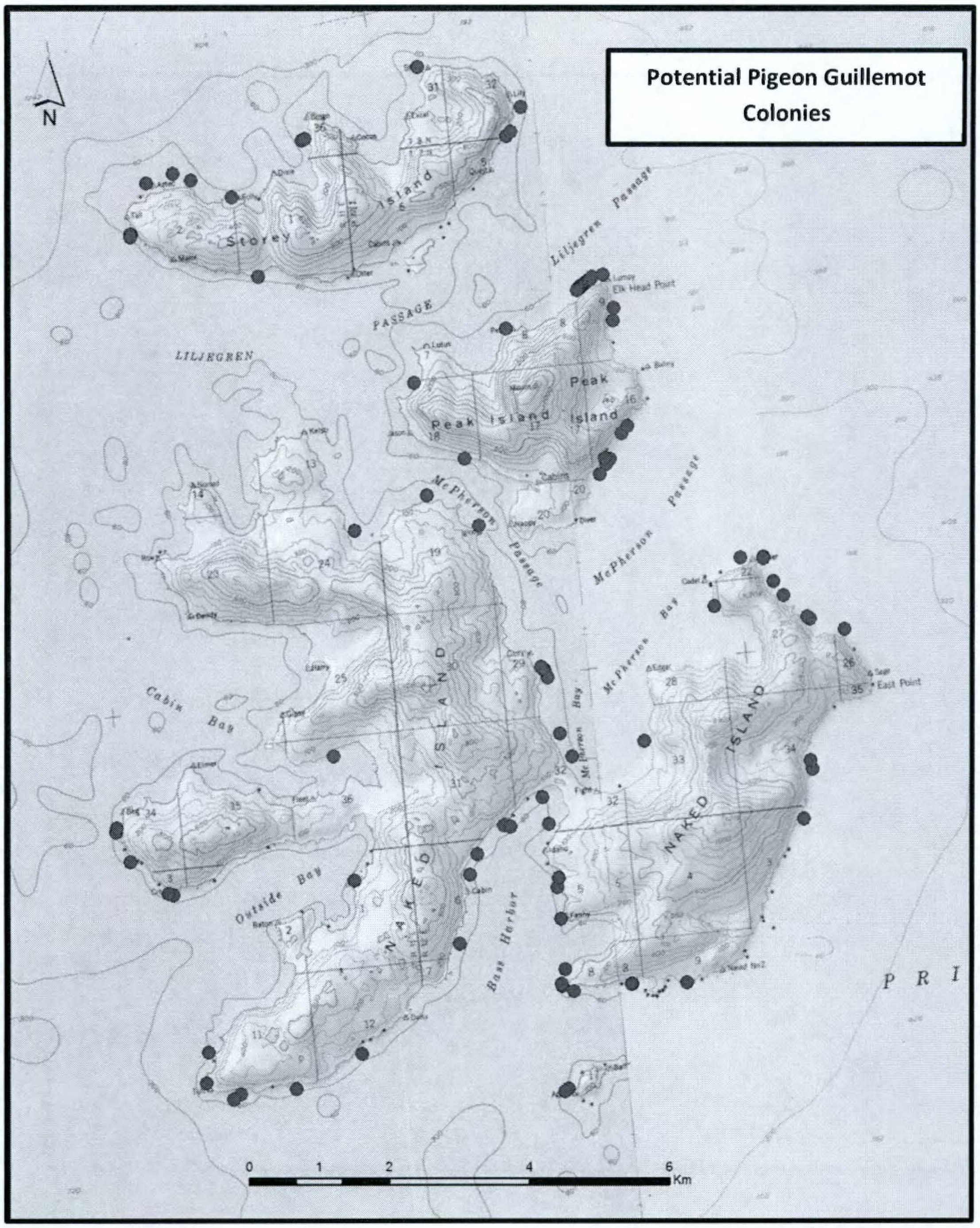


Figure 5. Locations of potential pigeon guillemot colonies based on sightings of breeding birds on the water (red dots) at the Naked Island group.

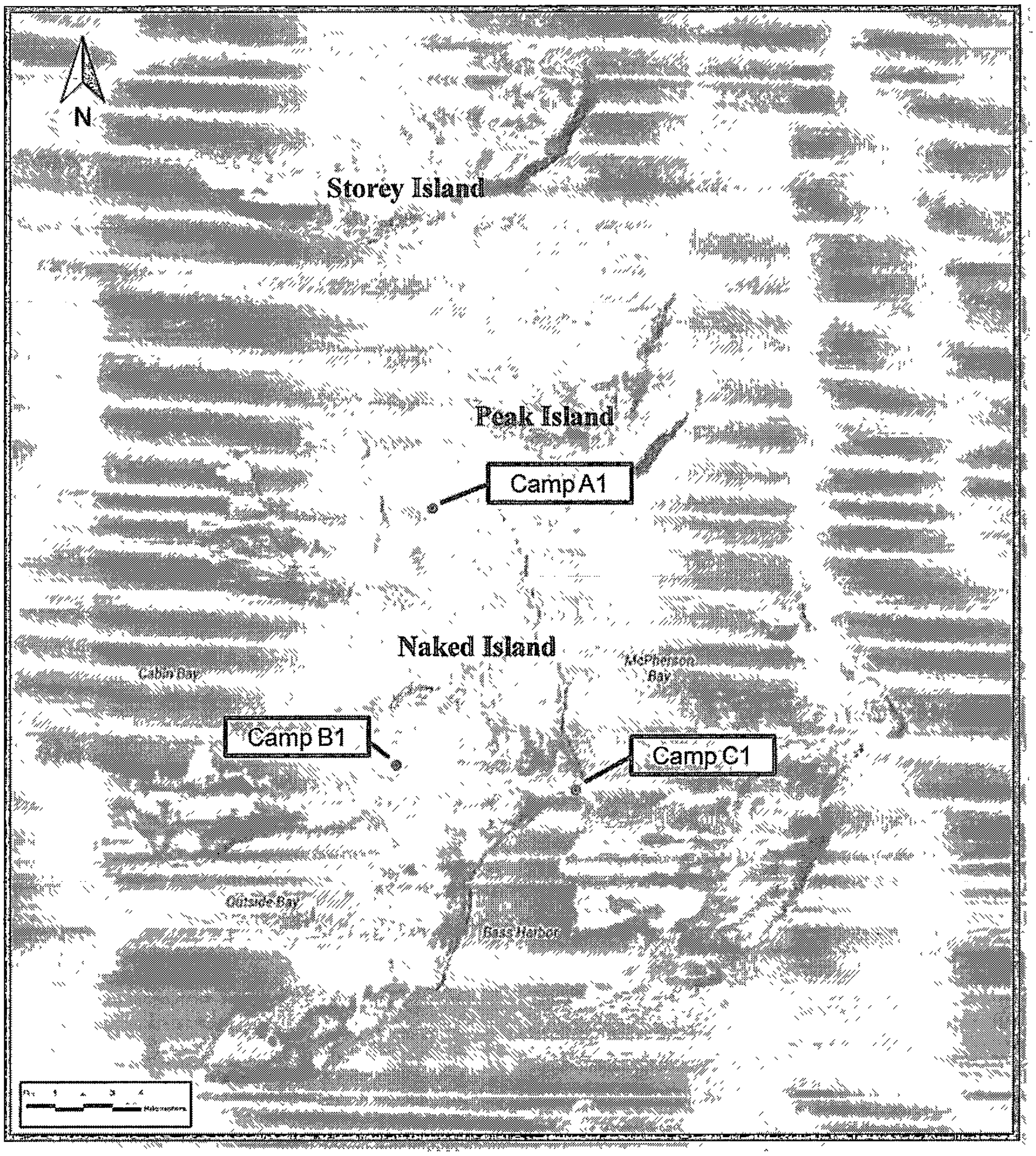


Figure 6. Map of Naked, Storey and Peak Islands showing three potential camp sites, Camp A1 - North Camp, Camp B1 – Cabin Bay and Camp C1 – Bass Harbor All three camps would be used in winter and Camp B1- Cabin Bay would also be used in summer.

Boat or Land Based Trapping Options

A boat or land based trapping option exist for housing trappers during the January to May trapping period. A thorough review of all details and advantages/disadvantages of each option would occur prior to the initiation of mink removal. The trapping program is identical for either option. APHIS-WS will follow all requirements agreed to by all parties. The ADF&G will issue appropriate permits for the take of mink, while the USFS will issue a special use permit for temporary land-based camping and associated activities on USFS lands during the trapping and monitoring program. All operational details specified in the special use permit will be according to the Forest Service Handbook, FSH 2709 – Special Uses. A Minimum Requirements Decision Guide will be utilized during all project phases to minimize effects on the wilderness character of the Nellie Juan-College Fiord Wilderness Study Area. All camp sites will be surveyed for archaeological and cultural resources prior to permit issuance.

Option 1: Boat Based

One or two support vessels would provide lodging and food during the trapping period from January to May for five years under this option. Nine to twelve wildlife specialists would stay on one or two support vessels for perhaps one to two weeks on six to ten occasions during the five month period. Support vessels would have a boat crew present. Small boats would provide access from the support vessel to Storey, Peak, and Naked Islands to conduct trapping operations. No temporary field camps or caching of supplies would be required on the islands for trapping activities.

Summer restoration monitoring/research staff would use campsite B.1 during May- August for five years. The camp would be utilized by two to four research staff for the entire summer and the camp would be located along the coastline beach within ~50 m of the high tide line. This activity is covered by a previously issued USFS Special Use Permit. On-site storage of supplies is allowed under this permit. Please note that the current permit is not part of the proposed action but rather an ongoing monitoring program.

Additional details agreed to by all parties would be part of the APHIS-WS funding Agreement and approved by the USFS during the permitting process if this option is selected.

Cost of Alternative B Boat Based

$1.0 million - National Fish and Wildlife Foundation
1.2 million – EVOS Trustee Council
$2.2 million - Total (five years)

Option 2: Land Based

One to three temporary winter field camps located at Camp A.1-North Camp, Camp B.1- Cabin Bay, and Camp C.1 -Bass Harbor (Figure 6) for three to four wildlife specialists each (total of nine to 12 wildlife specialists) would be established for the five month period. A support vessel would ferry supplies and resupply, as necessary. Field camps would be utilized as long as from January to May for five years under this option. It is likely that wildlife specialists would be present or one to two week period on six to ten occasions during the five month period. No on-site storage of supplies would occur on the islands at these camp locations unless approved by a USFS special use permit.

Summer restoration monitoring/research staff would use campsite B.1 during May to August for five years. The camp would be utilized by two to four research staff for the entire summer and the camp would be located along the coastline beach within ~50 m of the high tide line. This activity is covered by a previously issued USFS Special Use Permit. On-site storage of supplies is allowed under this permit.

Each camp in summer and winter would consist of a Weather port® structure (approximately four by seven m) for field operations (generator, fuel, oil, and battery storage); three or four approximately two m2 tents for sleeping; and possibly one additional approximately three m2 storage tent. Each camp would have a small inflatable boat, anchored off shore. Each camp would have an approved fuel storage area with a containment system.

- Camp locations would be approved by the USFS.
- Camps would be resupplied and garbage and human wastes removed every two to four weeks, weather allowing.
- All tents would be located on wooden platforms.
- Oil stoves would be used for heat.
- If needed, boardwalks would be used to prevent soil and vegetation damage.
- All food would be stored in tamper-proof containers
- Human/ dog waste and all garbage would be contained in barrel or portable container and removed from the island.
- No fires would be allowed except by USFS special use permit.
- Winter camps would be placed on frozen ground or snow to prevent impact to vegetation.
- Boardwalks would be used, if necessary, to allow easy walking on the snow trails and to prevent vegetation damage during periods of no snow.
- Camps would be disassembled, removed, and stored off site during the off season to preserve wilderness character of the Naked Island group, unless permitted by a USFS special use permit.
- Terms and conditions of the field operations, as well as stipulations to ensure to minimal environmental impact, would be outlined by a USFS special use permit.

If this option is selected, additional details agreed to by all parties would part of the APHIS-WS funding Agreement and approved by the USFS during the permitting process.

Cost of Alternative B Land Based

$0.9 million - National Fish and Wildlife Foundation
1.0 million – EVOS Trustee Council
$1.9 million - Total (five years)

ALTERNATIVES NOT CONSIDERED IN DETAIL

During preparation of the Restoration Project Report for the EVOS Trustee Council, it was important to explore all alternatives with potential for the recovery of the pigeon guillemot population. The final report, published in November 2010, is the most recent analysis of a range of alternatives for "recovering" pigeon guillemot.

Bixler et al. (2010) analyzed a wide range of alternatives in detail and provided the final report to the EVOS Trustee Council, most of which are presented below. The alternatives presented below represent alternatives that were considered, analyzed, and found not to be feasible for "recovering" the pigeon guillemot population at the Naked Island group and were therefore not recommended.

Removal of Mink

Complete removal of mink over a five year period from the Naked Island group would be undertaken in this alternative. This alternative was in the original proposal and was commented upon by the public. Circumstantial evidence exists that mink may have been introduced at the Naked Island group, but without conclusive documentation. Additional information can be found at Irons et al. (2013). In the final report to the EVOS Trustee Council, complete removal of mink was recommended, but uncertainty that mink are native or introduced has resulted in eliminating this alternative.

Mink Translocation/Relocation

Translocation/relocation of mink from the Naked Island group to other locations was considered, but rejected for a number of reasons. Mink populations are well established in PWS and other parts of Alaska and all mink habitat is occupied by existing mink populations. Relocation of mink has the risk of introducing disease and parasites to new and uninfected locations. Additionally, relocated mink would have to establish food sources and shelter in an unfamiliar environment, already occupied by mink. In the winter time, relocated mink have little time to find shelter or food and would most likely perish. ADF&G transplant policy sets strict guidelines for wildlife transplants to, within, or from the state (ADF&G 2013). Transplanting mink from the Naked Island group to other locations would not meet ADF&G standards or criteria for a transplant program.

Nest Boxes to Enhance Nest Site Availability

Pigeon guillemot nest boxes would be installed on cliff faces inaccessible to mink. Boxes would be placed in the immediate vicinity of either current or historical nesting locations (Figure 6). A few nest boxes were installed at the Naked Island group during the late 1990s, but there was low incidence of use (Irons; pers. obs.), most likely because there was an abundance of natural cavities available. No evidence exists that pigeon guillemot at the Naked Island group are limited by the availability of nesting habitat. This alternative was not pursued because nest box installation would most likely be an ineffective restoration technique, requiring extensive maintenance. Nest boxes would deter from the wilderness character of the site.

Protective Fencing of Nest Sites

Protective fencing would be used to reduce predation by mink of pigeon guillemot. This alternative was not pursued because gaps larger than one inch in the fence (Boggess 1994) on talus slopes and cliffs are not practically avoidable and mink can easily swim around any fence, unless the fence completely encloses the nesting area. Fencing of numerous dispersed nesting sites would be impractical and fencing would impact pigeon guillemot movement within the nesting area. Fencing would deter from the wilderness character of the site.

Mink Behavioral Modification

No registered chemical repellents or known effective frightening devices to modify the behavior of mink near pigeon guillemot nests exist (Boggess 1994, NWRC 2008).

Control Avian Predators of Pigeon Guillemot Nests

Avian predation of pigeon guillemot is very limited and not a significant mortality factor (Oakley and Kuletz 1979). Avian species considered, included the common raven (*Corvus corax*), northwestern crow (*Corvus caurinus*), and black-billed magpie (*Pica pica*).

Combination of Nest Boxes and Control of Predator Populations

Nest predators of pigeon guillemot (i.e., mink, raven, crow, and magpie) would be culled and nest boxes would be installed at the Naked Island group. Actions taken include suppression of the mink population, construction and installation of nest boxes, and lethal control of avian predators. This alternative was not pursued for the same reasons each scenario was dropped as viable option on its own. Due to flaws in each action (see previous alternatives) would not be lessened by the combination of alternatives, and a combined approach would not lead to significant improvements of the population of pigeon guillemot at the Naked Island group.

Use of Toxicants

There are currently no chemical agents registered by the U.S. Environmental Protection Agency for the control of mink (Boggess 1994, NWRC 2008), Further, This alternative was not considered further because poisoning or secondary poisoning of non-target species (Courchamp et al. 2003, Moore et al. 2003) such as river otter and bald eagle would be unacceptable.

Shooting

Shooting of mink as a single technique for population reduction is not effective because of their nocturnal habits (Boggess 1994, Courchamp et al. 2003), although it is maintained as a limited secondary treatment option under the proposed action due to possible disturbance to nesting birds.

Other

Other means of biological control, such as virus vectored immune-contraception, have yet to be fully developed (Courchamp and Cornell 2000; Macdonald and Harrington 2003) and might pose an irreversible danger to the viability of mink and other closely-related native furbearers (e.g., American marten) outside of the Naked Island group.

CHAPTER 3: AFFECTED ENVIRONMENT

INTRODUCTION

The Naked Island group, a cluster of three small islands with about 100 km of shoreline, is located in western PWS, a sub-arctic, inland sea connected to the Gulf of Alaska. PWS is approximately 1,000 km^2 in size and is bounded by the Chugach and Kenai mountains. PWS is a complex fjord estuarine system with about 5,000 km of coastline and is characterized by rugged coastal mountains, glaciers, sheltered waters, and forested islands which offer relatively pristine maritime habitats. Productive inter-tidal lands, estuaries, and mature coastal forests support a diverse assemblage of terrestrial and marine wildlife species. PWS provides habitat for seabirds, waterfowl, shorebirds and marine mammals, and upland habitat for birds and mammals. The wealth of abundant wildlife has drawn people to the area for thousands of years.

The Naked Island group consists of three main islands: Naked Island (38.6 km^2), Storey Island (7.2 km^2), and Peak Island (6.1 km^2). The islands are isolated, being 75 km from Valdez and Whittier and 90 km from Cordova. The bays of Naked Island, and the passages between it and the two neighboring islands, Peak and Storey, form an expanse of water that is less than 100 m deep. Near shore habitat is characterized by numerous bays and passages with shallow shelf habitat (<30 m) radiating about one km from shore. Island shorelines are characterized by low cliffs and cobble or boulder beaches. High, steep, exposed cliffs occur along portions of the eastern shores of the Naked Island group. Naked Island is the highest at 371 m. All of these islands are part of and managed by the Chugach National Forest and is managed as wilderness.

CLIMATE

The Naked Island group experiences a cool maritime climate with moderate temperatures and extended periods of clouds and fog with abundant precipitation ranging from 2.5 m to 3.0 m annually. The highest amount of precipitation generally occurs in the late summer and fall, and the lowest amount occurs in the spring and summer. Snow falls at all elevations between mid-October and mid-May and may persist for long periods at sea level. About ten percent of total annual precipitation falls as snow along the coast. Snowfall can occur anytime from September to June and can be highly variable ranging from a few inches to several feet.

Temperatures average -7 to -3 °C in January and 12 to 13 °C in July. January is the coldest month with an average temperature of -6 °C. The Naked Island group has temperate cold and warm seasons. Temperatures do not vary much between day and night. Winter has prolonged freezing. April generally has the most sunshine. June is the driest month with rainfall and other precipitation peaking around October. Low pressure storms in PWS generally come from the southeast. Permafrost is absent.

The Naked Island group is located in Alaska's South-central Intrastate Air Quality Control Region that includes the PWS area. The air quality meets state standards for visible and particulate air quality. Potential air contamination sources are far away (communities of Valdez, Seward, and Cordova) or from marine and air traffic. No prescribed burning occurs and high precipitation and cool summer temperatures preclude wildfire.

VEGETATION, GEOLOGY, AND SOILS

The Naked Island group is within the Pacific Gulf Coastal Forest-Meadow Province and the Northern Gulf of Alaska Fiord lands ecological region. Shoreline habitats transition rapidly from beach habitat to a temperate rainforest intermingled with muskeg vegetation. All islands are forested to their summit, mostly with Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*). Common understory species include blueberry (*Vaccinium sp.*), salmonberry *(Rubus sp.*), devil's club (*Oplopanax horridus*), yellow skunk cabbage (*Lysichiton americanus*), deer fern (*Blechnum spicant*), lady fern (*Athyrium filix-femina*), bunchberry (*Cornus canadensis*), and foam flower (*Tiarella trifoliate*). Common shrubland and herb land species include: salmonberry (*Rubus spectabilis*), crowberry (*Empetrum nigrum*), bog blueberry (*Vaccinium uliginosum*), cranberry (*Vaccinium sp.*), deer cabbage (*Nephrophyllidium crista-galli*), luetkea (*Luetkea sp.),* sedges (*Carex sp.*), sphagnum mosses (*Sphagnum sp.*), tufted hairgrass (*Deschampsia cespitosa*), and seaside sandplant (*Honckenya peploides).*

Naked Island shorelines are rocky and consist of cliffs, broken cliffs, and escarpments interspersed with boulder beaches. Diurnal tide ranges are 3.1 to 3.7 m.

A 9.2 magnitude earthquake occurred in the Gulf of Alaska on March 27, 1964 (the Good Friday Earthquake). Warping of the crust during this tectonic event resulted in uplift in the eastern portion of PWS and subsidence in the western portion. A maximum uplift of over 9.0 m occurred on Montague Island. The area around Whittier experienced 1.8 to 2.4 m of subsidence (USDA 2005). The Naked Island group experienced an uplift of about 1.2 m, permanently exposing nearly half of the intertidal zone (Johanson 1971) and altering both the shoreline and shallow near shore habitat.

Geologic, geophysical, and geochemical investigations have been conducted to evaluate the mineral resource potential of the Chugach National Forest. No oil or extractable mineral resources have been documented at the Naked Island group.

WATER RESOURCES

Streams at the Naked Island group are very short. Because of the marine influence, heavy precipitation, and mild temperatures, stream flows are predominantly controlled by rainfall runoff, although snowmelt runoff occurs in the spring. Peak flow events during fall rainstorms are generally larger than peak flows from snowmelt runoff. Wetlands associated with swamps, bogs, ponds, and floodplains, comprise the majority of wetlands at the Naked Island group.

Water quality is very good, with nearly pristine conditions as a result of the isolation and lack of development at the Naked Island group. The small streams generally have very low sediment loads. Human impacts on water quality are predominantly limited to the coastal areas, where most activities occur.

WILDLIFE

The Naked Island group landscapes and offshore waters provide habitat for variety of wildlife, including passerine birds, waterfowl, shorebirds, seabirds, and mammals. Federally listed endangered or threatened species that may potentially occur at the Naked Island group shorelines or offshore waters include Steller sea lion (*Eumetopias jubatus*), Steller's eider (*Polysticta stelleri*), humpback whale (*Megaptera novaeangliae*) and North Pacific right whale (*Eubalaena japonica*). The Naked Island Group provides habitat for one management indicator species identified in the Chugach National Forest Revised Land and Resource Management Plan (USDA 2002): the black oystercatcher (*Haematopus bachmani*). The Naked Island Group also provides habitat for special interest the bald eagle, marbled murrelet, Townsend's warbler (*Setophaga townsendi*), and river otter, and Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) (USDA USFS 2002). The pigeon guillemot is now the only marine bird species in PWS listed as "not recovering" by the EVOS Trustee Council's Injured Resources List (Bixler et al. 2010; EVOSTC 2010).

A complete inventory of birds, mammals, fish, and amphibians at the Naked Island group has not been conducted and it is presumed the species present at the Naked Island group are representative of those within PWS and species expected on a remote and isolated island group.

Birds

The Naked Island group was at one time the single most important breeding location for pigeon guillemot in PWS. In 1972, one quarter of the Sound-wide population of guillemot was counted there, though these islands include just two percent of the total shoreline in the Sound (Isleib and Kessel 1972). Of the 4,000 pigeon guillemot nesting in PWS in 1989, 1,000 were found at the Naked Island group (Bixler et al. 2010).

Pigeon guillemot numbers have been monitored at the Naked Island group since 1978 under special use permits issued by the USFS. The monitoring is ongoing and will continue for another 20 years. Pigeon guillemot surveys in 1979 counted 1,871 birds (Oakley and Kuletz 1996, G. Golet, USFWS unpubl. data). The pigeon guillemot breeding population at the Naked Island group has declined by more than 90 percent during the last 20 years (Irons et al. 2013). From 1990 to 2008 pigeon guillemot censused at the Naked Island group have declined from 1,124 birds observed in 1990 to 101 birds observed in 2008 (Bixler et al 2010). In 2008, only 17 pigeon guillemot nests were found. In one area only four nests were found where 124 nests were found in 1997 (Golet unpubl. data). Figure 6 shows the historical locations of pigeon guillemot colonies and Figure 7 shows the locations of observed individual pigeon guillemot in 2012. Parakeet auklet no longer nest and tufted puffin and horned puffin nest in greatly reduced numbers.

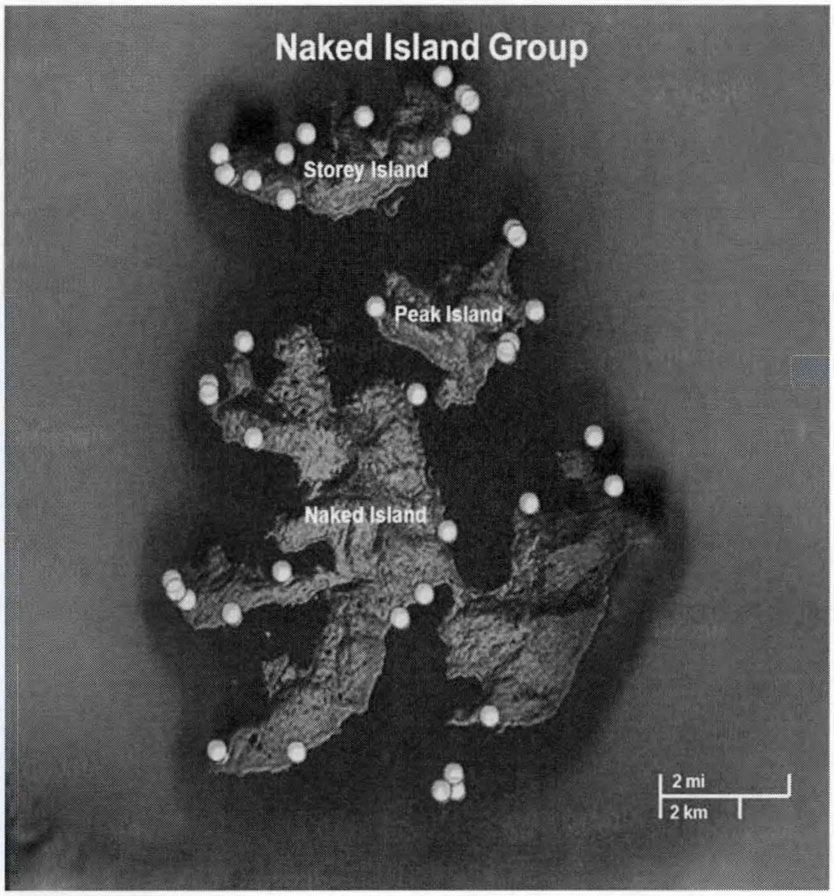


Figure 7. Locations of historical pigeon guillemot colonies at the Naked Island group (yellow dots).

Common seabirds at the Naked Island group include marbled murrelet, black-legged kittiwakes (*Rissa tridactyla*), glaucous-winged gull (*Larus glaucescens*), fork-tailed storm petrel (*Oceanodroma furcata*), mew gull (*Larus canus*), tufted puffin, Arctic tern, common murre (*Uria aalge*) pelagic cormorant (*Phalacrocorax pelagicus*) and pigeon guillemot. Common sea ducks, loons, and grebes in PWS include: harlequin duck (*Histrionicus histrionicus*), Barrow's goldeneye (*Bucephala islandica*), scoter (*Melanitta* spp.), long-tailed duck (*Clangula hyemalis*), bufflehead (*Bucephala albeola*), common loon (*Gavia immer*), pacific loon (*Gavia pacifica*), red-throated loon (*Gavia stellata*), red-necked grebe (*Podiceps grisegena*) and horned grebe (*Podiceps auritus*).

Breeding and wintering populations of black oystercatchers and migrating or wintering populations of black-bellied plover (*Pluvialis squatarola*), black turnstone (*Arenaria melanocephala*), surfbird (*Aphriza virgata*), marbled godwit (*Limosa fedoa*), western sandpiper (*Calidris mauri*), dunlin (*Calidris alpina*), and rock sandpiper (*Calidris ptilocnemis*) may be found on marine shorelines.

Common landbirds are the blackpoll warbler (*Dendroica striata*), chestnut-baked chickadee (*Poecile rufescens*), hermit thrush (*Catharus guttatus*), fox sparrow (*Passerella iliaca*), orange crowned warbler *Oreothlypis celata*), pine siskin (*Carduelis pinus*), ruby-crowned kinglet

(*Regulus calendula*), tree swallow (*Tachycineta bicolor*), olive-sided flycatcher (*Contopus cooperi*), and varied thrush (*Ixoreus naevius*). Other landbirds include black-billed magpie, common raven, and northwestern crow. Bald eagles are common.

Mammals

The Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) was introduced to islands in PWS in the 1950's (ADF&G 2006) including the Naked Island group. Small mammals at the Naked Island group include meadow vole (*Microtus pennsylvanicus*), red squirrel (*Tamiasciurus hudsonicus*), and northern red-backed vole (*Myodes rutilus*).

Carnivores found at the Naked Island group include mink, river otter and sea otter (*Enhydra lutris*). Neither American marten nor weasel has been documented at the Naked Island group (Irons et al. 2013). Mink were first documented on the island group in the mid-1990's (Bixler et al.1990). Anecdotal evidence exists that past Naked Island group residents released mink in the 1970's to establish a population for trapping, but that the population did not grow much until the 1990's (Bixler et al.
2010; Irons et al. 2013). Although mink predation was not a recorded cause of pigeon guillemot nesting failure at the Naked Island group during studies in the late 1970s and early 1980's, mink predation on guillemot nests was frequently recorded by the mid-1990's (Hayes 1995, Golet et al. 2002).

Common marine mammals include Dall's porpoise (*Phocoenoides dalli*), harbor seal (*Phoca vitulina),* humpback whale, killer whale (*Orinus orca*), minke whales (*Balaenoptera acutorostrata*), and sea otter. The endangered Steller sea lion is also present. PWS is within the range of the North Pacific right whale.

Amphibians

No amphibians are known to occur at the Naked Island group.

Fisheries

Capelin (*Mallotus villosus*), Dover sole (*Solea solea*), lingcod (*Ophiodon elongatus*), Pacific herring, Pacific sand lance, smelt (*Osmeridae* spp.), walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), and other species common to PWS are found in the waters surrounding the Naked Island group and most are fed on by pigeon guillemot. Three small pink salmon (*Oncorhynchus gorbuscha*) streams are located at the Naked Island group, two on western side of Naked Island, and one on the southern side of Peak Island. Coast range sculpin (*Cottus aleuticus*) and tide pool sculpin (*Oligocottus maculosus*) are found in Naked Island waters and are foraged by mink.

Wilderness

The Naked Island group is located within a congressionally designated wilderness study area. In 1980, the Nellie Juan – College Fiords Wilderness Study Area (WSA) was created by the Alaska National Interest Lands Conservation Act (ANILCA), and includes the Naked Island group within its boundaries. Forest Service Region 10 policy directs the Chugach National Forest to manage the WSA in a way that does not impair the WSA from being designated by Congress as wilderness in the future. The area is managed to maintain the wilderness character to provide for natural landscapes and processes and for the public enjoyment of solitude, education, and primitive recreation such as hunting, fishing and camping, among other values. These values are measured through four qualities. untrammeled, natural, undeveloped, and outstanding opportunities for solitude and primitive or unconfined recreation.

CULTURAL RESOURCES

Pre-history

Archaeological investigations show that the Chugach (Sugpiaq) people have occupied the PWS area for thousands of years, from the time when the Sound was still largely covered by glaciers during the last ice age (CAC 2012). The Chugach lived in rectangular bark or plank houses along the shoreline in permanent settlements and traveled to temporary summer fish camps located along salmon streams. The Chugach subsisted on fishery resources, marine mammals, and shellfish supplemented with birds, land mammals, berries, and plants. Eight groups (Chenega, Montague Island, Nuchek, Shallow Water, Eyak, Gravina Bay, Tatitlek and Kiniklik) numbering 500 to700 individuals were well established throughout PWS. Because of the isolated and remote nature of the Naked Island group, it is probable that prehistoric use was transitory and related to hunting and gathering activities. Permanent settlement was unlikely.

Prehistoric archaeological sites in PWS date from within the past 4000 years and encompass three cultural phases. The Uqciuvit phase is identified with dates ranging from 4000-2500 B.P., the Palugvik phase with dates ranging from 2500-900 B.P., and the Chugach phase with dates ranging from 900-200 B.P. (Yarborough 2000). The protohistoric period dates between A.D. 1741, when Vitus Bering made landfall on Kayak Island, and A.D. 1778, when Captain James Cook made direct contact with Native inhabitants of PWS.

Archaeological surveys conducted at the Naked Island group were primarily in association with the Exxon Valdez Oil Spill Cleanup efforts. New sites were documented during this time and known sites were monitored in an active program. Monitoring of known sites and additional small scale surveys have been conducted in recent years by USFS archaeologists in association with permitted activities.

The USFS determined the proposed action alternative specific to removal of mink would cause no affect to historic properties per Appendix B of the Programmatic Agreement among the USFS, Alaska Region, the Advisory Council on Historic Preservation, and the Alaska State Historic Preservation Officer regarding Heritage Program Management on National Forests in Alaska (USDA 2010); and therefore did not conduct any surveys specific to the proposed action. However, a cultural resource survey of the proposed campsites was conducted and no cultural resources that could be considered as eligible for inclusion in the National Register of Historic Places were identified (USFWS 2013).

History

The Chugach were the first Alaskans to meet the European explorer, Vitus Bering, who came to

Alaska at Kayak Island in 1741 under the Russian flag. Bering was followed in 1779 by the British explorer James Cook. Spanish expeditions occurred under Inacio Aretega in 1779 and Salvador Fidalgo in 1790, and in 1791 another British expedition to PWS was undertaken by George Vancouver. From 1785 to 1867 the Russians established settlements and developed the fur trade. Smallpox epidemics in 1837 and 1885 decimated the Chugach people.

In 1867 Alaska was purchased from Russia by the United States. Resource exploitation continued. Gold and copper mines were developed. Salmon canneries were established and railroads constructed. With the decline of sea otter, commercial fox farms developed in the late 1890's.

By the turn of the century, fox farms were increasingly common in south-central and southeastern Alaska. In 1900, 35 islands were being leased from the government. In southeast Alaska an island could be leased from the USFS for as little as $25 a year (AHF 2012). Beginning in 1903, fur prices bottomed out and many islands were abandoned. Prices remained low for a decade; during this early period, many raised foxes as breeding stock and began selling them to newly established fur farms in the U.S.

In 1913, the popularity of furs (and their prices) started to rise. For the next 15 years fur farms–particularly those that raised blue foxes,–became increasingly popular. The height of popularity was reached in 1931, when 431 Alaska fur farm licenses were issued (Paul 2009), although according to Isto (2012) 622 private farm owners were identified by at least one government agency in 1929. Though fox farming was carried on in many parts of Alaska, it was most common in the coastal areas, where salmon, harbor seals, sea lions, porpoises, whales, and other marine food sources were available. The best fox farming sites were small offshore islands, where pens and feed houses were largely unnecessary (Cook and Norris 1998). Approximately, 73 islands were stocked with foxes in the Gulf of Alaska and PWS (Paul 2009).

In 1924, the Bureau of Biological Survey identified 21 mink farms – almost all in southeast Alaska and by 1929 there were 153 mink farmers (Isto 2012). Following World War II only about 60 fur farms survived in Alaska and most were mink farms. USFS fur farm permits declined to eight in 1955 and by 1955 31 fur farmers were active in Alaska and most raised mink. Only two fur farms permits were issued in the Tongass and Chugach National Forests in 1959 (Isto 2012). In the late 1970's increases in mink pelt prices brought renewed interest in mink farming and started four new fur farms (Isto 2012). In 1993 the last fur farm in Alaska closed.

