EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY20 (YEAR 9) CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Project Number and Title

Gulf Watch Alaska: Pelagic Component Project

20120114-N—Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords

Primary Investigator(s) and Affiliation(s)

Craig Matkin, North Gulf Oceanic Society

Date Proposal Submitted

August 16, 2019

Project Abstract

This project is a continuation of the long-term photo-identification based program that has continuously monitored killer whale populations in Prince William Sound since 1984. A primary focus has been on resident killer whales and the recovery of AB pod and the threatened AT1 population of transient killer whales. These two groups of whales suffered serious losses at the time of the oil spill and have not recovered at projected rates. Assessment of population dynamics, feeding ecology, movements, range, and contaminant levels for all major pods in the area will help determine their vulnerability to future perturbations and environmental change, including oil spills. In addition to population dynamics from annual photo-identification, this project uses other techniques to determine the health and trends of the population. These techniques have included biopsy/skin sampling to compare genetics between populations, occasional biopsy/blubber to investigate contaminants, prey sampling of flesh, fish scales, and whale scat to investigate diet, behavioral observation, and remote acoustic monitoring to determine important off-season habitat. During FY18 and FY19 remote recording hydrophones have been recovered and redeployed in Montague Strait, Hinchinbrook Entrance, and Kenai Fjords. Initial investigation of this raw acoustic data suggests that strong fall activity in Montague Strait still occurs, but in 2016-18 it was 2-3 weeks later than in past years. To the extent possible we are adjusting the field effort dates to improve late summer/fall encounter rates. Between our surveys and contributed photos, we were able to confirm that all seven of the remaining Threatened AT1 transient population have survived to 2019. AB pod has not yet been photographed in 2019. We are not proposing any major changes to this project for FY20.

EVOSTC Funding Requested* *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$152,800	$151,300	$142,100	$140,300	$139,500	$726,100

Non-EVOSTC Funds to be used, please include source and amount per source: (see Section 6C for details)

FY17	FY18	FY19	FY20	FY21	TOTAL
$25,000	$25,000	$25,000	$25,000	$25,000	$125,000

1. PROJECT EXECUTIVE SUMMARY

Pelagic Component

The pelagic component research team proposed for FY17-21 to continue monitoring key pelagic species groups in Prince William Sound (PWS) using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. Thus, the two overarching questions for the pelagic component to answer during this 5-year period are:

1. What are the population trends of key upper trophic level pelagic species groups in PWS – killer whales, humpback whales, marine birds, and forage fish?
2. How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in PWS and Middleton Island?

Killer Whale Monitoring

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 26 years but has still not reached pre-spill numbers. The AT1 population is not recovering and may be headed toward extinction (Matkin et al. 2008) (Fig. 1). This project has determined that killer whales are sensitive to perturbations such as oil spills but has not yet determined the long-term consequence (which may include extinction) or the recovery period required. As an apex predator, this species (both fish and mammal eating types) has an important role in the ecosystem. Additionally, they are a primary focus of viewing by a vibrant tour boat industry in the region. Data from this project are used by tour boats to enhance viewers experience and understanding of the local environment and fauna.

Unlike many cetaceans, killer whales can be closely monitored, and for resident (fish eating) killer whales detailed population dynamics can also be monitored (Matkin et al. 2014).

The AT1 transient population can be directly monitored by each individual, and the wide-ranging Gulf of Alaska transients (mammal eating) population monitored for trends (Matkin et al. 2012). We also contribute all photo identification data for the offshore form of killer whale to a coast-wide database at the Pacific Biological Station (Nanaimo, BC, Canada). This project is a unique opportunity to continue a comprehensive monitoring program for a keystone marine species with three ecotypes that was initiated in the early 1980s. The importance of long-term killer whale monitoring has been borne out by companion studies in other regions such as Puget Sound and British Columbia.

