Exxon Valdez **Oil Spill Trustee Council**

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

Project Number: 22120114-N

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

Principal Investigator(s): John Durban and Craig Matkin, North Gulf Oceanic Society

Reporting Period: February 1, 2022 – January 31, 2023

Submission Date: March 1, 2023

Project Website: https://www.whalesalaska.org/

Please check all the boxes that apply to the current reporting period.

☒ **Project progress is on schedule.**

☐ **Project progress is delayed.**

☒ **Budget reallocation request.**

Owing to the late arrival of the FY22 allocation we would like to request carryover for some FY22 funds beyond May 2023, to add to the proposed FY23 funds. However, we do plan further spending of FY22 funds through May 2023, so details of carryover are not yet available.

☒ **Personnel changes.**

Dan Olsen is taking a step back from the science side of this project. He has therefore been removed from the PI list, but he will remain involved in outreach for the project.

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1. Summary of Work Performed:

We completed 50 vessel survey days in 2022 with timing and geographic components of effort similar to previous years (Fig. 1). Specifically, search effort was focused in known killer whale hotspots in the Kenai Fjords in late May and early June, Hinchinbrook Entrance to Prince William Sound (PWS) in early May and the second half of June and Montague Strait / southwest PWS in July (Fig. 1). The total distance surveyed was 4643 km with 900 km spent collecting data in the company of killer whales (Fig. 2). We had 38 total encounters with killer whales, including 36 with resident ecotype killer whales. This included one off-season encounter with a resident pod in February in Kenai Fjords. There were no AT1 (Chugach transient) encounters on

our surveys, but photographs of AT1s were reviewed from eight opportunistic encounters that were contributed by our network of on-water collaborators.

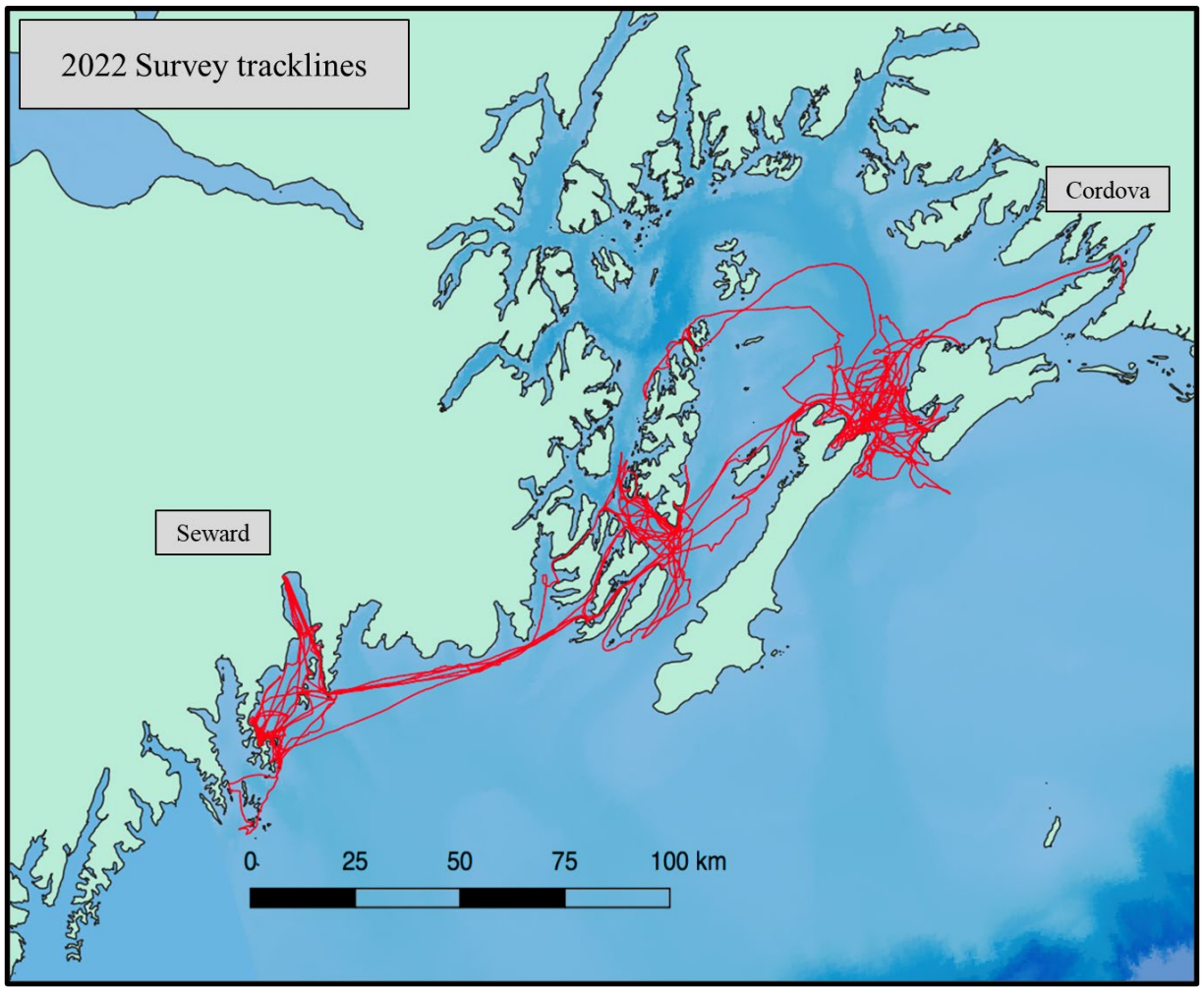

Figure 1. Vessel survey tracks (red) when searching for killer whales in Prince William Sound and Kenai Fjords, 2022.