The Naked Island group was the site of arctic fox fur farms for more than 50 years. In 1895 Jim McPherson established a fur farm on Peak Island as did Fred Liljegren on Storey Island (Lethcoe and Lethcoe 2001). As the pioneer fox farmers retired or died, their children continued the farms. Alice Clock at Peak Island was the daughter of Capt. Jim McPherson, while John Beyer on Storey Island was the son of early fur trader, Bill Beyer. His partner, Edwin Liljegren, was the son of early prospector and fox farmer, Fred Liljegren. By 1919 fur farms existed on all three islands. Mailboat records from the mid 1930's indicated there were five people living on Storey Island and 14 on Peak Island, where a school existed. The Storey Island fur farm closed in 1944 and the Peak Island farm closed in 1950. The Naked Island fur farm likely closed in 1950 or earlier.

Fox were allowed to roam freely and were fed in pens. Pens were closed to capture the fox for their pelts. The 1930's depression, end of World War II, and fashion changes lead to fox farming becoming unprofitable. The Naked Island group is now free of foxes for various reasons, including starvation after the destruction of bird colonies, the end of feeding by fur farmers, disease (Paul 2009), or intestinal worms (Lethcoe and Lethcoe 2001). Since 1950, there has been no permanent human occupation of the Naked Island group. A seasonal use dwelling and buildings associated with past fox farming are located on private land on Peak Island.

RECREATION RESOURCES

The Naked Island group is used for boating, camping, hiking, deer hunting, and fishing. An average of 159 hunters harvested 153 deer annually during the last ten years from the Naked Island group during August thru December (ADF&G Harvest Data). Other recreational use is probably comparatively light, as the islands are accessible only by water and are located more than 75 km from any community within PWS. An average of seven boats per day were counted during summer boat transect studies from 2005 to 2007, and no commercially-guided recreation use was reported in 2010 to 2011. Eleven outfitter guide companies are authorized by the USFS to use the Naked Island group. One permit holder has a camping permit. Five permit holders are authorized guided hunting. Four permit holders are authorized day use (charter boats) and one permit holder is authorized hiking and camping.

The protected bays on the west and north sides of Naked Island can provide safe anchorages for boats. The Naked Island group is part of the Nellie Juan- College Fiords Wilderness Study Area. Ecotourism of the PWS is anticipated to increase and its effect on visitation at the Naked Island group is unknown. Visitors' interest in viewing wildlife, particularly pigeon guillemot, parakeet auklet, tufted puffin, and horned puffin, has been a popular activity in PWS for many years.

SOCIOECONOMIC RESOURCES

Introduction

There are five communities that are most closely associated with the Naked Island group in PWS. Each community was affected, some more significantly, by the 1964 Good Friday Earthquake. Many residents were killed either by the earthquake itself, or by the tsunami which followed. The earthquake affected community rebuilding efforts as well as destroying the livelihood of many residents.

Naked Island Group

The Naked Island group is publicly managed by the USDA, USFS as part of the Chugach National Forest. There is one privately owned parcel of land on the SW portion of Peak Island. Little or no subsistence hunting and trapping occurs because of the logistics of getting to the islands from a village.

Chenega Bay Village

Chenega is located on Evans Island at Crab Bay, 67.5 km southeast of Whittier and is 167.5 air km southeast of Anchorage and 80.5 km east of Seward. The village has a total area of 75 square km, of which, 74.5 square km of it is land and 0.75 square km (1.2 percent) is water. Winter temperatures range from -8 to -2 °C. Summer temperatures range from nine to 17 °C. Average annual precipitation includes 1.7 m of rain and 2.0 m of snowfall.

According to the 2010 Census, there is a population of 76 residents with a median age of 35 years old. A federally-recognized tribe is located in the community -- the Native Village of Chenega (aka Chanega). Chenega Bay is an Alutiiq community practicing a subsistence and commercial fishing lifestyle (USCB 2010).

Commercial fishing, a small oyster farming operation, and subsistence activities occur in Chenega. Cash employment opportunities are limited. Chenega has a small boat harbor and dock. Scheduled and chartered flights depart from Cordova, Valdez, Anchorage, and Seward. In 1996, the Alaska Marine Highway began "whistle-stop" service (vessel does not stop if there are no reservations) (ADCCED 2012).

Cordova

Cordova is located near the mouth of the Copper River at the head of Orca Inlet on the east side of PWS and is 83.5 air km southeast of Valdez and 241.4 km southeast of Anchorage. The city has a total area of 195.5 square km, of which, 159 square km of it is land and 37 square km of it is water. The total area is 18.9 percent water. Winter temperatures average from -8 to -2 °C. Summer temperatures average from nine to 17 °C. Average annual precipitation is 4.2 m, and average annual snowfall is 2 m.

According to the 2010 Census, there is a resident population of 2,239 with a median age of 42 years old. Cordova has a significant Eyak Athabascan population with an active village council. Commercial fishing and subsistence are central to the community's culture (USCB 2010). Cordova supports a large fishing fleet for PWS and several fish processing plants. In 2010, 337 residents held commercial fishing permits and nearly half of all households work in commercial harvesting or processing. Red salmon (*Oncorhynchus nerka)*, Chinook salmon *(Oncorhynchus tshawytscha)*, silver salmon (*Oncorhynchus kisutch)*, pink salmon, chum salmon (*Oncorhynchus keta)*, herring, halibut *(Hippoglossus stenolepis)*, bottom fish, and other fish are harvested.

Cordova is accessed by plane or boat and linked directly to the North Pacific Ocean shipping lanes through the Gulf of Alaska and has year-round barge service and state ferry service. Daily scheduled jet flights and air taxis are available. Harbor facilities include a breakwater, dock, and small boat harbor (ADCCED 2012). A 77 kilometer gravel road provides access to the Copper River Delta to the east.

Tatitlek Village

Tatitlek is located on the northeast shore of Tatitlek Narrows, on the Alaska Mainland in PWS and lies near Bligh Island, southwest of Valdez by sea and 48 air km northwest of Cordova. The Tatitlek village has a total area of 19 square km, all of it land. Winter temperatures range from -8 to -2 °C, while summers average nine to 17 °C. Annual precipitation averages 0.71 m of rain and 3.8 m of snowfall.

According to the 2010 Census, there are 88 residents with a median age of 30 years old. A federally-recognized tribe is located in the community -- the Native Village of Tatitlek. Tatitlek is a coastal Alutiiq village with a fishing and subsistence-based culture (USCB 2010). Fish processing and oyster farming provide limited employment in Tatitlek. In 2010, one resident held a commercial fishing permit. Subsistence activities provide the majority of food items (ADCCED 2012). A silver salmon hatchery, supporting subsistence activities, is located at Boulder Bay. The community has a store. Air charters are available from Valdez and Cordova. Boats are the primary means of local transportation. In 1996, the Alaska Marine Highway began "whistle stop" service (ADCCED 2012).

Valdez

Valdez is located on the north shore of Port Valdez, a deep water fjord in PWS and is 482 road km east of Anchorage and 586 road km south of Fairbanks. Valdez is the southern terminus of the Trans-Alaska oil pipeline and the northernmost ice-free year-round port in North America. The city has a total area of 717.5 square km of which, 575 square km is land and 143 square km (20 percent) is water. January temperatures range from -6 to 0°C; July temperatures are from eight to 16 °C. Annual precipitation averages 1.58 m. The average snowfall is, incredibly, 8.3 m annually.

According to the 2010 Census, there are 3,976 residents with a median age of 37 years old (USCB 2010). Valdez is a major seaport and a foreign free trade zone, with a $48 million cargo and container facility. The Port of Valdez is navigated by hundreds of ocean-going oil cargo vessels each year. Four of the top ten employers in Valdez are directly connected to the oil terminus. City, state, and federal agencies provide significant employment. In 2010, 52 residents held commercial fishing permits. Two fish processing plants operate in Valdez, as well as a fish hatchery. Several cruise ships dock in Valdez each year. In 2011, 98 uniformed Coast Guard personnel were stationed in Valdez. Valdez is a fishing port, both for commercial and sport fishing. Marine life and glacier sightseeing, deep-sea fishing, and heli-skiing support a tourist industry in Valdez (ADCCED 2012).

The Richardson Highway connects Valdez to Alaska's road system. The Alaska Marine Highway Ferry System provides transport to Cordova, Whittier, Kodiak, Seward, and Homer. Daily scheduled jet flights and air taxis are available.

Whittier

Whittier is on the northeast shore of the Kenai Peninsula, at the head of Passage Canal and on the west side of PWS, 96.5 km southeast of Anchorage. The city has a total area of 51 square km, of which, 32.5 square km of it is land and 18.5 square km of it (36 percent) is water. Winter temperatures range from -8 to -2 °C, while summer temperatures average nine to 17 °C. Average annual precipitation includes 5.0 m of rain and 6.1 m of snowfall.

According to the 2010 Census there are 220 residents with a median age of 48 years old (USCB 2010). Whittier has an ice-free port, two city docks, and a small boat harbor that accommodates fishing, recreation, and charter vessels. It is served by road, rail, the state ferry, boat, and aircraft. Since 2000, a tunnel has provided a road connection to Anchorage. The railway carries passengers, vehicles, and cargo 19.5 km from the Portage Station east of Girdwood. Daily scheduled air flights are available. The city, school, local services, and summer tourism support Whittier. Tours, charters, and sport fishing in PWS attract seasonal visitors. In 2010, 12 residents held commercial fishing permits. Whittier is a popular port of call for cruise ships, as it has connections to Anchorage and the interior of Alaska by both highway and rail. Whittier is the embarkation/debarkation point of the Denali Express nonstop rail service (ADCCED 2012). Whittier is also popular with tourists, sport fishermen and hunters.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter describes the effects of the No Action – Current Management and the Proposed Action - Control of Predatory Mink alternatives. Each major environmental impact is evaluated under each alternative and the direct, indirect, and cumulative impacts are analyzed, where applicable. The following factors were considered under each alternative in evaluating impacts:

Likelihood of impact –would the action result in an impact or; is the chance of impact so small as to discount effects?

Duration and frequency of the impact – is the action seasonal, temporary, ongoing, etc.?

Magnitude of impact – is it likely the magnitude of impact would cause significant impacts to the quality of the human environment? (No impact, negligible impact, moderate impact, or severe impact).

Geographic extent – are the impacts expected to be local or far-reaching?

Legal status of a species – are there species that may be impacted that have special protections, regardless of the other levels of impact?

Under either alternative the Naked Island group would remain as part of the Chugach National Forest and managed under State and Federal regulations for currently permitted public uses, including trapping, hunting, wilderness recreation, and other activities. The Naked Island group would continue to be managed as a wilderness study area to maintain and protect the existing wilderness character.

ALTERNATIVE A: NO ACTION – CURRENT MANAGEMENT

No management actions would be undertaken to control or reduce the population of mink. The pigeon guillemot population in PWS would not be moved toward recovery status.

Cost

No additional costs.

Impacts to Geology, Soils, and Vegetation

Vegetation, geology, and soil resources would not be affected.

Impacts to Water Resources

Streams and wetlands would not be affected.

Impacts to Wildlife

Birds

The breeding population of pigeon guillemot at the Naked Island group, where 25 percent of the PWS population bred at the time of the EVOS would likely remain either exceedingly low (≤ 100 birds) or decline to local extirpation in the absence of restoration action (see Figure 4 and Table 1). Pigeon guillemot would remain the only marine bird species "not recovering", on the EVOS Trustee Council's Injured Resources List.

Other breeding seabird populations, including horned puffin, parakeet auklet, and tufted puffin would likely continue to decline or become absent at the Naked Island group. Mink are opportunistic feeders and would continue to depredate on ground/burrow nesting seabirds, which generally breed only on predator free islands.

Mammals

Mammals present on the islands would not be affected.

Fishery Resources

Fishery resources present on and near the islands would not be affected.

Threatened and Endangered Species

North Pacific right whale, Steller sea lion, Steller's eider, and the humpback whale would not be affected.

Impacts to Wilderness Study Area

The Naked Island group has historically been a major pigeon guillemot and seabird breeding area. The decline or possible extirpation of pigeon guillemot and other nesting seabirds would change the qualities that seabirds contribute to the islands' wilderness character. Bird numbers were dramatically higher in 1980 than today, when the wilderness study area was designated through the Alaska National Interest Lands Conservation Act (ANILCA). In 1979 surveys of the Naked Island Group counted 1871 pigeon guillemot. Currently only ≤100 pigeon guillemot exist, parakeet auklets no longer breed and tufted and horned puffin numbered less than ten individuals in 2010.

Impacts to Cultural Resources

Cultural resources would not be affected.

Impacts to Recreational Resources

Effects to recreation resources would likely be negligible to moderate. There may be fewer visitations for those interested in birding and sightseeing with few nesting seabirds and the absence of pigeon guillemot, parakeet auklet, tufted puffin, and horned puffin.

Impacts to Social and Economic Values

Communities

Social and economic effects would likely be negligible to moderate. Reduced populations of seabirds, particularly pigeon guillemot at the Naked Island group would have negligible to moderate effect on tourism.

Subsistence

Although pigeon guillemot has little subsistence value, pigeon guillemot contribute to the local culture. Effects would likely be negligible.

Cumulative Impacts

Continued reduction of pigeon guillemot to potential extirpation and dramatically reduced numbers of other seabirds could have a cumulative impact to PWS. The USFWS has a previously issued USFS Special Use Permit for an ongoing summer monitoring/research operations at campsite B-1. On-site storage of supplies has been allowed under this permit. The Naked Island group is particularly important because it was historically the main pigeon guillemot breeding location in PWS (Sanger and Cody 1994). One fourth of all pigeon guillemot nests in PWS in 1989 (just after the spill) were located at the Naked Island group, although the islands constitute only about two percent of the total shoreline in PWS (Bixler et al. 2010).

The Naked Island group is part of a larger wilderness study area which was designated in 1980. At the time of designation, the number of pigeon guillemot and other seabirds were dramatically higher than today. The lack of seabirds could have a cumulative impact to PWS within the wilderness study area.

ALTERNATIVE B: PROPOSED ACTION –CONTROL OF PREDATORY MINK

Control of predatory mink would be accomplished during five years by trapping mink entering the pigeon guillemot coastal zone nesting area.

Impacts to Geology, Soils, and Vegetation

Option 1: Boat Based

Vegetation, geology, and soil resources would not be affected by the alternative actions. It is likely that 9-12 wildlife specialists would be present one to two week periods on six to ten occasions during the five month period from January to May. The islands are generally snow free by mid-April to early May. Food would be confined to the boat and would not attract or change any wildlife behavior; no vegetation would be trampled or removed; water quality would be maintained by avoiding riparian areas and streams, No fires or land based waste would be left. No holes would be dug. This alternative would be the same as Option 2; except that a support vessel would provide food and lodging to trappers and no upland camps would be used.

Carcasses of mink will be frozen and placed in a tamper-proof container and removed from the island every two to four weeks. Carcasses will be donated to research organizations for additional genetic and other study or to permanent archives in public museums or universities, whenever feasible. There is also the opportunity to provide carcasses to Native Alaskans for their cultural programs. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.) Carcasses that are taken off island but cannot be salvaged for donation may be disposed of in a city landfill.

Option 2: Land Based

Vegetation, geology, and soil resources would not be affected by the actions in this alternative. It is likely that three to four wildlife specialists would be present in one to three winter field camps established for the five month period from January to May for five years. The islands are generally snow free by mid-April to early May. While there would be a temporary presence, all precautions would be taken to use minimum tools requirements and prevent natural resource impacts. All camping would be at locations approved by the USFS special use permitting process.

Carcasses of mink will be frozen and placed in a tamper-proof container and removed from the island every two to four weeks. Carcasses will be donated to research organizations for additional genetic and other study or to permanent archives in public museums or universities, whenever feasible. There is also the opportunity to provide carcasses to Native Alaskans for their cultural programs. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.) Carcasses that are taken off island but cannot be salvaged for donation may be disposed of in a city landfill.

Impacts to Water Resources

Streams and wetlands would not be affected by the boat based or land based actions in this alternative. No waste would be deposited on the island. No latrines would be built that could leak into subsurface waterways. No carcasses would be left in the water.

Impacts to Wildlife

Birds

Trapping activities would take place during the winter season, when few birds are in the area, and no disturbance to pigeon guillemot would occur. In the summer there would be one camp to monitor reproductive success of nests, the camp would be well away from bird nests and would not disturb them. The monitoring activities would be permitted by the USFWS and have an Institutional Animal Use and Care Committee permit to ensure minimum disturbance to the birds. In year five, a trained dog may be used to hunt mink, the dog would be either leased or under voice control at all times. Dogs would not be allowed to approach birds and disturbance would be negligible.

There would be a positive effect to birds under either the boat based or land based alternative. Pigeon guillemot populations at the Naked Island group are likely to recover from the current ≤100 birds to near the approximately 1,000 birds observed at the time of EVOS in 20 years after the project is initiated (See Table 1 and Figure 4) under this alternative with either the boat based or land based option. It is anticipated that within three years of the beginning of the reduction program, the pigeon guillemot would have increasing productivity and be removed from the EVOS Trustee Council "not recovering" Injured Resources List and be classified as "recovering", and when the population reached 1,000 they would be considered "recovered".

A suite of other seabird species (e.g., parakeet auklet, tufted puffin, and horned puffin) with depressed breeding populations at the Naked Island group (KSB, pers. obs., Oakley and Kuletz 1979) would also benefit from this restoration action. Based on historical counts, tufted puffins should increase from a few to more than 750, parakeet auklets should increase from none to about 170 and horned puffins would likely increase from the few remaining birds to more than 60. Mink reduction may promote local increases in other populations of ground-nesting birds, including the black oystercatcher, a USFS "Management Indicator Species (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, and crustaceans (Bonesi and Palazon 2007). The Service uses predator control as a management tool when appropriate and consistent with mandates, laws, and policies of federal land management agencies.

Black oystercatcher, a USFS "Management Indicator Species", would not be affected by trapping activities. Trapping would occur prior to the nesting initiation in May and fledgling in July. Black oystercatchers nest on rocky beach substrate just above high tide and personnel onsite would be trained to recognize defensive behavior during the breeding season and areas with nesting black oystercatchers would be avoided. Trained dogs would not be utilized where nesting black oystercatchers occur.

Some mink may be taken with the use of firearms during the winter months, when no recreational users are present. Firearm noise would be infrequent and isolated. The noise would have minimal effect, as no nesting birds would be present would be present when firearms are used.
Sound suppressed firearms would be used to remove mink from around the breeding colonies after pigeon guillemot arrive. Sound suppressed firearms will be used at all times during the bird breeding season to meet the intent of the Migratory Bird Treaty Act.

Mammals

Impacts to mammals resulting from the trapping and associated camping activities would be negligible for most species except mink. The boat based or land based actions in this alternative would reduce the mink population at the Naked Island group substantially but would likely have no measureable impact on the overall PWS mink population, as the mink habitat at the Naked Island group is about 2 percent of the PWS habitat and the mink at the Naked Island group are not genetically unique. It should also be noted that the there is no limit as to the number of mink trappers that are allowed to trap in PWS or any other Game Management Unit in Alaska.

River otter on the islands are unlikely to be captured using the AFWA Best Management Practices for mink and if captured could escape, as the traps are too small to contain an otter. There are no other mammals that reside at the Naked Island group that could be impacted by trapping.

The historic number of nesting seabirds at the Naked Island group indicates that either mink were not present or mink numbers were very low compared to current mink numbers.

Populations, including ground nesting birds and small mammals would likely increase when mink are reduced. The possibility exists that all the mink on the Naked Island group would potentially be removed. Total extirpation of mink would likely not adversely affect the environment because the island ecology has evolved for long periods when mink were absent or present in low levels of abundance. Populations of the normal food of mink which include most accessible animals, small enough for the mink to eat such as: birds, fish, intertidal invertebrates, and voles, would likely increase when mink predation is absent.

Camp sites and trapping are unlikely to affect Sitka deer as deer feed in the intertidal areas, well away from camp sites. In year five, when dogs may be used to hunt mink, dogs would be kept within sight and voice control and would not be allowed to approach deer or other animals. Any disturbance would be negligible.

Fish

No impact to fish under this alternative utilizing either the boat based or land based option would occur. Actions in streams or fish-bearing habitat would be avoided. No sediment would result from these actions. Fish use by pigeon guillemot is not significant compared to fish predation by other fish, mammals, and other birds. There are about 225,000 other fish-eating seabirds in PWS and only about 2,000 pigeon guillemot (Cushing et al 2011). Impacts to herring and other fish would be negligible. Pacific herring are not an important part of the diet of guillemot (Golet et al. 2000).

The anadromous fish streams on the islands would not be disturbed by the trapping operation or by the small infrastructure necessary to trap mink on the islands. No impact to pink salmon would occur under this alternative and there would be no change to riparian vegetation.

Threatened and Endangered Species

No effect to threatened and endangered species would occur under this alternative with either the boat based or land based option. No designated Critical Habitat occurs within the project area. The endangered Steller sea lion do not breed at the Naked Island group, but may occasionally occur on island beaches. There are no haul-outs or rookeries within 3000 feet of the Naked Island group that would be impacted by project activities. Sea lion observed during the operation would not be disturbed. Trappers would avoid beaches that are being used by Steller's sea lion. Steller's eider, North Pacific right whale, and humpback whale would not be affected.

Impacts to Wilderness Study Area

Under both the boat or land based option, there would be a positive effect to the wilderness character as more pigeon guillemot and other seabirds increase in numbers similar to those found at the time of wilderness study designation in 1980. Restoring the guillemot population would also have a positive impact on the recreation, scenic, and conservation public purposes of wilderness. Mink would still be present but at lower numbers than currently exist. Mitigation listed on pages 49-50 would further reduce any negative potential impacts to wilderness character.

Option 1: Boat Based. There would be minor temporary effects to wilderness character while the wildlife specialists were removing mink from the coastal trapping zone. The impacts relate to opportunities for solitude during the project However, these impacts to wilderness character are temporary and would not be permanent.

- No temporary shelters or structures would be used during the reduction program, so there would be no impact to the undeveloped qualities of the area
- All evening activities (food and lodging) would occur on a support vessel, while mink removal in the coastal trapping zone would be land based.
- Summer restoration monitoring/research staff would use campsite B.1 during May-August for five years. The camp would be utilized by two to four research staff for the entire summer and the camp would be located along the coastline beach within ~50 m of the high tide line. This activity is covered by a previously issued USFS Special Use Permit. On-site storage of supplies is allowed under this permit.

Option 2: Land Based. There would be temporary effects to both the undeveloped quality and opportunities for solitude from camp operations and the presence of wildlife specialists removing mink from the nesting area and nesting buffer area. These impacts to wilderness character would not be permanent.

- Temporary structures would be used for the reduction program for up to five years. On-site storing of platforms throughout the year, if permitted by a USFS special use permit, would temporarily affect the wilderness character.
- Camping associated with trapping operations would occur during a three to five month period from January to May, when visitation is low. The presence of snow during these periods and use of wooden floor sections and wooden walkways would negate trampling of vegetation. The wilderness character for island visitors would not be affected as island visitation in these months is extremely low. All human waste would be stored and transported off-site for disposal at a waste treatment plant.
- Summer restoration monitoring/research staff would use campsite B.1 during May-August for five years. The camp would be utilized by two to four research staff for the entire summer and the camp would be located along the coastline beach within ~50 m of the high tide line. This activity is covered by a previously issued USFS Special Use Permit. On-site storage of supplies is allowed under this permit.

Impacts to Cultural Resources

According to the Programmatic Agreement among the USDA USFS, Alaska Region, the Advisory Council on Historic Preservation, and the Alaska State Historic Preservation Officer regarding Heritage Program Management on National Forests in Alaska, the proposed undertaking has no potential to effect historic properties. The Heritage Program on the Glacier Ranger District reached this conclusion based on the guidelines set forth in Appendix B of the Programmatic Agreement, section 33. Reintroduction or management of endemic or native faunal species into their historical habitats is included within the class of undertakings that has No Potential to Affect Historic Properties.

<u>Option 1: Boat Based</u>

No temporary shelters or structures would be used at the Naked Island group, as all mink removal support activities would be conducted by boat. Actions would cause no effects to cultural resources. Mitigation measures to ensure protection of cultural areas include: no cutting of trees, avoiding placement of traps on trees over 50 years old, and avoidance of sensitive areas. In the event of unintentional discovery during program implementation, any cultural artifacts or human remains encountered would not be disturbed or removed, left in place, and reported to the USFS.

Option 2: Land Based

Temporary structures would be used for support of the trapping program. Actions would cause no effects to cultural resources. All camping would be at camps approved by the USFS and would follow guidelines established in the special use permit to avoid adverse impacts to cultural resources possibly encountered during trapping program implementation.

Impacts to Recreational Resources

There would likely be a negligible to moderate positive effect to recreation resources as a result of this alternative. Recovery of pigeon guillemot and other seabirds at the Naked Island group would likely increase ecotourism potential with a greater number of seabirds to observe by visitors.

- Mink reduction activities would be conducted during the winter/spring months and would avoid potential conflicts with visiting publics, as little, if any visitation occurs during the winter/spring period.
- There would be no impact to deer hunting under this alternative, as the season ends December 31.
- Existing trapping opportunities would exist; the public trapping season starts November 10 and continues through February, but there would be fewer mink on the islands. It is likely that this alternative would have a negligible to minor impact on public trapping activities, as few trappers utilize the Naked Island group because of its remoteness.
- Camps would be taken down when trapping is complete or by June 1. Materials will be stored as specified by the USFS.

Impacts to Social and Economic Values

Communities

Removal of mink at the Naked Island group would not adversely affect trappers in PWS, as mink fur prices are currently low and the Naked Island group is too remote for most trappers in the region. There may be temporary benefit as local trappers could potentially be used for the trapping program.

Mink carcasses could be donated to universities for research purposes and/or donated to Native villages for cultural purposes. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.)

Tourism would be enhanced as the pigeon guillemot and other seabird populations' increase.

Subsistence

Removal of mink at the Naked Island group would not adversely affect subsistence trapping in PWS, as the Naked Island group constitutes less than two percent of the PWS shoreline. Low mink fur prices and the remoteness of Naked Island group preclude trapping activity. There would be temporary benefit if local Native Alaskan trappers would be used for the trapping program. Native villages could benefit from mink carcasses that would be used for cultural purposes. There is currently little interest in trapping for mink.

Cumulative Impacts

The actions in Alternative B: Proposed Action – Control of Predatory Mink would result in negligible to moderate cumulative impacts. The USFWS has a previously issued USFS Special Use Permit for an ongoing summer monitoring/research operations at campsite B-1. On-site storage of supplies has been allowed under this permit. The USFWS have not occupied the site for the last few years. Impacts have been and are negligible. Mink would be reduced at the Naked Island group, but it represents only two percent of the shoreline in PWS, so any impact would be negligible. Pigeon guillemot have historically been important at the Naked Island group and comprised 25 percent of the pigeon guillemot in PWS, therefore, an increase of the pigeon guillemot population as well as other seabirds would have a moderate positive cumulative impact on PWS.

Mitigation Measures

Removal methods/techniques proposed are specific to mink and would pose no risk to human health and safety. Trapping would be the primary reduction method and is the most practical and effective control method available (Boggess1994; Macdonald and Harrington 2003; Moore et al. 2003; Davis et al. 2012) and balances efficacy, humane euthanasia, and human safety. Techniques to lessen or eliminate the catching species other than mink, specifically river otter would be utilized (Bixler and Irons 2010). No other mammals similar in size to mink, such as American marten or weasel, are known to occur on the islands.

Seasonal timing and careful placement of capture devices to specifically target mink are the primary mitigation measures to avoid unintended take of other species during trapping operations. All trapping in burrow-nesting seabird colonies would be completed before seabirds begin to attend nesting burrows in May. Crevice-nesting and cliff ledge nesting seabird use areas, not likely used by mink, would not be affected by the removal operation.

Intensive trapping would take place primarily during the winter months, when public visitation is minimal, snow covers the ground, and vegetation is not vulnerable to trampling and erosion. Camp locations would be approved by the USFS.

The geography of the Naked Island group improves the likelihood of removing mink. The islands are relatively small with gentle topography and access to safe anchorages (Courchamp et al. 2003, Bonesi and Palazon 2007). By trapping in the winter/spring months when there is one to two meters of snow on the islands, the mink would be concentrated along the snow-free intertidal zone where food would be most available.

Mitigation measures are all positive actions that reduce or avoid impacts to the Nellie Juan-College Fiord Wilderness Study Area and the environment. Measures include:

- The USFWS and APHIS-WS would coordinate with USFS personnel to select and establish camp locations to minimize impacts to vegetation and other resources.
- The USFWS, APHIS-WS, and those working under the funding Agreement would follow Leave No Trace (LNT) practices during all operations. The USFS would require LNT training to project personnel prior to project implementation.
- Photographs of campsites prior to establishment and during operations will be provided to the USFS permit administrator at least once per trapping season.
- The USFWS would conduct the project in a manner that requires the fewest camps (three or less) established at one time.
- Minimize to greatest extent possible use of motorized or mechanized equipment and include all motorized/mechanized uses in Wilderness Minimum Requirements Decision Guide (MRDG) process.
- Limit installations such as tent platforms, storage sites, and others to only what is described in the permit and MRDG.
- USFS will provide to project personnel materials on WSA to promote an understanding of how the WSA is managed differently than other lands.
- Winter camps would use chargeable marine or similar batteries for electronics to minimize use of generators
- Camps would be placed to take advantage of natural screening from beaches and marine waters.
- Camp personnel would avoid having fires, unless allowed under a USFS special use permit.
- Food and food waste would be stored in a manner that prevents wildlife access.
- Camp equipment and trash would be neatly maintained and kept out of sight of visitors. Camp developments would be kept to the minimum necessary for the project.
- Camping equipment would not be stored on-site, unless permitted under a USFS special use permit.)
- Sites would be restored to USFS standards before camps are abandoned for the season. Photographs of each abandoned campsite will be provided to the USFS permit administrator.
- Human waste would be packed out from all camps in sealed containers.
- Camps would be at least 60 m from flowing streams or lakes.

Mitigation measures designed to maintain the natural quality and opportunities for solitude in the Wilderness Study Area would include:

- Without compromising health or safety, vessels with minimal generator requirements are preferable to vessels requiring overnight generator use. Low noise generators would be utilized intermittently.
- Personnel would minimize motorized tender use as best as possible and avoid loud music or other sights and sounds not related to the project and that may increase impacts to solitude.

- Personnel would exercise consideration that visitors to the Wilderness Study Area often seek opportunities for solitude and primitive recreation.
- Wildlife specialists would follow LNT practices while implementing this project.

Conclusion

The opportunity to recover pigeon guillemot breeding to 1,000 birds or more from the current 100 birds and to recover the other impacted species: tufted puffins from a few to 750, parakeet auklets from a few to about 170 and horned puffins from the few remaining birds to more than 60 are possible with the control of predatory mink at the Naked Island group. "Recovered" numbers would reflect the seabird populations after the wilderness study area was designated in 1980.

Recovery of pigeon guillemot at the Naked Island group would result in a substantial increase in the PWS-wide population and the removal of the pigeon guillemot from the EVOS Trustee Council "not recovering list" and be classified as "recovered".

CONSULTATION AND COORDINATION

Collaborating and communicating with federal, state, and local agencies; stakeholders and the public; including consultation with Native Alaskan Tribes and Corporations has taken place throughout preparation of this EA. There are over 50 organizations and individuals on the EA mailing list.

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APPENDIX A: PUBLIC INVOLVEMENT

INTRODUCTION

Collaborating and communicating with federal, state, and local agencies; stakeholders and the public; including consultation with Alaska Native Tribes and Corporations has taken place throughout preparation of this EA. Providing the public and partners with an opportunity to voice their issues, concerns, and ideas during preparation of the EA regarding restoration of pigeon guillemots to the Naked Island group has been critical to the success of this project.

PUBLIC SCOPING

The public scoping period began January 30, 2012 and ended March 29, 2012 A variety of means were used during the public scoping period to reach out to those who wanted to comment. A press release was prepared and sent out; a mailing list with over 60 individuals and organizations was prepared, Alaska Native consultations were conducted; four public scoping meetings were held in Valdez (February 21, 2013), Cordova (February 22, 2013), Whittier (February 23, 2013), and Anchorage (February 27, 2013), Alaska; a summary of the project was prepared and provided to meeting participants; and those interested in the EA were encouraged to contact the project leader There were few participants at the four public meetings and no written correspondence, emails, or phone calls were received from the public during this public scoping period. Information gathered during the public scoping period was considered during preparation of the draft and this final EA.

Tribal Consultation

The USFS began formal consultations on December 29, 2011. Glacier District Ranger sent out consultation letters to the Chugach Alaska Corporation, Chenega IRA Council, Native Village of Eyak, Port Graham Village Council, Seldovia Village Tribe, Tatitlek Village IRA Council, and the Native Village of Nanwalek. Tribes and organizations were contacted again after the initial consultation for any additional feedback, but provided no further response The Chugach Alaska Corporation stated there were pre-historic sites on the island that required protection and suggested efforts should be made to incorporate native trappers for project implementation if the proposal were to go forward. On June 11, 2013, Ed DeCleva, Chugach Forest Archaeologist and Tribal Relations Specialist, discussed the project with John Johnson, Chugach Alaska Corporation. Mr Johnson reiterated the corporation's desire that the project would be implemented utilizing local Alaska Native workforce.

Public Comment

The following issues, concerns, questions, and ideas were received during the public scoping period. Responses to questions, concerns, and suggestions follow in italics. They were addressed in the draft EA, dated July 19, 2013.