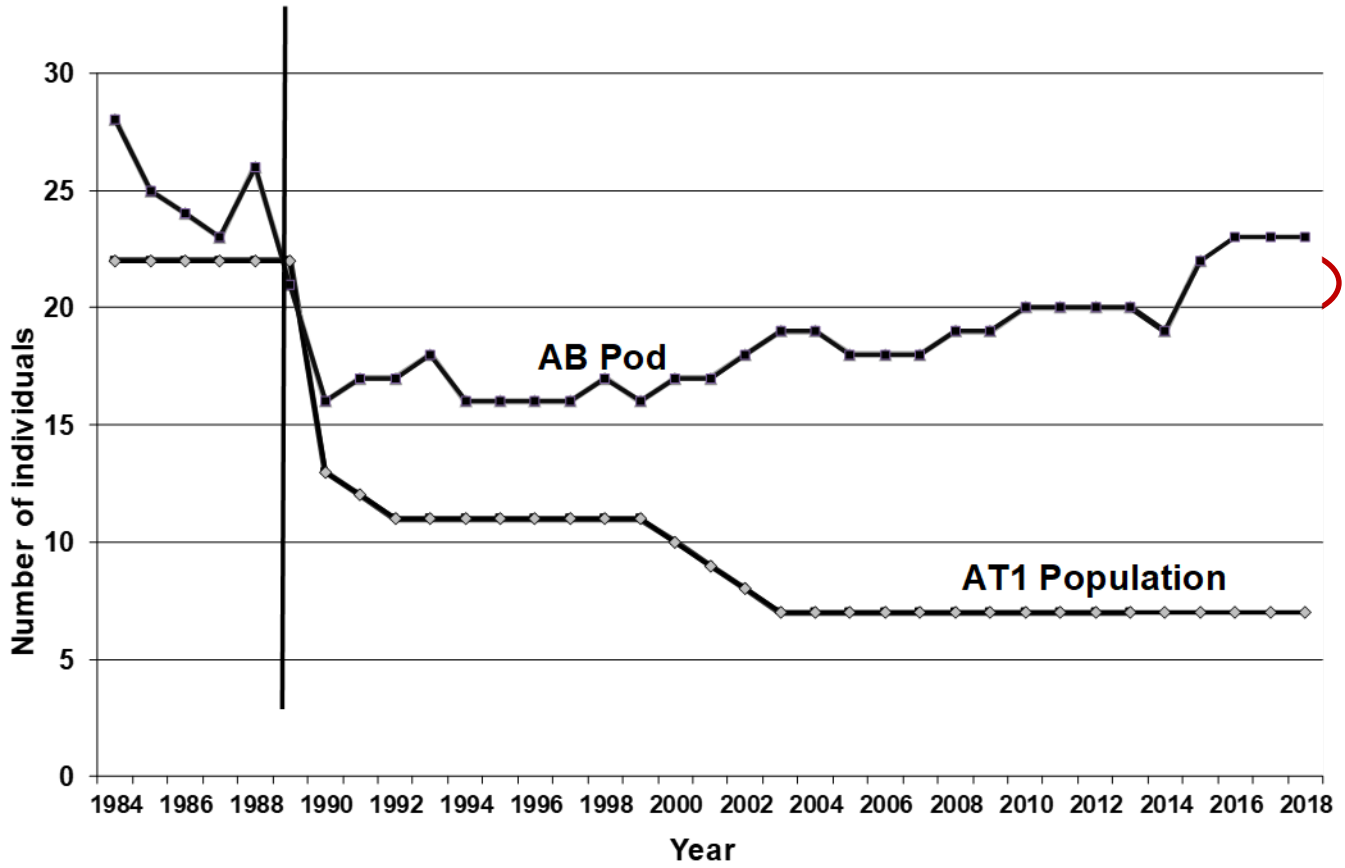

Figure 1. Number of whales in AB pod and AT1 population by year. Note: past three years total for AB pod (circled) does not take into account three missing matrilines (AB17, AB22, and AB14).