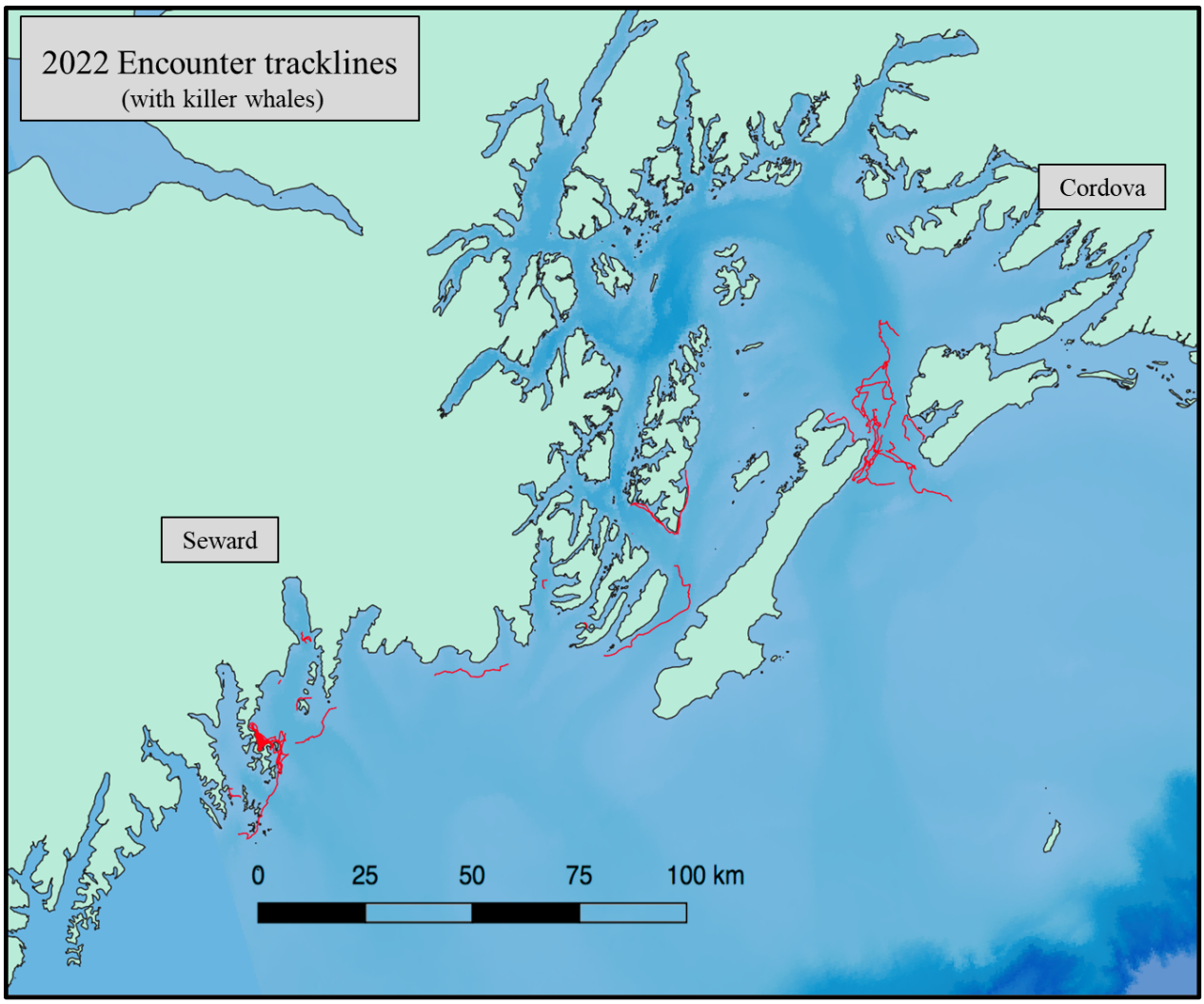

Figure 2. Vessel survey tracks (red) when collecting data in the presence of killer whales in Prince William Sound and Kenai Fjords, 2022.

We had encounters with 9/10 index pods of residents that we are currently monitoring for population dynamics (Matkin et al. 2023), including pods from both AB and AD acoustic clans (Table 1). Photo-identification analyses indicated general slow growth, but pod- and clan-specific dynamics will be interpreted in the context of our longer time series. AB pod, which has been documented to have been injured by the *Exxon Valdez* oil spill, remained constant in size at 17 whales, below the pre-spill high of 27 individuals.

Table 1. Recruitment, likely mortalities, and total number of killer whales in index pods (See Matkin et al. 2023). Shading indicates pods from the AB acoustic clan listed above those pods from the AD acoustic clan.

POD	Total 2021	Calves since 2021	Missing since 2021*	Total 2022
AB	17	1	1	17
AB25	27	1	2	26
AJ	44	4	2	46
AJ08	19	1	0	20
AI	10	0	0	10
AB Clan sum		**7**	**5**	
AE	18	1	1	18
AK02	20	0	0	20
AK06	10	1	0	11
AD08	10	NA	NA	NA
AD16	14	1	0	15
AD Clan Sum		**3**	**1**	

** Missing likely indicates death but may be due to incomplete photo-identification coverage. Photo-identification in future years will help confirm, along with fitting of mark-recapture model to account for matriline-specific capture probabilities when estimating survival.*

One of the index pods monitored in the previous five-year period (AD08) was not encountered in 2022. In addition, we had encounters with pods that were index groups in previous assessments but have not been encountered annually in recent years (AD11) or for several years (AD05, AN10), Also photos were contributed from opportunistic encounters with AF22 and AG pods in southeast Alaska, which have only had incomplete coverage in recent years. Rather than being monitored by direct photo-identification census, the dynamics of these pods will be assessed by fitting mark-recapture models to estimate demographic changes while accounting for the uncertainty due to lower identification probabilities resulting from incomplete identification records.

In addition, we encountered whales in a further pod that has been poorly documented in irregular encounters (AX27) over the years and one pod that is new to our dataset. We do not have statistical power to assess their population dynamics, but photo-identification data will be analyzed to inform us about the size of the larger population of southern Alaska residents.

All seven of the AT1 transients were identified from contributed photographs, with no observed mortality since the previous year. No new calves were documented in this population. The youngest female is estimated to be 48 years old, which is likely beyond reproductive age. This

population has been documented to have been directly injured by the *Exxon Valdez* oil spill and remains below the pre-spill high of 22 individuals.

To help understand ecosystem interactions underlying population dynamics for these top predators we continued to collect samples to investigate diet. In 2022 we collected 17 free-floating fecal samples and two scale samples that will be genetically analyzed to identify prey species. These came from encounters with eight different resident pods. These will be added to 86 fecal samples collected between 2016-2021 and 362 scale samples collected 1991-2021 (Matkin et al. 2023).