Questions and Comments:

- Are mink natural or introduced, and if so, are they part of the natural ecosystem process? *There were mink present at the Naked Island group prior to the EVOS Evidence indicates* *that some mink were introduced at the Naked Island group, but conclusive evidence is lacking whether all mink on the islands were introduced. The determination of whether or not mink are native or introduced is uncertain and beyond the scope of this EA.*

- Mink always have been present (in PWS) and were there before the EVOS. *Mink are native to the mainland and many islands close to the mainland of PWS. Again, evidence indicates mink may have been introduced at the Naked Island group, but conclusive evidence is lacking. Whether or not mink are native or introduced is uncertain and beyond the scope of this EA.*
- Did the original mink population decline from an event and then recover? *We have no data on this topic.*
- Don't know of anyone trapping at the Naked Island group. *Trapping of mink is authorized at the Naked Island group by ADF&G regulations (ADF&G 2013) and 2013 harvest limits for mink at the Naked Island group are unrestricted. Public trapping efforts appear to be minimal due to the isolation and remoteness of the Naked Island group.*
- Forage resources, i.e. herring, that have declined are the possible impact to pigeon guillemot and other birds. *Forage fish have declined, but now are increasing. Forage fish been determined to have little effect on decline of pigeon guillemot and other seabirds.*
- Herring and sand lance are recovering and you will see a recovery of forage fish, and consequently a recovery of birds. *Herring and sand lance are recovering. However, mink are the primary predator of birds and the recovery of herring and sand lance do not appear to be helping the recovery of birds. Pigeon guillemot populations at the Naked Island group do not appear to be food-limited (Bixler et al 2010). Data (Irons 2013) indicates that nesting success and chick survival are the primary limiting factor of that population, and the reason for population decline on the islands. Data indicates mink are responsible for these declines.*
- Trapping will be a multi-year effort. *We agree and expect it would be a three to five year effort. A significant increase in the pigeon guillemot population is expected after ten years. The Proposed Action has more information on this topic.*
- Will birds be transplanted to the Naked Island group after the removal of mink to increase biodiversity? *Pigeon guillemot still nests but in greatly reduced numbers at the Naked Island group, so no transplants are required or being considered in this proposal.*
- How did mink get to the Naked Island group? *There is uncertainty determining how mink got to the Naked Island group. Fox farming was prevalent throughout PWS and parts of Alaska (Isto 2012), and a wide variety of fur bearing animals (and prey to feed them) were placed on islands by early Russian and later fur trappers. Reports from local residents suggest mink were dropped on the Island in the late 1970's (Bilderback, Jensen pers comm).*

Issues and Concerns:

- There is concern that other animals, river otter, sea otter, on these islands will not be exterminated during this removal process. *Traps that would be used are too small to kill or harm other mammals living on the islands. The Proposed Action in Chapter 2, as well as mitigation measures discussed in Chapter 4, address this topic in more detail.*
- It is impossible to eliminate mink at the Naked Island group. R*ecovery of pigeon guillemot is the purpose of this EA, not the extirpation of mink from the Naked Island group.*
- Dangers exist with a trapping program in the winter, i.e. weather, poor anchorages. *These dangers are recognized and safety precautions would be undertaken.*

Suggestions:

- It is felt that the local PWS residents and the Alaska Native population or rural residents of PWS should be offered the jobs such as: the trapping, boat charters and maintenance of camp facility. *APHIS-WS, working closely with USFWS would provide opportunities for assisting in the trapping program.*
- The furs should be donated for cultural programs within the Chugach Region. *Mink carcasses would be made available for cultural programs, as per ADF&G regulations.*
- Chugach Regional Corporation has a historic site on Storey Island that was once a fox farm. Efforts should be made to protect this site from adverse impacts. *Historic sites would not be affected by project implementation (see migration measures).*
- Conduct a limited harvest to reduce mink numbers. *Currently, no limit on the numbers of mink that can be legally trapped exists, but little or no public trapping occurs at this time because of the isolation of the Naked Island group.*
- Use a bounty or fee system and local trappers to eliminate mink. *Local trappers may have the opportunity to be part of the trapping program and work with APHIS-WS as part of their funding Agreement. The recovery of pigeon guillemot on the Naked Island group and PWS is the EA purpose, not the elimination of mink.*
- Utilize local people to conduct trapping effort. *APHIS-WS, working closely with USFWS would provide opportunities for assisting in the trapping program.*
- Use a bid process to select trappers. *APHIS-WS would be conducting the trapping and has the responsibility to select trappers.*
- Requested planning team to look at the Rat Island Plan/implementation to determine how birds are recovering after removal of rats. *The planning team reviewed the results and it appears that birds are already recovering.*

REVIEW OF THE DRAFT ENVIRONMENTAL ASSESSMENT

The review period for the draft EA began on July 19, 2013 and ended on August 16, 2013. Over 60 organizations and individuals were included on a mailing list and received the draft EA for their review and comment. A press release was prepared and sent out with a copy of the draft EA on July 19, 2013 to Anchorage, Cordova, and Valdez. The project leader was interviewed by the Alaska Dispatch and an article explaining the project and encouraging the public to respond followed. The USFWS website announced the review period and encouraged the public to review and comment on the draft EA. During this 30-day review period, thirty two individuals and organizations responded and provided comments. The ADF&G provided formal comments (letter part of this appendix). Finally, the cooperators, USFWS, USFS, and APHIS-WS worked closely to ensure that public and agency comments were addressed and incorporated.

Following are those comments considered substantive and requiring a response.

Restore Pigeon Guillemot population. Remove, but do not harm American mink. Relocate mink from the Naked Island group.

It is not recommended to remove and relocate mink for the following reasons:

- *There are already sufficient and established mink populations in PWS, so that a transplant program would not be advisable.*

- *If a mink transplant program were proposed, a new EA would likely need to be prepared to assess the impacts of transplanting mink.*
- *Relocated mink must find new food sources and shelter in an unfamiliar environment. In the winter time, relocated mink have little time to find shelter or food and would most likely perish.*
- *Relocation may result in the starvation deaths of young that have lost their mother by inadvertently relocating her away from her young.*
- *Relocating mink raises the risk of introducing diseases to new and uninfected locales.*
- *Mink will likely be relocated to areas that are already home to mink and other animals. These animals may not welcome newcomers or share good sources and shelter. This may create stress and conflict among animals, which can lead to injury or death.*
- *The ADF&G 2010 policy on transplanting wildlife contain criteria and procedures for allowing wildlife transplants. Transplanting mink from the Naked Island group does not meet these criteria or procedures. Due to the established mink populations being present where mink habitat exists, the ADF&G would not support a transplant program.*

Restore pigeon guillemot population by removal of mink. Supports Alternative B: Proposed Action-Control of Predatory Mink.

There are compelling reasons for restoring the pigeon guillemot population at the Naked Island group. Predator control is a practical, scientifically based management tool for initiating the recovery of the pigeon guillemot population. Please refer to the Final Environmental Assessment for a full discussion of this topic. However, some of the main reasons for restoring the pigeon guillemot population are:

- *Pigeon guillemot is the only marine bird species listed as "not recovering" on the Exxon Valdez Oil Spill (EVOS) Trustee Council's Injured Resources List, and shows no indication of population recovery. An EVOS Trustee Council objective is to pursue alternatives to actively shift the population status toward full recovery.*
- *One fourth of all pigeon guillemot nests in Prince William Sound (PWS) in 1989 (just after the spill) were located at the Naked Island group, although the islands constitute only about two percent of the total shoreline in PWS.*
- *Restoration of pigeon guillemot at the Naked Island group to the 1989 levels could result in a substantial PWS-wide population increase. It is estimated that 15 years after mink removal, the pigeon guillemot will be removed from the "not recovering" list and be added to the "recovered list" with more than 1000 birds present.*
- *Pigeon guillemot restoration to historic levels at the time of congressional designation of the Nellie Juan-College Fiord Wilderness Study Area would enhance its wilderness values and character since bird populations have diminished significantly since designation.*

Does not support Alternative A: No Action-Current Management or Alternative B: Proposed Action-Control of Predatory Mink.

- *The USFS is mandated to manage the Nellie Juan-College fiord Wilderness Study Area as wilderness until such time that congress determines its future.*
- *Please refer to comments above regarding reasons for implementing Alternative B: Proposed Action-Control of Predatory Mink.*

Do not remove the American mink. Protect American Mink.

- *The proposed action does not propose extirpating all mink from the Naked Island group, rather removing mink from within 500 m of nesting and breeding pigeon guillemot.*
- *Predation by mink is the primary factor limiting pigeon guillemot population recovery at the Naked Island group (Irons et al. 2013).*
- *Mink predation on eggs and chicks in nests and adults combined with the decline due to EVOS has suppressed pigeon guillemot populations at the Naked Island group.*
- *Other seabirds have also been affected. Parakeet auklets, tufted puffins, and horned puffin declined from about 1,400 breeding birds to approximately twelve (Bixler 2010). Prior to the EVOS the Naked Island group supported the highest number of nesting pairs of parakeet auklet in PWS.*
- *Available evidence and modeling indicate that reducing mink predation on eggs, chicks and adults would result in a measureable increase in the breeding population and productivity of pigeon guillemot.*
- *Removing mink will allow full "recovery" of pigeon guillemot at the Naked Island group within 15 years after mink removal.*

Just let nature run its course. Supports Alternative A: No Action-Current Management.

- *Allowing nature to run its course would result in a further decline of pigeon guillemot at the Naked Island group.*
- *Mink would continue to depredate pigeon guillemot. It is predicted that 18 birds would remain at the end 20 year, if nothing is done. There is the potential of the loss of all pigeon guillemot and other seabirds nesting from the Naked Island group over time.*
- *Pigeon guillemot would remain the only marine bird species on the EVOS Trustee Council "not recovering" list.*

Is there potential to sterilize the mink to cut down on their population?

Sterilization will not stop mink from depredating pigeon guillemot, it will continue until all mink have been successfully sterilized, ceased reproduction, and the population ceases to exist due to age. However, that would be an eradication program and does not support the proposed action for controlling predatory mink. Technically, significant issues exist with sterilizing mink in the field that need to be considered and overcome. If a sterilization program were proposed, it is likely that a new EA would be needed to evaluate the feasibility and impacts.

Support removal of American mink but save money by providing a generous bounty to private trappers to accomplish the project.

Bounties are not an effective tool to reduce wildlife populations. The bounty system has a long history (>100 years in the U.S.) of use in many states without ever achieving the intended results of reducing damage and population levels (Parker 1995). Issues associated with the use of a bounty system include:

- *Circumstances surrounding take of mink would be largely unregulated.*
- *No effective process exists to prohibit taking of animals from outside the Naked Island group for compensation purposes.*

- *Bounty hunters may indiscriminately kill other species while trapping mink.*
- *Mink could be extirpated from the islands by overzealous bounty hunters and that does not support the proposed action for controlling predatory mink.*

Support removal of mink, but skeptical that mink can be thinned, as their numbers rebound quickly.

- *Mink are not particularly long-lived. Captive mink may reach eight years, but the average longevity for wild animals is believed to be about three years. Coastal mink are born primarily in mid- to late July with litters of up to eight kits, but with an average of about four. Females produce only one litter yearly. Fur farm mink have 20% kit mortality from birth to weaning (Schneider and Hunter 1993) and wild mink are probably very similar.*
- *Winters, especially those with heavy snowfall, would reduce mink foraging to areas primarily along the water. Mink have a high metabolic rate and lose condition rapidly, if food is scarce. Inadequate nutrition can lead to direct mortality by starvation, or indirectly, through reduced resistance to disease, and increased exposure to predation as mink spend more time searching for food. Dispersing juveniles have inconsistent access to productive hunting spots, and are the most vulnerable in that regard. Adult females may also be relegated to a position of nutritional deprivation, when the ratio of males in a population is high.*
- *These factors and the elimination of mink from the areas surrounding pigeon guillemot colonies are anticipated to reduce mink populations and predation of nesting pigeon guillemots and other seabirds.*

Wild mink immigration and emigration from island group to larger islands and mainland is underestimated in frequency.

- *Studies of introduced mink colonizing islands in Europe suggest mink will traverse no more than 2 km of open water (e.g., Craik 1997, Clode & MacDonald 2002), although a study in Tierra del Fuego reported that mink swam 4 km to reach an island (Anderson 2006). Liberated or escaped animals from mink farms on the Argentine side of Tierra del Fuego might have swum across the Beagle Channel (ca.5 km wide) (Schuttler et al. 2010). Whether mink populations that evolved in a marine environment, such as those in PWS, are more inclined to swim distances of 6 km is not known, but European mink is one of the larger subspecies, so long-distance dispersal over open water may be more likely for them than for a smaller, freshwater-adapted subspecies (Bixler et al. 2010).*

THE STATE
of ALASKA
GOVERNOR SEAN PARNELL

Department of Fish and Game
DIVISION OF WILDLIFE CONSERVATION
Headquarters Office

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August 16, 2013

David Irons, Seabird Coordinator
U.S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, Alaska 99503 USA

Dear Mr. Irons:

The Department of Fish and Game (Department) has reviewed the Environmental Assessment Draft Potential Recovery of Pigeon Guillemots Populations Naked Island Group, Prince William Sounds, Chugach National Forest, Alaska, July 19, 2013 (EA). As a professional fish and wildlife management agency, the Department supports scientifically responsible management actions to respond to alterations in the populations of species when determined necessary. In this instance we believe that the proposed action of using a predator control program to reduce predation by mink on pigeon guillemots has been properly developed and analyzed. The proposed action would support the intent of recovering the affected population of pigeon guillemots from declines caused initially by the Exxon Valdez Oil Spill (EVOS) and exacerbated by predation by mink.

Because the Department has been able to work closely with the US Forest Service and the US Fish and Wildlife Service during the development of this EA we have few comments. We remain available to assist the Service in responding to questions related to the proposed action.

Please accept the following comments:

Page 9, the Department disagrees that mink are the major reason for the population decline of pigeon guillemots as indicated in the italicized comment below. It is our understanding that the EVOS was the cause of the population decline and that predation by mink is responsible for their continued low abundance.

> Mink are native to the Gulf of Alaska ecoregion (ADF&G 2006). Genetic analysis of populations in PWS (Fleming and Cook 2012) indicates mink at the Naked Island group are of the same or very close lineage to mink found in PWS. Fleming and Cook (2010) also regarded the Knight Island Archipelago, as the primary source of mink at the Naked Island group. Neither mink nor their predation was noted until mid-1990, although studies of pigeon guillemot were ongoing at

the Naked Island group since the late 1970's (Hayes 1995, Golet et al. 2002). As definitive data are not conclusive, ADF&G considers mink to be native to the Naked Island group. Whether or not mink are native or introduced will not be addressed in this EA. However, what is clear is that the population of pigeon guillemot has declined at a dramatic rate, *and mink are the major reason for this population decline.* Additional information can be found at Irons et al. (2013)."(*italics added*)

Page 13, the italicized comment below indicates the US Forest Service considers mink to be an exotic animal in the Naked Island Group. The Department does not agree and absent definitive proof otherwise, consider mink to be a native species of the area.

2002 Revised Land and Resource Management Plan, Chugach National Forest
The Revised Forest Plan (USDA Forest Service 2002), as amended, provides a framework that guides the Chugach National Forest's day-to-day resource management operations. It is reviewed and revised approximately every 15 years. The Naked Island group is managed under the Recommended Wilderness management prescription. During preparation of this EA, the two alternatives met the goals and objectives of the Revised Forest Plan. The USFS prepared a Forest Plan Consistency Checklist (part of administrative record) to ensure that all Forest Plan standards and guidelines were considered in this EA. The Recommended Management Area is managed to maintain and protect the existing wilderness character. The ecological desired conditions stipulate that the area would be largely unaffected by human activity and dominate the area. *The Recommended Wilderness Management prescriptions allow for treatments or measures to be taken on exotic animals to minimize impacts on ecological processes.(italics added)*

Sincerely,

Douglas Vincent-Lang
Director

APPENDIX B: DECISION NOTICE/FINDING OF NO SIGNIFICANT IMPACT

U.S. Department of the Interior
Fish and Wildlife Service
Region 7, Alaska

DECISION NOTICE
FINDING OF NO SIGNIFICANT IMPACT

Final Environmental Assessment:
Potential Recovery of Pigeon Guillemot Populations
Naked Island Group, Prince William Sound
Chugach National Forest, Alaska
October 2013

The U.S. Fish and Wildlife Service (USFWS) as the lead agency, along with the cooperating agencies, U.S. Forest Service (USFS) and the U.S. Animal and Plant Health Inspection Service-Wildlife Services (APHIS-WS) have completed the Environmental Assessment (EA) for Potential Recovery of Pigeon Guillemot Populations. The Exxon Valdez Oil Spill (EVOS) Trustee Council provided funding for this EA in order to determine the potential for restoring the pigeon guillemot (*Cepphus columba*) at the Naked Island group in Prince William Sound, Alaska and removing the pigeon guillemot as the last bird remaining on their "not recovering" list. The Naked Island group is administered by the USFS and is part of the designated Nellie Juan-College Fiord Wilderness Study Area. Predation by American mink (*Neovision vision*) is the primary factor limiting pigeon guillemot population recovery at the Naked Island group.

PUBLIC REVIEW

Collaborating and communicating with federal, state, and local agencies; stakeholders and the public; including consultation with Native Alaskan Tribes and Corporations has taken place throughout preparation of this EA. Public comments were received during the public scoping period of late January-March 2012 and considered during preparation of the draft EA. Thirty-two public comment letters from individuals and organizations were received on the draft EA from July 19, 2013 to August 17, 2013. These comments, as well as those received from the Alaska Department of Fish & Game (ADF&G), were considered during preparation of the final EA.

ALTERNATIVES CONSIDERED

The Final EA (herein incorporated by reference) describes two alternatives that explore the potential to recover the pigeon guillemot populations at the Naked Island group:

Alternative A: No Action-Current Management. Under this alternative, no management action to control or reduce mink would be taken. Nesting pigeon guillemot and other seabirds would still persist at the Naked Island group, but greatly reduced from historical abundance numbers.

Alternative B: Proposed Action-Control of Predatory Mink. Restoring the pigeon guillemot would be accomplished in about fifteen years following the removal of mink. Mink would be removed by trapping, and later, shooting during a five year period. Restoration of the pigeon guillemot population at the Naked Island group would result in the pigeon guillemot being removed from the EVOS Trustee Council's "not recovering" list.

DECISION AND SELECTION OF PREFERRED ALTERNATIVE

Based on this assessment and comments received, I have selected Alternative B: Proposed Action-Control of Predatory Mink as the preferred alternative for implementation. The preferred alternative was selected because it best meets the purpose of restoring the pigeon guillemot population at the Naked Island group to 1,000 adult/breeding birds, fifteen years after removal of mink, and subsequently removing the pigeon guillemot from the EVOS Trustee Council "not recovering" list to the "recovered" list. Great care will be taken to use minimum tools, as well as proper mitigation measures during implementation of the preferred alternative to protect wilderness values at the Naked Island group. The details for implementing this alternative are contained in the Final EA.

The following is a summary of anticipated environmental effects from implementation of the preferred alternative:

- The preferred alternative will not adversely impact geological resources, soils, vegetation, water resources or wildlife.
- The preferred alternative will not adversely impact endangered or threatened species or their habitat.
- The preferred alternative will not adversely impact archaeological or historical resources.
- The preferred alternative will not adversely impact wilderness values or wilderness character.
- The preferred alternative will not have a disproportionately high or adverse human health or environmental effect on minority or low-income populations.

Based on review and evaluation of the information contained in the Final EA, I have determined that there will be no significant individual or cumulative impacts to the human environment, within the meaning of section 102(2)(c) of the National Environmental Policy Act of 1969, as amended. I have determined that the activities prescribed in the preferred alternative are not major Federal actions. Accordingly, preparation of an environmental impact statement is not required.

Completion and approval of this Final EA, including decision and selection of the preferred alternative provides the justification for reviewing funding by the EVOS Trustee Council. This Final EA and preferred alternative provide information for the issuance of appropriate permits by the USFS and ADF&G. Lastly; the preferred alternative provides direction to APHIS-WS for assisting to control predatory mink.

U. S. Fish and Wildlife Service:

10/21/2013

Pete Probasco Date
Assistant Regional Director, Migratory Birds and State Programs

Cooperating Agency – APHIS-Wildlife Services

APHIS-Wildlife Services, under its own agency authorities, agree with the USFWS Final EA, the FONSI, and Decision to protect pigeon guillemots at the Naked Island group from predatory mink and hereby adopt the Final EA, the FONSI, and Decision Notice.

10/21/13

Gary Littauer Date
Acting Western Regional Director

APPENDIX C: ONLINE RESOURCES

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APPENDIX D: COMPLIANCE WITH OTHER LAWS AND REGULATIONS

ANILCA Section 810, Subsistence Evaluation and Finding

As documented or reported there is little subsistence uses or resources that would be impacted by the alternatives at the Naked Island Group. For this reason, this action would not result in a significant possibility of a significant restriction of subsistence use of wildlife, fish, or other foods.

ANILCA Section 811, Subsistence Evaluation and Finding

There is no documented or reported subsistence access that would be restricted as a result of the proposed action. For this reason, this action would not result in a significant possibility of a significant restriction of subsistence users having reasonable access to subsistence resources on National Forest System Lands.

Endangered Species Act of 1973

The endangered Steller sea lion do not breed or have known haul-out sites at the Naked Island group, but may occasionally occur on island beaches. Sea lions observed during the operation would not be disturbed. Trappers would avoid beaches that are being used by Steller's sea lions. Steller's eider, North Pacific right whale, and humpback whale would not be affected.

National Historic Preservation Act of 1966

This EA evaluated the environmental impacts to cultural resources and determined that because the alternatives proposed do not propose to disturb significant areas, and most activity would be over snow, and it is unlikely that cultural resources are present or would be impacted.

Floodplain Management (E.O. 11988), Protection of Wetlands (E.O. 11990)

The construction of the facilities needed for trapping operations or the actual trapping would not impact the functional value of any floodplain as defined by Executive Order 11988 and would not have negative impacts on wetlands as defined by Executive Order 11990.

Recreational Fisheries (E.O. 12962)

There are five anadromous streams at the Naked Island group. These have the only recreational fishing potential within National Forest System lands. As documented since there are no effects to fisheries resources there would be no negative direct, indirect or cumulative impacts related to this Order.

Environmental Justice (E.O. 12898)

It has been determined that, in accordance with Executive Order 12898, the implementation of the proposed action does not have disproportionately high and adverse human health or environmental effects on minority populations and low income populations.

Migratory Bird Treaty Act of 1918, as amended

Most trapping activities would occur outside the breeding season for birds in Southcentral Alaska. No vegetation or nest sites would be affected due to the proposed action. Potential disturbances to nesting birds would be avoided by following the mitigation measures identified in this EA. The ongoing monitoring activities on pigeon guillemot, under separate USFS Special Use Permit, follow USFWS bird permitting policies to reduce impacts.

Magnuson-Stevens Fishery Conservation and Management Act

The project area contains five anadromous streams. Action taken under the action would not impact anadromous fish habitat. Since no disturbance of the anadromous fish habitat (EFH) on the islands is anticipated, this project would not affect EFH.

APPENDIX E: INFORMATION ON THE MODEL USED TO PROJECT PIGEON GUILLEMOT POPULATION TRENDS WITH CURRENT MANAGEMENT AND CONTROL OF PREDATORY MINK MODELING

Potential changes in the growth of the pigeon guillemot population at the Naked Island group were modeled to inform the decision-making process. This modeling coincides with the two management alternatives: Alternative A: No Action-Current Management and Alternative B: Proposed Action-Control of Predatory Mink (Chapter 2). A stochastic Leslie matrix model after Golet et al. (2002) and Bixler et al (2010) was used to project guillemot population growth under these scenarios.

The following equation was used to project the growth rate of the guillemot population:

(λ): $\lambda = ((PF * FX * PA^{2}) + (NX * PA)) / NX$

λ = annual population growth rate
P_F = annual sub-adult survival rate
F_X = number of offspring produced
P_A = age-constant annual adult survival
N_X = initial population size

The observed rate of population change of pigeon guillemot at the Naked Island group from 1989 to 2008 was an approximate 12.7 percent annual decline (Bixler et al. 2010). Observed population change of pigeon guillemot at the also oiled, but mink-free Smith Islands was a 0.53 percent increase over the same time period, as pigeon guillemot recovered from EVOS. Thus, it is assumed that the long-term decline at the Naked Island Group was likely due to mink predation.

An example of the possible maximum rate of increase for pigeon guillemot was 13.6 percent annually for six years was noted by Byrd (2001) in the western Aleutian Islands when arctic fox were removed from two islands. Pigeon guillemot numbers on nearby islands where arctic fox were not removed changed only slightly. Seabirds prospect at the end of summer for good breeding sites (ones with evident chicks) and this may result in immigration to productive colonies from nonproductive colonies (Boulinier and Danchin 1997).

The modeling strategy used the best data available to quantify a matrix population projection model. The model assumed a maximum average adult survival rate of 0.9 under optimal conditions. Although no empirical estimates of adult survival exist for pigeon guillemot, this assumption is reasonable considering adult survival data across a range of different seabird species (Schmutz 2009). The assumption is very similar to the rate of 0.89 estimated for black guillemot (Frederiksen and Petersen 1999). To emulate the decline depicted by Bixler et al. (2010), the mean nest productivity rate of 0.35 was used from study years at Naked Island (1989, 1990, and 1994-1998). Bixler et al. (2010) also noted adult pigeon guillemots were killed at up to ten percent of nest sites. This rate may be an underestimate, if mink remove carcasses from the nest, as the investigator would assume the nest had failed and the adults simply dispersed Regardless, a maximum predation rate of ten percent of the adults was used in the presence of mink (thus base adult survival without mink of 0.9 multiplied by 0.9 (the percent surviving predation in the presence of mink) equals 0.81. This nest survival rate of 0.35 and adult survival rate of 0.81 produced a rate of decline less steep than depicted in Bixler et al. (2010) An adult emigration rate was added, sufficient to produce the trend shown by Bixler et al. (2010). The best value for emigration rate was 15 percent. If this trend were to continue, a population of 100 pigeon guillemot would decrease to seven pigeon guillemot in 20 years. This model reflects the No Action – Current Management alternative.

An adult survival rate of 0.9, a nest survival rate equal of 0.61 (Golet et al. 2002), and an immigration rate equated to the emigration rate was needed to model the pigeon guillemot observed decline at the Naked Island group. The average increase of pigeon guillemot over 20 years was 17 percent annually, nearly identical to the value noted by Byrd (2001) for Simeonof Island. The projection starting point begins when there is assumed to be no mink predation. Additional model simulations could be done to characterize pigeon guillemot response to gradual mink eradication. To emulate a significant removal of mink (90 percent removal) nest survival and adult survival rates of 90 percent of the maximum values in the previous model were utilized. For the Control of Predatory Mink alternative, the average rate of annual increase of pigeon guillemot, over 20 years, was 16 percent.

The above model descriptions are deterministic, as each model parameter has a singular value without variation (e.g., if adult survival is 0.9, then 0.9 is maintained throughout the projection). Stochastic models were run where variability was applied to the system with these core model structures. If biologically realistic parameter values of variability are used, then a stochastic model should be a more realistic representation of possible outcomes. For variability in nest survival (productivity), the data presented in Golet et al. (2002) was used for Naked Island. These data represent both ecologically real variability and also variability due to the sampling process. Variance decomposition procedures were used (Burnham et al.1987) to extract an estimate of process variation in nest survival. A normal distribution of this variability was imposed on the model by using random draws from the distribution, and running the model 1,000 times. The 50th and 950th model runs, sorted by population growth estimates, reflect the confidence interval of this model projection. Stochastic variability was imposed on adult survival rates. This level of variability was taken by using the mean process variation in adult survival from 18 seabird populations listed in Schmutz (2009).

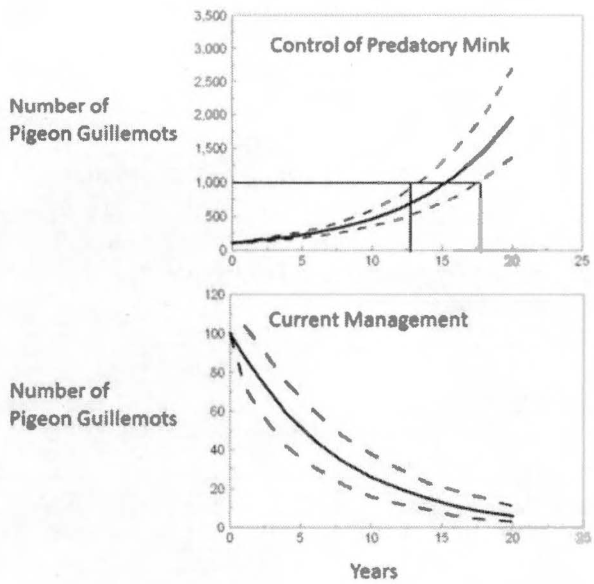

Figure 1. Results of stochastic Leslie matrix modeling of the changes in the pigeon guillemot population at the Naked Island group for two alternatives: No Action – Current Management and Proposed Action – Control of Predatory Mink (Fleming and Cook 2010). Across the two model scenarios, guillemot productivity varies in a monotonic fashion. The graphs start with the year after the actions were completed.

The "No Action – Current Management" alternative represents no control of predatory mink at the Naked Island group and a predation rate based on the empirical predation rate of the 1990s (Bixler et al. 2010). Under the "Proposed Action – Control of Predatory Mink" alternative, a model projecting guillemot population growth, assumed annual removal of mink was sufficient so that few survived at the Naked Island group after each annual management effort and mink predation on guillemot was minimal.

APPENDIX F: TIMELINES

	PIGEON GUILLEMOT	AMERICAN MINK
1895 -1950		Duration of fox fur farming at the Naked Island group.
1908		Alexander Expedition does not note the presence or absence of mink at the Naked Island group
1929		135 mink fur farms operating, mostly in southeast Alaska
1946-1995		No mink observed at the Naked Island group according to local trapper.
1951		Mink introduced to Montague Island in PWS.
1956		Mink introduced to Strait Island in southeast Alaska by Alaska Game Commission and the USFWS.
1972	15,000 summer population of pigeon guillemot and 4,000 pigeon guillemot in winter in PWS	
1972-1997	Pigeon guillemot declined from 15,000 to less than 3,500 in PWS.	
Mid 1970's		Mink released at the Naked Island group according to a local source
Late 1970's – early 1980's		No mink predation recorded.
1979	1,871 pigeon guillemot recorded at the Naked Island group.	No evidence of mink predation
Pre-EVOS	Approximately 2,000 pigeon guillemot at the Naked Island group	
1989	EVOS (3/24/1989). 500 to 1,500 pigeon killed in PWS as a result of EVOS. Just after spill – 1,000 pigeon guillemot at the Naked Island group and 4,000 in PWS	
1990	1,000 pigeon guillemot at the Naked Island group and 4,000 in PWS.	Mink population started increasing
1993	Estimated 3,000 - 4,900 pigeon guillemot in PWS.	
1998-2008	Dramatic decline in pigeon guillemot densities at the Naked Island group compared to PWS.	
Mid 1990's		Mink predation recorded. Local trapper observed mink on Peak Island.
2004	No evidenced of pigeon guillemot exposure to residual oil from EVOS.	
2008 to present	≤100 pigeon guillemot at the Naked Island group	

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PROPOSAL SUMMARY PAGE

Project Title:	Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, FY14 Amendment
Project Period:	January 1, 2014 to December 31, 2018
Proposer(s):	David B. Irons, U.S. Fish and Wildlife Service, and Daniel D. Roby, U.S. Geological Survey – Oregon Cooperative Research Unit
Study Location:	Prince William Sound, Alaska

Abstract: This amendment to project 11100853, Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, provides an opportunity to restore the population of Pigeon Guillemots (*Cepphus columba*) in Prince William Sound, Alaska, which has fallen by more than 90% at the Naked Island Group since 1989. A restoration plan for Pigeon Guillemots in PWS was prepared to address the species' lack of population recovery following injury by the 1989 *Exxon Valdez* oil spill. Predation on nests and adults by mink is now the primary limiting factor for guillemot reproductive success and population recovery at the most important historical nesting site for guillemots in PWS (i.e., the Naked Island group). Mink on the Naked Island group are descended in part from fur farm stock and apparently arrived on the island group during the 1980s. Control of predatory mink at these islands was selected as the preferred restoration alternative because it is feasible and most likely to result in the recovery of guillemots in PWS. Other alternatives are either currently unavailable or unlikely to be effective. A control effort is likely to be successful but if it is not then the agencies would discuss alternatives, one of which would be to amend the EA and remove the remaining mink from the islands. Potential negative effects of the preferred alternative are either negligible or largely avoidable. The Naked Island group guillemot population would likely increase five-fold within the first 10 years following mink control, and the Sound-wide population of guillemots would likely increase within 15 years of mink control at the Naked Island group, once the Naked Island group had become a source population for other parts of PWS.
Phase I : Completion of the NEPA process for the proposed action. (Completed)
Phase II: Control of predatory mink on the Naked Island Group, PWS Alaska

approve

Trustee Council Use Only **Project No:** <u>11100853</u> **Date Received:**	**PROPOSAL SUMMARY PAGE**

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Phase I : Completion of the NEPA process for the proposed action. (Completed)
Phase II: Control of predatory mink on the Naked Island Group, PWS Alaska

Funding:	**EVOS Funding Requested:** (must include 9%GA) FY 2014 -- $396,655.80 Phase II FY 2015 –$391,205.80 Phase II FY 2016 –$154,014.50 Phase II FY 2017 –$139,967.70 Phase II FY 2018 --$124,707.70 Phase II TOTAL: $1,206,551.40 Phase II **Non-EVOS Funds to be Used:** USFWS NFWF FY 2014 -- $173,000.00 $218.280.00 FY 2015 –$173,000.00 $198,280.00 FY 2016 –$113,000.00 $204,580.00 FY 2017 – $98,000.00 $215,580.00 FY 2018 --$98,000.00 $214.580.00 TOTAL non-EVOS funding: $1,716,000.00 **TOTAL, EVOS and non-EVOS funding: $2,922,851.40**
Date:	August 29, 2013

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EXECUTIVE SUMMARY

The Pigeon Guillemot (*Cepphus columba*) is now the only marine bird species in Prince William Sound (PWS), Alaska that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List. Since 1989, the population of Pigeon Guillemots in Prince William Sound (PWS) has undergone a continuous and marked decline, with no sign of stabilization. Given this alarming trend, restoration is warranted for the recovery of Pigeon Guillemots in PWS. The logical location to focus restoration effort for guillemots is the most important historical breeding location in the Sound, the Naked Island group in central PWS. These islands provide an opportunity for recovery of a significant proportion of the PWS guillemot population, although the Naked Island group constitutes only about 2% of the total shoreline in PWS. One fourth of all guillemots nesting in PWS in 1989 (just after the spill) were located at the Naked Island group. Restoration of guillemots at the Naked Island group to the number counted at that time would result in a substantial increase in the Sound-wide population. Most of the available information on the factors limiting the Pigeon Guillemot population in PWS originates from research on guillemot population size, nesting success, and diet conducted at the Naked Island group during 15 breeding seasons between 1978 and 2008. These data, placed in a historical and socioeconomic context, permit the development of a restoration plan designed to facilitate the population recovery of Pigeon Guillemots in PWS.

A few historical events have had a considerable impact on Pigeon Guillemots nesting at the Naked Island group in PWS. First, fox farming occurred at the Naked Island group for more than 50 years beginning in 1895. The foxes (*Alopex lagopus*) almost certainly caused severe declines in the populations of native fauna, including Pigeon Guillemots, as they did across many formerly fox-free islands in Alaska. Nearly a century later, the EVOS caused acute mortality from oiling estimated at between 500 and 1,500 Pigeon Guillemots in PWS in the immediate aftermath of the spill. There was evidence that guillemots were exposed to and negatively affected by residual oil for at least a decade after the spill. However, there was no longer an indication of guillemot exposure to residual oil from EVOS by 2004. Studies have demonstrated that EVOS and/or a climatic regime shift associated with the Pacific Decadal Oscillation affected guillemots in the Sound through reduced availability of preferred forage fish species. The prevalence of high-lipid schooling forage fish in the diet of guillemot chicks at the Naked Island group was significantly lower in the decade after EVOS, and this change was associated with lower nestling survival and growth rates, and lower overall nesting success. The level of predation on guillemot nests at the Naked Island group also increased significantly during the 1990s when compared to pre-spill, potentially limiting the recovery of Pigeon Guillemots at this location.

The primary limiting factor for guillemot reproductive success and population recovery at the Naked Island group is now predation of nests and adults by American mink (*Neovison vison*). Guillemot population trends at the Naked Island group compared to the rest of PWS are consistent with this conclusion. At sites outside of PWS, guillemot population declines and even local extirpation of breeding guillemots due to predation by mink have been successfully and rapidly reversed through mink control or eradication as a restoration action. Although a precise estimate of the guillemot population response to proposed mink control at the Naked Island group is not possible, all available evidence indicates that eliminating mink predation on guillemot nests and adults would result in a dramatic increase in the breeding population and productivity of Pigeon Guillemots at the Naked Island group. Nest predation by mink may also have caused declines in populations of other seabirds nesting at the Naked Island group, including Arctic Terns (*Sterna paradisaea*), Parakeet Auklets (*Aethia psittacula*), Tufted Puffins (*Fratercula cirrhata*), and Horned Puffins (*Fratercula corniculata*). The presence of foraging marine mammals and large flocks of piscivorous birds provide supporting evidence that predation by mink and not limitations in food supply have caused the declines in seabirds breeding at the Naked Island group. The introduction or range expansion of mink in areas outside of PWS have caused rapid population declines in a wide variety of taxa, including several species of ground-nesting birds, small mammals, amphibians(Banks et al. 2008)(Banks et al. 2008)(Banks et al. 2008)(Banks et al. 2008), and crustaceans.