The core objective of this project is the monitoring of population parameters based on photo identification. Annual prey sampling and fecal sampling are used to investigate feeding habits and trophic changes. Remote acoustic stations have been placed to monitor of temporal and geographic use patterns of resident killer whales, particularly in winter. We have pioneered this type of acoustic work in Alaska in the past (Yurk et al. 2010) but now employ more comprehensive technologies. Sampling for stable isotope and contaminant analysis has been completed and reanalysis of stable isotope trends is being conducted by Northwest Fisheries Science Center for publication.

Analysis includes population dynamics and modeling at appropriate intervals, genetic sequencing as necessary for determination of population affiliation, and acoustic analysis of remote hydrophone data. Genetic analysis of scats and of predation samples is conducted at the Northwest Fisheries Science Center, Seattle and Pacific Biological Station, Nanaimo, B.C. Although we will focus on the southern Alaska resident and AT1 transient populations which were impacted by the *Exxon Valdez* oil spill, the study also includes the other two recognized populations in the region, the Gulf of Alaska transients and offshore killer whales and the project contributes annually to the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service killer whale stock assessments.

Data will be collected during a minimum 50-day field season from May through October from the R.V. Natoa, although opportunistic photographic data is contributed from other collaborating vessels. This is the

continuation of a long-term project spanning 34 years and has benefited from continued support of mariners and the coastal communities of the north Gulf of Alaska coast.

FY19 Accomplishments and Highlights

During the 2019 reporting period of February to July, we completed 39 field days and had 27 encounters with killer whales. This compares favorably with our long-term average for number of encounters per field day; however, the rate of encounter was much higher in the Kenai Fjords regions than in PWS. We completely photo-identified a number of the major resident pods including AD8, AD11, AD16, AK6, AK2, AE 2, AE5, AI and AX48. and some matrilines of other pods including the AB, AB25, AJ, AX1 and AX27 pods. This year, as well as last year, most of these pods are genetically southern resident haplotype, and we hope to encounter more of the pods with the northern resident haplotype, especially AB and the un-photographed matrilines of AJ and AJ8 pods in late August and September surveys. In the last several years there has been a reduced presence of northern resident haplotype whales inshore and often matrilines from these pods are traveling separately.

Between our surveys and contributed photos, it is confirmed that all seven of the of the remaining threatened AT1 transient population have survived into 2019. There are no new calves in the group.

During 2019 fieldwork we have collected 25 scale or flesh samples during predation events by resident killer whales and also collected 25 scat samples. This is part of our emphasis on long term study of resident killer whale feeding ecology. Recently received results from previous scat analysis, indicate the dominance of Chinook, coho, and chum salmon in the diet, with minor contributions from other species (including halibut). The data support the accuracy of scale and flesh (predation) analysis that was questioned in the previous final report. In particular, the at times ubiquitous pink salmon have not been found in the predation samples (scales and flesh collected at predation sites) or in the scat.

Remote recording SoundTrap hydrophones have been recovered and redeployed in Montague Strait, Hinchinbrook Entrance, and Kenai Fjords. Recordings from all 3 hydrophones stations have been recovered and contain killer whale vocalizations with pod specific information. Additional acoustic data were downloaded from a hydrophone placed on the mid-Sound mooring by Rob Campbell (environmental drivers project 19120114-G). We have collected 48 months' worth of data so far from Montague Strait, Hinchinbrook, and Kenai Fjord and 28 months of data so far from Naked Island/Center Sound buoy. Detection rates (% of days per month) are 16-23% in Hinchinbrook and 25-90% in Montague Strait. Analysis will be ongoing this fall and winter and a new graduate student, Hannah Meyers, at University of Alaska Fairbanks (UAF) will lead analytical efforts.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Table 1. This table breaks down project deliverables and their status into milestones and tasks by fiscal year and quarter, beginning February 1, 2017. Yellow highlight indicates proposed fiscal year workplan.
C = completed, X = not completed or planned. Fiscal year quarters: 1 = Feb 1 – April 30; 2 = May 1 – July 31; 3 = Aug. 1 – Oct. 31; 4 = Nov. 1 – Jan. 31.