During previous research we have established acoustic monitoring stations in areas important for resident killer whales to monitor changes in their distribution and habitat use. During 2022, we continued to service and collect data from bottom-mounted hydrophones at four sites in the northern Gulf of Alaska (Hinchinbrook Entrance, Montague Strait, Resurrection Bay, and Kachemak Bay), and deployed a hydrophone at a new location off the northeast corner of Kodiak Island (Fig. 3). Monitoring across these locations will provide insight into the movement patterns and habitat preferences of killer whale pods that frequent PWS. We also collected 20 field acoustic recordings from ten different resident pods (AB, AB25, AD11, AD16, AE, AJ, AJ08, AK01, AN10, and AX27 resident pods), to identify pod-specific dialects and describe calling rates for application to passive acoustic density estimation.

In 2022 we used drone photogrammetry for quantitative measurements of health metrics, specifically to better understand nutritional health and the ecological factors underpinning contrasting pod dynamics. We successfully flew 65 drone flights over nine days in late May/early June in Kenai Fjords and a further 13 flights over five days in July in Montague Strait and adjacent southwest PWS. A total of 16,124 images were collected from eight different resident pods (AK02, AK06, AD05, AD16, AB25, AJ08, AX27, unknown pod) including those know to be from both AB acoustic clan (AB25, AJ08, AX27) and AD clan (AK02, AK06, AD05, AD16), potentially representing measurement photos of 133 different individuals.

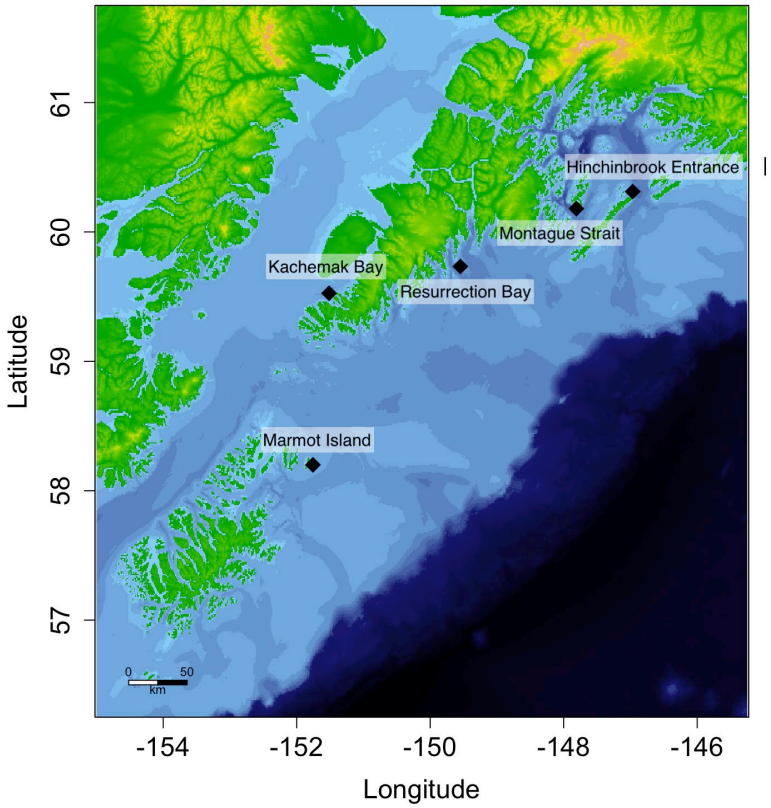

Figure 3. Location of five remote hydrophone stations operated by North Gulf Oceanic Society.

We are currently in the process of querying and adding to our existing aerial identification catalog to identify distinct individuals from these overhead photographs using pigmentation patterns and scarring on their saddle patches (Matkin et al. 2023). Once complete, we will make measurements of body condition and length that can be linked to individuals of known age, sex, reproductive status, and pod affiliation (Fig 4). These measurements will be used to quantify length-at-age relationships to examine growth, and to measure body condition to infer nutritional health and pregnancies. Expected products for this project are comparisons of the condition and growth trends of different pods and an evaluation of the influence of female size on reproductive success. Furthermore, we aim to conduct a comparison of the body condition and size of southern Alaska resident killer whales to other killer whale populations, specifically the endangered Southern Resident killer whales off Washington State. In the longer term we aim to track temporal changes in growth, body condition and reproductive success in response to environmental change if this project is funded in sufficient future years.

Figure 4. Drone-derived aerial images are being used to produce quantitative measurements of body condition and length to infer nutritional status on the short and long term and identify pregnancies. Here are two adult males in contrasting body condition: a male from AX27 pod in relatively lean condition on the left and a male from AD16 pod in relative robust condition on the right. Both images collected in 2022 off Kenai Fjords.

2. Products:

Peer-reviewed publications:

None

Reports:

Matkin, C. O., J. Durban, D. Olsen, H. Myers, and G. Ellis. 2023. Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords. *Exxon Valdez* Oil Spill Long-term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 21120114-M), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Popular articles:

None

Conferences and workshops:

Arimitsu, M., D. Cushing, J. Durban, S. Hatch, R. Kaler, K. Kuletz, E. Labunski, C. Matkin, J. Moran, D. Olsen, S. Pegau, J. Piatt, J. Straley, S. Whelan, and L. Wild. 2023. Changes in marine predator and prey populations in the Northern Gulf of Alaska: Gulf Watch Alaska pelagic update 2022. Poster presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Durban, J., D. Olsen, and C. Matkin. 2023. Declines in survival and fecundity of fish-eating killer whales indicate abrupt and prolonged impacts of a marine heatwave in the Gulf of Alaska. Poster presentation, Alaska Marine Science Symposium, Anchorage, Alaska January.

Myers, H. 2022. Killer whale vocal behavior and passive acoustic density estimation. Poster presentation, National Defense Science and Engineering Graduate Fellows Conference, Boston, Massachusetts, July.

Myers, H. 2022. Year-round calling rate of a southern Alaska resident killer whale pod. Oral presentation, Workshop on Detection, Classification, Localization, and Density Estimation of Marine Mammals using Passive Acoustics, Honolulu, Hawaii, March.