Mink are native to the mainland and nearshore islands of PWS but do not naturally occur on offshore islands. Observational data suggest that mink were absent on the Naked Island group until the 1970's (Appendix A), but the State of Alaska, ADF&G, who manage mink, has the position that mink are native to the islands and that pigeon guillemots can live in high densities, as they did in the 1970's and 1980's with mink on the islands. Data from both mtDNA sequencing and nuclear microsatellite genotyping indicate that the mink on the Naked Island group are descended in part from fur farm mink stock and were introduced to the Naked Island group by humans.

The Naked Island group is part of Chugach National Forest with the exception of one small privately-owned parcel on Peak Island. The islands are used periodically for camping, hiking, deer hunting, and fishing. Although frequently exploited for their fur in other parts of PWS, trapping of mink at the Naked Island group occurs rarely. Pigeon Guillemots contribute to the success of ecotourism in PWS through their conspicuous, vocal, and charismatic displays along the shoreline.

The restoration objective for Pigeon Guillemots in PWS is population recovery, which in this case is defined as a stable or increasing population. All reasonable potential restoration alternatives have been considered and assessed for their likelihood of facilitating guillemot population recovery. The preferred alternative (Alternative A) is the control of predatory mink (i.e., the removal of all individuals from the pigeon guillemot nesting areas) at the Naked Island group. If this alternative is not successful after 2-3 years the agencies involved will discuss other alternatives, one of which would be to amend the EA and remove all the remaining mink.The suggested method is trapping with lethal body grip traps set along the coastline during fall, winter, and especially early spring (when snow cover is present and mink are largely restricted to the shoreline), supplemented with hunting using dogs, as necessary. Successful control will likely require multiple years of effort, likely 3-5 years. Long-term monitoring of the islands should be conducted periodically. The eradication of mink (Alternative B) would result in in recovery of pigeon guillemots also. This alternative was rejected because the State of Alaska, who manages mink would prefer to try controlling mink as the first management tool and does not think it is necessary at this time to restore pigeon guillemots. Alternative C, enhancement of the guillemot food supply during the nesting season, included the release of high-lipid hatchery-reared juvenile fish (i.e., Pacific herring, *Clupea pallasi*, and/or Pacific sand lance, *Ammodytes hexapterus*) near foraging areas of Pigeon Guillemots at the Naked Island group. Although this alternative may be an effective restoration technique for guillemots and other species in the future, it was eliminated because there is currently no stock enhancement program for herring or sand lance in PWS, plus it fails to address the primary cause of guillemot egg and chick mortality at the Naked Island group. The construction and installation of guillemot nest boxes (Alternative D) to enhance the availability of sites inaccessible to mink was considered and rejected as well. A few nest boxes were installed at the Naked Island group during the 1990s, but there was a low incidence of use by guillemots, most likely because there was an abundance of available, unoccupied natural cavities. The population of Pigeon Guillemots at the Naked Island group is now significantly lower than it was during the 1990s, and thus nest box installation would almost certainly be an ineffective restoration technique. Alternative E consists of the lethal control of avian predators of Pigeon Guillemots and their nests, including Common Ravens (*Corvus corax*), Northwestern Crows (*Corvus caurinus*), and Black-billed Magpies (*Pica pica*). This alternative would require a constant, persistent, and intensive effort to reduce populations of avian predators, and the resulting increase in survival of guillemot eggs and chicks is likely to be insignificant in comparison to the loss of eggs, chicks, and adults due to mink predation. Alternative F consisted of a combination of provisioning of nest boxes (Alternative D) and control of corvid (Alternative E) and mink (Alternative B) populations. This combination of alternatives is unlikely to be more effective than any of the alternatives implemented on its own. The current management strategy (Alternative G), involves no restoration action. Given the high predation pressure on guillemot nests at the Naked Island group, this alternative will almost certainly lead to a continued low (< 25 nesting pairs) breeding population or local extirpation of the guillemot breeding population at this site.

Control of predatory mink was selected as the preferred alternative because it is most likely alternative that was agreed upon by all agencies to facilitate the recovery of Pigeon Guillemots throughout PWS. Other alternatives are either currently unavailable or unlikely to be effective. An effort to control mink at the Naked Island group is likely to be successful in a relatively short period of time (3-5 years) due to well-developed methods of control. Although, the preferred alternative would be implemented to address the Pigeon Guillemot population decline in PWS, a suite of other seabird species, including Tufted Puffins, Horned Puffins, and Arctic Terns, with depressed breeding populations at the Naked Island group would also benefit. Mink control may also promote local increases in other populations of ground-nesting birds (e.g., waterfowl), small mammals, amphibians, and crustaceans.

Potential negative effects of the preferred alternative appear to be either negligible or largely avoidable. Proposed control methods include steps to minimize capture of non-target species (i.e., selection of trap type and use of artificial burrows in which to set traps). The restoration of guillemots at the Naked Island group will not have a significant negative impact on herring stocks because juvenile herring have never been an important part of the diet of guillemots nesting at this location. Control of mink at the Naked Island group would not adversely affect trappers in PWS because mink at the Naked Island group are rarely exploited for their fur and are remote to trappers in the region. Due to the fur farm ancestry of mink at the Naked Island group, this alternative would not injure the Sound-wide population of native mink. There is no concern over a potential detrimental population eruption by small introduced herbivores or omnivores, such as rabbits or rats, following mink control because no such species occur at the Naked Island group.

The population response of guillemots to mink control at the Naked Island group is measurable through the comparison of historical and recent guillemot population surveys completed at the Naked Island group and the Smith Island group (mink-free islands) using a Before–After–Control–Impact design. Although a precise prediction of the guillemot population response to mink control is not possible, the time expected to population recovery can be estimated. If the expected increase in guillemot productivity from mink control is realized and model assumptions are correct, guillemot population at the Naked Island group will increase five fold within 10 years following mink control and the Sound-wide population of Pigeon Guillemots will begin to increase within 15 years after control of mink at the Naked Island group.

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Introduction

The Pigeon Guillemot (*Cepphus columba*) is now the only marine bird species injured by the 1989 *Exxon Valdez* oil spill (EVOS) that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List (*Exxon Valdez* Oil Spill Trustee Council 2010). Since 1989, the population of Pigeon Guillemots in Prince William Sound (PWS) has declined by an alarming 47%, and there is no sign of population stabilization (McKnight et al. 2008). Given this steady, long-term, and drastic trend, restoration action is warranted and in all probability necessary for the recovery of the Pigeon Guillemot population in PWS.

The Naked Island group is a logical location to focus restoration efforts for guillemots in PWS (Figure 1). These islands provide a unique opportunity to facilitate the recovery of a disproportionately large number of guillemots through restoration along a small portion (~2%) of the total PWS shoreline. The Naked Island group was historically the most important breeding location for guillemots in the Sound (Sanger and Cody 1994). Approximately one quarter of the guillemot population in PWS nested at the Naked Island group in 1989 in the aftermath of the EVOS (U.S. Fish and Wildlife Service, unpubl. data). Recovery of Pigeon Guillemots at the Naked Island group to the number counted just after the spill (Oakley and Kuletz 1996) would increase the Sound-wide population by nearly 45% (McKnight et al. 2008).

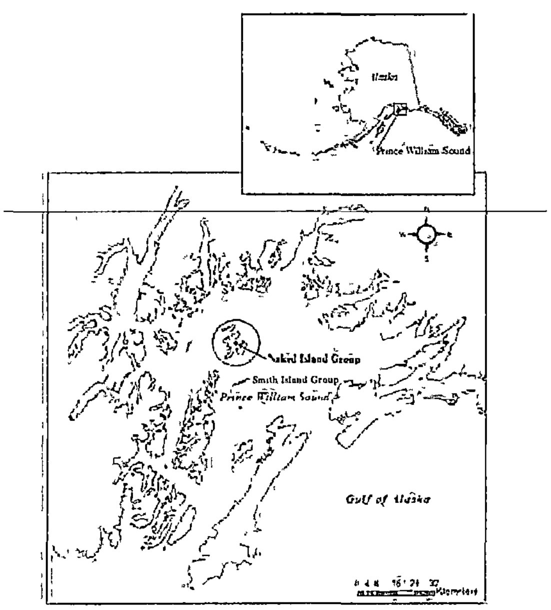

Figure 1. The location of Prince William Sound (inset map), the Naked Island group, and the nearby mink-free Smith Island group in Alaska

The Naked Island group is also the site where we have the most thorough understanding of mechanisms regulating Pigeon Guillemot populations in PWS. Data on population size, nesting success, and diet of guillemots has been collected at the Naked Island group during 15 years between 1978 and 2008 (Bixler 2010) The historical, ecological, and socioeconomic contexts of Pigeon Guillemots at the Naked Island group are presented below. This information provides the foundation crucial for the development and assessment of feasible restoration alternatives designed to facilitate the population recovery of Pigeon Guillemots in PWS.

Historical Context

The Naked Island group was the site of arctic fox (*Alopex lagopus*) fur farms for more than 50 years beginning in 1895 (Bailey 1993, Lethcoe and Lethcoe 2001). The foxes roamed free on the islands (Evermann 1914) and, as in other locations, likely relied on native small mammals (i.e., voles, shrews, and mice) and seabirds as a food source (Heller 1910, Bailey 1993). The populations of native fauna, including Pigeon Guillemots, almost certainly plummeted following the introduction of foxes to the Naked Island group, as they did across many formerly fox-free islands in Alaska (Bailey 1993). In fact, there were apparently no rodents or shrews on Storey Island and no shrews on Naked Island by 1908, within 15 years of the commencement of fox farming (Heller 1910). A variety of native species including salmon, herring, harbor seals, and even whales were killed to provide supplemental food for foxes in the Sound (Bailey 1993, Lethcoe and Lethcoe 2001, Wooley 2002), thereby altering the entire ecosystem. The depression of the 1930's, the end of World War II, and changes in women's fashions in Europe together caused fox farming to become unprofitable (Lethcoe and Lethcoe 2001). Upon closure of the fox farms, foxes in PWS either were removed by trapping or died of starvation; arctic foxes are no longer found in the PWS region (Bailey 1993).

Other historical developments in PWS that may have directly or indirectly impacted the nearshore habitat of the Naked Island group include mining, commercial fishing of salmon and herring, pink salmon hatcheries, marine mammal harvest, and logging (Lethcoe and Lethcoe 2001, Wooley 2002). The 1964 earthquake resulted in an uplift of about four feet at the Naked Island group and massively altered both the shoreline and shallow nearshore habitat (Hanna 1971) where guillemots nest and forage (Ewins 1993).

On 24 March 1989, the T/V *Exxon Valdez* ran aground at Bligh Reef in PWS resulting in the release of at least 44 million liters of Prudhoe Bay crude oil into PWS. The oil spread to the southwest through the Sound and into the northern Gulf of Alaska. An estimated 500 to 1,500 Pigeon Guillemots in PWS were immediately killed due to oil exposure (Piatt and Ford 1996). There was evidence that guillemots were exposed to residual oil for at least a decade after the spill (Golet et al. 2002). However, there was no longer indication of direct contact with oil in guillemots by 2004 (B. Ballachey, U.S. Geological Survey, pers. comm.).

Previous studies have demonstrated that EVOS and/or a climatic regime shift associated with the Pacific Decadal Oscillation may have indirectly affected Pigeon Guillemots in PWS (Agler et al. 1999, Golet et al. 2002). The decline in the number of guillemots in the Sound, which began prior to EVOS, has been associated with the 1976 shift in the Pacific Decadal Oscillation (Agler et al. 1999, Golet et al. 2002) that resulted in reduced abundance of schooling forage fish across the North Pacific Ocean (Anderson et al. 1997, Francis et al. 1998, Anderson and Piatt 1999). EVOS also apparently contributed to the decline in populations of schooling forage fish, specifically Pacific herring (*Clupea pallasi*) and Pacific sand lance (*Ammodytes* *hexapterus)* in Prince William Sound (Marty et al. 1999, Golet et al. 2002, Marty 2008). The prevalence of high-lipid schooling forage fish in the diet of guillemot chicks at the Naked Island group was significantly lower in the decade after EVOS than prior to EVOS (Oakley and Kuletz 1996, Golet et al. 2002). Low proportions of high-lipid schooling prey, particularly sand lance, in the diet of Pigeon Guillemot chicks have been associated with lower nestling survival, lower nestling growth rates, and lower overall nesting success (Golet et al. 2000, Litzow et al. 2002).

Top-down factors, such as predation, may also have limited the recovery of the Pigeon Guillemot population in PWS (Hayes 1995, Oakley and Kuletz 1996, Golet et al 2002). Common potential predators of guillemot nests in PWS include Glaucous-winged Gulls (*Larus glaucescens*), Black-billed Magpies (*Pica hudsonia*), Northwestern Crows (*Corvus caurinus*), Common Ravens (*Corvus corax*), river otters (*Lontra canadensis*), and American mink (*Neovison vison*) with mink being the most important (Oakley and Kuletz 1979, Ewins 1993, Hayes 1995, Oakley and Kuletz 1996). The level of mink predation on guillemot nests at the Naked Island group increased significantly during the late 1990s compared to earlier years (Golet et al. 2002).

Current Ecological Context

The Pigeon Guillemot is a pursuit-diving seabird that preys upon a variety of nearshore demersal fishes, schooling fishes, and, occasionally, crustaceans (Ewins 1993). Guillemots are semi-colonial members of the seabird family Alcidae that produce 1- or 2-egg clutches (Ewins 1993). Pigeon Guillemots usually nest in rock crevices or burrows along rocky shorelines but are also known to nest in crevices of anthropogenic structures such as piers, bridges, and wooden nest boxes (Ewins 1993). Guillemots nest along the coastline of western North America from the Bering Strait to Santa Barbara, California, and as far south as the Kurile Islands in the Russian Far East. The current number of Pigeon Guillemots is considered stable and estimated to be about 470,000 individuals range-wide (BirdLife International 2009). The species is regarded as "of least conservation concern" (BirdLife International 2009). The Pigeon Guillemot is however, susceptible to long-term local declines in breeding populations (Ewins 1993).

The availability of schooling forage fish may continue to limit the rate and extent of Pigeon Guillemot population recovery, both at the Naked Island group and in the Sound as a whole (Bixler 2010). The prevalence of schooling forage fish in the diet of Pigeon Guillemots at the Naked Island group has not recovered to pre-EVOS levels. In addition, the average group size of Pigeon Guillemots detected in surveys declined near the Naked Island group, but also across a number of other important guillemot nesting areas in central and western PWS, a pattern consistent with a region-wide reduction in food availability.

However, the primary limiting factor for guillemot reproductive success and population recovery at the Naked Island group is now predation by a recent colonizer of the islands, the American mink (Bixler 2010). The overall abundance of schooling forage fish at the Naked Island group has increased since the 1990s, suggesting that forage fish populations are recovering from EVOS. Despite improving prey resources, the guillemot breeding population at the Naked Island group has declined by more than 90% during the last 15 years. Guillemots, like many other seabirds, produce few offspring and their populations are sensitive to even small decreases in adult survival. The rate of egg and chick predation increased during the 1990s and caused the majority of nest failures during this period. By 1998, at least 60% of monitored guillemot nests and 4.5% of breeding adults at those nests were killed by mink. In 2008, we determined that the rate of nest predation at the Naked Island group was similar to the late 1990s, and mink were still able to locate guillemot nests and kill guillemot nestlings, despite few remaining nests (only 17 active guillemot nests found). The prevalence of guillemot nest sites in crevices on cliffs increased at the Naked Island group, while the prevalence of nests in crevices or burrows near the ground, presumably more accessible to mink, decreased compared to pre-spill. The guillemot population trend at the Naked Island group compared to elsewhere in PWS is also consistent with the hypothesis that mink predation is the primary limiting factor. Guillemot numbers were stable between 1990 and 2008 at nearby mink-free islands (Smith Island group), and guillemot population declines at the Naked Island group since EVOS have been much more severe than across the rest of PWS. The number of guillemots at the Naked Island group comprised about 25% of the total population in PWS just after the spill in 1989. But in 2008, the number of guillemots at the Naked Island group comprised just 1% of the total Sound-wide population. Prior to the increase in mink predation the Naked Island group had the largest nesting colony of Parakeet Auklets (*Aethia psittacula*) in PWS and high densities of Tufted Puffins (*Fratercula cirrhata*), Horned Puffins (*Fratercula corniculata*), and Arctic Terns (*Sterna paradisaea*), in addition to supporting the highest numbers of nesting Pigeon Guillemots (Oakley and Kuletz 1979). Nest predation by mink likely caused declines in these other seabirds nesting at the Naked Island group. Arctic Terns and Parakeet Auklets have been extirpated as breeding species at the Naked Island group. Other seabirds currently nest in greatly reduced numbers (i.e., Tufted Puffins and Horned Puffins; KSB, pers. obs). The few remaining pairs of puffins nesting on the Naked Island group are restricted to the highest available shoreline cliffs (80 - 100 m) on the archipelago. Foraging humpback whales (*Megaptera novaeangliae*), minke whales (*Balaenoptera acutorostrata*), harbor seals (*Phoca vitulina*), and Steller sea lions (*Eumetopias jubatus*) along with large foraging flocks of piscivorous birds, including Marbled Murrelets (*Brachyramphus marmoratus*), Black-legged Kittiwakes (*Rissa tridactyla*), and Glaucous-winged Gulls (*Larus glaucescens*) still occurred in the nearshore waters of the Naked Island group in 2008 (KSB, pers. obs.). These aggregations of piscivorous marine birds and mammals near the Naked Island group provide supporting evidence that predation by mink, and not limited forage fish, have caused the decline in seabirds breeding at the site.

Mink are semi-aquatic, largely nocturnal, generalist carnivores that are native to the mainland and nearshore islands of PWS. The natural distribution of mink on the more isolated, offshore islands in PWS is less well known, however, due to two centuries of trapping of furbearers by non-Native Alaskans and 50 years of fur farms for foxes and mink (Lethcoe and Lethcoe 2001, Fleming and Cook 2010). There is evidence that there was no mink predation in the 1970s and 1980s at the Naked Island group (U.S. Fish & Wildlife Service, unpubl. Data; Appendix A. Evidence from both mtDNA sequencing and nuclear microsatellite genotyping suggest that the mink on the Naked Island group are descended in part from fur farm mink (Fleming and Cook 2010). There is no evidence of a gradual natural immigration of individuals and the founding population size was about 5 pairs, larger than expected from a natural colonization event. Mink from the Naked Island group are most closely related to those that occur on Knight Island, the nearest island to the Naked Island group (6 km away). This distance exceeds by 2 km the longest recorded natural dispersal distance over open water by mink. Mink were intentionally introduced by federal and state agencies to at least one remote island in PWS (i.e., Montague Island) in order to provide a harvestable population (Paul 2009). There is also suggestive evidence of introductions of mink to islands in PWS by fox farmers (Fleming and Cook 2010) and fur trappers (R. Ellis, pers. comm.) to establish new harvestable populations

American mink have escaped from fur farms or from been intentionally introduced across much of Europe (Bonesi and Palazon 2007) where they have caused rapid population declines in a variety of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007). These effects are especially apparent on islands (Banks et al. 2008). A long-term, large-scale American mink removal program on islands in the Baltic Sea demonstrated that 1) nearly all species of birds, mammals, and amphibians present on the islands were negatively affected by mink predation and 2) populations of most species increased following mink removal (Nordström et al. 2003, Banks et al. 2008). Mink eradication resulted in successful reversal of the population decline and local extirpation of Black Guillemots (*Cepphus grylle*), a close relative of Pigeon Guillemots, in this study (Nordström et al. 2003).
Although we are unaware of any examples of mink control or eradication programs within the breeding range of Pigeon Guillemots, introduced arctic foxes have been removed from multiple islands in the Alaska Maritime National Wildlife Refuge Complex (Byrd et al. 1997). At two of these islands, Simeonof and Chernabura islands in the Shumagin Islands, the population of Pigeon Guillemots increased by 275% and 150%, respectively, within just six years of fox removal (Byrd 2001).
Not all guillemot nesting failure on the Naked Island group is caused by mink predation and the diet of the few guillemots that continue to nest on the Naked Island group does not include as high a proportion of schooling forage fishes as pre-EVOS (Bixler 2010). Consequently, a precise estimate of the guillemot population response should mink be controlled at the Naked Island group is not possible. However, all available evidence indicates that eliminating mink predation on guillemot nests and adults would result in a measureable increase in the Pigeon Guillemot breeding population and its productivity at the Naked Island group, as well as increases in the breeding populations of other seabirds at the Naked Island group.

Socioeconomic Context

Outside of one privately owned parcel of land on Peak Island, the Naked Island group is part of the publically owned Chugach National Forest (Oakley and Kuletz 1979). The islands are used periodically for camping, hiking, deer hunting, and fishing (Oakley and Kuletz 1979). The protected bays on the west and north sides of Naked Island provide safe anchorages for sailboats, fishing boats, and an oil spill response barge. Although frequently exploited for their fur in other parts of PWS, trapping of mink at the Naked Island group rarely occurs due to the low price of furs and the time and expense involved in traveling to the islands (R. Ellis, pers. comm.). Although Pigeon Guillemots have little subsistence value, they contribute to the success of ecotourism in PWS. Guillemots are conspicuous, vocal, and charismatic and thus play a role in the auditory and visual experience of all who frequent the shoreline of PWS.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed restoration would facilitate the recovery of a species injured by EVOS, the Pigeon Guillemot, through control of predatory mink at the Naked Island group. Given the high level of guillemot egg and chick mortality at the Naked Island group, there is no evidence to suggest that the population could recover without restoration action. Because the Naked Island group is the most important historical nesting area for guillemots in PWS, this proposal provides an opportunity for recovery of a significant proportion of the PWS guillemot population.

The control of mink from the Naked Island group would promote naturally occurring productivity and diversity in Prince William Sound. This population of mink was almost certainly introduced to the Naked Island group. A suite of seabird species with depressed breeding populations at the Naked Island group (e.g., Arctic Terns, Parakeet Auklets, Tufted Puffins, and Horned Puffins) (KSB, pers. obs.; Oakley and Kuletz 1979) would benefit from this restoration action in addition to Pigeon Guillemots. Mink control may promote local increases in other populations of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007).

II. PROJECT DESIGN

A. Alternatives

Introduction

The restoration objective for Pigeon Guillemots in PWS is population recovery, in this case defined as a stable or increasing population (*Exxon Valdez* Oil Spill Trustee Council 1994). All reasonable potential restoration alternatives have been considered. The ability of each alternative to meet the restoration objective was assessed and the most effective approach was selected as the preferred alternative. The preferred alternative complies with the policies and standards of restoration of the *Exxon Valdez* Oil Spill Trustee Council (*Exxon Valdez* Oil Spill Trustee Council 1994).

Detailed description of alternatives

Alternative A – Control of Predatory Mink – PREFERRED ALTERNATIVE

Actions under this alternative aim to control predatory mink at the Naked Island group. We consider control “the complete removal of all the individuals in the pigeon guillemot nesting areas”. The suggested method is lethal trapping with body grip traps along the coastline within 500m of each historical or current nest location, supplemented with hunting using dogs as necessary.

Trapping is the most practical and effective method available to control mink (Boggess 1994, Macdonald and Harrington 2003, Moore et al. 2003). Although lethal trapping is more successful (Boggess 1994, Moore et al. 2003), live trapping followed by euthanasia with an air pistol or shotgun has been utilized in a few mink control projects due to concern for non-target captures and public acceptance (Moore et al. 2003). Other methods of euthanasia were considered but rejected. Although toxicants (e g., sodium fluoroacetate - compound 1080 and sodium cyanide - M44) and fumigants (e.g. carbon monoxide) are in use in the United States for carnivore control, there are currently no chemical agents registered by the U.S. Environmental Protection Agency for the control of mink (Boggess 1994, National Wildlife Research Center

2008). Further, poisoning or secondary poisoning of non-target species (Courchamp et al. 2003, Moore et al. 2003) such as river otters (*Lontra canadensis*) and Bald Eagles (*Haliaeetus leucocephalus*) would likely be unacceptable. Shooting as a method of killing mink is considered inefficient (Boggess 1994, Courchamp et al. 2003). Although a potentially important management tool in European countries (Macdonald and Harrington 2003, Bonesi and Palazon 2007), control of mink through enhancement of possible competitors (i.e., river otters) seems unlikely to be effective in PWS given the lack of evidence for niche overlap (BenDavid et al. 1996). Other means of biological control, such as virus vectored immune-contraception, have yet to be fully developed (Courchamp and Cornell 2000, Macdonald and Harrington 2003) and might pose an irreversible danger to the viability of mink and other closely-related native furbearers (e.g., American marten) outside of the Naked Island group.

Trapping success would be maximized through continuous effort for three to five months of the year during the winter (January to May) season (Bonesi et al. 2007). The precise timing of trapping will be determined using an adaptive management approach (see below). Traps would be set along the coastline of the islands (See Bixler et al. 2010 for details). We suggest the use of experienced trappers (Macdonald and Harrington 2003) for the duration of the project and hunting dogs to locate the last few mink in the nesting area if necessary (Moore et al. 2003). Although we do not know the total number of mink at the Naked Island group, there likely is between 80 and 200 mink in this population (Fleming and Cook 2010). We anticipate that successful control would likely require multiple years of effort (Macdonald and Harrington 2003), potentially up to five years. Carcasses of mink would be frozen and placed in a tamper-proof container and removed from the island approximately every two to four weeks. Carcasses would be donated to research organizations for additional genetic and other study or to permanent archives in public museums or universities, whenever feasible. There is also the opportunity to provide carcasses to Native Alaskans for their cultural programs Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.) Carcasses that cannot be salvaged for donation may be disposed of in a city landfill.

The geography of the Naked Island group improves the likelihood of successful mink control. The islands are relatively small with gentle topography and access to safe anchorages (Courchamp et al. 2003, Bonesi and Palazon 2007). Because the Naked Island group is geographically isolated, it is unlikely to encounter mink from other islands immigrating (Nordström and Korpimäki 2004, Bonesi and Palazon 2007).

Mink control at the Naked Island group would likely be followed by a clear and dramatic increase in the guillemot breeding population, but the precise response of the guillemot population following mink control is unknown. Based on the best available information, however, we estimate that the productivity of guillemots at the Naked Island group will increase by 16% to 36%. If this change in productivity is realized and model assumptions are accurate, the Sound-wide population should begin to increase within 15 years following mink control (See Chapter 4). However, if after 2-3 years this alternative is not leading to pigeon guillemot recovery and mink are still entering the nesting zone, the agencies would discuss other alternatives, one of which would be to amend the EA and remove the mink remaining on the islands, with appropriate approvals from all agencies involved.

Alternative B - Eradication of Mink

Alternative B is similar to Alternative A, with the exception that in this alternative the aim of lethal trapping is the eradication of the mink population at the Naked Island group, rather than control. Methods used would be identical to Alternative A with one main difference; 1) lethal trapping would occur throughout the islands in all mink habitat.

This alternative was not pursued because the State of Alaska, ADF&G, who manage mink believes that the mink are native to the islands and that pigeon guillemots can coexist at high densities, as they were in the 1970s and 1980s, with mink. However if control of predatory mink is not successful in restoring pigeon guillemots after a few years ADF&G is willing to discuss other alternatives.

Alternative C – Enhance the Pigeon Guillemot Food Supply during the Nesting Season

Actions under Alternative C would include the release of hatchery-reared juvenile forage fish within PWS, preferably in close proximity to the foraging areas of Pigeon Guillemots nesting at the Naked Island group Due to the importance of prey lipid content to the reproductive success of guillemots (Golet et al. 2000, Litzow et al. 2002), only high-lipid schooling forage fish would be released (i.e. herring and/or sand lance). An increase in the abundance of high-lipid prey might lead to increased productivity and survival in guillemots (Golet et al. 2000, Litzow et al. 2002). The enhancement of native stocks of forage fish in PWS might also have a positive impact on populations of a variety of other species of seabirds, fish, and mammals that prey upon them, including the ESA-listed humpback whale (*Megaptera novaeangliae*) and Steller sea lion (*Eumetopias jubatus*) There is currently no stock enhancement program for either herring or sand lance in PWS. The initiation of such a program requires further research in order to ensure no unexpected negative consequences to the ecosystem (*Exxon Valdez* Oil Spill Trustee Council 2009). Although this alternative might be an effective restoration technique in the future, it is not a viable solution to stem the current alarming population decline of guillemots. More importantly however, this alternative fails to address the primary cause of guillemot nesting failure at the Naked Island group, namely predation on eggs and chicks.

Other methods of supplementing the guillemot food supply have been considered and rejected. For instance, releases of dead herring or sand lance into waters adjacent to active nests are unlikely to be utilized by guillemots because there is no indication that this species currently exploits such potential food resources (i.e., offal discarded from fishing vessels; Ewins 1993). Supplementing the diet of chicks in the nest was rejected as well. Although studies suggest that the supplementation of prey to nests can significantly increase productivity of seabirds (Robb et al. 2008), Pigeon Guillemots are prone to nest abandonment when subjected to high rates of human disturbance at the nest (Ainley et al. 1990, Vermeer et al. 1993).

Alternative D - Provide Nest Boxes to Enhance Nest Site Availability

Under this alternative, nest boxes would be installed on cliff faces that appear to be inaccessible to mink. The boxes would be placed in the immediate vicinity of either current or historical nesting locations.

Other options to prevent mink from depredating guillemot adults, chicks, and eggs inside nests were considered but eliminated. For instance, fencing is highly unlikely to be effective at reducing predation of guillemot nests at the Naked Island group. The prevention of gaps larger than 1 inch (Boggess 1994) on talus slopes and cliffs is not feasible. There are no registered chemical repellents or known effective frightening devices to modify the behavior of mink near guillemot nests (Boggess 1994, National Wildlife Research Center 2008).

There is no evidence that Pigeon Guillemots at the Naked Island group are limited by the availability of nesting habitat (Bixler 2010). A few nest boxes were installed at the Naked Island group during the late 1990s, but there was low incidence of use (DBI; pers. obs), most likely because there was an abundance of natural cavities available. The population of Pigeon Guillemots at the Naked Island group is now significantly lower than it was during the late 1990s. Consequently, nest box installation would almost certainly be an ineffective restoration technique.

Alternative E - Control Avian Predators of Pigeon Guillemot Nests

Actions under Alternative E intend to prevent the predation of Pigeon Guillemot nests through reduction in population of native avian predators at the Naked Island group. Avian species targeted would include the Common Raven (*Corvus corax*), Northwestern Crow (*Corvus caurinus*), and Black-billed Magpie (*Pica pica*). Lethal population control would be attained by shooting avian nest predators throughout the guillemot nesting season, April through August.

There are no other feasible methods of lethal or non-lethal control available. Although there is a conditioned taste aversion chemical registered by the U.S. Environmental Protection Agency (methiocarb) for corvid control, it is limited in use for the protection of federally threatened or endangered species (National Wildlife Research Center 2008). Similarly, lethal control of corvids through a toxicant (i.e. DRC-1339 [3-chloro-4-methylbenzenamine HCL]) is not permitted for this application (National Wildlife Research Center 2008). Harassment techniques, such as auditory deterrents, were rejected because they would likely negatively affect guillemot nest attendance.

There are several flaws inherent to this alternative. Culling by shooting has a decreasing efficacy for corvid species through time (Liebezeit and George 2002) suggesting that each year of control would require more effort with less success. The program would need to be conducted annually and continue indefinitely due to the high dispersal capability of these species. Finally, because an increase in survival of chicks after culling avian predators is likely to be insignificant in comparison to the loss of eggs, chicks, and adults due to mink predation, it seems very unlikely that this alternative would change the current population trajectory of Pigeon Guillemots at the Naked Island group.

Alternative F - Combination of Nest Boxes and Control of Predator Populations

Under this alternative, nest predators of Pigeon Guillemots (i.e., mink, ravens, crows, and magpies) would be culled and nest boxes would be installed at the Naked Island group. Actions taken include all of those listed in Alternatives B, D, and E. Due to flaws in each action (see above) that will not be lessened by the combination of alternatives, the population trajectory of Pigeon Guillemots at the Naked Island group is unlikely to change significantly.

Alternative G - No Action – Current Management

No management action would be taken under this alternative. The current breeding population of Pigeon Guillemots at the Naked Island group is likely to remain either exceedingly low (< 25 nesting pairs) or decline to local extirpation in the absence of restoration action given the high rate of predation on guillemot nests and adults by mink.

Rationale for selection of control of predatory mink on the Naked Island Group as the preferred alternative

Alternative A, control of predatory mink, is the preferred alternative because it is the most effective method to elevate the productivity of Pigeon Guillemots at the Naked Island group and facilitate the recovery of the species in PWS. This alternative is less expensive, both financially and in number of mink killed, than any other method (Courchamp et al. 2003). Other alternatives are either currently unavailable or unlikely to facilitate guillemot population recovery. Given the high level of guillemot egg and chick mortality at the Naked Island group, there is no evidence to suggest that the population could recover without such restoration action. Mink control at the Naked Island group is likely to be successful due to well-developed methods of control (Bonesi and Palazon 2007) and geographic isolation of the islands (Nordström and Korpimäki 2004). The control of mink at the Naked Island group can be achieved within a relatively short period of time (3-5 years). Although the population response of guillemots is difficult to predict precisely, mink control would result in an increase in adult survival, reproductive success, and population size at the Naked Island group. A suite of seabird species with depressed breeding populations at the Naked Island group (e.g., Arctic Terns, Parakeet Auklets, Tufted Puffins, and Horned Puffins) (KSB, pers. obs.; Oakley and Kuletz 1979) would also benefit from this restoration action. Mink control may promote local increases in other populations of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007).

Potential negative effects of the preferred alternative appear to be negligible or largely avoidable. The preferred alternative includes steps to minimize capture of non-target species (i.e., trap type and use of artificial burrows as trap sites; see Bixler et al. 2010). There is no evidence to suggest that restoration of guillemots at the Naked Island group would have a significant negative impact on herring because they have never been an important part of the diet of guillemots at this site (Golet et al. 2000). Mink at the Naked Island group are rarely exploited for their fur (R. Ellis, pers. comm.), and thus the control of mink at these islands would not adversely affect trappers in PWS. Due to fur farm ancestry, the preferred alternative would not have a negative impact on the Sound-wide population of mink. There is no concern of sudden destructive eruptions of small exotic herbivore or omnivore (e.g. rabbits, rats) populations (Bergstrom et al. 2009) following mink control because no such introduced species occur at the Naked Island group.

B. Objectives

Phase I

Complete the NEPA process to decide how to proceed. (Completed)

Phase II

1. Restore pigeon guillemots through control of predatory mink on the Naked Island group.
2. Monitor the guillemot population response to mink control at the Naked Island group.

C. Procedural and Scientific Methods

Experimental Design

1. Mink control at the Naked Island group would require up to five years to accomplish via lethal trapping (Bixler et al. 2010) and hunting with dogs.

2. A long-term monitoring program is integral to the success of this proposed restoration. The Naked Island group would be surveyed every year of the project for sign (tracks, scat) in snow, when mink are most easily detected (Bonesi and Palazon 2007). The population of guillemots would be censused at both the Naked Island group and the Smith Island group during late May/early June every year using the protocol described in Oakley and Kuletz (1996). Monitoring will be continued by USFWS after the current project is over.

3. The preferred alternative requires an adaptive management strategy. This technique requires that data collected during trapping (e.g., trapping success, sex of trapped animals) as well as Pigeon Guillemot censuses be reviewed regularly to assess the success of the actions and methods. If there is evidence that the specified objective is not being met, the restoration methods or actions should be altered.

Time Frame for Pigeon Guillemot Population Recovery

Potential changes in the growth of the pigeon guillemot population at the Naked Island group were modeled to inform the decision-making process. This modeling coincides with the two management alternatives: Alternative G: No Action-Current Management and Alternative A: Proposed Action-Control of Predatory Mink (Chapter 2). A stochastic Leslie matrix model after Golet et al. (2002) and Bixler et al (2010) was used to project guillemot population growth under these scenarios.