	FY17				FY18				FY19				FY20				FY21			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1: Collection																				
Field prep	C				C				C				X				X			
Field surveys		C	C			C	C			C	X			X	X			X	X	
Retrieve and re-deploy hydrophones		C	C			C	C			C	X			X	X			X	X	
Milestone 2: Data																				
Data summary/analysis				C	C			C	C			X	X			X	X			X
Review hydrophone data				C	C			C	C			X	X			X	X			X
Photo-identification analysis				C	C			C	C			X	X			X	X			X
Analysis of predation samples				C	C			C	C			X	X			X	X			X
Upload previous FY data					C				C				X				X			
Milestone 3: Reporting																				
Annual Reports					C				C				X				X			
Annual PI meeting				C				C				X				X				X
FY Work Plan (DPD)			C				C				C				X					

In addition to the primary project deliverables in Table 1, during the past year we led or contributed to 5 oral presentations. One manuscript is in review with Marine Mammal Science and another is in preparation for submission (See Section 7). We anticipate completing FY19 and FY20 milestones and tasks as planned.

B. Explanation for not completing any planned milestones and tasks

All sampling, milestones, and tasks for 2018 and first two quarters of 2019 were completed in accordance with our proposal and with sampling protocols available on the GWA Research Workspace.

C. Justification for new milestones/tasks

No new milestones/tasks proposed.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Gulf Watch Alaska

As part of the Gulf Watch Alaska program we collaborate at annual meetings and regular teleconferences that include all members of the program. We collaborate directly with 20120114-O—Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound, by sharing photographic and observational data. We collaborate with Rob Campbell (project 20120114-G), Prince William Sound Science Center, in placing remote hydrophones on oceanographic buoys also supported by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) under the Gulf Watch Alaska program.

Herring Research and Monitoring

This project coordinates with the herring research and monitoring program by sharing data and discussion of relevant trends, as well as collaborating on reports and publications.

Data Management

This project coordinates with the data management program by submitting data and preparing metadata for publication on the Gulf of Alaska Data Portal and DataONE within the timeframes required.

B. With Other EVOSTC-funded Projects

This project will coordinate with other EVOSTC-funded projects as appropriate by providing data, discussing the relevance and interpretation of data, and collaborating on reports and publications.

C. With Trustee or Management Agencies

Data are supplied annually and upon request to NOAA National Marine Mammal Laboratory in Seattle, Washington for application to marine mammal stock assessments, which are reviewed regularly. We also collaborate on papers and journal articles with the NOAA Northwest regional office that conducts long-term research on the endangered Southern Resident killer whale population.

4. PROJECT DESIGN

A. Overall Project Objectives

Objective 1

Photo-identification of all major resident pods and AT1 transient groups that use Prince William Sound/Kenai Fjords. Extension of individual histories, identification catalogues of individuals and an annual update of population model are products of these data.

Objective 2

Collect fish scale samples and marine mammal tissue from predation sites to monitor potential changes in feeding habits.

Objective 3

Collect fecal samples from resident killer whales for comparison with results of fish scale/tissue collection (Objective 2).

Objective 4

Use remotely deployed submerged acoustic recorders to track killer whales year-round using calls.

Objective 5

Collect genetic tissue samples when necessary to determine population/ecotype affiliations.

B. Changes to Project Design and Objectives

As stated in our FY18 Work Plan, we are deemphasizing the collection of biopsy samples for examination of feeding habits due in part to the retirement of the chemist at NOAA Northwest Region who led the project, and are replacing it with a program of feces collection and analysis, as suggested in review of our FY12-16 final report. The chemical data on feeding habits are being reanalyzed by NOAA Northwest Region and a publication is in process (see Section 7 Matkin et al. in prep).

The following secondary objectives (optional projects suggested in FY17-21 proposal) will not be implemented at this time:

Objective 6

Use photogrammetry to develop morphometrics for individuals and groups to assess body condition over time and develop measures to determine pregnancy rate as an additional important population parameter (secondary objective, completed as possible). Possible additional funding may be available to initiate this objective in 2020.