Myers, H. 2023. How much do killer whales call? Quantifying calling rates for passive acoustic density estimation. Oral presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Myers, H., D. Olsen, C. Matkin, and B. Konar. 2022. Listening for killer whales: Passive acoustic monitoring reveals year-round distribution and residency patterns of *Orcinus orca* in the northern Gulf of Alaska. Poster presentation, Society for Marine Mammalogy Biennial Conference, online, August.

Olsen, D., A. VanCise, K. Parsons, and J. Durban. 2023. Diverse diet of resident killer whales in southern Alaska revealed by two distinct sampling methods. Oral presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Public presentations:

Fearnbach, H., and J. Durban. 2022. Studying killer whale health using aerial photogrammetry. Naturalist Training, The Whale Museum, Friday Harbor, Washington, August.

Myers, H. 2023. Eavesdropping on killer whales. Forum on Ecoacoustics, Anchorage Museum Pass the Mic Series. Anchorage, Alaska, January.

Olsen, D. 2022. Killer whale culture. Alaska Wildlife Alliance marine mammal forum, Homer, Alaska, April.

Olsen, D. 2022. Killer whales of Kenai Fjords. Seward Captain and naturalist training, Seward, Alaska, May.

Olsen, D. 2022. Killer whales of Kenai Fjords. Kayak Adventures Worldwide guide training, Seward, Alaska, May.

Olsen, D. 2022. Killer whales of Kenai Fjords. Sunny Cove guide training, Seward, Alaska, May.

Olsen, D. 2022. Killer whales of Kenai Fjords. Kachemak Bay naturalist training, Homer, Alaska, May.

Data and/or information products developed during the reporting period:

An updated analysis of resident killer whale population dynamics, inferred from photo-identification records, is in the final stages of preparation for submission to a peer-reviewed scientific journal. Preliminary information was reported to the GWA-LTRM Annual Meeting in November 2022 in an oral presentation (Durban et al.) and at the Alaska Marine Science Symposium in January 2023 as a poster presentation (Durban et al.).

An updated analysis of resident killer whale diet, inferred from fecal and scale samples, is in the final stages of preparation for submission to a peer-reviewed scientific journal. Preliminary information was reported to the Gulf Watch Alaska-Long-Term Research and Monitoring (GWA-LTRM) program annual principal investigator (PI) meeting in November 2022 and at the Alaska Marine Science Symposium in January 2023 as an oral presentation (Olsen et al.).

An analysis of the acoustic calling rates of resident and transient killer whales, inferred from passive acoustic recordings, has been completed and is in the final stages of preparation for submission to a peer-reviewed scientific journal (Myers et al., in prep). This is an important component of passive acoustic density estimation.

Data sets and associated metadata:

Data sets have not yet been updated on the Gulf of Alaska Data Portal to include 2022 data. The photographic and acoustic files are very large and cannot be uploaded and accessed with a browser easily, but will be transferred by hard drive to add to the following datasets which have been published online by Axiom Data Science for previous years (https://researchworkspace.com/project/4682/files):

- Database of surveys and encounters
- Shipboard acoustic recordings
- Remote hydrophone recordings
- Prey samples
- Field identification photographs

In addition, new data on drone-derived aerial photographs will be supplied. For these data, and data from field identification photographs and acoustic recordings, discussions are underway within Axiom to determine how to deal with a very large number of large files that are impractical to access through a browser.

Additional Products not listed above:

NA

3. Coordination and Collaboration:

The Alaska SeaLife Center or Prince William Sound Science Center

We coordinate closely with the Prince William Sound Science Center (PWSSC) in their role as administrative lead of the GWA-LTRM. This includes managing award contracts, meeting reporting requirements and attending in-person and online meetings arranged by PWSSC.

EVOSTC Long-Term Research and Monitoring Projects

We coordinate closely with the GWA-LTRM program, specifically by providing data for synthesis with the Pelagic Component (see Arimitsu et al. poster on 2022 update to Alaska Marine Science Symposium) and broader synthesis efforts across GWA-LTRM components (Rob Suryan, Science Lead for GWA-LTRM). We collect humpback whale identification photos and provide data on distribution and abundance of humpback whales (encounter data) as possible during our surveys. The raw data are provided to the humpback whale project (PIs Moran and Wild, project 22120114-O). Conversely, the humpback whale project contributes opportunistic killer whale identification photographs to our dataset. We also work with the Environmental Drivers Component, specifically working cooperatively with PI Rob Campbell (project 22120114-G) to deploy Soundtrap hydrophones on his oceanographic moorings as additional data for our killer whale acoustic monitoring efforts.

EVOSTC Mariculture Projects

No coordination/collaborations for this reporting period.

EVOSTC Education and Outreach Projects

We are working closely with financial support from a Seward kayak guiding company to provide local education regarding killer whales, humpback whales, porpoise, and the whole Kenai Fjords ecosystem. This includes school visits, tangible wildlife guides and guidelines, naturalist trainings, and social media and website outreach. We have also participated in meetings with members of the CORaL network funded by EVOSTC to evaluate ways the programs can work together on outreach activities.

Individual EVOSTC Projects

We work with the Data Management program to ensure data collected on killer whales are properly reviewed, have current metadata, and are posted to the Gulf of Alaska data portal. We will work with other individually funded EVOSTC projects if collaborative efforts make sense based on data collected.

Trustee or Management Agencies

We directly collaborate with the National Oceanic and Atmospheric Administration's (NOAA's) Northwest Fisheries Science Center (Dr. Kim Parsons), including sharing data for genetic analysis of killer whale fecal samples to infer dietary preference. This is facilitating a comparison of the diet of southern Alaska resident killer whales and endangered Southern Resident killer whale population in Washington State waters.

Population data on resident and transient killer whales are supplied to the NOAA Alaska Fisheries Science Center (Dr. Paul Wade) for incorporation into Alaska Marine Mammal Stock Assessment Reports and use in management applications.

Native and Local Communities

We have delivered naturalist trainings, school visits, and other educational opportunities in Seward and Homer during 2022. Our social media engagement and email information outreach has seen participation from Chenega, Cordova, Valdez, Whittier, Seward, Homer, and Kodiak.