The following equation was used to project the growth rate of the guillemot population:

(λ): $\lambda = ((PF * FX * PA^2) + (NX * PA)) / NX$

λ = annual population growth rate
P_F = annual sub-adult survival rate
F_X = number of offspring produced
P_A = age-constant annual adult survival
N_X = initial population size

The observed rate of population change of pigeon guillemot at the Naked Island group from 1989 to 2008 was an approximate 12.7 percent annual decline (Bixler et al. 2010). Observed population change of pigeon guillemot at the also oiled, but mink-free Smith Islands was a 0.53 percent increase over the same time period, as pigeon guillemot recovered from EVOS. Thus, it is assumed that the long-term decline at the Naked Island Group was likely due to mink predation.

An example of the possible maximum rate of increase for pigeon guillemot was 13.6 percent annually for six years was noted by Byrd (2001) in the western Aleutian Islands when arctic fox were removed from two islands. Pigeon guillemot numbers on nearby islands where arctic fox were not removed changed only slightly. Seabirds prospect at the end of summer for good breeding sites (ones with evident chicks) and this may result in immigration to productive colonies from nonproductive colonies (Boulinier and Danchin 1997).

The modeling strategy used the best data available to quantify a matrix population projection model. The model assumed a maximum average adult survival rate of 0.9 under optimal conditions. Although no empirical estimates of adult survival exist for pigeon guillemot, this assumption is reasonable considering adult survival data across a range of different seabird species (Schmutz 2009). The assumption is very similar to the rate of 0.89 estimated for black guillemot (Frederiksen and Petersen 1999). To emulate the decline depicted by Bixler et al. (2010), the mean nest productivity rate of 0.35 was used from study years at Naked Island (1989, 1990, and 1994-1998). Bixler et al. (2010) also noted adult pigeon guillemots were killed at up to ten percent of nest sites. This rate may be an underestimate, if mink remove carcasses from the nest, as the investigator would assume the nest had failed and the adults simply dispersed. Regardless, a maximum predation rate of ten percent of the adults was used in the presence of mink (thus base adult survival without mink of 0.9 multiplied by 0.9 (the percent surviving predation in the presence of mink) equals 0.81. This nest survival rate of 0.35 and adult survival rate of 0.81 produced a rate of decline less steep than depicted in Bixler et al. (2010). An adult emigration rate was added, sufficient to produce the trend shown by Bixler et al. (2010). The best value for emigration rate was 15 percent. If this trend were to continue, a population of 100 pigeon guillemot would decrease to seven pigeon guillemot in 20 years. This model reflects the No Action – Current Management alternative.

An adult survival rate of 0.9, a nest survival rate equal of 0.61 (Golet et al. 2002), and an immigration rate equated to the emigration rate was needed to model the pigeon guillemot observed decline at the Naked Island group. The average increase of pigeon guillemot over 20 years was 17 percent annually, nearly identical to the value noted by Byrd (2001) for Simeonof Island. The projection starting point begins when there is assumed to be no mink predation. Additional model simulations could be done to characterize pigeon guillemot response to gradual mink control. To emulate a significant removal of mink (90 percent removal) nest survival and adult survival rates of 90 percent of the maximum values in the previous model were utilized. For the Control of Predatory Mink alternative, the average rate of annual increase of pigeon guillemot, over 20 years, was 16 percent.

The above model descriptions are deterministic, as each model parameter has a singular value without variation (e.g., if adult survival is 0.9, then 0.9 is maintained throughout the projection).

Stochastic models were run where variability was applied to the system with these core model structures. If biologically realistic parameter values of variability are used, then a stochastic model should be a more realistic representation of possible outcomes. For variability in nest survival (productivity), the data presented in Golet et al. (2002) was used for Naked Island. These data represent both ecologically real variability and also variability due to the sampling process. Variance decomposition procedures were used (Burnham et al.1987) to extract an estimate of process variation in nest survival. A normal distribution of this variability was imposed on the model by using random draws from the distribution, and running the model 1,000 times. The 50th and 950th model runs, sorted by population growth estimates, reflect the confidence interval of this model projection. Stochastic variability was imposed on adult survival rates. This level of variability was taken by using the mean process variation in adult survival from 18 seabird populations listed in Schmutz (2009).

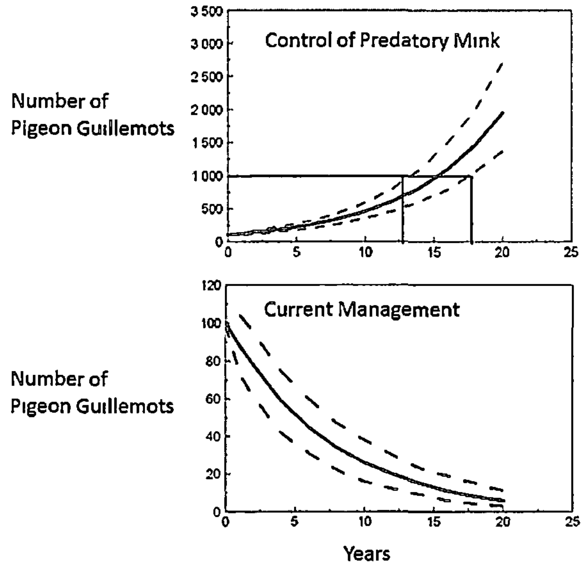

Figure 2. Results of stochastic Leslie matrix modeling of the changes in the pigeon guillemot population at the Naked Island group for two alternatives: No Action – Current Management and Preferred alternative – Control of Predatory Mink (Fleming and Cook 2010). Across the two model scenarios, guillemot productivity varies in a monotonic fashion. The graphs start with the year after the actions were completed.

The "No Action – Current Management" alternative represents no control of predatory mink at the Naked Island group and a predation rate based on the empirical predation rate of the 1990s (Bixler et al 2010). Under the "Preferred alternative – Control of Predatory Mink", a model projecting guillemot population growth, assumed annual removal of mink was sufficient so that few survived at the Naked Island group after each annual management effort and mink predation on guillemot was minimal.

C. Data Analysis and Statistical Methods

The Pigeon Guillemot population trajectory between 1989 and 2008 at the Naked Island group and at the nearby Smith Island group (mink-free islands) can be compared to population trends following control using a Before–After–Control–Impact design (Smith 2002).

D. Description of Study Area

Restoration would occur at the Naked Island group. The Pigeon Guillemot population at both the Naked Island group and the Smith Island group would be monitored.

E. Coordination and Collaboration with Other Efforts

Implementation of this plan would require coordination with agencies with authority and responsibility of the Naked Island group, American mink, and Pigeon Guillemots (See below). Monitoring of Pigeon Guillemots would be conducted by the U.S. Fish and Wildlife Service. Permits for control of mink at the Naked Island group would be obtained from both the Alaska Department of Fish and Game and the U.S. Department of Agriculture – Forest Service. Mink control would be conducted by the U.S. Department of Agriculture – Wildlife Services or other contractor.

Authority and Responsibility

U. S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service mission is "to work with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people." Along with other Federal, State, Tribal, local, and private entities, the Service protects migratory birds, endangered species, certain fish species, and wildlife habitat. The Service is the primary agency responsible for the conservation of the Pigeon Guillemot and its habitat as authorized by the Migratory Bird Treaty Act.

Alaska Department of Fish and Game

The mission of the Alaska Department of Fish and Game is to "protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle." The Department is responsible for maintaining a harvestable surplus of fish and wildlife species, including furbearers and marine forage fish.

U.S. Department of Agriculture Forest Service

The mission of the Forest Service is "to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations." The Forest Service is responsible for the management of the 5.4 million acre Chugach National Forest that includes nearly all of the Naked Island group, along with most of the rest of the land area of Prince William Sound.

III. SCHEDULE

A. Project Milestones

- Mink control completed at Naked Island group
  To be met by March 31, 2018

- Revise final report for EVOS project 10070853 to include details of mink management efforts and Pigeon Guillemot population trends.
  To be met by Sept 30, 2018

B. Measurable Project Tasks

FY 14, 2nd quarter (January 1 – March 31)
Trap and monitor mink at the Naked Island group

FY 14, 3rd quarter (April 1 – June 30)
Trap and monitor mink at the Naked Island group
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 14, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 15, 1st quarter (October 1 – December 31)

FY 15, 2nd quarter (January 1 – March 31)
Trap and monitor mink at the Naked Island group

FY 15, 3rd quarter (April 1 – June 30)
Trap and monitor mink at the Naked Island group
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 15, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 16, 1st quarter (October 1 – December 31)

FY 16, 2nd quarter (January 1 – March 31)
Complete mink trapping and use dogs to check for any remaining mink at the pigeon guillemot nesting areas on the Naked Island group

FY 16, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 16, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 17, 1st quarter (October 1 – December 31)

FY 17, 2nd quarter (January 1 – March 31)
Check for any remaining mink at the pigeon guillemot nesting areas using dogs at the Naked Island group

FY 17, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 17, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 18, 1st quarter (October 1 – December 31)
Monitor absence of mink at the at the pigeon guillemot nesting areas on the Naked Island group

FY 18, 2nd quarter (January 1 – March 31)
Set up field camp on Naked Island (Cabin Bay)
Monitor absence of mink at the at the pigeon guillemot nesting areas on the Naked Island group
Control complete
Remove field camp on Naked Island

FY 18, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May
Amend Final Report with information on control and guillemot population trends

FY 16, 4th quarter (July 1 – September 30)
Submit Final report to Trustee Council

IV. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

All community input is always welcome to our project, the proposal process is open and the PAG members and other members of local communities may comment on proposals. The findings of the study will be communicated to local communities through various means including the annual EVOS meeting, on the web, distribution of reports and of course the reports will always be available in the local libraries.

B. Resource Management Applications

The restoration described in this proposal is only option likely to be effective or currently available to "initiate, sustain, or accelerate recovery", a recovery objective for Pigeon Guillemots identified in the 1994 Restoration Plan. The amendment represents the culmination of several years of research previously supported by the EVOS Trustee Council that assessed factors limiting recovery of Pigeon Guillemot populations damaged by EVOS. It directly reflects the findings of research conducted under Project 10070853 in 2007 and 2008 on current limiting factors of Pigeon Guillemot recovery at the Naked Island group.

V. PUBLICATIONS AND REPORTS

An annual report for each year of this project will be submitted by 15 April of the following year. The final report for this project will be submitted 30 September 2018. One manuscript will be generated from this research and will be published in peer-reviewed scientific literature.

Budget Justification

FY 2014 -- $396,655.80 Phase II
FY 2015 –$391,205.80 Phase II
FY 2016 –$154,014.50 Phase II
FY 2017 –$139,967.70 Phase II
FY 2018 --$124,707.70 Phase II
TOTAL: $1,206,551.40 Phase II

NOTE: David Irons and Dan Roby submitted a proposal to the National Fish and Wildlife Foundation for ~50% of the original $2.2 million budget (half of the budget, excluding the NEPA budget). NFWF awarded $1,051,300.00 about two years ago, dependent on EVOSTC funding.

Project Title: Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, FY13 Amendment

Personnel: A project leader (GS 11) is needed to assist the Principal Investigators and must possess supervisory skills to govern the activities of 9 subordinate workers. For the recovery monitoring we will need two bio techs for one month the first two years and three bio techs for three months the last three years. We will need one bio tech for 12 months each year to take care of all field gear preparation/maintenance and survey logistics. The project leader will allocate 7 months to the project -- 4 months for field work in each year of the project to conduct QA/QC on the data, enter data into the North Pacific Pelagic Seabird Database, conduct the analysis and write the report. The analysis and writing will occur in FY18, when the report is due.

Request: (FY 2014: $43.8K; FY2015: $43.8K; FY 2016: $70.2K; FY 2017;$70.2K; FY 2018: $70.2K TOTAL: $298.2K)

Travel: Three people in years 1 and 2, and four people in years 3, 4, and 5 will be traveling throughout Prince William Sound and will need approximately 8 nights of lodging in towns around the Sound. Per diem rates will be given to each person during the survey. A tunnel fee is assessed to every vehicle traveling through the tunnel near Portage and the truck/boat will make 10 round trips during the survey.

Request: (FY 2014: $1.9K; FY2015: $1.9K; FY 2016: $3.7K; FY 2017;$3.7K; FY 2018: $3.7K TOTAL: $14.9K)

Contractual: APHIS - Wildlife Services will be contracted to control mink at the Naked Island group. A minimum of three persons per boat (3 boats) for a total of nine persons are needed to trap mink for the first two years and two boats the third year and one boat the last three years. We will need nine trappers for three months in winter the first two years, six trappers for one month in year 3, and three trappers for one month for years 4 and 5. The trappers will need 6 nights of lodging in Whittier. Per diem rates will be given to the trappers while traveling and camping.
Prince William Sound is large and requires extensive travel by boat. To make the survey cost effective, a support vessel will be contracted to provide lodging and food for the winter trapping period which is three months the first two years and one month the last three years. The small boats used to put the trappers on shore and for restoration monitoring will operate for hundreds of hours and will need repairs and replacement parts. There are also fees associated with launching and parking the boat in the harbors. Fuel storage at Naked Island will require a barge for transportation.

Request: (FY 2014: $275.2K; FY2015: $270.2K; FY 2016: $44.0K; FY 2017;$37.1K; FY 2018: $23.1K TOTAL: $649.7K)
)

Commodities: Includes gas and oil to support boat transport and operation during the trapping in the winter which will have three boats for three months the first two years, two boats for one month in the third year, and one boat for one month in the last two years. Restoration monitoring will require one boast for one month in the summer the first two years. During the last three years, monitoring will require two boats for one month and one boat for two months. This also includes food for 4 people while conducting the restoration monitoring in the summer when there is no support vessel; and personal safety devices.

Request: (FY 2014: $40.0K; FY2015: $40.0K; FY 2016: $20.4K; FY 2017;$14.4K; FY 2018: $14.4K TOTAL: $129.1K)

Equipment: We are using USFWS equipment for this survey as an in-kind contribution but the survey work takes a toll on boats; on average, each boat will run a total of 30-90 full days per year. As a result, we are including funds for emergency replacement of motor parts that fail during the survey should that need arise.

Request: (FY 2014: $3.0K; FY2015: $3.0K; FY 2016: $3.0K; FY 2017;$3.0K; FY 2018: $3.0K TOTAL: $15.0K)

Indirect: We are using the standard G&A rate of 9%.

Request: (FY 2014: $32.7K; FY2015: $32.3K; FY 2016: $12.7K; FY 2017;$11.5K; FY 2018: $10.2.0K TOTAL: $99.6K)

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Appendix A

Pigeon Guillemot Restoration Research in Prince William Sound, Alaska: A Summary of Findings and Evidence for Recent Introduction of American Mink to the Naked Island Group

David Irons, Kirsten Bixler, and Dan Roby

2013

Summary

This project, Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, identified an opportunity to restore the breeding population of Pigeon Guillemots (*Cepphus columba*) in Prince William Sound, Alaska. The numbers of Pigeon Guillemots that nest at the Naked Island group in central Prince William Sound (PWS) has declined by more than 90% since 1989. Based on the findings from this research project, a restoration plan for Pigeon Guillemots in PWS was prepared to address the species' lack of population recovery following injury by the 1989 *Exxon Valdez* oil spill. Predation on guillemot nests and adults by American mink (*Neovison vison*) is now the primary limiting factor for guillemot reproductive success and population recovery at the most important historical nesting site for guillemots in PWS (i.e., the Naked Island group). Mink on the Naked Island group are descended in part from fur farm stock and the available evidence and testimonies of local people indicate that mink were introduced on the island group during the 1970's. Removal of all mink in the pigeon guillemot nesting areas through control of predatory mink on the Naked Island group was selected as the preferred restoration alternative because it is feasible and likely to result in the substantial recovery of guillemots in PWS. Other alternatives are either currently unavailable or unlikely to be effective. A mink reduction effort is likely to be successful due to both well-developed methods and the low likelihood of natural re-colonization to the pigeon guillemot nesting areas Potential negative effects of the preferred alternative are either negligible or largely avoidable. The numbers of Pigeon Guillemots nesting at the Naked Island group would likely increase five-fold within the first 10 years following mink control, and the Sound-wide population of guillemots would likely increase substantially within 15 years of mink control at the Naked Island group, once the Naked Island group has become a source population for other parts of PWS.

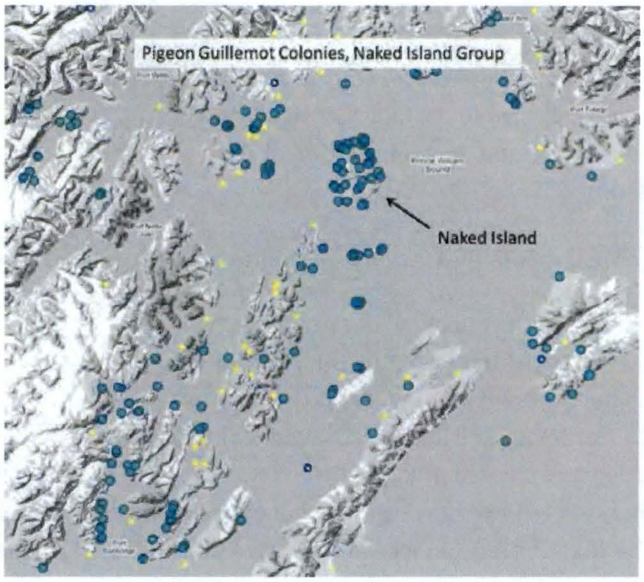


Figure1. Map of Prince William Sound and the Naked Island group showing Pigeon Guillemot breeding colonies before the detection of mink on the Naked Island group.

American Mink Introduction to the Naked Island Group in Prince William Sound, Alaska: A Review of the Evidence

A recent drastic decline in numbers of Pigeon Guillemots (*Cepphus columba*) nesting at the Naked Island group in central Prince William Sound (PWS) is concurrent with the onset of sightings of American mink (*Neovison vison*) on the Naked Island group and frequent guillemot nest failure due to mink predation.

- Data from shoreline surveys of entire islands showed four islands in central PWS without mink had an average density of 49.4 Pigeon Guillemots/kilometer of shoreline in 1993. Four islands in central PWS with mink had an average density of 0.55 Pigeon Guillemots/kilometer of shoreline in 1993. In 1978 before the introduced mink increased and began depredating pigeon guillemot nests on the Naked Island group, the average density was 47.8 Pigeon Guillemots/kilometer of shoreline. After mink colonization, in 2008, the Naked Island group had an average density of 0.96 Pigeon Guillemots/kilometer of shoreline.
- In 1978, no predation of guillemot nests was observed on the Naked Island group during an in-depth study of Pigeon Guillemot nesting ecology.
- By 1998, just 20 years later, at least 60% of guillemot nests and 4.5% of breeding adult guillemots on the Naked Island group were depredated by mink.
- The Pigeon Guillemot breeding population at the Naked Island group has declined by more than 90% during the last 15 years, following the arrival of mink; in contrast, the guillemot breeding population at nearby mink-free islands in central PWS has been stable since 1990.
- Researchers have documented abundant food for guillemots (forage fishes) near the Naked Island group.

- In addition to Pigeon Guillemots, several other colonial seabird species show similar recent drastic declines in breeding populations on the Naked Island group Tufted Puffins (*Fratercula cirrhata*) and Horned Puffins (*F corniculata*) nest in greatly reduced numbers on the Naked Island group and are confined to the tallest cliffs Parakeet Auklets (*Aethia psittacula*) no longer nest at the Naked Island group. In contrast, Sound-wide populations have remained stable or declined slightly (Figure 2).

Testimonies of local people indicate that American mink were introduced at the Naked Island group.

- Herb Jenson of Cordova is the nephew of Jerry Clock who grew up on Peak Island, Herb stated that his uncle had released American mink in the 1970's on Naked Storey and Peak islands to establish a population for trapping, but that the population did not grow much until the 1990's.
- A local trapper in Cordova, Ed Bilderback, saw no mink or evidence of mink on the Naked Island group between 1946 and the mid-1990's.
- There is also other suggestive evidence of introductions of American mink to islands in Prince William Sound by fox farmers (Lethcoe and Lethceo 2001) and fur trappers (R. Ellis, USDA-WS, pers comm) to establish new harvestable populations

Historical and current distribution of mink in Prince William Sound (PWS) strongly suggest that mink are not native to the Naked Island group.

- Mink do not naturally occur on isolated islands (> 5 km from the nearest mainland) in PWS (i.e., Montague, Green, Seal, Smith, and Little Smith islands)
- The Naked Island group is similarly isolated (6 km from the nearest island)
- The record for longest natural dispersal distance over open water by mink is 4 km
- There were no mink found on the Naked Island group during a collecting expedition in 1908
- American mink have been intentionally introduced to isolated islands in PWS where they were formerly not found (i.e., Montague Island) and undocumented introductions of mink to other isolated islands have also occurred in PWS.

Studies of the population genetic structure of mink in PWS suggest that mink on the Naked Island group were introduced.

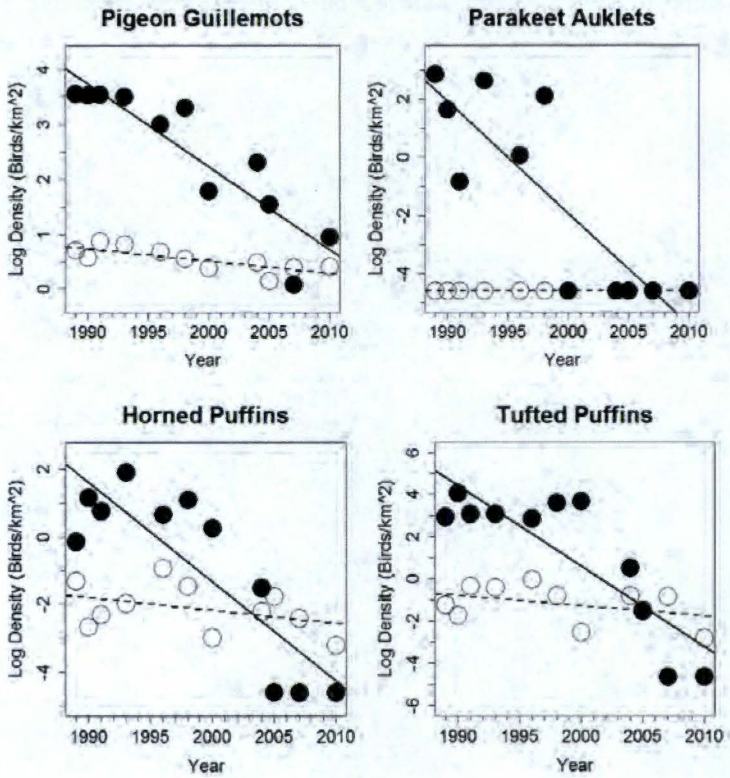
- Mink at the Naked Island group are descended in part from fur farm stock.
- Observed genetic diversity of mink at the Naked Island group is not consistent with natural colonization due to infrequent dispersal events.
- The estimate of initial (founder) population size (about 5 pairs) is much larger than would be expected from a natural colonization event

Published accounts of the effects of introduced American mink on their prey elsewhere document rapid and drastic declines in numbers of birds after mink introduction and large increases in bird populations following mink removal.

- On islands where mink were introduced, nearly all native species of birds, mammals, and amphibians present on the islands declined due to mink predation.
- Populations of most of these native species increased dramatically following mink removal

- Eradication of introduced American mink on islands in the Baltic Sea resulted in increases in numbers of breeding Black Guillemots (*Cepphus grylle*), a close relative of Pigeon Guillemots

Species for which nests are susceptible to American mink predation



Species for which nests are not susceptible to American mink predation

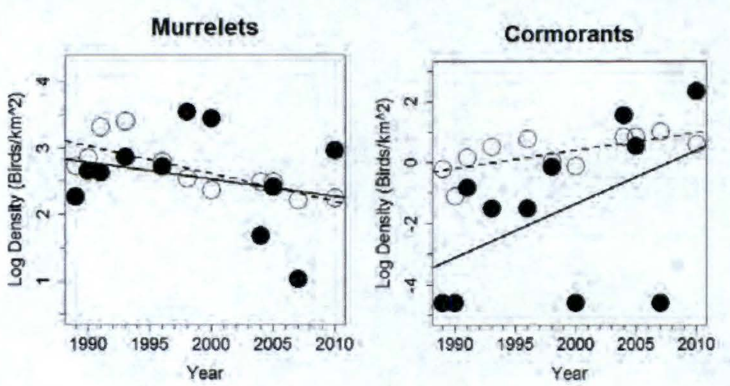


Figure 2. Comparison of population trends from 1989 to 2010 for species of fish-eating seabirds, whose nests are susceptible to American mink predation and whose nests are not susceptible to American mink predation at the Naked Island group (filled circles) and the remainder of PWS (open circles). Data are from EVOSTC-funded, PWS-wide surveys of a random sample of 25 percent of the shoreline transects. (Note: negative values on the natural log scale indicate that densities were less than one bird/km^2 (Cushing et al. 2012).

In 1978 pigeon guillemot equally nested in three habitats, but by 2008 almost all the nests occurred in cliff habitat that was least accessible to American mink (Table 3).

Table 3. Number and percent of active pigeon guillemot nests in different nest site types at the Naked Island group, PWS, Alaska in 1978 and 2008.*

	1978		2008	
Nest Type	Number	Percent	Number	Percent
In a crevice on a cliff face	52	35.6	15	88.2
In overhanging soil at a cliff top	58	39.7	2	11.8
Under boulders at the base of a cliff or amidst rocks on a cliff ledge	36	24.7	0	0 0
Total	146	100.0	17	100 0

*Reproduced from Bixler et al (2010).

History of mink on Naked, Storey and Peak Islands as told by Herb Jenson, son of Dolly Clock and nephew of Jerry Clock, to David Irons on 13 June, 2012.

Herb is a commercial fisherman and lives in Cordova. Herb spent most of his summers at the Peak Island homestead in the 1960's, 1970's and 1980's and still goes to the homestead when he can.

Alice McPherson married James Clock and homesteaded Peak Island and had a fox farm in the early 1900's James died early, but Alice stayed on Peak Island and raised six children: Dolly, Virginia, Elizabeth, Jerry, Tom, and Ray. Jerry trapped river otter on the islands for years, but there were no mink on the islands. In the 1970's Jerry decided he wanted to be able to trap mink on the islands so he live-trapped mink in areas of Prince William Sound that had mink and released them on Naked, Storey, and Peak islands. He brought a few every year for several years, but they did not establish a sustainable population right away and Jerry was never able to trap them. He became ill with cancer in the 1980's so he stopped trapping on the Naked Island Group. As Herb remembers, mink did not become abundant on the Naked Island Group until the 1990's.

Statement from Ed Bilderback, who trapped annually in Prince William Sound from 1946-2002.

June 17, 2008

To Whom It May Concern:

I trapped mink, river otter, martin and wolverine throughout Prince William Sound from 1946 to 2002. I had a boat and traveled around trapping on the mainland and on most large islands. In the 1940's I noted that there were no mink on Montague, Green, Naked, Storey and Peak islands. There were river otter but no mink or martin. Mink occurred on the mainland and most large islands except for the ones mentioned above. Martin occurred on the mainland, but not on islands. In the 1950's the Alaska Department of Fish and Game introduced farmed mink on Montague Island, after that, I caught mink on Montague. I trapped the Sound every year and I never saw or caught a mink on the Naked Island group until the mid 1990's, when I saw a mink on Peak Island. It is my belief that mink did not naturally occur on Montague, Green, Naked, Storey, or Peak Islands.

Sincerely, Ed E. Bilderback

Ed Bilderback
P.O. Box 536
Cordova Alaska
99574

Appendix B

ENVIRONMENTAL ASSESSMENT

DRAFT

POTENTIAL RECOVERY OF PIGEON GUILLEMOT POPULATIONS

NAKED ISLAND GROUP, PRINCE WILLIAM SOUND,

CHUGACH NATIONAL FOREST, ALASKA

JULY 19, 2013

Prepared by:

U.S. Fish and Wildlife Service

U.S. Forest Service,
Chugach National Forest

U.S. Animal and Plant Health Inspection Service
Wildlife Services

GAP Solutions, Inc.

For:

The *Exxon Valdez* Oil Spill Trustee Council

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CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

On March 24, 1989, the T/V Exxon Valdez ran aground at Bligh Reef resulting in the release of at least 44 million liters of Prudhoe Bay crude oil into Prince William Sound (PWS; Figure 1). Oil spread to the southwest through the PWS and into the northern Gulf of Alaska. An estimated 500 to 1,500 pigeon guillemot in PWS were immediately killed due to oil exposure (Piatt and Ford 1996). Ten to 15 percent of the pigeon guillemot (*Cepphus columba*) population within the entire spill area, an estimated 2,000 to 6,000 birds, died from acute oiling (EVOSTC 2010). The Naked Island group (Naked, Storey, and Peak islands), located within PWS (Figure 1) were one of the first areas to be oiled (Oakley and Kuletz 1994). Evidence indicates that pigeon guillemot were exposed to and negatively affected by residual oil for at least a decade after the spill (Golet et al. 2002). By 2004 there was no longer an indication of pigeon guillemot exposure to residual oil from the Exxon Valdez Oil Spill (EVOS; Bixler 2010).

As a result of the Exxon Valdez Oil Spill (EVOS), the State of Alaska, the federal government, and Exxon Corporation entered into "the Agreement and Consent Decree (Consent Decree), as approved by the court on October 8, 1991 (A91-082-CIV)", to ensure restoration of injured resources and resources dependent services due to the oil spill. The Consent Decree provided that money paid to the Governments would only be used for certain purposes, which included to "plan, implement, and monitor the restoration, rehabilitation, or replacement of Natural Resources, natural resources services,...injured as a result of the Oil Spill..." The EVOS Trustee Council established a list of resources that suffered population-level injuries due to the spill and developed specific, measurable recovery objectives for each injured species. The pigeon guillemot is on that list. Studies were completed in 2010 (see Most Recent Research and Studies section, Chapter 1) to address the lack of population recovery of pigeon guillemot.

The Naked Island group is particularly important because it was historically the main pigeon guillemot breeding location in PWS (Sanger and Cody 1994) One fourth of all pigeon guillemot nests in PWS in 1989 (just after the spill) were located at the Naked Island group, although the islands constitute only about two percent of the total shoreline in PWS (Bixler et al. 2010). Restoration of pigeon guillemot at the Naked Island group to the 1989 levels could result in a substantial PWS-wide population increase. The Naked Island group is also the site where researchers and managers have the most information and have investigated mechanisms regulating pigeon guillemot populations in PWS. Data on population size, nesting success, and diet of pigeon guillemot has been collected at the Naked Island group for 15 years between 1978 and 2008.

Predation by American mink (*Neovision vision*) (hereafter referred to as mink) appears to be the primary factor limiting pigeon guillemot population recovery at the Naked Island group (Irons et al. 2013). Mink predation on eggs and chicks in nests and adults combined with the decline due to EVOS has likely suppressed pigeon guillemot populations at the Naked Island group. Other seabirds have also been affected. Parakeet auklets (*Aethia psittacula*), tufted puffins (*Fratercula cirrhata*), and horned puffin (*Fratercula corniculata*) declined from about 1,400 breeding birds to approximately twelve (Bixler 2010). Prior to the EVOS the Naked Island group supported the highest number of nesting pairs of parakeet auklet in PWS.

Available evidence and modeling indicate that reducing mink predation on eggs, chicks and adults would result in a measureable increase in the breeding population and productivity of pigeon guillemot.

To assess potential methodologies for recovery of pigeon guillemot within the oil spill area, the EVOS Trustee Council authorized Project 11100853, *Pigeon Guillemot Restoration Research in PWS; providing an opportunity to restore the population of pigeon guillemot at the Naked Island group*. Preparation of this Environmental Assessment (EA) represents the first phase of implementing Project 11100853. The EVOS Trustee Council, comprised of three state and three federal trustees, has provided funding for this EA. Once a preferred alternative is selected (except the No Action Alternative) with potential funding partners, the EVOS Trustee Council and the National Fish and Wildlife Foundation would provide funding for project implementation.

PURPOSE OF ACTION

The purpose of the action is to restore pigeon guillemot at the Naked Island group from the present 100 birds to 1,000 birds (observed at the time of the 1989 EVOS) and to remove pigeon guillemot from the EVOS Trustee Council "not recovering" list. This recovery at the Naked Island group would effectively recover pigeon guillemot in Prince William Sound. Mink are the primary predator responsible for pigeon guillemot declines and the Proposed Action discussed in Chapter 2 requires reduction in their population. Recovery is expected to be measureable three years after project initiation. Initial signs of recovery would be recognized by observing sustained or increasing pigeon guillemot productivity and an increase in the number of nesting birds. Productivity is defined as the number of young pigeon guillemots produced from each nest each year (Table 1). While recovery will be slow during initial implementation of the Proposed Action, it is anticipated that their population would be "recovered" in 15 years after the mink trapping program has been completed.

The EVOS Trustee Council has three definitions for the status of injured species: "not recovering", "recovering", and "recovered". The pigeon guillemot would be considered "recovering" when productivity at the Naked Island group is sustained or increasing, as stipulated within the EVOS Restoration Plan 2010 Update Injured Resources and Services. "Recovered" is defined as increasing the pigeon guillemot populations at the Naked Island group to 1,000 birds observed at the time of the 1989 EVOS from the current 100 birds. When the total population at the Naked Island group has reached 1,000 birds, the PWS population would also be "recovered" by having a stable population, as stipulated within the EVOS Restoration Plan 2010 Update Injured Resources and Services.

Table 1. Expected results for Proposed Action-Control of Predatory Mink and No Action-Current Management Alternatives.

Timeline*	**Pigeon Guillemot Status***	
	Proposed Action – Control of Predatory Mink	**No Action-Current Management**
Current	*Not Recovering* (100 birds)	*Not Recovering* (100 birds)
3 years after project initiation	*Recovering* Chick productivity increases to 0.5 chicks and nesting birds increase up to 10% from 100 (baseline) to 110 birds observed three years after project initiation	*Not Recovering* Chick productivity of <0.5 chicks/nest static or declining and nesting birds declining from the 100 birds (baseline) to 70 birds
5 years after project initiation	*Recovering* Chick productivity remains at 0.5 chicks/nest or higher and nesting birds increase to 10-30% from 100 (baseline) to 110 to 130 birds	*Not Recovering* Chick productivity of <0.5 chicks/nest and nesting birds declining to 55 birds
10 years after project completion	*Recovering* Chick productivity remains at 0.5 chicks/nest or higher and nesting birds increase to 500 birds or more	*Not Recovering* Chick productivity of <0.5 chicks/nest and nesting birds declining to 30 birds
15 years after project completion	*Recovered* Chick productivity remains at 0.5 chicks/nest or higher and nesting birds increase to 1,000 birds or more	*Not Recovering* Chick productivity of <0.5 chicks/nest and nesting birds declining to 18 birds

*Timeline and milestones for observing "not recovering", "recovering", and "recovered" pigeon guillemot status as defined by the EVOS Restoration Plan: 2010 Updated Injured Resources.

NEED FOR ACTION

The number of pigeon guillemot breeding at the Naked Island group has declined from approximately 1,000 birds in 1989 to about 100 in 2008; a 90 percent decline. Other PWS pigeon guillemot populations, excluding the Naked Island group, declined 22 percent during the same period (Irons et al. 2013; Bixler et al. 2010). The Naked Island group had 47.8 pigeon guillemot observed per kilometer of shoreline in 1990 and 0.96 in 2008 (Bixler et al. 2010, Irons et al. 2013).

Pigeon guillemot is the only marine bird species listed as "not recovering" on the EVOS Trustee Council's Injured Resources List, and shows no indication of population recovery. An EVOS Trustee

Council objective is to pursue alternatives to actively shift the population status toward full recovery. Research and several studies to address the lack of population recovery of pigeon guillemot were completed in 2010. Pigeon guillemot recovery would allow the EVOS Trustee Council to remove this bird from its "not recovering" list and added to the "recovering" list and eventually to the "recovered" list.