Objective 7

Use time/depth/location satellite tags coupled with prey sampling to examine feeding ecology during fall and/or spring feeding aggregations (secondary objective, completed as possible).

If additional funding is obtained, and if possible without compromising the core project, we will explore the use of morphometrics obtained from drone captured, low altitude photos to develop an annual index of individual and population health and possibly determine pregnancy rates. Satellite tagging will be pursued only if less invasive techniques are developed that will reduce risk of infection. Infection that resulted in a killer whale death in Puget Sound was directly linked to tag attachment and resulting infection.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

There have been no changes or updates in project personnel from previous fiscal year. A new graduate student, Hannah Meyers, at UAF is scheduled to come on board in FY20.

6. PROJECT BUDGET

A. Budget Forms (See GWA FY20 Budget Workbook)

Please see project budget forms compiled for the program.

B. Changes from Original Project Proposal

The overall cost of this project for FY19-21 has not changed. We have reallocated funds between categories, but the overall project design and objectives also have not changed. In this budget we move funds ($3.5K) from travel (already covered) to contractual to cover increased acoustic analysis costs. We have dropped funds ($2K) allocated to the Northwest Fisheries Science Center in contractual to also cover more in-house

analytical costs. Personnel amount remains unchanged from the original proposal; however, the allocation within the category has changed.

C. Sources of Additional Project Funding

We continue to receive in kind support from Northwest Fisheries Science Center (Kim Parsons) for genetic analysis of scats and from Pacific Biological Station (Briana Wright) for analysis of predation samples. This amounts to an estimated $22K per year as indicated in budget workbook. Also see attached email.

7. FY17-19 PROJECT PUBLICATIONS AND PRODUCTS

Publications

Chasco, B., I. Kaplan, A.C. Thomas, A. Acevedo-Gutierrez, D.P. Noren, M.J. Ford, M.B. Hanson, J.J. Scordino, S.J. Jeffries, K.N. Marshal, A.O. Shelton, C. Matkin, B.J. Burke, and E.J. Ward. 2017. Competing tradeoffs between increasing marine mammal predation and fisheries harvest of Chinook salmon. Scientific Reports 7:15439 DOI: 10.1038/s41598-017-14984-8

Danishevskaya, A.V., O. Filatova, F.I P. Samarra, P.J.O. Miller, J.K.B. Ford, H. Yurk, C.O. Matkin, and E. Hoyt. 2018. Crowd intelligence can discern between repertoires of killer whale ecotypes. Bioacoustics. DOI: 10.1080/09524622.2018.1538902

Olsen D.W. and C.O. Matkin. 2017. Behavioral changes during multi-pod aggregations of southern Alaska resident killer whales (*Orcinus Orca*). 2017 Society for Marine Mammalogy Biennial Conference.

Matkin, C.O., and D. Olsen. 2018. Long term killer whale monitoring in Prince William Sound / Kenai Fjords. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-N.

Matkin, C.O., and D. Olsen. 2019. Long term killer whale monitoring in Prince William Sound / Kenai Fjords. FY18 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 18120114-N.

Matkin, C., D. Olsen, G. Ellis, G. Ylitalo, R. Andrews. 2017. Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 16120114-M), North Gulf Oceanic Society Homer, Alaska.

Matkin, C.O., G.M. Ylitalo, P. M. Chittaro, M. B. Hanson, C. Emmons C., et al. in prep. Chemical tracer changes in tissues of two eastern North Pacific killer whale (*Orcinus orca*) populations: Ecosystem flux or changing diet?

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. DOI:10.1016/j.dsr2.2017.10.009

Olsen, D. W., C.O. Matkin. in prep. Mating opportunities? Social behavior increases in multi-pod aggregations of southern Alaska Resident Killer Whales (*Orcinus orca*). Submitted to Marine Mammal Science.