4. Response to EVOSTC Review, Recommendations and Comments:

The comments and responses in this section regard the FY22-31 proposal submitted to the EVOSTC in response to their Invitation for Proposals and subsequent proposal revisions in response to the comments. This project also submitted a revised proposal requesting additional funding for FY23 after the Trustees decided to fund the project for one year only (FY22).

May 2021 EVOSTC Science Panel Comment: This proposed continuing project is a component in the multidisciplinary Gulf Watch Alaska Long-Term Monitoring Program: Pelagic Ecosystem Monitoring Component, with the other projects focusing on forage fish, seabirds (2), and humpback whales. This project would continue 35 years of monitoring killer whales in PWS. $600,000 in matching funds is secured for the next 10 years.

The primary objective and core objectives 1 and 2 would extend long-term time series of information on killer whales in the study areas using methods well-established there by the proposers. Core objective 3 is new to their work in the GOA, and provides additional strength to the project. Although drones have not been used in Alaska for this purpose, they have been used extensively elsewhere in studies of killer whales, notably the endangered Southern Resident population in Washington State and British Columbia. The proposers are pioneers in the use of drone techniques, and are experts in the field. An additional strength of the new drone objective is that data obtained from it would be useful for comparison to other killer whale populations in the Pacific Northwest, such as the Southern Residents, to better understand possible drivers of population dynamics.

Thus, in those respects the proposal is strong. But we noted that it does not appear to seek mechanistic explanations of some observations they have obtained to date. For example, why do the killer whales go where they go during the year? Following the trails of prey? Are there physical or biological correlates to interannual variability in numbers and/or distribution of killer whales in PWS, the Kenai Fjords, and elsewhere in the GOA? If so, how might they be related? It seems shortsighted not to propose work aimed at better understanding the mechanisms for their observations, given the amount of historic data and the proposed 10-year timeline. One example can be seen in Figure 1, which shows a sharp drop in numbers of AB Pod during the Pacific Marine Heat Wave, with a steady recovery during the following years. Did the AB animals simply leave the area, but are now returning? If so, where might they have gone? They must not have died, with numbers now recovering through recruitment or immigration?

PI Response: We believe the combined suite of proposed investigations will provide the foundations for further analysis to examine and identify physical and biological correlates for behavioral, health, and population responses of killer whales. Specifically, we will seek mechanistic explanations of previous observations through new aerial body condition assessment, dietary assessment through fecal sampling, and acoustic monitoring for seasonal

occurrence and distribution. All of these new methods will serve for a range of time scales. Short-term: data on changes in distribution and occurrence derived from passive acoustic monitoring will provide information on short-term responses to their dynamic environment. Medium term: body condition data from aerial photogrammetry will provide information on seasonal and inter-annual changes in health that can be related to covariates that vary similarly across seasons and years; this will include monitoring changes in the incidence of pregnancies related to successful reproductions. Long term: data on individual growth and asymptotic sizes from photogrammetry will indicate non-lethal responses to multi-year trends in the physical environment and associated biological ecosystem and will combine with the higher diet resolution offered by fecal sampling. Detailed photo-identification monitoring will provide information on changes in mortalities and reproductive success. Further, our historic data from 35-years of photo-identification monitoring, added to the proposed 10-year timeframe, will allow for examination of trends across decades that can be examined against similar physical and ecosystem time series, where they exist. We have modified the proposal to emphasize the value of both our long-term data and the complementary power of our project components that will provide shorter-term measures of killer whale status (see the Abstract on page 1, Section 2, Relevance to the Invitation, on page 5, and Section 3, Project History, on page 6).

In combination, our data on killer whales at varied time scales will facilitate linkages to lower trophic level changes monitored by other GWA-LTRM projects and will help integrate our project more closely to other studies in the Pelagic Component and provide additional information for synthesis work (as now stated in Section 2, Relevance to the Invitation, on page 5). That said, performing extensive modelling work to identify physical and ecosystem correlates is beyond the scope and budget of our project proposal. Nonetheless, we have highlighted how this work may advance in Section 5, Coordination and Collaboration, pages 16 and 17. However, by combining the results of our prey sampling and body condition metrics, we may have the opportunity to advance some of this modeling, or at least evaluate plausible scenarios. Specifically, prey and distribution data will be used to hypothesize important salmon species/stocks as likely covariates for changes in body condition, and we will evaluate the significance of correlation with changes in body condition of the whales (if time series of abundance for those salmon species/stocks exist). We have added new text in Section 4, Project Design, C. Data Analysis and Statistical Methods, on page 14 (and a related edit on page 13). We also added text on page 11 (Section 4, Project Design, B. Procedural and Scientific Methods) and added Stewart at al. (2021) reference to Literature Cited as an example of a similar analysis we have conducted with Southern Resident killer whales.

In response to the specific comment about the dynamics of AB pod, our ongoing photo-identification census results is a complete enumeration of our core resident pods on an annual, or at least regular, basis (Matkin et al. 2014). As such, we have documented that the changes in abundance of AB pod is driven by births and deaths, not immigration or emigration (Matkin et

al. 2008). Page 3 in the original proposal states that "in recent years following the Pacific marine heatwave the loss of older females and their older sons has driven numbers down to levels near those following the spill." The caption for Figure 1 has been modified to highlight this.

Matkin C.O., E.L. Saulitis, G.M. Ellis, P. Olesiuk, and R.D. Rice. 2008. Ongoing population level impacts on killer whales following the Exxon Valdez oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series 356:269-281.

Matkin, C.O., G.W. Testa, G.M. Ellis, and E.L. Saulitis. 2014. Life history and population dynamics of southern Alaska resident killer whales (Orcinus orca). Marine Mammal Science 30:460-479.

Stewart, J.D., J.W. Durban, H. Fearnbach H., L.G. Barrett-Lennard, P.K. Casler, E.J. Ward and D.R. Dapp. In Press. Survival of the Fattest: Linking body condition to prey availability and survivorship of killer whales. Ecosphere

May 2021 EVOSTC Science Panel Comment: While we recognize the importance of this valuable long-term study, we had a few additional questions:

1. The proposers state that if biopsy samples are obtained, the samples will be analyzed for contaminants. Who will do the actual lab work, how will it be done, and why will it be done in the first place?