The primary limiting factor for pigeon guillemot recovery at the Naked Island group appears to be mink predation (Irons et al. 2013). Reduction of mink is critical to the success for "recovering" pigeon guillemot, but complete removal is currently not a viable alternative.

Figure 1. Prince William Sound, Alaska.

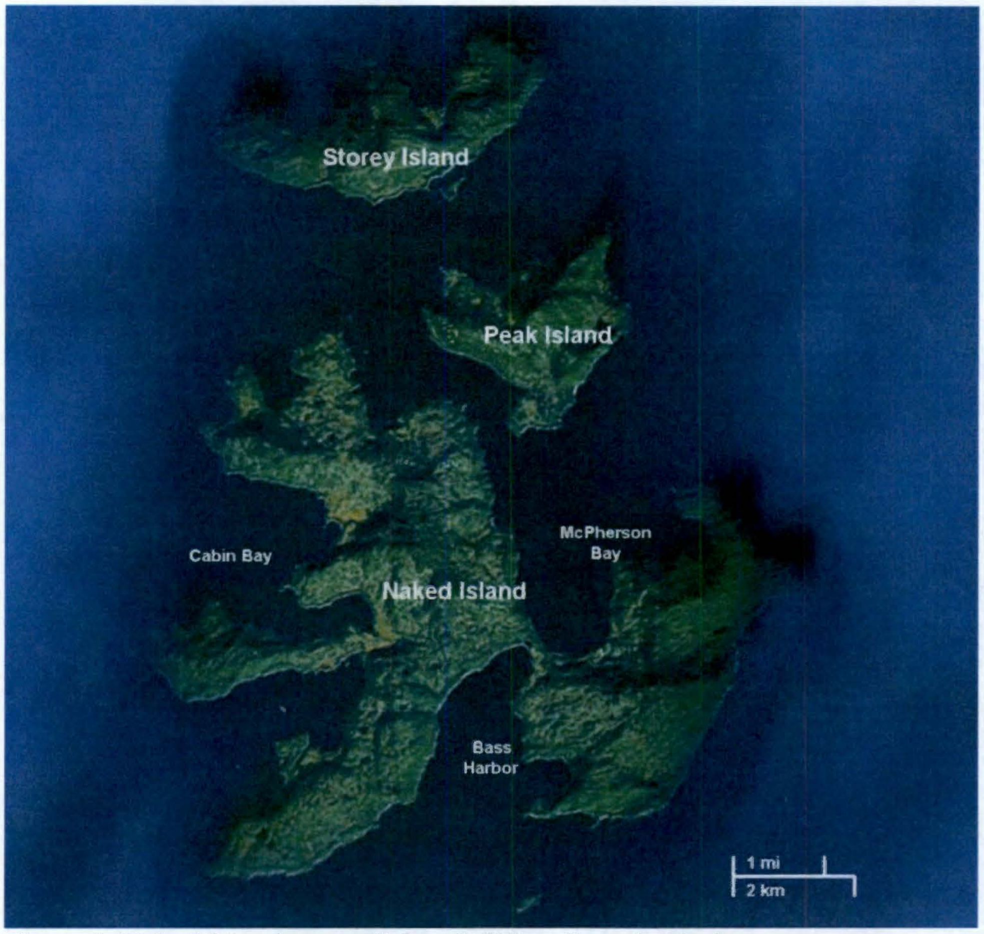


Figure 2. Naked Island group, Prince William Sound, Alaska.

BACKGROUND

Importance of Naked Island group

The Naked Island group was one of the most important historical breeding and rearing locations for seabirds in PWS (Bixler et al. 2010). From the early 1970s until the EVOS in 1989, the Naked Island group supported some of the highest densities of breeding pigeon guillemot (93.2 birds/km^2) as well as parakeet auklet (23.8 birds/km^2), tufted puffin (39.2 birds/km^2), and horned puffin (6.0 birds/km^2) on approximately 100 km of shoreline as compared with the remainder of PWS, which encompasses approximately 5,000 km of shoreline (Isleib and Kessel 1973; Table 2). While the purpose of the Proposed Action is the recovery of pigeon guillemot, it is important to understand the benefit to other seabirds as a result of removing predatory mink.

Table 2. Seabird densities of randomly selected transects at the Naked Island group (NIG) and Prince William Sound (PWS).

Period or Year	Pigeon Guillemot birds/km²		Parakeet Auklet birds/km²		Tufted Puffin birds/km²		Horned Puffin birds/km²	
	NIG	PWS	NIG	PWS	NIG	PWS	NIG	PWS
1970's *	93.2	15.5	23.8	1.9	39.2	9.6	6.0	3.6
1990 *	34.4	1.78	5.1	0	59.0	0.2	3.2	0.1
1998*	27.3	1.74	8.4	0	37.6	0.4	3.0	0.2
2010*	2.6	1.51	0	0	0	0.1	0	0.1

*Dywer et al. 1976, Oakley and Kultez 1979, and Cushing et al.2012

Population Decline

Declines in numbers of pigeon guillemot at the Naked Island group were concurrent with the onset of sightings of and predation by mink. No predation of pigeon guillemot nests was observed in 1978, but by the late 1990's at least 60 percent of pigeon guillemot nests and10 percent of breeding adult pigeon guillemot were depredated by mink (Irons et al. 2013, Bixler 2010, and Bixler et al. 2010). Mink were identified as a predator of pigeon guillemot at the Naked Island group by:

- snaring mink entering pigeon guillemot nest cavities (Irons et al. 2013).
- confirmation that bite wounds were the cause of chick death and that these wounds were consistent with the inter-canine width of mink (generally nine to11 mm) (Irons et al. 2013); and
- identification that the method of death is consistent with mink predation, i.e., bite wounds on the head and neck, decapitation of the bird, and caching of carcasses (Irons et al. 2013).

Aside from river otter (*Lontra canadensis*) and mink, no other mammalian predators including American marten (*Martes americana*) and weasel (*Mustela ssp.*) have been documented on the islands, despite extensive trapping efforts. River otter have been documented on the islands since at least 1908 (Heller 1910) and have been known to depredate a limited number of pigeon guillemot nests. River otter access nests by digging into them and the disturbance is obvious and easily distinguishable from mink. No such disturbance was detected in depredated nests since 1989, suggesting that the recent observed predation events can only be attributed to mink (Bixler et al. 2010).

Other predators of pigeon guillemot exist. Corvids have been observed in the vicinity of pigeon guillemot nests at the Naked Island group, but have not been observed entering a nest cavity (Irons et al. 2013). A few adult pigeon guillemot beaks have been found in bald eagle (*Haliaeetus leucocephalus*) nests, but bald eagles cannot access the pigeon guillemot nest cavity.

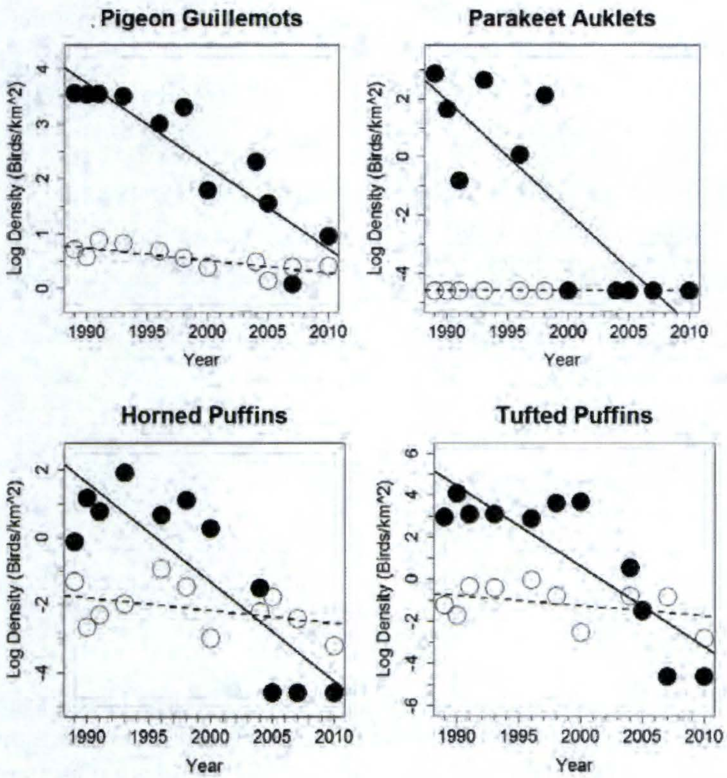
Pigeon guillemot nest in talus and rock crevices and are susceptible to ground based predation. Mink are the only known ground-based predator occurring at the Naked Island group, except for river otter. Little predation of seabirds by river otter has been observed at the Naked Island group (Irons, pers. obs.).

Mink and Seabird Populations

As stated earlier, while recovering pigeon guillemot is the purpose of the Proposed Action, it is important to show the benefit to other seabirds as a result of removing predatory mink from the Naked Island group. By comparing trends in seabird numbers susceptible to mink predation to trends in seabirds not susceptible to mink predation at the Naked Island group and the rest of PWS, indicates that an increase in mink likely caused pigeon guillemot and other seabirds to decline.

Densities of seabirds susceptible to mink predation were much higher in 1989 at the Naked Island group than in the rest of PWS. From 1989 to 2008 the seabird densities declined sharply at the Naked Island group, while declining only slightly in the rest of PWS (Figure 3). Initial densities and trends in densities of seabirds not susceptible to mink predation are similar at the Naked Island group and the rest of PWS (Cushing et al. 2012, Cushing unpubl. data). These data support the premise that in 1989, few mink were at the Naked Island group compared to the rest of PWS and mink numbers increased over the next several years at Naked Island group, but changed little in the rest of PWS. Likewise, the increase in mink caused pigeon guillemots and other bird species (whose nests are susceptible to mink predation) to decline significantly at the Naked Island group as compared to the birds in the rest of PWS.

Species With Nests Susceptible to Mink Predation



Species With Nests Not Susceptible to Mink Predation

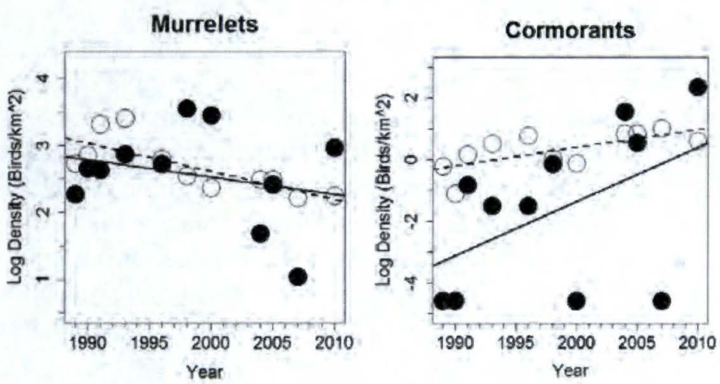


Figure 3. Comparison of population trends from 1989 to 2010 for species of fish-eating seabirds, with nests are susceptible to mink predation, and with nests are not susceptible to mink predation at the Naked Island group (filled circles) and the remainder of PWS (open circles). Data are from EVOS Trustee Council-funded, PWS-wide surveys of a random sample of 25 percent of the shoreline transects. (Note: negative values on the natural log scale indicate that densities were less than one bird/km^2 (Cushing et al. 2012).

In 1978 when little pigeon guillemot predation by mink occurred at the Naked Island group, birds nested mainly in three different habitats: crevices on cliff faces; overhanging soil at a cliff top, and under boulders at the base of a cliff, or amidst rocks on a cliff edge. Mink could access most nests in overhanging soil at a cliff top and nests under boulders at the cliff base or amidst rocks on a cliff ledge, but mink were not able to access crevice or cliff face nests easily. Most nests in the habitat easily accessible to mink were gone by 2008 and remaining nests occurred in habitat difficult for mink to access (Table 3.). These results provide evidence that mink predation is responsible for the pigeon guillemot decline at the Naked Island group.

Table 3. Number and percent of active pigeon guillemot nests in different nest site types at the Naked Island group, Prince William Sound, Alaska in 1978 and 2008.*

	1978		2008	
Nest Type	Number	Percent	Number	Percent
In a crevice on a cliff face	52	35.6	15	88.2
In overhanging soil at a cliff top	58	39.7	2	11.8
Under boulders at the base of a cliff or amidst rocks on a cliff ledge	36	24.7	0	0.0
Total	146	100.0	17	100.0

*Reproduced from Bixler et al (2010)

Mink predation was not a recorded cause of pigeon guillemot nest failure at the Naked Island group during studies in the late 1970's and early 1980's. However, by the mid-1990's mink predation on pigeon guillemot nests was frequently recorded (Hayes 1995, Golet et al. 2002). The population of pigeon guillemot has declined at a dramatic rate, and mink are the major reason for this population decline

Mink are native to the Gulf of Alaska ecoregion (ADF&G 2006). Genetic analysis of populations in PWS (Fleming and Cook 2012) indicates mink at the Naked Island group are of the same or very close lineage to mink found in PWS. Fleming and Cook (2010) also regarded the Knight Island Archipelago, as the primary source of mink at the Naked Island group. Neither mink nor their predation was noted until mid-1990, although studies of pigeon guillemot were ongoing at the Naked Island group since the late 1970's (Hayes 1995, Golet et al 2002). As definitive data are not conclusive, ADF&G considers mink to be native to the Naked Island group. Whether or not mink are native or introduced will not be addressed in this EA. However, what is clear is that the population of pigeon guillemot has declined at a dramatic rate, and mink are the major reason for this population decline. Additional information can be found at Irons et al. (2013).

Theoretical projections of the mink population at the Naked Island group, based on published values on reproduction and survival in other systems, suggested that mink colonization most likely preceded the EVOS and may have been followed by a decline as a result of the spill, although no study was done to confirm this (Ben-David 2012a, b). Simulations also support the hypothesis that a recovery of the mink population in the late 1990's, which coincided with low numbers of nesting seabirds, led to increase in predation rates by these carnivores (Ben-David 2012a, b). This is supported by the observation that the highest predation rates on pigeon guillemot nests occurred in 1998 (Irons et al. 2013). Mink forage at sites with shallower tidal slopes, with mostly bedrock, and protected from wave action, mostly during low tides when large areas of shallow rock-pools are exposed (Ben-David et al. 1996). To avoid contaminated intertidal resources, a still high mink population may have switched to feed on nesting seabirds.

MODELING

The potential changes in the growth of the pigeon guillemot population at the Naked Island group were modeled in an effort to inform the decision-making process. Two management alternatives were modeled: Alternative A: No Action-Current Management; and Alternative B: Proposed Action-Control of Predatory Mink. A stochastic Leslie matrix model after Golet et al. (2002) and Bixler et al (2010) was used to project pigeon guillemot population growth under these two alternatives at the Naked Island group.

The following equation was used to project the growth rate of the pigeon guillemot population:

(λ): $\lambda = ((PF * FX * PA^2) + (NX * PA)) / NX$

Where,

λ = annual population growth rate
P_F = annual sub-adult survival rate
F_X = number of offspring produced
P_A = age-constant annual adult survival
N_X = initial population size

The details of the model and justification are found in Appendix C.

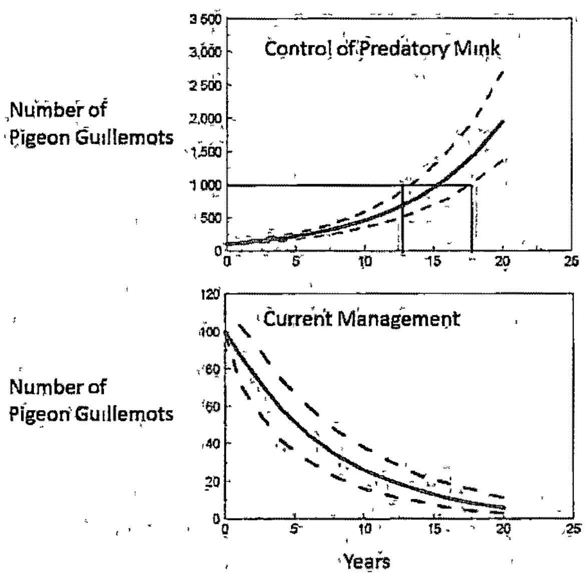


Figure 4. Results of stochastic Leslie matrix modeling of the changes in the pigeon guillemot population at the Naked Island group for the Proposed Action-Control of Predatory Mink and No Action-Current Management Alternatives (Fleming and Cook 2010). Pigeon guillemot productivity varies in a monotonic fashion across the two model scenarios. The graphs start with the year after the actions were completed.

Under the Proposed Action-Control of Predatory Mink alternative, the model projecting pigeon guillemot population growth assumes minimal mink predation (~2 nests depredated per year). Pigeon guillemot population is projected to reach 1,000 in about 15 years but could be as early as 13 years or as late as 18 years.

The No Action-Current Management alternative represents no control of mink and a predation rate based on the empirical predation rate during the 1990s (Bixler et al. 2010). The result would be a continued reduction in the pigeon guillemot population.

DECISION FRAMEWORK

U.S. Fish and Wildlife Service

The Department of Interior (DOI), U.S. Fish and Wildlife Service (USFWS) is the lead agency responsible for preparing this EA, as defined in 40 CFR 1508.16, as well as developing the National Environmental Policy Act (NEPA) analysis and findings. The USFWS has a responsibility for evaluating possible impacts on Federal trust resources (birds, mammals, etc.) in accordance with applicable Federal law. The USFWS's Chief of Migratory Bird Management is responsible for any decision document once a preferred alternative is selected.

U.S. Forest Service

The U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) is authorized by applicable Federal law and regulations to administer the management of natural resources, including fish and wildlife habitat, wilderness, and recreational resources on the Chugach National Forest. The Naked Island group is within the Chugach National Forest, Glacier Ranger District and within the Nellie Juan-College Fiord Wilderness Study Area.

The Forest Supervisor is the Responsible Official. The Forest Supervisor is responsible to ensure that action alternatives are consistent with the 2002 Chugach National Forest Revised Land and Resource Management Plan, as amended, including maintaining the character of the Nellie-Juan-College Fiord Wilderness Study Area which was designated in 1980. The Forest Supervisor's decision would be documented in a Decision Notice and if the proposed action is selected as the preferred alternative, would specify measures to implement actions proposed on National Forest System land and would issue a special use permit for project implementation.

Animal and Plant Health Inspection Service – Wildlife Services

The USDA Animal and Plant Health Inspection Service-Wildlife Services (APHIS-WS) mission is to provide Federal leadership and expertise to resolve wildlife conflicts. APHIS-WS is recognized as having the authority and expertise to conduct wildlife damage management activities on federally administered lands and would implement field operations under a funding Agreement. The APHIS-WS Western Regional Director would sign a decision document based on selection of the preferred alternative.

Alaska Department of Fish and Game

The Alaska Department of Fish and Game (ADF&G) has the responsibility and authority to provide for the sustainability of all fish and wildlife in Alaska, regardless of land ownership or designation, unless specifically preempted by Federal law. If the proposed action is selected as the preferred alternative, the ADF&G would assist the USFWS in consulting with those State entities necessary to gain authorization for a predator control program. The ADF&G is responsible for issuance of applicable permits.

EVOS Trustee Council

The Trustee Council is providing partial funding for this project and would determine whether to fund the proposed action, if it is selected as the preferred alternative. There are three State and three Federal trustees, including ADF&G, the Alaska Department of Environmental Conservation, the Alaska Department of Law, the National Oceanic and Atmospheric Administration, the USDA, and the DOI.

Cooperating Agencies

The USFWS, USFS, and APHIS-WS are cooperating agencies for preparation of this EA.

LEGAL/ADMINISTRATIVE REQUIREMENTS

Wilderness Study Area

The Naked Island group is located within the congressionally designated Nellie Juan-College Fiord Wilderness Study Area (Alaska National Interest Lands Conservation Act (ANILCA) (Section 702). The ANILCA directs the USFS to maintain the wilderness character of the area. The Nellie Juan-College Fiord Wilderness Study Area is managed to maintain and protect the existing (1980) wilderness character in the western half of PWS until Congress acts on permanent wilderness designation or releases the area from Wilderness Study Area designation. A Minimum Requirements Decision Guide is being prepared that would define the minimum required activity necessary to meet the objectives of the proposed action.

Roadless Area Conservation

The Naked Island group was part of a Roadless Area Review and Evaluation (RARE II area) in 1978 and the Chugach Forest completed an inventory of unroaded areas as part of the national process (USDA 2002). There are no roads on any of the islands at the Naked Island group and none are proposed. No tree removal or other vegetation manipulation is proposed with this action.

2002 Revised Land and Resource Management Plan, Chugach National Forest

The Revised Forest Plan (USDA Forest Service 2002), as amended, provides a framework that guides the Chugach National Forest's day-to-day resource management operations. It is reviewed and revised approximately every 15 years. The Naked Island group is managed under the Recommended Wilderness management prescription. During preparation of this EA, the two alternatives met the goals and objectives of the Revised Forest Plan. The USFS prepared a Forest Plan Consistency

Checklist (part of administrative record) to ensure that all Forest Plan standards and guidelines were considered in this EA. The Recommended Management Area is managed to maintain and protect the existing wilderness character. The ecological desired conditions stipulate that the area would be largely unaffected by human activity and dominate the area. The Recommended Wilderness Management prescriptions allow for treatments or measures to be taken on exotic animals to minimize impacts on ecological processes.

PUBLIC INVOLVEMENT

Introduction

Collaborating and communicating with federal, state, and local agencies; stakeholders and the public; including consultation with Native Alaskan Tribes and Corporations has taken place throughout preparation of this EA.

A variety of means were used during the public scoping period to reach out to those who wanted to comment. A news release was prepared; Native Alaskan consultations were conducted; four public scoping meetings were held in Valdez, Cordova, Whittier, and Anchorage, Alaska; a summary of the project was prepared and provided; and those interested in the EA were encouraged to contact the project leader. Information gathered during the public scoping period was considered during preparation of this Draft EA.

Tribal Consultation

The USFS began formal consultations on December 29, 2011. Glacier District Ranger sent out consultation letters to the Chugach Alaska Corporation, Chenega IRA Council, Native Village of Eyak, Port Graham Village Council, Seldovia Village Tribe, Tatitlek Village IRA Council, Native Village of Nanwalek, and the Valdez Native Tribe. Call back to the initial consultation did not result in further response. The Chugach Alaska Corporation stated there were pre-historic sites on the island, that needed to be protected and suggested efforts should be made to incorporate native trappers for project implementation if the proposal were to go forward. On June 11, 2013, Ed DeCleva, Chugach Forest Archaeologist and Tribal Relations Specialist, discussed the project with John Johnson, Chugach Alaska Corporation. Mr. Johnson reiterated the corporation's desire that the project would be implemented in such a way that local Alaska Native hire would be utilized.

Public Comment

The following issues, concerns, questions, and ideas were received during the public scoping period. It is recognized that not all of the issues, concerns, and questions will be addressed; however, it is important to recognize the wide range of comment received. It should be noted that these comments were based on extirpation of mink from the entire Naked Island group rather than just removal of mink in the pigeon guillemot nesting areas. Many of the questions and concerns expressed during the public scoping are reflected in Chapters 2 and 4. Please note that not all concerns related directly to the purpose and need for preparing this EA, and as such, will not be addressed further. Responses to questions, concerns, and suggestions follow in italics

Questions and Information:

- Are mink natural or introduced, and if so, are they part of the natural ecosystem process? *Evidence indicates mink may have been introduced at the Naked Island group, but conclusive evidence is lacking Whether or not mink are native or introduced is uncertain and beyond the scope of this EA.*

- Mink always have been present (in PWS) and were there before the EVOS. *Mink are native to the mainland and many islands close to the mainland of PWS Again, evidence indicates mink may have been introduced at the Naked Island group, but conclusive evidence is lacking Whether or not mink are native or introduced is uncertain and beyond the scope of this EA.*

- Did the original mink population decline from an event and then recover? *We have no data on this topic.*

- Don't know of anyone trapping at the Naked Island group *Public trapping effort appears to be minimal due to the isolation and remoteness of the Naked Island group.*

- Forage resources, i.e. herring, that have declined are the possible impact to pigeon guillemot and other birds. *Forage fish have declined, but now are increasing and forage fish been determined to have little effect on decline of pigeon guillemot and other seabirds.*

- Herring and sand lance are recovering and you will see a recovery of forage fish, and consequently a recovery of birds. *Herring and sand lance are recovering However, mink is the primary predator of birds and the recovery of herring and sand lance do not appear to be helping the recovery of birds.*

- Trapping will be a multi-year effort. *We expect it would take three to five years. A significant increase in the pigeon guillemot population is expected after ten years The Proposed Action has more information on this topic*

- Will birds be transplanted to the Naked Island group after the removal of mink to increase biodiversity? *Pigeon guillemot still nests in greatly reduced numbers at the Naked Island group, so no transplants are required*

- How did mink get to the Naked Island group? *There is uncertainty determining how mink got to the Naked Island group*

Issues and Concerns:

- There is concern that other animals, river otter, sea otter (*Enhydra lutris*), on these islands will not be exterminated during this removal process. *Traps that would be used are too small to* *kill or harm other mammals living on the islands The Proposed Action in Chapter 2 as well as mitigation measures discussed in Chapter 4 address this topic in more detail.*

- It is impossible to eliminate mink at the Naked Island group. *Recovery of pigeon guillemot is the purpose of this EA, not the extirpation of mink at the Naked Island group.*

- Dangers exist with a trapping program in the winter, i.e. weather, poor anchorages. *These dangers are recognized and safety precautions would be undertaken*

Suggestions:

- It is felt that the local PWS residents and the Native population of PWS should be offered the jobs such as: the trapping, boat charters and maintenance of camp facility. *APHIS-WS, working closely with USFWS and the USFS would provide opportunities for assisting in the trapping program.*

- The furs should be donated for cultural programs within the Chugach Region. *Mink Carcasses would be made available for cultural programs as requested*

- Chugach Regional Corporation has a historic site on Storey Island that was once a fox farm. Efforts should be made to protect this site from adverse impacts. *Historic sites would be protected*

- Conduct a limited harvest to reduce mink numbers. *Currently, no limit on the numbers of mink that can be legally trapped exists, but little or no public trapping occurs at this time because of the isolation of the Naked Island group*

- Use a bounty or fee system and local trappers to eliminate mink. *Local trappers may have the opportunity to be part of the trapping program and work with APHIS-WS as part of their funding Agreement. The recovery of pigeon guillemot on the Naked Island group and PWS is the EA purpose, not the elimination of mink*

- Utilize local people to conduct trapping effort. *APHIS-WS, working closely with USFWS and the USFS would provide opportunities for assisting in the trapping program*

- Use a bid process to select trappers. *APHIS would be conducting the trapping and has the responsibility to select trappers*

- Requested planning team to look at the Rat Island Plan/implementation to determine how birds are recovering after removal of rats. *The planning team reviewed the results and it appears that birds are already recovering*

MOST RECENT RESEARCH AND STUDIES

Considerable pigeon guillemot research has been conducted in PWS, particularly since the EVOS in 1989. Most recently, three reports, building upon prior research and studies have been completed. These reports represent the most recent information on the pigeon guillemot population at the Naked Island group as well as predation by mink. Please refer to these reports for more detailed presentation of data, analysis, and findings. Lastly, please refer to the Literature Cited section for a complete listing of all materials used during preparation of this EA.

Why Aren't Pigeon Guillemot in PWS, Alaska Recovering from the *Exxon Valdez* Oil Spill? Kirsten S. Bixler. A THESIS. Submitted to Oregon State University the requirements for the degree of Master of Science. July 2010.

Exxon Valdez Oil Spill: Restoration Project Final Report. Pigeon Guillemot Restoration Research in PWS, Alaska. Restoration Project 10070853 Final Report. Kirsten S. Bixler, Daniel D. Roby, David B. Irons, Melissa A. Fleming, and Joseph A. Cook. November 2010.

MtDNA and Microsatellite DNA Provide Evidence of Fur Farm Ancestry for American Mink Populations in PWS. Melissa A. Fleming and Joseph A. Cook. February 2010.

CHAPTER 2: ALTERNATIVES, INCLUDING THE PROPOSED ACTION

INTRODUCTION

This chapter describes two alternatives, **No Action** and the **Proposed Action**. Eight other alternatives were considered and rejected. Rationale for their not being considered further is provided. Under either alternative, the Naked Island Group would remain as part of the Chugach National Forest and managed under State and Federal regulations for currently permitted public uses, including trapping, hunting, wilderness recreation, and other activities. The Naked Island group would continue to be managed as a wilderness study area to maintain and protect the existing wilderness character.

ALTERNATIVE A: NO ACTION – CURRENT MANAGEMENT

No management action to control or reduce mink would be taken under this alternative. Nesting pigeon guillemot and other seabirds would still persist at the Naked Island group but greatly reduced from historical abundance numbers (see Table 1).

Cost of Alternative A

No new additional costs.

ALTERNATIVE B: PROPOSED ACTION- CONTROL OF PREDATORY MINK

Purpose: Restore pigeon guillemot in PWS, by removing them from the "not recovering" list to the "recovered" list.

This action would be accomplished during a five year period at the Naked Island group. The first two to three years of the project would entail removing mink through trapping or shooting within 500 m of historical nest sites, from January to May, with the expectation that mink removal efforts could expand to include any new pigeon guillemot nesting sites.

If initial efforts did not produce the desired results, further action would evaluate expanding the mink removal zone to 1,000 m around historical and current pigeon guillemot nesting sites in later years to improve chances of pigeon guillemot recovery. Up to 250–300 mink may be harvested during this five year effort. It is expected that reducing the mink population would increase the current 100 pigeon guillemot at the Naked Island group to 1,000 pigeon guillemots in about 15 years following the removal of mink (see Table 1).

Pigeon guillemot recovery would be assessed by data collected for this project and by data collected for another ongoing pigeon guillemot boat-based monitoring project. The number of pigeon guillemot nests depredated by mink would be assessed by this project and a separate, ongoing pigeon guillemot boat-based monitoring project would assess pigeon guillemot productivity and population levels during the five project years and then for an additional 15 years.

After three years, chick predation by mink would be greatly reduced or eliminated and pigeon guillemot productivity would increase to 0.5 chicks fledged per nest, and the number of nesting birds would be stable or start to increase slightly to 10 percent. After five years chick predation by mink would continue to be greatly reduced or eliminated and pigeon guillemot productivity would be stable at least at 0.5 chicks fledged per nest, and the number of nesting birds would begin to increase by 10 percent to 30 percent compared to the numbers at the beginning of the project (see Table 1).

The pigeon guillemot nesting areas represent current potential and historical pigeon guillemot colonies (Figure 5 and Figure 7). Features within these areas include; beaches, creeks, game trails, cliff bases, driftwood, or points of land connecting adjacent beaches.

Trapping would be the primary means for reducing mink. Lethal body grip traps would be used as the principal trap type. Approximately 100-500 traps would be placed in groups of one to five within 500 m of nest sites and would be checked every one to14 days as weather allows. Traps would be secured with a wire to deadwood, rocks, roots, or trees less than 50 years old or approximately five inches in diameter. The wires would be attached loosely to the trees to prevent any damage.

Carcasses of mink would be frozen and placed in a tamper-proof container and removed from the island approximately every two to four weeks. Carcasses would be donated to research organizations for additional genetic and other study or to permanent archives in public museums or universities, whenever feasible. There is also the opportunity to provide carcasses to Native Alaskans for their cultural programs. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.) Carcasses that cannot be salvaged for donation may be disposed of in a city landfill.
Firearms, using non-toxic ammunition, could also be used to remove mink. Shooting is a highly species-specific method, as positive identification is made prior to shooting. Shooting would be conducted primarily prior to pigeon guillemot arrival. Firearms with sound suppression would be used to remove mink from around the breeding colonies after pigeon guillemot arrive, if required. One or two small hunting dogs may be used for a few weeks to find trap-shy mink. Dogs would be monitored at all times, when not kenneled, and would be leashed or under voice control at all other times. Dogs would be kenneled on land or on a boat. Dog food would be kept in a tamper-proof container.

The Association of Fish and Wildlife Agencies (AFWA) best management practices would be utilized to determine trapping methods. Continuous monitoring and manipulations of trapping efforts would take place to ensure maximum trapping effectiveness and to minimize or eliminate non-target take. APHIS-WS would implement the management program under a funding Agreement. An estimated eight to 12 experienced wildlife specialists would conduct mink removal efforts for the project duration. Protocols and methodologies for mink removal would be agreed upon by USFWS and APHIS-WS, prior to implementation.

Trapping success would be maximized through a continuous three to five month effort from January to May during periods of heavy snow and the mink mating season (Bones et al. 2007). The precise timing of trapping would be determined by evaluating data collected during trapping (e.g., trapping success, trapped animal sex and age class). If the specified objective is not being achieved, restoration methods or actions could be altered as per agreement with all parties involved.

Mink abundance would be assessed by numbers of tracks observed in the area, by catch per unit effort (the number caught per number of trap-nights), or by the use of bait stations with track plates or cameras placed along island shoreline., As mink numbers decline as a result of trapping, the numbers of these measures would also decline. A fur sample would be taken for DNA analysis, if further study was warranted. Age, sex, and diet from stomachs and perhaps, stable isotopes of mink would be assessed. This information would be collected and analyzed by the project leader to provide a greater understanding of pigeon guillemot and mink in PWS.

Bait, likely herring, would be purchased or caught and stored in tamper-proof containers at the camp sites or on the support vessels.

No tree removal or other vegetation manipulation is proposed with this action. No exotic plants or animals would be introduced.

If the pigeon guillemot is "recovering" after five years, and there is no mink predation, the ongoing recovery of pigeon guillemots would be documented by a separately funded, ongoing 15-year, boat-only based pigeon guillemot population monitoring program to enumerate and track pigeon guillemot numbers breeding at the Naked Island group. This monitoring program has been established and funded through the EVOS Long Term Monitoring Program. If after five years pigeon guillemot are not recovering because of mink predation, the program would be reevaluated and alternatives considered. A new EA would be written to address the depredation of pigeon guillemot by mink.

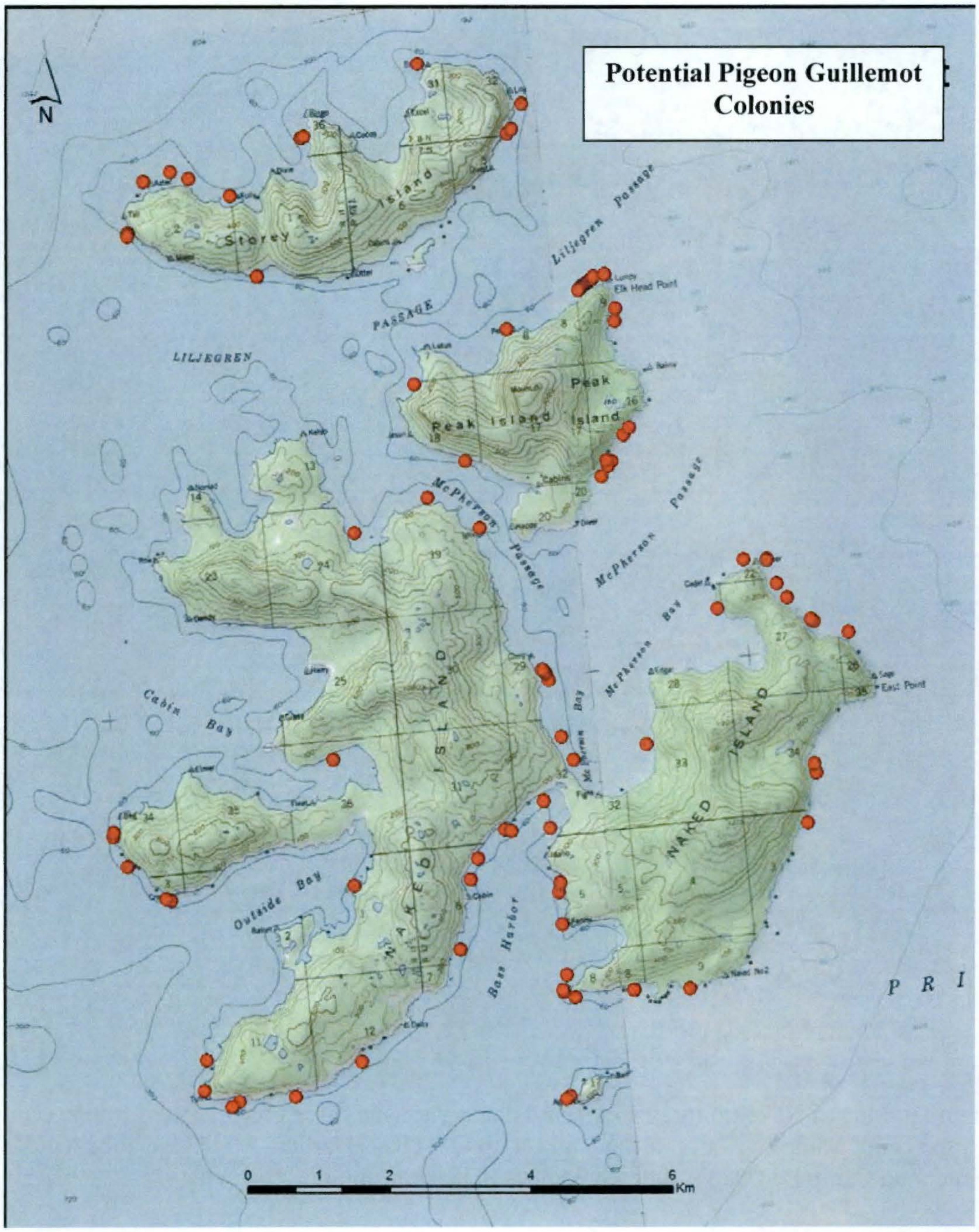


Figure 5. Locations of potential pigeon guillemot colonies based on sightings of breeding birds on the water (red dots) at the Naked Island group.