PI Response: Lab work will continue to be conducted at NOAA's Northwest Fisheries Science center for continuity, building on previous work (as stated in Section 4, Project Design, B. Procedural and Scientific Methods, on page 9). We have cited a recent publication that describes the methods (Lawson et al. 2020, and other papers referred to therein). Periodic assessment of contaminants will enable updated comparisons to other killer whale populations (e.g., Krahn et al. 2007) and also monitor changes over time that might be indicative of changes in prey (text added to page 9), which may have health consequences (see A. Objectives and Hypotheses on page 6).

Krahn, M.M, D.P. Herman, C.O. Matkin, J.W. Durban, L. Barrett-Lennard, D.G. Burrows, M.D. Dahlheim, N. Black, R.G. Leduc, and P.R. Wade. 2007. Use of chemical tracers in assessing the diet and foraging regions of eastern North Pacific killer whales. Marine Environmental Research 63:91-114.

Lawson, T.M., G.M. Ylitalo, S.M. O'Neill, M.E. Dahlheim, P.R. Wade, C.O. Matkin, V. Burkanov and D.T. Boyd, 2020. Concentrations and profiles of organochlorine contaminants in

North Pacific resident and transient killer whale (Orcinus orca) populations. Science of The Total Environment 722 p.137776.

<u>*May 2021 EVOSTC Science Panel Comment:*</u> 2. PIs will use call diversity and calling rates obtained from the acoustic recorders to remotely estimate the number of killer whale pods and number of individuals present in the pods. Does this suggest that call diversity can be used to identify individual animals in the absence of focal follows of individuals? If so, is this not quite a significant development?

<u>*PI Response:*</u> *Call diversity and calling rates will be used to model the number of pods, with estimates ground truthed by field recordings in presence of a known quantity of pods and individuals. Call diversity cannot be used to identify individuals, and therefore will not be used for counting individuals, but rather serve as a marker of the number of pods present. Because call dialects are specific to pod groupings, presence of specific pods of known size is possible. Mean and median pod sizes were assessed in this project (Olsen et al. 2020) and can be used to extrapolate numbers of individuals. Of particularly strong value, however, is the ability to detect the timing of arrival and departure of specific pods, giving much improved resolution to presence/absence data, detection of timing shifts, and seasonal use. The proposal has been modified to reflect this in Section 4, Project Design, A. Objectives and Hypotheses, page 6.*

Olsen, D.W., C.O. Matkin, F.J. Mueter, and S. Atkinson. 2020. Social behavior increases in multipod aggregations of southern Alaska resident killer whales (Orcinus orca). Marine Mammal Science 36:1150-1159.

<u>*May 2021 EVOSTC Science Panel Comment:*</u> 3. Can this work inform studies of killer whales elsewhere in the NE Pacific, e.g., the Northern and Southern Residents?

<u>*PI Response:*</u> *Yes. Population dynamics can be directly compared to other killer whale populations. Our population model for resident killer whales will provide a quantitative framework for these comparisons, as will estimates of population parameters from our mark-recapture models for transient killer whales (as stated in Section 4, Project Design, A. Objectives and Hypotheses, page 6). Indeed, incomplete data on two Alaska resident pods was already used in a comparative study of resident killer whale population dynamics (Ward 2016) and our study will allow more complete data to better inform such comparisons. In the case of the endangered Southern Resident killer whales, population dynamics of relatively healthy and increasing Alaska resident pods can provide benchmarks for recovery (mentioned on page 6).*

Data from our diet studies is directly comparable to similar studies being conducted for Northern Resident killer whales, particularly given that laboratory analysis of scale samples is being conducted by the Fisheries and Oceans Canada lab that also analyzes scales from fish kills by Northern and Southern Residents, and our fecal samples are being analyzed by the

NOAA Fisheries laboratory that is performing similar work on these adjacent populations. This is elaborated on in Section 4, Project Design, B. Procedural and Scientific Methods, on pages 8-9.

In the same section (see pages 9-14) we have provided several figure examples and references to our parallel photogrammetry research on Southern and Northern Resident killer whales. Our work on Alaska killer whales will use the same flight team, equipment methods and analysis tools to provide directly comparable data. Our ability to directly compare identical sets of photogrammetry metrics on size-at-age, body condition and pregnancy rates is stated explicitly in Section 4, Project Design, A. Objectives and Hypotheses, page 6. Notably, in the case of the endangered Southern Resident killer whales, growth and body condition parameters for relatively healthy and increasing Alaska resident pods can provide benchmarks for recovery.

Ward, E.J., M.E. Dahlheim, J.M. Waite, C.K. Emmons, K.N. Marshall, B.E. Chasco, and K.C. Balcomb III. 2016. Long-distance migration of prey synchronizes demographic rates of top predators across broad spatial scales. Ecosphere 7, p.e01276.

<u>*May 2021 EVOSTC Science Panel Comment:*</u> There has been only one first author publication by the PIs since 2014, and we feel that this could be improved at this juncture of this long-term study. In addition, the Education and Outreach potential of this project is very high given that killer whales are charismatic predators that the public is naturally drawn to. Thus, we strongly suggest the PIs take advantage of this unique opportunity to promote EVOSTC-funded work through increased Education & Outreach activities with this project. One suggestion is collaboration with The Whale Museum in Friday Harbor for E&O activities.

<u>*PI Response:*</u> *We would highlight additional first-author papers by the PIs in recent years on spatial distribution (Olsen et al. 2018) and social dynamics (Olsen et al. 2020).*

With the new proposed investigations, there are papers that will be produced relatively quickly, for example 1) length-at-age relationships compared to other killer whale populations in the NE Pacific and 2) body condition comparisons, both from photogrammetry. We are currently underway with a publication using 3) DNA analysis of fecal samples to describe feeding habits. Additionally, we plan updated publications on population dynamics of 4) resident killer whales and 5) Gulf of Alaska transients that will result from continued photo-identification. Similarly, an important paper on inferring distribution and occurrence from passive acoustic monitoring has now been submitted (Myers et al. in review) and we have added this reference to Section 4, Project Design, B. Procedural and Scientific Methods, on page 9.

We agree that Education and Outreach potential is very high for this project. We already perform a high degree of outreach given our limited funding, including Captain and Naturalist presentations, collaborations with the Prince William Sound Regional Citizens' Advisory

Council, University of Alaska Anchorage, U.S. Forest Service, and National Park Service; Facebook and Instagram updates; updated pod catalogues; an updated website; and educationally thematic emails to 170 naturalist recipients. Future collaborations are always welcome, and perhaps the best focus is to strengthen our current local relationships with the National Park Service, U.S. Forest Service, and local schools. Due to our own limited budget, we look forward to collaboration with the agencies that receive funding as part of EVOSTC's Education and Outreach focal area. Details of our outreach have been updated in the proposal in Section 6, Deliverables on pages 18 and 19.

Myers, H.J., D.W. Olsen, C.O. Matkin, L.A. Horstmann, and B. Konar. In review. Listening for killer whales (Orcinus orca): Passive acoustic monitoring reveals year-round distribution and residency patterns. Scientific Reports.

Olsen, D.W., C.O. Matkin, R.D. Andrews, and S. Atkinson. 2018. Seasonal and pod-specific differences in core use areas by resident killer whales in the Northern Gulf of Alaska. Deep Sea Research Part II 147:196-202.

Olsen, D.W., C.O. Matkin, F.J. Mueter, and S. Atkinson. 2020. Social behavior increases in multipod aggregations of southern Alaska resident killer whales (Orcinus orca). Marine Mammal Science 36:1150-1159.

September 2021 EVOSTC Science Panel Comment: This proposed continuing project is a component in the multidisciplinary Gulf Watch Alaska Long-Term Monitoring Program: Pelagic Ecosystem Monitoring Component, with the other projects focusing on forage fish, seabirds (2), and humpback whales. This project would continue 35 years of monitoring killer whales in PWS. The approach would extend a highly valuable time series of information on killer whales in the study areas using methods well-established by the PIs. The PIs would add a new component of photogrammetry using drones to document various characteristics of individual whales, such as growth, condition, and pregnancy status that would be important in its own right and for comparisons to similar data obtained on killer whales elsewhere. We are impressed by the time series of data collected by this project, the importance of the new component, and the qualifications of the PIs.

The principal concerns we have are an apparent lack of attention to developing mechanistic explanations for observations obtained over the course of this study, and a paucity of recent publications. The PIs responded that the proposed new studies, including health assessments, diet analysis, and pregnancy will provide a foundation for seeking such explanations of previous observations. While this is true, numerous physical, biological, and environmental indices exist that would have allowed the PIs to have already embarked on such analyses. The PIs further noted that "extensive modelling work to identify physical and ecosystem correlates is beyond the scope and budget of our project proposal." Yet the valuable data sets they have acquired over the

past 35 years are fertile ground for such work, and if the PIs do not undertake it, who will? The PIs identified two rather recent publications by members of the group, and a third that is in review. They further identified additional manuscripts they have in mind "that will be produced relatively quickly," which is vague. Our other questions and concerns posed were adequately addressed.

We strongly encourage the PIs to expand their project, beginning by proposing conceptual models of relationships between killer whales and their environments that would inform more rigorous modeling approaches. To facilitate this, if necessary to expand the expertise of their group, we recommend a revised proposal and budget to include an appropriate postdoctoral fellow upon whom this responsibility would fall. The comparatively low budget would increase accordingly, which should not materially reduce the financial competitiveness of the proposal, but would measurably increase its scientific competitiveness. Their progress in this direction would be assessed after five years (FY22-26) and a recommendation would be made concerning the future of the project (FY27-31).

PI Response: We are grateful to the Science Panel for their recommendation to expand our project. In response, we proposed new field and analytical methods. The Executive Director consulted with the Science Panel and concluded that the recommendations of the Science Panel had been adequately addressed and recommended this project be fully funded for 10 years (comment on record in the FY22 work plan: https://evostc.state.ak.us/media/7613/fy22-work-plan-rev12522.pdf):

October 2021 EVOSTC Executive Director Comment: The PI submitted a revised proposal as suggested in response to the Science Panel's comments. As a cost-saving measure, the new PI (Dr. John Durban) will be responsible for the suggested modelling efforts instead of a postdoc (salary included for Dr. Durban for this work is lower than the estimated cost for 3-yr postdoc) and time associated with looking for a postdoc. Dr. Durban has extensive experience in modelling approaches for killer whales and publication record, which makes him a very suitable addition to this project. Without having to spend the time to search for and hire a postdoc, the modelling objective can be investigated without delay with the historical data available. I concur with the Science Panel and PAC and further recommend that this project be fully funded for the 10 years as the recommendations by the Science Panel have been adequately addressed.

PI Response: Nonetheless, Trustee Council decided (January 2022) to only fund this project for one initial year in 2022. Clearly with a one-year window we were not able to address all deliverables proposed in the 10-year proposal, specifically seven proposed papers over ten years, the first of which was proposed for 2023 (year 2). However, with this funding we were able to put in place our expanded program of data collection to investigate mechanistic ecosystem links underpinning our core dataset of killer whale population dynamics. Specifically

in 2022 we adopted the routine use of non-invasive drone photogrammetry to track short-term changes in killer whale body condition and growth, which will (given time to develop a time series) be used to link these health metrics to population demography to help understand longer-term population changes. Similarly, field studies of diet and distribution were continued, which (given time to develop time series) will help understand these changes at an ecosystem level. We were very successful in this expanded field program, in particular the new component of drone photogrammetry that resulted in the collection of aerial images of an estimated 133 different individuals from eight different resident killer whale pods. This was efficiently accomplished alongside our routine studies of population dynamics, diet, and distribution. Photogrammetry measurements of length, body condition and pregnancy status are now underway from more than 16,000 aerial photographs.

Fall 2022 EVOSTC Science Panel Comment: The PIs are requesting continued funding for three years, FY23-FY25, during the current 5-year funding cycle. They were previously funded for FY22 by the TC as a bridge year to allow them time to transition fully to other funding sources. Their total 3-year request is $385,359, or less than $130 K/year, representing a 60% reduction from their earlier request. They were able to achieve this by securing support from other sources. Their current request is a paltry amount for this project considering that it is of extremely high value to understanding the ecology of an injured, non-recovering resource; the only study of killer whales in Alaska, the apex marine predator in the N. Pacific Ocean pelagic domain; the role killer whales play in ecosystem function and their relationships to other upper-trophic level species in PWS and the Kenai Fjords; their value as an indicator of ecosystem change; and that they have highly significant social and cultural value to residents and visitors in the region. Moreover, the lessons learned about these killer whales will be valuable to achieving a broad understanding of killer whale biology and ecology across their range in the GOA, SE Alaska, and British Columbia, where one stock, the Southern Residents, is in notable decline for reasons that are not fully understood.