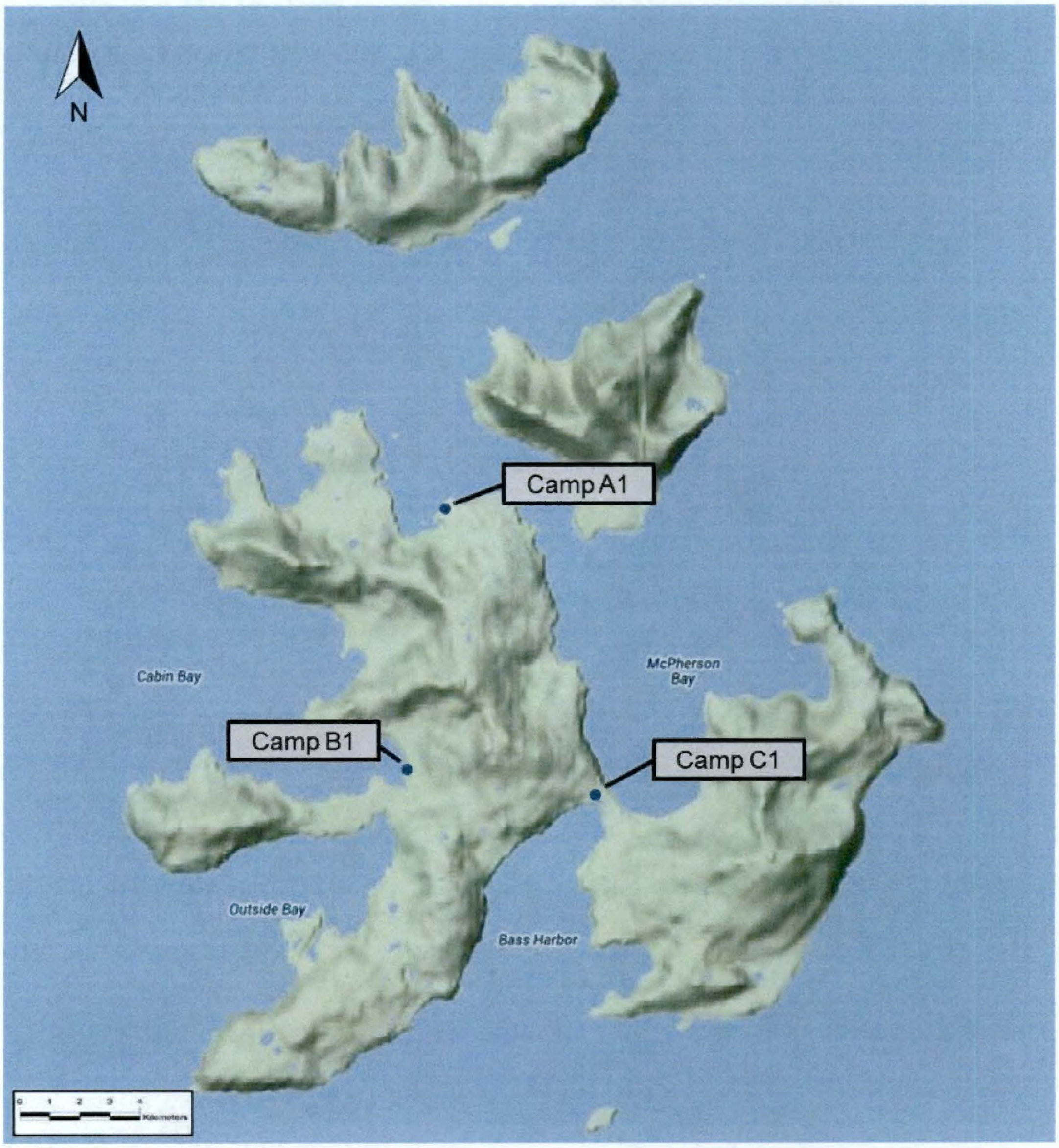


Figure 6. Map of Naked, Storey and Peak Islands showing three potential camp sites, Camp A1 - North Camp, Camp B1 – Cabin Bay and Camp C1 – Bass Harbor. All three camps would be used in winter and Camp B1- Cabin Bay would also be used in summer.

During the three to five month trapping program from January to May, two options exist for housing trappers. The trapping program would be identical for either option. Before any mink removal would be initiated, a thorough review of the details regarding either a boat based or land based operation would occur. APHIS-WS would follow all requirements agreed to by all parties. The ADF&G would issue appropriate permits for the take of mink, while the USFS would be responsible for issuing a special use permit for temporary camping associated with activities on USFS lands during the trapping program. All operational details specified in the special use permit would be according to the Forest Service Handbook, FSH 2709 – Special Uses Handbook.

Option 1: Boat Based

Under this option, up to two support vessels would provide lodging and food during the three to five month trapping period from January to May for five years. Small boats would provide access from the support vessel to Storey, Peak, and Naked Islands to conduct trapping operations. This alternative would not require temporary field camps be established on the islands. If this option is selected, additional details agreed to by all parties would be part of the APHIS-WS funding Agreement and approved by the USFS during the permitting process.

Cost of Alternative B

$1.0 million - National Fish and Wildlife Foundation
1.2 million – EVOS Trustee Council
$2.2 million - Total (five years)

Option 2: Land Based

Up to three temporary field camps would be established where a support vessel could ferry supplies at the beginning of the field season and return for resupply as necessary on one to three islands for a three to five month period from January to May for up to five years. Each camp would have two to three wildlife specialists present. All camp locations would be approved by the USFS. Each year following trapping, the camps would be removed and tent platforms stored out of sight. Camps would be placed on frozen ground or snow and would have no impact to vegetation. If this option is selected, additional details agreed to by all parties would part of the APHIS-WS funding Agreement and approved by the USFS during the permitting process. A special use permit would outline the terms and conditions of the field operations, as well as stipulations to ensure no to minimal environmental impact.

Camp sites may vary but would likely include Camp A.1-North Camp, Camp B.1- Cabin Bay, and Camp C.1 -Bass Harbor (Figure 6). Research staff would use campsite B.1 during May-August for five years. Each camp would consist of a Weather port® structure (approximately four by seven m) for field operations (generator, fuel, oil, and battery storage); three approximately two m^2 tents for sleeping; and possibly one additional approximately three m^2 storage tent. Each camp would have a small inflatable boat, anchored off shore. Each camp would have an approved fuel storage area with a containment system. Camps would be resupplied and garbage and wastes removed every two to four weeks, weather allowing. All tents would be located on wooden platforms. Oil stoves would be used for heat. Boardwalks would be used, if necessary, to allow easy walking on the snow trails. Camps would be located along the coastline within 30 m of the high tide line. Camps would be disassembled following activities, leaving behind a stack of wooden floor sections for use the next season. All food would be stored in tamper-proof containers and all garbage would be removed from the island. Human wastes would be removed from the island when possible. There would be no fires unless allowed by a USFS special use permit.

Cost of Alternative B

$0.9 million - National Fish and Wildlife Foundation
1.0 million – EVOS Trustee Council
$1.9 million - Total (five years)

ALTERNATIVES NOT CONSIDERED IN DETAIL

During preparation of the Restoration Project Report for the EVOS Trustee Council, it was important to explore all alternatives with potential for the recovery of the pigeon guillemot population. The final report, published in November 2010, is the most recent analysis of a range of alternatives for "recovering" pigeon guillemot.

Bixler et al. (2010) analyzed a wide range of alternatives in detail and provided the final report to the EVOS Trustee Council, most of which are presented below. The alternatives presented below represent alternatives that were considered, analyzed, and found not to be feasible for "recovering" the pigeon guillemot population at the Naked Island group and were therefore not recommended.

Removal of Mink

Complete removal of mink over a five year period from the Naked Island group would be undertaken in this alternative. Circumstantial evidence exists that mink may have been introduced at the Naked Island group, but a definitive finding with 100 percent certainty that mink were introduced does not exist. ADF&G considers mink as native to the Naked Island group. The ADF&G does not recommend removing all mink as a first management action. They prefer that mink are reduced and then determine if the pigeon guillemot are recovering. In the final report to the EVOS Trustee Council, complete removal of mink was recommended, but uncertainty that mink are native or introduced has resulted in eliminating this alternative.

Nest Boxes to Enhance Nest Site Availability

Pigeon guillemot nest boxes would be installed on cliff faces inaccessible to mink. Boxes would be placed in the immediate vicinity of either current or historical nesting locations (Figure 6). A few nest boxes were installed at the Naked Island group during the late 1990s, but there was low incidence of use (Irons; pers. obs.), most likely because there was an abundance of natural cavities available. No evidence exists that pigeon guillemot at the Naked Island group are limited by the availability of nesting habitat. This alternative was not pursued because nest box installation would most likely be an ineffective restoration technique.

Protective Fencing of Nest Sites

Protective fencing would be used to reduce predation by mink of pigeon guillemot. This alternative was not pursued because gaps larger than one inch in the fence (Boggess 1994) on talus slopes and cliffs are not practically avoidable and mink can easily swim around any fence, unless the fence completely encloses the nesting area. Fencing of numerous dispersed nesting sites would be impractical and fencing would impact pigeon guillemot movement within the nesting area.

Mink Behavioral Modification

No registered chemical repellents or known effective frightening devices to modify the behavior of mink near pigeon guillemot nests exist (Boggess 1994, NWRC 2008).

Control Avian Predators of Pigeon Guillemot Nests

Avian predation of pigeon guillemot is very limited and not a significant mortality factor (Oakley and Kuletz 1979). Avian species considered, included the common raven (*Corvus corax*), northwestern crow (*Corvus caurinus*), and black-billed magpie (*Pica pica*).

Combination of Nest Boxes and Control of Predator Populations

Nest predators of pigeon guillemot (i.e., mink, raven, crow, and magpie) would be culled and nest boxes would be installed at the Naked Island group. Actions taken include suppression of the mink population, construction and installation of nest boxes, and lethal control of avian predators. This alternative was not pursued for the same reasons each scenario was dropped as viable option on its own. Due to flaws in each action (see previous alternatives) would not be lessened by the combination of alternatives, and a combined approach would not lead to significant improvements of the population of pigeon guillemot at the Naked Island group.

Use of Toxicants

There are currently no chemical agents registered by the U.S. Environmental Protection Agency for the control of mink (Boggess 1994, NWRC 2008), Further, This alternative was not considered further because poisoning or secondary poisoning of non-target species (Courchamp et al. 2003, Moore et al. 2003) such as river otter and bald eagle would be unacceptable.

Shooting

Shooting of mink as a single technique for population reduction is not effective because of their nocturnal habits (Boggess 1994, Courchamp et al. 2003), although it is maintained as one secondary treatment option under the proposed action.

Other

Other means of biological control, such as virus vectored immune-contraception, have yet to be fully developed (Courchamp and Cornell 2000; Macdonald and Harrington 2003) and might pose an irreversible danger to the viability of mink and other closely-related native furbearers (e.g., American marten) outside of the Naked Island group.

CHAPTER 3: AFFECTED ENVIRONMENT

INTRODUCTION

The Naked Island group, a cluster of three small islands with about 100 km of shoreline, is located in western PWS, a sub-arctic, inland sea connected to the Gulf of Alaska. PWS is approximately 1,000 km^2 in size and is bounded by the Chugach and Kenai mountains. PWS is a complex fjord estuarine system with about 5,000 km of coastline and is characterized by rugged coastal mountains, glaciers, sheltered waters, and forested islands which offer relatively pristine maritime habitats. Productive inter-tidal lands, estuaries, and mature coastal forests support a diverse assemblage of terrestrial and marine wildlife species. PWS provides habitat for seabirds, waterfowl, shorebirds and marine mammals, and upland habitat for birds and mammals. The wealth of abundant wildlife has drawn people to the area for thousands of years.

The Naked Island group consists of three main islands: Naked Island (38.6 km^2), Storey Island (7.2 km^2), and Peak Island (6.1 km^2). The islands are isolated, being 75 km from Valdez and Whittier and 90 km from Cordova. The bays of Naked Island, and the passages between it and the two neighboring islands, Peak and Storey, form an expanse of water that is less than 100 m deep. Near shore habitat is characterized by numerous bays and passages with shallow shelf habitat (<30 m) radiating about one km from shore. Island shorelines are characterized by low cliffs and cobble or boulder beaches. High, steep, exposed cliffs occur along portions of the eastern shores of the Naked Island group. Naked Island is the highest at 371 m. All of these islands are part of and managed by the Chugach National Forest

CLIMATE

The Naked Island group experiences a cool maritime climate with moderate temperatures and extended periods of clouds and fog with abundant precipitation ranging from 2.5 m to 3.0 m annually. The highest amount of precipitation generally occurs in the late summer and fall, and the lowest amount occurs in the spring and summer. Snow falls at all elevations between mid-October and mid-May and may persist for long periods at sea level. About ten percent of total annual precipitation falls as snow along the coast.

Temperatures average -7 to -3 °C in January and 12 to 13 °C in July. January is the coldest month with an average temperature of -6 °C. The Naked Island group has temperate cold and warm seasons. Temperatures do not vary much between day and night. Winter has prolonged freezing. April generally has the most sunshine. June is the driest month with rainfall and other precipitation peaking around October. Low pressure storms in PWS generally come from the southeast. Permafrost is absent.

The Naked Island group is located in Alaska's South-central Intrastate Air Quality Control Region that includes the PWS area. The air quality meets state standards for visible and particulate air quality. Potential air contamination sources are far away (communities of Valdez, Seward, and Cordova) or from marine and air traffic. No prescribed burning occurs and high precipitation and cool summer temperatures preclude wildfire.

VEGETATION, GEOLOGY, AND SOILS

The Naked Island group is within the Pacific Gulf Coastal Forest-Meadow Province and the Northern Gulf of Alaska Fiord lands ecological region. Shoreline habitats transition rapidly from beach habitat to a temperate rainforest intermingled with muskeg vegetation. All islands are forested to their summit, mostly with Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*). Common understory species include blueberry (*Vaccinium sp*), salmonberry *(Rubus sp*), devil's club (*Oplopanax horridus*), yellow skunk cabbage (*Lysichiton americanus*), deer fern (*Blechnum spicant*), lady fern (*Athyrium filix-femina*), bunchberry (*Cornus canadensis*), and foam flower (*Tiarella trifoliate*). Common shrubland and herb land species include: salmonberry (*Rubus spectabilis*), crowberry (*Empetrum nigrum*), bog blueberry (*Vaccinium uliginosum*), cranberry (*Vaccinium sp*), deer cabbage (*Nephrophyllidium crista-galli*), luetkea (*Luetkea sp),* sedges (*Carex sp.*), sphagnum mosses (*Sphagnum sp.*), tufted hairgrass (*Deschampsia cespitosa*), and seaside sandplant (*Honckenya peploides)*

Naked Island shorelines are rocky and consist of cliffs, broken cliffs, and escarpments interspersed with boulder beaches. Diurnal tide ranges are 3.1 to 3.7 m.

A 9.2 magnitude earthquake occurred in the Gulf of Alaska on March 27, 1964 (the Good Friday Earthquake). Warping of the crust during this tectonic event resulted in uplift in the eastern portion of PWS and subsidence in the western portion. A maximum uplift of over 9.0 m occurred on Montague Island. The area around Whittier experienced 1.8 to 2.4 m of subsidence (USDA 2005). The Naked Island group experienced an uplift of about 1.2 m, permanently exposing nearly half of the intertidal zone (Johanson 1971) and altering both the shoreline and shallow near shore habitat.

Geologic, geophysical, and geochemical investigations have been conducted to evaluate the mineral resource potential of the Chugach National Forest. No oil or extractable mineral resources have been documented at the Naked Island group.

WATER RESOURCES

Streams at the Naked Island group are very short. Because of the marine influence, heavy precipitation, and mild temperatures, stream flows are predominantly controlled by rainfall runoff, although snowmelt runoff occurs in the spring. Peak flow events during fall rainstorms are generally larger than peak flows from snowmelt runoff. Wetlands associated with swamps, bogs, ponds, and floodplains, comprise the majority of wetlands at the Naked Island group.

Water quality is very good, with nearly pristine conditions as a result of the isolation and lack of development at the Naked Island group. The small streams generally have very low sediment loads. Human impacts on water quality are predominantly limited to the coastal areas, where most activities occur.

WILDLIFE

The Naked Island group landscapes and offshore waters provide habitat for variety of wildlife, including passerine birds, waterfowl, shorebirds, seabirds, and mammals. Federally listed endangered or threatened species that may potentially occur at the Naked Island group shorelines or offshore waters include Steller sea lion (*Eumetopias jubatus*), Steller's eider (*Polysticta stelleri*), humpback whale (*Megaptera novaeangliae*) and North Pacific right whale (*Eubalaena japonica*). The Naked Island Group provides habitat for one management indicator species identified in the Chugach National Forest Revised Land and Resource Management Plan (USDA 2002): the black oystercatcher (*Haematopus bachmani*). The Naked Island Group also provides habitat for special interest the bald eagle, marbled murrelet, Townsend's warbler (*Setophaga townsendi*), and river otter, and Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) (USDA USFS 2002). The pigeon guillemot is now the only marine bird species in PWS listed as "not recovering" by the EVOS Trustee Council's Injured Resources List (Bixler et al. 2010) (EVOSTC 2010).

A complete inventory of birds, mammals, fish, and amphibians at the Naked Island group has not been conducted and it is presumed the species present at the Naked Island group are representative of those within PWS and species expected on a remote and isolated island group.

Birds

The Naked Island group was at one time the single most important breeding location for pigeon guillemot in PWS. In 1972, one quarter of the Sound-wide population of guillemot was counted there, though these islands include just two percent of the total shoreline in the Sound (Isleib and Kessel 1972). Of the 4,000 pigeon guillemot nesting in PWS in 1989, 1,000 were found at the Naked Island group (Bixler et al. 2010).

Pigeon guillemot numbers have been monitored at the Naked Island group since 1978 under special use permits issued by the USFS. The monitoring is ongoing and will continue for another 20 years. Pigeon guillemot surveys in 1979 counted 1,871 birds (Oakley and Kuletz 1996, G. Golet, USFWS unpubl. data). The pigeon guillemot breeding population at the Naked Island group has declined by more than 90 percent during the last 20 years (Irons et al. 2013). From 1990 to 2008 pigeon guillemot censused at the Naked Island group have declined from 1,124 birds observed in 1990 to 101 birds observed in 2008 (Bixler et al 2010). In 2008, only 17 pigeon guillemot nests were found. In one area only four nests were found where 124 nests were found in 1997 (Golet unpubl. data). Figure 6 shows the historical locations of pigeon guillemot colonies and Figure 7 shows the locations of observed individual pigeon guillemot in 2012. Parakeet auklet no longer nest and tufted puffin and horned puffin nest in greatly reduced numbers.

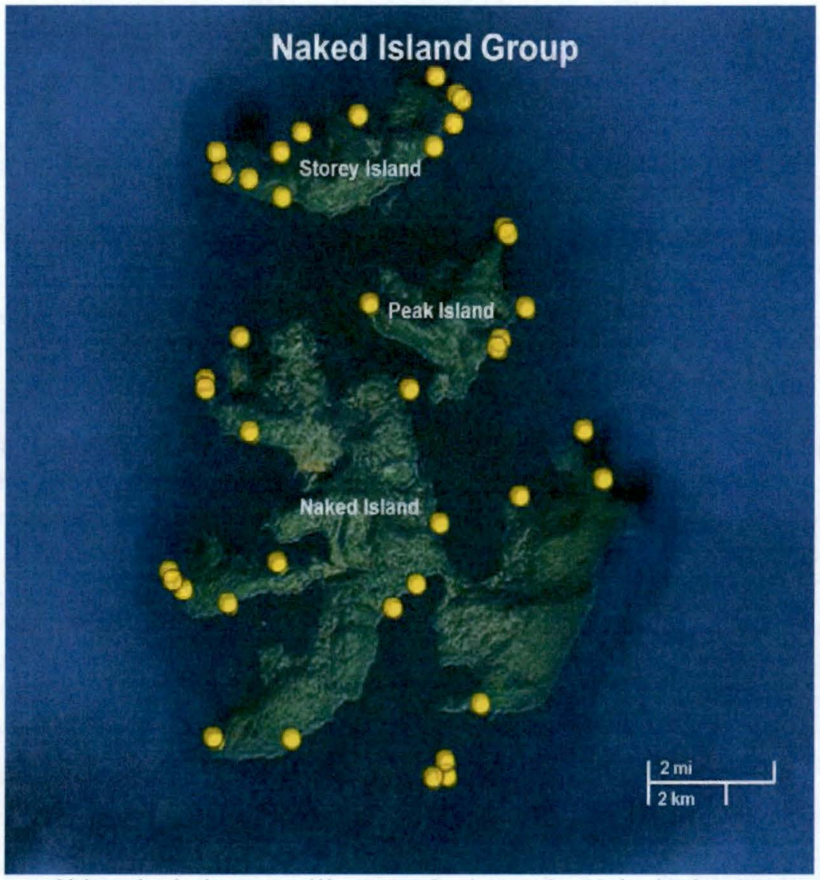


Figure 7. Locations of historical pigeon guillemot colonies at the Naked Island group (yellow dots).

Common seabirds at the Naked Island group include marbled murrelet, black-legged kittiwakes (*Rissa tridactyla*), glaucous-winged gull (*Larus glaucescens*), fork-tailed storm petrel (*Oceanodroma furcata*), mew gull (*Larus canus*), tufted puffin, Arctic tern, common murre (*Uria aalge*) pelagic cormorant (*Phalacrocorax pelagicus*) and pigeon guillemot. Common sea ducks, loons, and grebes in PWS include: harlequin duck (*Histrionicus histrionicus*), Barrow's goldeneye (*Bucephala islandica*), scoter (*Melanitta* spp.), long-tailed duck (*Clangula hyemalis*), bufflehead (*Bucephala albeola*), common loon (*Gavia immer*), pacific loon (*Gavia pacifica*), red-throated loon (*Gavia stellata*), red-necked grebe (*Podiceps grisegena*) and horned grebe (*Podiceps auritus*).

Breeding and wintering populations of black oystercatchers and migrating or wintering populations of black-bellied plover (*Pluvialis squatarola*), black turnstone (*Arenaria melanocephala*), surfbird (*Aphriza virgata*), marbled godwit (*Limosa fedoa*), western sandpiper (*Calidris mauri*), dunlin (*Calidris alpina*), and rock sandpiper (*Calidris ptilocnemis*) may be found on marine shorelines.

Common landbirds are the blackpoll warbler (*Dendroica striata*), chestnut-baked chickadee (*Poecile rufescens*), hermit thrush (*Catharus guttatus*), fox sparrow (*Passerella iliaca*), orange crowned warbler *Oreothlypis celata*), pine siskin (*Carduelis pinus*), ruby-crowned kinglet (*Regulus calendula*), tree swallow (*Tachycineta bicolor*), olive-sided flycatcher (*Contopus cooper*i), and varied thrush (*Ixoreus naevius*). Other landbirds include black-billed magpie, common raven, and northwestern crow. Bald eagles are common.

Mammals

The Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) was introduced to islands in PWS in the 1950's (ADF&G 2006) including the Naked Island group. Small mammals at the Naked Island group include meadow vole (*Microtus pennsylvanicus*), red squirrel (*Tamiasciurus hudsonicus*), and northern red-backed vole (*Myodes rutilus*).

Carnivores found at the Naked Island group include mink, river otter and sea otter. Neither American marten nor weasel has been documented at the Naked Island group (Irons et al. 2013). Mink were first documented on the island group in the mid-1990's (Bixler et al.1990). Anecdotal evidence exists that past Naked Island group residents released mink in the 1970's to establish a population for trapping, but that the population did not grow much until the 1990's (Bixler et al. 2010, Irons et al. 2013). Although mink predation was not a recorded cause of pigeon guillemot nesting failure at the Naked Island group during studies in the late 1970s and early 1980's, mink predation on guillemot nests was frequently recorded by the mid-1990's (Hayes 1995, Golet et al 2002).

Common marine mammals include Dall's porpoise (*Phocoenoides dalli*), harbor seal (*Phoca vitulina),* humpback whale, killer whale (*Orinus orca*), minke whales (*Balaenoptera acutorostrata*), sea otter, and Steller sea lion. PWS is within the range of the North Pacific right whale.

Amphibians

No amphibians are known to occur at the Naked Island group.

Fisheries

Capelin (*Mallotus villosus*), Dover sole (*Solea solea*), lingcod (*Ophiodon elongatus*), Pacific herring, Pacific sand lance, smelt (*Osmeridae* spp.), walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), and other species common to PWS are found in the waters surrounding the Naked Island group and most are fed on by pigeon guillemot Three small pink salmon (*Oncorhynchus gorbuscha*) streams are located at the Naked Island group, two on western side of Naked Island, and one on the southern side of Peak Island. Coast range sculpin (*Cottus aleuticus*) and tide pool sculpin (*Oligocottus maculosus*) are found in Naked Island waters and are foraged by mink.

CULTURAL RESOURCES

Pre-history

Archaeological investigations show that the Chugach (Sugpiaq) people have occupied the PWS area for thousands of years, from the time when the Sound was still largely covered by glaciers during the last ice age (CAC 2012). The Chugach lived in rectangular bark or plank houses along the shoreline in permanent settlements and traveled to temporary summer fish camps located along salmon streams. The Chugach subsisted on fishery resources, marine mammals, and shellfish supplemented with birds, land mammals, berries, and plants. Eight groups (Chenega, Montague Island, Nuchek, Shallow Water, Eyak, Gravina Bay, Tatitlek and Kiniklik) numbering 500 to700 individuals were well established throughout PWS. Because of the isolated and remote nature of the Naked Island group,, it is probable that prehistoric use was transitory and related to hunting and gathering activities. Permanent settlement was unlikely.

Prehistoric archaeological sites in PWS date from within the past 4000 years and encompass three cultural phases. The Uqciuvit phase is identified with dates ranging from 4000-2500 B.P., the Palugvik phase with dates ranging from 2500-900 B.P., and the Chugach phase with dates ranging from 900-200 B.P. (Yarborough 2000). The protohistoric period dates between A.D. 1741, when Vitus Bering made landfall on Kayak Island, and A.D. 1778, when Captain James Cook made direct contact with Native inhabitants of PWS.

Archaeological surveys conducted at the Naked Island group were primarily in association with the Exxon Valdez Oil Spill Cleanup efforts. New sites were documented during this time and known sites were monitored in an active program. Monitoring of known sites and additional small scale surveys have been conducted in recent years by USFS archaeologists in association with permitted activities.

The USFS determined the proposed action alternative specific to removal of mink would cause no affect to historic properties per Appendix B of the Programmatic Agreement among the USFS, Alaska Region, the Advisory Council on Historic Preservation, and the Alaska State Historic Preservation Officer regarding Heritage Program Management on National Forests in Alaska (USDA 2010); and therefore did not conduct any surveys specific to the proposed action. However, a cultural resource survey of the proposed campsites was conducted and no cultural resources that could be considered as eligible for inclusion in the National Register of Historic Places were identified (USFWS 2013).

History

The Chugach were the first Alaskans to meet the European explorer, Vitus Bering, who came to Alaska at Kayak Island in 1741 under the Russian flag. Bering was followed in 1779 by the British explorer James Cook. Spanish expeditions occurred under Inacio Aretega in 1779 and Salvador Fidalgo in 1790, and in 1791 another British expedition to PWS was undertaken by George Vancouver. From 1785 to 1867 the Russians established settlements and developed the fur trade. Smallpox epidemics in 1837 and 1885 decimated the Chugach people.

In 1867 Alaska was purchased from Russia by the United States. Resource exploitation continued. Gold and copper mines were developed. Salmon canneries were established and railroads constructed. With the decline of sea otter, commercial fox farms developed in the late 1890's.

By the turn of the century, fox farms were increasingly common in south-central and southeastern Alaska. In 1900, 35 islands were being leased from the government. In southeast Alaska an island could be leased from the USFS for as little as $25 a year (AHF 2012). Beginning in 1903, fur prices bottomed out and many islands were abandoned. Prices remained low for a decade; during this early period, many raised foxes as breeding stock and began selling them to newly established fur farms in the U.S.

In 1913, the popularity of furs (and their prices) started to rise. For the next 15 years fur farms–particularly those that raised blue foxes,–became increasingly popular. The height of popularity was reached in 1931, when 431 Alaska fur farm licenses were issued (Paul 2009), although according to Isto (2012) 622 private farm owners were identified by at least one government agency in 1929. Though fox farming was carried on in many parts of Alaska, it was most common in the coastal areas, where salmon, harbor seals, sea lions, porpoises, whales, and other marine food sources were available. The best fox farming sites were small offshore islands, where pens and feed houses were largely unnecessary (Cook and Norris 1998). Approximately, 73 islands were stocked with foxes in the Gulf of Alaska and PWS (Paul 2009).

In 1924, the Bureau of Biological Survey identified 21 mink farms – almost all in southeast Alaska and by 1929 there were 153 mink farmers (Isto 2012). Following World War II only about 60 fur farms survived in Alaska and most were mink farms. USFS fur farm permits dropped to eight in 1955 and by 1955 31 fur farmers were active in Alaska and most raised mink. Only two fur farms permits were issued in the Tongass and Chugach National Forests in 1959 (Isto 2012). In the late 1970's increases in mink pelt prices brought renewed interest in mink farming and started four new fur farms (Isto 2012). In 1993 the last fur farm in Alaska closed.

The Naked Island group was the site of arctic fox fur farms for more than 50 years. In 1895 Jim McPherson established a fur farm on Peak Island as did Fred Liljegren on Storey Island (Lethcoe and Lethcoe 2001). As the pioneer fox farmers retired or died, their children continued the farms. Alice Clock at Peak Island was the daughter of Capt. Jim McPherson, while John Beyer on Storey Island was the son of early fur trader, Bill Beyer. His partner, Edwin Liljegren, was the son of early prospector and fox farmer, Fred Liljegren. By 1919 fur farms existed on all three islands. Mailboat records from the mid 1930's indicated there were five people living on Storey Island and 14 on Peak Island, where a school existed. The Storey Island fur farm closed in 1944 and the Peak Island farm closed in 1950. The Naked Island fur farm likely closed in 1950 or earlier.

Fox were allowed to roam freely and were fed in pens. Pens were closed to capture the fox for their pelts. The 1930's depression, end of World War II, and fashion changes lead to fox farming becoming unprofitable. The Naked Island group is now free of foxes for various reasons, including starvation after the destruction of bird colonies, the end of feeding by fur farmers, disease (Paul 2009), or intestinal worms (Lethcoe and Lethcoe 2001). Since 1950, there has been no permanent human occupation of the Naked Island group. A seasonal use dwelling and buildings associated with past fox farming are located on private land on Peak Island.

RECREATION RESOURCES

The Naked Island group is used periodically for boating, camping, hiking, deer hunting, and fishing. An average of 159 hunters harvested 153 deer annually during the last ten years from the Naked Island group during August thru December (ADF&G Harvest Data). Other recreational use is probably comparatively light, as the islands are accessible only by water and are more than 75 km from any community within PWS. An average of seven boats per day were counted during summer boat transect studies from 2005 to 2007, and no commercially-guided recreation use was reported in 2010 to 2011. The protected bays on the west and north sides of Naked Island can provide safe anchorages for boats. The Naked Island group is part of the Nellie Juan-College Fiords Wilderness Study Area. Ecotourism of the PWS is anticipated to increase and its effect on visitation at the Naked Island group is unknown. Visitors' interest in viewing wildlife, particularly pigeon guillemot, parakeet auklet, tufted puffin, and horned puffin, has been a popular activity in PWS for many years.

SOCIOECONOMIC RESOURCES

Introduction

There are five communities that are most closely associated with the Naked Island group in PWS. Each community was affected, some more significantly, by the 1964 Good Friday Earthquake. Many residents were killed either by the earthquake itself, or by the tsunami which followed. The earthquake affected community rebuilding efforts as well as destroying the livelihood of many residents.

Naked Island Group

The Naked Island group is publicly managed by the USDA, USFS as part of the Chugach National Forest. There is one privately owned parcel of land on the SW portion of Peak Island. Little or no subsistence hunting and trapping occurs because of the logistics of getting to the islands from a village.

Chenega Bay Village

Chenega is located on Evans Island at Crab Bay, 67.5 kilometers southeast of Whittier and is 167.5 air kilometers southeast of Anchorage and 80.5 kilometers east of Seward. The village has a total area of 75 square kilometers, of which, 74.5 square kilometers of it is land and 0.75 square kilometers (1.2 percent) is water. Winter temperatures range from -8 to -2 °C. Summer temperatures range from nine to 17 °C. Average annual precipitation includes 1.7 m of rain and 2.0 m of snowfall.

According to the 2010 Census, there is a population of 76 residents with a median age of 35 years old. A federally-recognized tribe is located in the community -- the Native Village of Chenega (aka Chanega). Chenega Bay is an Alutiiq community practicing a subsistence and commercial fishing lifestyle (USCB 2010).

Commercial fishing, a small oyster farming operation, and subsistence activities occur in Chenega. Cash employment opportunities are limited. Chenega has a small boat harbor and dock. Scheduled and chartered flights depart from Cordova, Valdez, Anchorage, and Seward. In 1996, the Alaska

Marine Highway began "whistle-stop" service (vessel does not stop if there are no reservations) (ADCCED 2012).

Cordova

Cordova is located near the mouth of the Copper River at the head of Orca Inlet on the east side of PWS and is 83.5 air kilometers southeast of Valdez and 241.4 kilometers southeast of Anchorage. The city has a total area of 195.5 square kilometers, of which, 159 square kilometers of it is land and 37 square kilometers of it is water. The total area is 18.9 percent water. Winter temperatures average from -8 to -2 °C. Summer temperatures average from nine to 17 °C. Average annual precipitation is 424 cm, and average annual snowfall is 203 cm.