The primary, initial concern of the SP was that the original proposal did not emphasize studies to develop mechanistic explanations of observations they have obtained over the long course of this program. In their revised proposal of September 2021, and in the reduced request presently under consideration, the PIs have emphasized an expanded range of field studies, including acoustic monitoring of movements and behaviors; photogrammetry using drones to determine morphometric, growth and health status of individuals, and pregnancy status of females; and genetic barcoding of prey remains in fecal samples to refine estimates of diet. Further, and of particular note, they are developing sophisticated Bayesian modelling approaches to assess impacts of the marine heatwave and other environmental variables at the population level, e.g., departures from expected levels of survival based on age and sex composition, and departures from expected patterns of fecundity in females and covariance in survival and fecundity. This

addresses well the SP's principal concern about a lack of emphasis on developing mechanistic explanations of their long series of observations.

A second concern was the relative lack of first-author, peer-reviewed publications resulting from this long-term project. In response, the PIs pointed out two recent publications by Olsen et al. (2018, 2020), which examined core use areas by resident killer whales as well as the relationship between social behavior and multipod aggregations, respectively. A third paper on year-round patterns of distribution based on passive acoustic monitoring was published in 2021 by Myers, Olsen, Matkin, et al. in the prestigious journal Scientific Reports (H. Myers is a doctoral student at UAF working directly on the project). They offer an impressive, coherent plan of modeling/synthesis work linked to that already planned within the broader LTRM synthesis and modeling effort. The SP particularly appreciates recognition of the need for modeling to be a continuing effort throughout the project and not just the final step after data are gathered. This will be achieved by involvement in all years of Dr. John Durban, who has wide experience and a strong publication record in the proposed methodologies.

They further outlined seven anticipated publications focused on integration of information they have obtained and would have obtained over the course of a 10-y funding cycle. Those papers would address well the concerns of the SP about mechanistic explanations of their many field observations. The PIs are now requesting only three years of additional funding, and producing the seven papers in that time might seem ambitious. However, the PIs will undoubtedly pursue other sources of funding going forward from this 3-year request, and the SP is confident that they will produce the important papers they described—the expertise of the current team of researchers working on the project is very strong, and a post-doc was recently employed who will be of great value to the modeling and publication efforts.

The SP believes this project is very important in many ways to refining our understanding of killer whale ecology and ecosystem function in the northern GOA, and by extension other regions of the broader GOA and N. Pacific. The continuation of the 37-year time series for the true "poster children" of the spill needs to continue: it is integral to all of the monitoring in the GOA, as there is no other focus on apex predators within the LTRM. And, as noted above, killer whales have extremely high cultural and societal values. The SP strongly recommends that this project be funded for the additional three years requested.

PI Response: We are pleased that the Science Panel recognizes the value of our expanded field program and modelling efforts to develop mechanistic explanations for killer whale population dynamics, which address their previous concerns. On the back of a successful start to this expanded research in 2022, we are also grateful for the recommendation of the Science Panel for continued funding for three years, which we proposed at a reduced cost to at least meet the

objectives proposed for the first five years of the study (possible leveraging support from other sources).

To date the Trustee Council (January 2023) has only approved continued funding of our project through 2023, representing just a second year of our expanded field efforts. This will clearly not be long enough to track changes in killer whale health (photogrammetry) and ecosystem interactions (diet and distribution) to relate to interannual changes in body condition. As such it will not be long enough to generate the data to support the deliverables proposed for the ten-year period, specifically the seven papers.

Despite not having a multi-year funding commitment, we are on track with annual progress both in field data collection and model-based analysis. As highlighted above by the Science Panel's comments in September 2021, we are "developing sophisticated Bayesian modelling approaches to assess impacts of the marine heatwave and other environmental variables at the population level" and we are grateful for their review of our preliminary progress. As such we anticipate being on track to deliver our first proposed deliverable on time in 2023, specifically a paper updating population dynamics of Alaska resident killer whales, examining pod-specific demography, quantify correlation between pods and identifying key temporal trends and any abrupt shifts. With alternative sources of support, we also anticipate being able to deliver the second proposed paper in 2024, specifically a manuscript comparing body size and condition of Alaska Resident killer whales to Southern Resident and Northern Resident killer whale populations.

Additional future deliverables will be dependent on additional support but based on our successful field program in 2022 we clearly have the capacity to collect the data required, should we be funded.

5. Budget:

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0	$0	$0	$0	$0	$0	$0
Travel	$7,200	$3,000	$0	$0	$0	$10,200	$799
Contractual	$152,200	$88,500	$0	$0	$0	$240,700	$104,092
Commodities	$18,500	$13,550	$0	$0	$0	$32,050	$6,225
Equipment	$0	$0	$0	$0	$0	$0	$0
Indirect Costs Rate = 10%	$17,790	$10,505	$0	$0	$0	$28,295	$11,112
SUBTOTAL	$195,690	$115,555	$0	$0	$0	$311,245	$122,228
General Administration (9% of subtotal)	$17,612	$10,400	$0	$0	$0	$28,012	N/A
PROJECT TOTAL	$213,302	$125,955	$0	$0	$0	$339,257	
Other Resources (In-Kind Funds)	$76,000	$126,000	$56,000	$56,000	$56,000	$370,000	

COMMENTS:
Further expenditure of FY22 funds is expected through May 2023 to coincide with the NOAA grant. We do not expect to fully spend out some categories by then because of the late arrival of fY22 funds.

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Owing to the late arrival of the FY22 allocation we would like to request carryover for some FY22 funds beyond May 2023, to add to the proposed FY23 funds. However, we do plan further spending of FY22 funds through May 2023, so details of carryover are not yet available.

6. Literature Cited:

Matkin, C. O., J. Durban, D. Olsen, H. Myers, and G. Ellis. 2023. Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords. *Exxon Valdez* Oil Spill Long-term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 21120114-M), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.