According to the 2010 Census, there is a resident population of 2,239 with a median age of 42 years old. Cordova has a significant Eyak Athabascan population with an active village council. Commercial fishing and subsistence are central to the community's culture (USCB 2010). Cordova supports a large fishing fleet for PWS and several fish processing plants. In 2010, 337 residents held commercial fishing permits and nearly half of all households work in commercial harvesting or processing. Red salmon *(Oncorhynchus nerka)*, Chinook salmon *(Oncorhynchus tshawytscha)*, silver salmon (*Oncorhynchus kisutch)*, pink salmon, chum salmon (*Oncorhynchus keta)*, herring, halibut *(Hippoglossus stenolepis)*, bottom fish, and other fish are harvested.

Cordova is accessed by plane or boat and linked directly to the North Pacific Ocean shipping lanes through the Gulf of Alaska and has year-round barge service and state ferry service. Daily scheduled jet flights and air taxis are available. Harbor facilities include a breakwater, dock, and small boat harbor (ADCCED 2012). A 77 kilometer gravel road provides access to the Copper River Delta to the east.

Tatitlek Village

Tatitlek is located on the northeast shore of Tatitlek Narrows, on the Alaska Mainland in PWS and lies near Bligh Island, southwest of Valdez by sea and 48 air kilometers northwest of Cordova. The Tatitlek village has a total area of 19 square kilometers, all of it land.
Winter temperatures range from -8 to -2 °C, while summers average nine to 17 °C. Annual precipitation averages 0.71 m of rain and 3.8 m of snowfall.

According to the 2010 Census, there are 88 residents with a median age of 30 years old. A federally-recognized tribe is located in the community -- the Native Village of Tatitlek. Tatitlek is a coastal Alutiiq village with a fishing and subsistence-based culture (USCB 2010).

Fish processing and oyster farming provide limited employment in Tatitlek. In 2010, one resident held a commercial fishing permit. Subsistence activities provide the majority of food items (ADCCED 2012). A silver salmon hatchery, supporting subsistence activities, is located at Boulder Bay. The community has a store. Air charters are available from Valdez and Cordova. Boats are the primary means of local transportation. In 1996, the Alaska Marine Highway began "whistle stop" service (ADCCED 2012).

Valdez

Valdez is located on the north shore of Port Valdez, a deep water fjord in PWS and is 482 road kilometers east of Anchorage and 586 road kilometers south of Fairbanks. Valdez is the southern terminus of the Trans-Alaska oil pipeline and the northernmost ice-free year-round port in North America. The city has a total area of 717.5 square kilometers of which, 575 square kilometers is land and 143 square kilometers (20 percent) is water. January temperatures range from -6 to 0 °C; July temperatures are from eight to 16 °C. Annual precipitation averages 1.58 m. The average snowfall is, incredibly, 8.3 m annually.

According to the 2010 Census, there are 3,976 residents with a median age of 37 years old (USCB 2010). Valdez is a major seaport and a foreign free trade zone, with a $48 million cargo and container facility. The Port of Valdez is navigated by hundreds of ocean-going oil cargo vessels each year. Four of the top ten employers in Valdez are directly connected to the oil terminus. City, state, and federal agencies provide significant employment. In 2010, 52 residents held commercial fishing permits. Two fish processing plants operate in Valdez, as well as a fish hatchery. Several cruise ships dock in Valdez each year. In 2011, 98 uniformed Coast Guard personnel were stationed in Valdez. Valdez is a fishing port, both for commercial and sport fishing. Marine life and glacier sightseeing, deep-sea fishing, and heli-skiing support a tourist industry in Valdez (ADCCED 2012).

The Richardson Highway connects Valdez to Alaska's road system. The Alaska Marine Highway Ferry System provides transport to Cordova, Whittier, Kodiak, Seward, and Homer. Daily scheduled jet flights and air taxis are available.

Whittier

Whittier is on the northeast shore of the Kenai Peninsula, at the head of Passage Canal and on the west side of PWS, 96.5 kilometers southeast of Anchorage. The city has a total area of 51 square kilometers, of which, 32.5 square kilometers of it is land and 18.5 square kilometers of it (36 percent) is water. Winter temperatures range from -8 to -2 °C, while summer temperatures average nine to 17 °C. Average annual precipitation includes 5.0 m of rain and 6.1 m of snowfall.

According to the 2010 Census there are 220 residents with a median age of 48 years old (USCB 2010). Whittier has an ice-free port, two city docks, and a small boat harbor that accommodates fishing, recreation, and charter vessels. It is served by road, rail, the state ferry, boat, and aircraft. Since 2000, a tunnel has provided a road connection to Anchorage. The railway carries passengers, vehicles, and cargo 19.5 kilometers from the Portage Station east of Girdwood. Daily scheduled air flights are available. The city, school, local services, and summer tourism support Whittier. Tours, charters, and sport fishing in PWS attract seasonal visitors. In 2010, 12 residents held commercial fishing permits. Whittier is a popular port of call for cruise ships, as it has connections to Anchorage and the interior of Alaska by both highway and rail. Whittier is the embarkation/debarkation point of the Denali Express nonstop rail service (ADCCED 2012). Whittier is also popular with tourists, sport fishermen and hunters.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter describes the effects of the No Action – Current Management and the Proposed Action - Control of Predatory Mink alternatives. Each major environmental impact is evaluated under each alternative and the direct, indirect, and cumulative impacts are analyzed, where applicable. The following factors were considered under each alternative in evaluating impacts:

Likelihood of impact –would the action result in an impact or; is the chance of impact so small as to discount effects?

Duration and frequency of the impact – is the action seasonal, temporary, ongoing, etc.?

Magnitude of impact – is it likely the magnitude of impact would cause significant impacts to the quality of the human environment? (No impact, negligible impact, moderate impact, or severe impact).

Geographic extent – are the impacts expected to be local or far-reaching?

Legal status of a species – are there species that may be impacted that have special protections, regardless of the other levels of impact?

Under either alternative the Naked Island Group would remain as part of the Chugach National Forest and managed under State and Federal regulations for currently permitted public uses, including trapping, hunting, wilderness recreation, and other activities. The Naked Island group would continue to be managed as a wilderness study area to maintain and protect the existing wilderness character.

ALTERNATIVE A: NO ACTION – CURRENT MANAGEMENT

No management actions would be undertaken to control or reduce the population of mink. The pigeon guillemot population in PWS would not be moved toward recovery status.

Cost

No additional costs.

Impacts to Geology, Soils, and Vegetation

Vegetation, geology, and soil resources would not be affected.

Impacts to Water Resources

Streams and wetlands would not be affected.

Impacts to Wildlife

Birds

The breeding population of pigeon guillemot at the Naked Island group, where 25 percent of the PWS population bred at the time of the EVOS, would likely remain either exceedingly low (≤ 100 birds) or decline to local extirpation in the absence of restoration action (see Figure 4 and Table 1). Pigeon guillemot would remain the only marine bird species "not recovering", on the EVOS Trustee Council's Injured Resources List.

Other breeding seabird populations, including horned puffin, parakeet auklet, and tufted puffin would likely continue to decline or become absent at the Naked Island group. Mink are opportunistic feeders and would continue to predate on ground/burrow nesting seabirds, which generally breed only on predator free islands.

Mammals

Mammals present on the islands would not be affected.

Fishery Resources

Fishery resources present on and near the islands would not be affected.

Threatened and Endangered Species

North Pacific right whale, Steller sea lion, Steller's eider, and the humpback whale would not be affected.

Impacts to Wilderness Study Area

There could be moderate effects to the wilderness character at the Naked Island group, if pigeon guillemot and other seabirds continue to decrease in population. Historically, seabirds have been present and contributed to the islands wilderness character. The wilderness study area was designated in 1980 through the Alaska National Interest Lands Conservation Act (ANILCA), when bird numbers were dramatically higher than today (1979 survey of the Naked Island Group counted 1871 pigeon guillemot). There are currently only about 100 pigeon guillemot; parakeet auklets no longer breed at the Naked Island group; and tufted and horned puffin in 2010 number less than ten individuals.

Impacts to Cultural Resources

There would be no effects to cultural resources.

Impacts to Recreational Resources

Effects to recreation resources would likely be negligible to moderate. There may be fewer visitations for those interested in birding and sightseeing with few nesting seabirds and the absence of pigeon guillemot, parakeet auklet, tufted puffin, and horned puffin.

Impacts to Social and Economic Values

Communities

Social and economic effects would likely be negligible to moderate. Reduced populations of seabirds, particularly pigeon guillemot at the Naked Island group would have negligible to moderate effect on tourism.

Subsistence

Although pigeon guillemot has little subsistence value, pigeon guillemot contribute to the local culture. Effects would likely be negligible.

Cumulative Impacts

Continued reduction of pigeon guillemot to potential extirpation and dramatically reduced numbers of other seabirds could have a cumulative impact to PWS. The Naked Island group is particularly important because it was historically the main pigeon guillemot breeding location in PWS (Sanger and Cody 1994). One fourth of all pigeon guillemot nests in PWS in 1989 (just after the spill) were located at the Naked Island group, although the islands constitute only about two percent of the total shoreline in PWS (Bixler et al. 2010).

The Naked Island group is part of a larger wilderness study area which was designated in 1980. At the time of designation, the number of pigeon guillemot and other seabirds were dramatically higher than today. The lack of seabirds could have a cumulative impact to PWS within the wilderness study area.

ALTERNATIVE B: PROPOSED ACTION –CONTROL OF PREDATORY MINK

Control of predatory mink would be accomplished during five years by trapping mink entering the pigeon guillemot coastal zone nesting area.

Impacts to Geology, Soils, and Vegetation

Option 1: Boat Based

Vegetation, geology, and soil resources would not be affected by the alternative actions. Trappers would be on the islands during the day for a three to five month period from January to May when the islands are mostly covered with snow. Food would be confined to the boat and would not attract or change any wildlife behavior; no vegetation would be trampled or removed; water quality would be maintained by avoiding riparian areas and streams, No fires or land based waste would be left. No holes would be dug. This alternative would be the same as Option 2, except that a support vessel would provide food and lodging to trappers and no upland camps would be used.

Option 2: Land Based

Vegetation, geology, and soil resources would not be affected by the actions in this alternative. Wildlife specialists would be on the islands day and night during a three to five month period from

January to May, when the islands are mostly covered in snow. While there would be a temporary presence, all precautions would be taken to use minimum tools requirements and prevent natural resource impacts. All camping would be at locations approved by the USFS special use permitting process.

Impacts to Water Resources

Streams and wetlands would not be affected by the boat based or land based actions in this alternative. No waste would be deposited on the island. No latrines would be built that could leak into subsurface waterways. No carcasses would be left in the water.

Impacts to Wildlife

Birds

Trapping and the camping activities would take place during the winter season, when few birds are in the area, and no disturbance to pigeon guillemot would occur. In year five, when a dog may be used to hunt mink, the dog would be kept within sight and voice control and would not be allowed to approach birds and disturbance would be negligible

There would be a positive effect to birds under this alternative with either the boat based or land based option. Pigeon guillemot populations at the Naked Island group are likely to recover from the current 100 birds to near the approximately 1,000 birds observed at the time of EVOS in 15 years after the project is completed (See Figure 4 and Table 1) under this alternative with either the boat based or land based option. It is anticipated that within three years of the beginning of the reduction program, the pigeon guillemot would have increasing productivity and be removed from the EVOS Trustee Council "not recovering" Injured Resources List and be classified as "recovering", and when the population reached 1,000 they would be considered "recovered".

A suite of other seabird species with depressed breeding populations at the Naked Island group (e.g., parakeet auklet, tufted puffin, and horned puffin) (KSB, pers. obs., Oakley and Kuletz 1979) would also benefit from this restoration action. Based on historical counts, tufted puffins should increase from a few to more than 750, parakeet auklets should increase from none to about 170 and horned puffins would likely increase from the few remaining birds to more than 60. Mink reduction may promote local increases in other populations of ground-nesting birds, including the black oystercatcher, a USFS "Management Indicator Species (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, and crustaceans (Bonesi and Palazon 2007). The Service uses predator control as a management tool when appropriate and consistent with mandates, laws, and policies of federal land management agencies.

Black oystercatcher, a USFS "Management Indicator Species", would not be affected by trapping activities. Trapping would occur prior to the nesting initiation in May and fledgling in July. Black oystercatchers nest on rocky beach substrate just above high tide and personnel onsite would be trained to recognize defensive behavior during the breeding season and areas with nesting black oystercatchers would be avoided. Dogs would not be utilized where nesting black oystercatchers occur.

Mammals

Impacts to mammals resulting from the trapping and associated camping activities would be negligible for most species except mink. The boat based or land based actions in this alternative would reduce the mink population at the Naked Island group substantially but would likely have no measureable impact on the overall PWS mink population, as the mink habitat at the Naked Island group is about 2 percent of the PWS habitat and the mink at the Naked Island group are not genetically unique. It should also be noted that the there is no limit as to the number of mink trappers that are allowed to trap in PWS or any other Game Management Unit in Alaska.

River otter on the islands are unlikely to be captured using the AFWA Best Management Practices for mink and if captured could escape, as the traps are too small to contain an otter. There are no other mammals that reside at the Naked Island group that could be impacted by trapping.

The historic number of nesting seabirds at the Naked Island group indicates that either mink were not present or mink numbers were very low compared to current mink numbers. Populations, including ground nesting birds and small mammals would likely increase when mink are reduced. The possibility exists that all the mink on the Naked Island group would potentially be removed. Total extirpation of mink would likely not adversely affect the environment because the island ecology has evolved for long periods when mink were absent or present in low levels of abundance. Populations of the normal food of mink which include most accessible animals, small enough for the mink to eat such as: birds, fish, intertidal invertebrates, and voles, would likely increase when mink predation is absent.

Camp sites and trapping are unlikely to affect Sitka deer as deer feed in the intertidal areas. In year five, when dogs may be used to hunt mink, dogs would be kept within sight and voice control and would not be allowed to approach deer or other animals. Any disturbance would be negligible.

Fish

No impact to fish under this alternative utilizing either the boat based or land based option would occur. Actions in streams or fish-bearing habitat would be avoided. No sediment would result from these actions. Fish use by pigeon guillemot is not significant compared to fish predation by other fish, mammals, and other birds. There are about 225,000 other fish-eating seabirds in PWS and only about 2,000 pigeon guillemot (Cushing et al 2011). Impacts to herring and other fish would be negligible. Pacific herring are not an important part of the diet of guillemot (Golet et al. 2000).

The anadromous fish streams on the islands would not be disturbed by the trapping operation or by the small infrastructure necessary to trap mink on the islands. No impact to pink salmon would occur under this alternative and there would be no change to riparian vegetation.

Threatened and Endangered Species

No effect to threatened and endangered species would occur under this alternative with either the boat based or land based option. The endangered Steller sea lion do not breed or have known haul-out sites at the Naked Island group, but may occasionally occur on island beaches. Sea lion observed during the operation would not be disturbed. Trappers would avoid beaches that are being used by Steller's sea lion. Steller's eider, North Pacific right whale, and humpback whale would not be affected.

Impacts to Wilderness Study Area

Option 1: Boat Based

There would be no to negligible impacts, however, there would be temporary effects to wilderness character while the wildlife specialists were removing mink.

- No temporary shelters or structures would be used during the reduction program.
- Evening activities (food and lodging) would occur on a support vessel, while mink removal would be land based.

Option 2: Land Based

There would be no to negligible impacts, however, there would be temporary effects to wilderness character from camp operations and the presence of wildlife specialists removing mink.

- Temporary structures would be used for the reduction program for up to five years.
- Trapping operations would occur during a three to five month period from January to May, when visitation is low. The presence of snow during these periods and use of wooden floor sections and wooden walkways would negate trampling of vegetation.

Under both options, there would be a positive effect to the wilderness character as pigeon guillemot and other seabirds increase in numbers to those comparable at the time of wilderness study designation in 1980. Mink would still occur but at lower numbers than currently exist.

Impacts to Cultural Resources

According to the Programmatic Agreement among the USDA USFS, Alaska Region, the Advisory Council on Historic Preservation, and the Alaska State Historic Preservation Officer regarding Heritage Program Management on National Forests in Alaska, the proposed undertaking has no potential to effect historic properties. The Heritage Program on the Glacier Ranger District reached this conclusion based on the guidelines set forth in Appendix B of the Programmatic Agreement, section 33. Reintroduction or management of endemic or native faunal species into their historical habitats is included within the class of undertakings that has No Potential to Affect Historic Properties.

Option 1: Boat Based

No temporary shelters or structures would be used at the Naked Island group, as all mink removal support activities would be conducted by boat. Actions would cause no effects to cultural resource. In the event of unintentional discovery during trapping program implementation, any cultural artifacts or human remains encountered would not be disturbed or removed, left in place, and reported to the USFS.

Option 2: Land Based

Temporary structures would be used for support of the trapping program. Actions would cause no effects to cultural resources. All camping would be at camps approved by the USFS and would follow guidelines established in the special use permit to avoid adverse impacts to cultural resources possibly encountered during trapping program implementation.

Impacts to Recreational Resources

There would likely be a negligible to moderate positive effect to recreation resources as a result of this alternative. Recovery of pigeon guillemot and other seabirds at the Naked Island group would likely increase ecotourism potential with a greater number of seabirds to observe by visitors.

- Mink reduction activities would be conducted during the winter/spring months and would avoid potential conflicts with visiting publics, as little, if any visitation occurs during the winter/spring period.
- There would be no impact to deer hunting under this alternative, as the season ends December 31.
- Existing trapping opportunities would exist; the public trapping season starts November 10 and continues through February, but there would be fewer mink on the islands. It is likely that this alternative would have a negligible to minor impact on public trapping activities, as few trappers utilize the Naked Island group because of its remoteness.

Impacts to Social and Economic Values

Communities

Removal of mink at the Naked Island group would not adversely affect trappers in PWS, as mink fur prices are currently low and the Naked Island group is too remote for most trappers in the region. There may be temporary benefit as local trappers could potentially be used for the trapping program.

Mink carcasses could be donated to universities for research purposes and/or donated to Native villages for cultural purposes. Not all carcasses may be donated and some carcasses may not be salvageable (spoilage, unable to retrieve, scavenging by other animals, etc.)

Tourism would be enhanced as the pigeon guillemot and other seabird populations increase.

Subsistence

Removal of mink at the Naked Island group would not adversely affect subsistence trapping in PWS, as the Naked Island group constitutes less than two percent of the PWS shoreline. Low mink fur prices and the remoteness of Naked Island group preclude trapping activity. There would be temporary benefit if local Native Alaskan trappers would be used for the trapping program Native villages could benefit from mink carcasses that would be used for cultural purposes. There is currently little interest in trapping for mink.

Cumulative Impacts

The actions in Alternative B: Proposed Action – Control of Predatory Mink would result in negligible to moderate cumulative impacts. Mink would be reduced at the Naked Island group, but it represents only two percent of the shoreline in PWS, so any impact would be negligible. Pigeon guillemot have historically been important at the Naked Island group and comprised 25 percent of the pigeon guillemot in PWS, therefore, an increase of the pigeon guillemot population as well as other seabirds would have a moderate positive cumulative impact on PWS.

Mitigation Measures

Removal methods/techniques proposed are specific to mink and would pose no risk to human health and safety. Trapping would be the primary reduction method and is the most practical and effective control method available (Boggess1994; Macdonald and Harrington 2003; Moore et al. 2003; Davis et al. 2012) and balances efficacy, humane euthanasia, and human safety. Techniques to lessen or eliminate the catching species other than mink, specifically river otter would be utilized (Bixler and Irons 2010). No other mammals similar in size to mink, such as American marten or weasel, are known to occur on the islands.

Seasonal timing and careful placement of capture devices to specifically target mink are the primary mitigation measures to avoid unintended take of other species during trapping operations. All trapping in burrow-nesting seabird colonies would be completed before seabirds begin to attend nesting burrows in May. Crevice-nesting and cliff ledge nesting seabird use areas, not likely used by mink, would not be affected by the removal operation.

Intensive trapping would take place primarily during the winter months, when public visitation is minimal, snow covers the ground, and vegetation is not vulnerable to trampling and erosion. Camp locations would be approved by the USFS.

The geography of the Naked Island group improves the likelihood of removing mink. The islands are relatively small with gentle topography and access to safe anchorages (Courchamp et al. 2003, Bonesi and Palazon 2007). By trapping in the winter/spring months when there is one to two meters of snow on the islands, the mink would be concentrated along the snow-free intertidal zone where food would be most available.

Mitigation measures to maintain and protect the wilderness character at the Naked Island group would be employed and include:

- The USFWS and APHIS-WS would coordinate with USFS personnel to select and establish camp locations to minimize impacts to vegetation and other resources.
- The USFWS, APHIS-WS, and those working under the funding Agreement would follow Leave No Trace (LNT) practices during all operations.
- The USFWS would conduct the project in a manner that requires the fewest camps (four or less) established at one time.
- Winter camps would use chargeable marine or similar batteries for electronics to minimize use of generators
- Camps would be placed to take advantage of natural screening from beaches and marine waters.
- Camp personnel would avoid having fires, unless allowed under a USFS special use permit.
- Food and food waste would be stored in a manner that prevents wildlife habituation. Camp equipment and trash would be neatly maintained and kept out of sight of visitors. Camp developments would be kept to the minimum necessary for the project.
- Sites would be restored to USFS standards before camps are abandoned for the season.
- Human waste would be packed out from all camps in sealed containers when possible.
- Camps would be at least 200m from flowing streams or lakes.

Mitigation measures designed to maintain the natural character of the Wilderness Study Area would include:

- Without compromising health or safety, vessels with minimal generator requirements are preferable to vessels requiring overnight generator use. Generator loudness is another consideration.
- Personnel would minimize motorized tender use as best as possible and avoid loud music or other sights and sounds not related to the project and that may increase impacts to solitude.
- Personnel would exercise consideration that visitors to the Wilderness Study Area often seek opportunities for solitude and primitive recreation.
- Wildlife specialists would follow LNT practices while implementing this project.
- The USFS would provide LNT training to project personnel prior to project implementation as required.

Conclusion

The opportunity to recover pigeon guillemot breeding to 1,000 birds or more from the current 100 birds and to recover the other impacted species: tufted puffins from a few to 750, parakeet auklets from a few to about 170 and horned puffins from the few remaining birds to more than 60 is possible with the control of predatory mink at the Naked Island group. These "recovered" numbers reflect the seabird populations after the wilderness study area was designated in 1980.

Recovery of pigeon guillemot at the Naked Island group would result in a substantial increase in the PWS-wide population and the removal of the pigeon guillemot from the EVOS Trustee Council "not recovering list" and be classified as "recovered".

CONSULTATION AND COORDINATION

Collaborating and communicating with federal, state, and local agencies; stakeholders and the public; including consultation with Native Alaskan Tribes and Corporations has taken place throughout preparation of this EA. There are over 50 organizations and individuals on the EA mailing list.

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APPENDIX A: ONLINE RESOURCES

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APPENDIX B: COMPLIANCE WITH OTHER LAWS AND REGULATIONS

ANILCA Section 810, Subsistence Evaluation and Finding

As documented or reported there is little subsistence uses or resources that would be impacted by the alternatives at the Naked Island Group. For this reason, this action would not result in a significant possibility of a significant restriction of subsistence use of wildlife, fish, or other foods.

ANILCA Section 811, Subsistence Evaluation and Finding

There is no documented or reported subsistence access that would be restricted as a result of the proposed action. For this reason, this action would not result in a significant possibility of a significant restriction of subsistence users having reasonable access to subsistence resources on National Forest System Lands.

Endangered Species Act of 1973

The endangered Steller sea lion do not breed or have known haul-out sites at the Naked Island group, but may occasionally occur on island beaches. Sea lions observed during the operation would not be disturbed. Trappers would avoid beaches that are being used by Steller's sea lions. Steller's eider, North Pacific right whale, and humpback whale would not be affected.

National Historic Preservation Act of 1966

This EA evaluated the environmental impacts to cultural resources and determined that because the alternatives proposed do not propose to disturb significant areas, and most activity would be over snow, and it is unlikely that cultural resources are present or would be impacted.

Floodplain Management (E.O. 11988), Protection of Wetlands (E.O. 11990)

The construction of the facilities needed for trapping operations or the actual trapping would not impact the functional value of any floodplain as defined by Executive Order 11988 and would not have negative impacts on wetlands as defined by Executive Order 11990.

Recreational Fisheries (E.O. 12962)

There are five anadromous streams at the Naked Island group. These have the only recreational fishing potential within National Forest System lands. As documented since there are no effects to fisheries resources there would be no negative direct, indirect or cumulative impacts related to this Order.

Environmental Justice (E.O. 12898)

It has been determined that, in accordance with Executive Order 12898, the implementation of the proposed action does not have disproportionately high and adverse human health or environmental effects on minority populations and low income populations.

Magnuson-Stevens Fishery Conservation and Management Act

The project area contains five anadromous streams. Action taken under the action would not impact anadromous fish habitat. Since no disturbance of the anadromous fish habitat (EFH) on the islands is anticipated, this project would not affect EFH.

APPENDIX C: INFORMATION ON THE MODEL USED TO PROJECT PIGEON GUILLEMOT POPULATION TRENDS WITH CURRENT MANAGEMENT AND CONTROL OF PREDATORY MINK MODELING

Potential changes in the growth of the pigeon guillemot population at the Naked Island group were modeled to inform the decision-making process. This modeling coincides with the two management alternatives: Alternative A: No Action-Current Management and Alternative B: Proposed Action-Control of Predatory Mink (Chapter 2). A stochastic Leslie matrix model after Golet et al. (2002) and Bixler et al (2010) was used to project guillemot population growth under these scenarios.

The following equation was used to project the growth rate of the guillemot population:

(λ): $\lambda = ((PF * FX * PA^2) + (NX * PA)) / NX$

λ = annual population growth rate
P_F = annual sub-adult survival rate
F_X = number of offspring produced
P_A = age-constant annual adult survival
N_X = initial population size

The observed rate of population change of pigeon guillemot at the Naked Island group from 1989 to 2008 was an approximate 12.7 percent annual decline (Bixler et al. 2010). Observed population change of pigeon guillemot at the also oiled, but mink-free Smith Islands was a 0.53 percent increase over the same time period, as pigeon guillemot recovered from EVOS. Thus, it is assumed that the long-term decline at the Naked Island Group was likely due to mink predation.

An example of the possible maximum rate of increase for pigeon guillemot was 13.6 percent annually for six years was noted by Byrd (2001) in the western Aleutian Islands when arctic fox were removed from two islands. Pigeon guillemot numbers on nearby islands where arctic fox were not removed changed only slightly. Seabirds prospect at the end of summer for good breeding sites (ones with evident chicks) and this may result in immigration to productive colonies from nonproductive colonies (Boulinier and Danchin 1997).

The modeling strategy used the best data available to quantify a matrix population projection model. The model assumed a maximum average adult survival rate of 0.9 under optimal conditions. Although no empirical estimates of adult survival exist for pigeon guillemot, this assumption is reasonable considering adult survival data across a range of different seabird species (Schmutz 2009). The assumption is very similar to the rate of 0.89 estimated for black guillemot (Frederiksen and Petersen 1999). To emulate the decline depicted by Bixler et al. (2010), the mean nest productivity rate of 0.35 was used from study years at Naked Island (1989, 1990, and 1994-1998). Bixler et al. (2010) also noted adult pigeon guillemots were killed at up to ten percent of nest sites. This rate may be an underestimate, if mink remove carcasses from the nest, as the investigator would assume the nest had failed and the adults simply dispersed. Regardless, a maximum predation rate of ten percent of the adults was used in the presence of mink (thus base adult survival without mink of 0.9

multiplied by 0.9 (the percent surviving predation in the presence of mink) equals 0.81. This nest survival rate of 0.35 and adult survival rate of 0.81 produced a rate of decline less steep than depicted in Bixler et al. (2010). An adult emigration rate was added, sufficient to produce the trend shown by Bixler et al. (2010). The best value for emigration rate was 15 percent. If this trend were to continue, a population of 100 pigeon guillemot would decrease to seven pigeon guillemot in 20 years. This model reflects the No Action – Current Management alternative.

An adult survival rate of 0.9, a nest survival rate equal of 0.61 (Golet et al. 2002), and an immigration rate equated to the emigration rate was needed to model the pigeon guillemot observed decline at the Naked Island group. The average increase of pigeon guillemot over 20 years was 17 percent annually, nearly identical to the value noted by Byrd (2001) for Simeonof Island. The projection starting point begins when there is assumed to be no mink predation. Additional model simulations could be done to characterize pigeon guillemot response to gradual mink eradication. To emulate a significant removal of mink (90 percent removal) nest survival and adult survival rates of 90 percent of the maximum values in the previous model were utilized. For the Control of Predatory Mink alternative, the average rate of annual increase of pigeon guillemot, over 20 years, was 16 percent.

The above model descriptions are deterministic, as each model parameter has a singular value without variation (e.g., if adult survival is 0.9, then 0.9 is maintained throughout the projection). Stochastic models were run where variability was applied to the system with these core model structures. If biologically realistic parameter values of variability are used, then a stochastic model should be a more realistic representation of possible outcomes. For variability in nest survival (productivity), the data presented in Golet et al. (2002) was used for Naked Island. These data represent both ecologically real variability and also variability due to the sampling process. Variance decomposition procedures were used (Burnham et al.1987) to extract an estimate of process variation in nest survival. A normal distribution of this variability was imposed on the model by using random draws from the distribution, and running the model 1,000 times. The 50th and 950th model runs, sorted by population growth estimates, reflect the confidence interval of this model projection. Stochastic variability was imposed on adult survival rates. This level of variability was taken by using the mean process variation in adult survival from 18 seabird populations listed in Schmutz (2009).

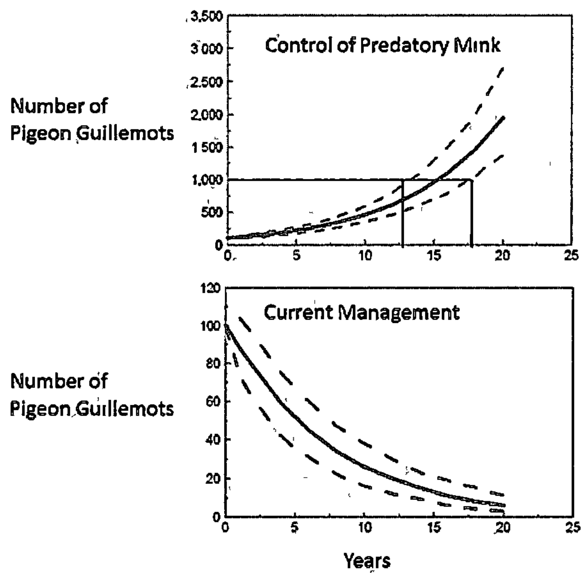

Figure 1. Results of stochastic Leslie matrix modeling of the changes in the pigeon guillemot population at the Naked Island group for two alternatives: No Action – Current Management and Proposed Action – Control of Predatory Mink (Fleming and Cook 2010). Across the two model scenarios, guillemot productivity varies in a monotonic fashion. The graphs start with the year after the actions were completed.

The "No Action – Current Management" alternative represents no control of predatory mink at the Naked Island group and a predation rate based on the empirical predation rate of the 1990s (Bixler et al. 2010). Under the "Proposed Action – Control of Predatory Mink" alternative, a model projecting guillemot population growth, assumed annual removal of mink was sufficient so that few survived at the Naked Island group after each annual management effort and mink predation on guillemot was minimal.

APPENDIX D: TIMELINES

	PIGEON GUILLEMOT	AMERICAN MINK
1895 -1950		Duration of fox fur farming at the Naked Island group.
1908		Alexander Expedition does not note the presence or absence of mink at the Naked Island group.
1929		135 mink fur farms operating, mostly in southeast Alaska
1946-1995		No mink observed at the Naked Island group according to local trapper.
1951		Mink introduced to Montague Island in PWS.
1956		Mink introduced to Strait Island in southeast Alaska by Alaska Game Commission and the USFWS
1972	15,000 summer population of pigeon guillemot and 4,000 pigeon guillemot in winter in PWS.	
1972-1997	Pigeon guillemot declined from 15,000 to less than 3,500 in PWS.	
Mid 1970's		Mink released at the Naked Island group according to a local source.
Late 1970's – early 1980's		No mink predation recorded.
1979	1,871 pigeon guillemot recorded at the Naked Island group.	No evidence of mink predation
Pre-EVOS	Approximately 2,000 pigeon guillemot at the Naked Island group.	
1989	EVOS (3/24/1989). 500 to 1,500 pigeon killed in PWS as a result of EVOS. Just after spill – 1,000 pigeon guillemot at the Naked Island group and 4,000 in PWS.	
1990	1,000 pigeon guillemot at the Naked Island group and 4,000 in PWS.	Mink population started increasing.
1993	Estimated 3,000 - 4,900 pigeon guillemot in PWS.	

1998-2008	Dramatic decline in pigeon guillemot densities at the Naked Island group compared to PWS.	
Mid 1990's		Mink predation recorded. Local trapper observed mink on Peak Island
2004	No evidenced of pigeon guillemot exposure to residual oil from EVOS.	
2008 to present	100 pigeon guillemot at the Naked Island group.	

Phase Two - Pigeon Guillemot Restoration Research in Prince William Sound, Alaska 2014-2018

Update of changes in proposed work since original proposal was accepted.

29 August 2013

As background, the EVOSTC has tried for years to restore the species injured by the EVOS, until this project was proposed direct restoration of seabirds has been difficult. The EVOSTC decided to fund this project to restore pigeon guillemots, the only non-recovering seabird, in two phases, the first phase was for the Environmental Assessment (EA) and was funded in 2011. Upon completion of the EA, the EVOSTC would consider the fieldwork.

The PI's had proposed to begin field work in 2012 after the EA was completed; however the EA has taken longer than expected, delaying start of the field work. By 28 October the EA will have been completed. Also since the trustees reviewed the original proposal of $2,434,218.40, the National Fish and Wildlife Foundation has agreed to fund $1,051,300 of the project and the funding for the EA has been paid. Therefore the remaining budget has declined substantially to $1,206,551.

As part of the EA, the PI's obtained additional data and revised the model on predicted recovery of pigeon guillemots. With the additional data the recovery is expected to occur more rapidly than previously predicted. Originally we predicted that after 10 years without mink predation the pigeon guillemot population would double, we now expect it to increase about five-fold in 10 years.

Additionally, as part of the EA internal review process among the four agencies involved (U.S. Fish and Wildlife Service, Alaska Department of Fish & Game, U.S. Forest Service, and Animal and Plant Health Inspection Service), the preferred alternative has changed from Eradication to Control of Predatory Mink (somewhat similar to the culling alternative in the original proposal) because ADF&G manages wildlife populations, but generally does not eradicate populations as a first step to management. Mink on the Naked Island group are likely less than 2% of the mink in Game Management Unit 6 (Prince William Sound and the Copper River Delta) and therefore reduction or removal of them would have minimal impact to the trappable population in GMU 6, particularly because it is known that very few if any mink are currently trapped on the Naked Island group.

At this point ADF&G has agreed to the Control of Predatory Mink alternative, as written in the EA, and is willing to proceed by removing all the mink from the pigeon guillemot nesting area, but not trap mink in the upland habitat of the Naked Island group. This is different from the original culling alternative in which not all mink would have been removed from the pigeon guillemot nesting area. The Principal Investigators of the project believe this revised alternative has a much greater probability of success than the original culling alternative, because all the mink nearest the guillemots would be removed. All agencies agreed that if mink reduction does not restore pigeon guillemots then through adaptive management, based on what is learned during the first 2-3 years of the project, another decision will be made on what to do. One of those options would to amend the EA remove the remaining mink from the Naked Island group.

Also some additional work on mink has been recommended by the ADF&G. Therefore we now plan to examine diets, age, and sex of the mink that are collected. We will also take a DNA sample, in case DNA analyses are needed at some future date. By using bait stations, we will be able to estimate the mink population and learn locations of mink that may become trap shy so that other means may be used to remove them. The cost of these new components is relatively low and will not cause the budget to increase by more than $25,000 overall (this is included in the attached budget).