Published and updated datasets

DataONE Published Datasets

Matkin, C. O. 2017. Acoustic Recordings of Killer Whales in Prince William Sound and Kenai Fjords, 2012 to 2016, Gulf Watch Alaska Pelagic Component. Dataset. Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. https://doi.org/10.24431/rw1k1f.

Matkin, C. O. 2017. Acoustic Kenai Fjords and Prince William Sound Long-Term Photographic Monitoring of Killer Whales, 2012-2016, Gulf Watch Alaska Pelagic Component. Dataset. Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. https://doi.org/10.24431/rw1k1s.

Matkin, C. O. 2017 Prince William Sound Killer Whale Satellite Telemetry Data, 2004 to 2016, Gulf Watch Alaska Pelagic Component. Dataset. Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. https://doi.org/10.24431/rw1k1g.

Matkin, C. O. 2017. Behavior and Feeding Summaries for Killer Whales in Alaska, 2012-2016. Dataset. Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. https://doi.org/10.24431/rw1k1r.

Gulf of Alaska Data Portal Datasets

Olsen, D.W. 2017. Acoustic Recordings of Killer Whales in Prince William Sound and Kenai Fjords, 2012 to 2016, Gulf Watch Alaska Pelagic Component

Olsen, D.W. 2017. Kenai Fjords and Prince William Sound Long-Term Photographic Monitoring of Killer Whales, 2012-2016, Gulf Watch Alaska Pelagic Component

Olsen, D.W. 2017. Killer Whale Biopsy Genetic and Chemical Data from Southern Alaska, 1994 to 2016, Gulf Watch Alaska Pelagic Component

Olsen, D.W. 2017 Database of Southern Alaska Killer Whale Surveys and Encounters, 2001 to 2016, Gulf Watch Alaska Pelagic Component.

Research Workspace

2017-18. Acoustic Recordings. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

2017-18. Genetics, Prey. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

2017-18. Photographic encounters. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

2017-18. Hydrophone data. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

Presentations

2017

Matkin, C.O. 2017. Tracking whales with hydrophones. Delta Sound Connections, PWS Science Center. March 2017.

Olsen, D.W. 2017. Kenai Fjords National Park Interpretive guide training. **Oral Presentation**. May 5, 2017.

Olsen, D.W. 2017. Killer whales. **Oral Presentation**. Seward public science night, Resurrect Art Coffee House. May 16, 2017.

Olsen, D.W. 2017. Killer Whales. Oral presentation to Kenai Fjords National Park Interpretive guide training. May 2017.

Olsen D.W. 2017. Killer whales. Presentation. Seward public science night, Resurrect Art Coffee House. May 2017.

Olsen et al. 2017. Behavioral Changes During Multi-pod Aggregations of Southern Alaska Resident Killer Whales (*Orcinus orca*). **Oral Presentation**. Society of Marine Mammalogy Conference, Halifax, Nova Scotia, November 2017.

2018

Matkin C.O. 2018. Life History and Social Structure of Alaskan Killer Whales, 2018. **Oral Presentation** to Kenai Peninsula College, October 2018.

Matkin C.O., D.W. Olsen, and G. Ellis. 2018. Southern Alaska resident killer whales may be dependent on more than Alaska salmon: some initial stream of origin genetic data from prey samples. **Poster Presentation.** Alaska Marine Science Symposium, Anchorage Alaska. January 2018.

Olsen, D.W. 2018. Zegrahm Expeditions, Killer whales of the world. **Oral Presentation** to Zegrahm Expeditions May 2018.

Olsen, DW. 2018. Mom knows best: Killer whale culture in Prince William Sound. **Oral Presentation**. Kenai Fjords National Park naturalist training May 2018.

Olsen, D.W. 2018. Mom knows best: Killer whale culture in Prince William Sound. **Oral Presentation**. Prince William Sound Science Center Brown Bag May 2018.

Olsen, D.W. 2018. Mom knows best: Killer whale culture in Southern Alaska. **Oral Presentation** to Public / naturalists / Captains, Seward, May 2018.

Olsen, D.W. 2018. Mom knows best: Killer whale culture in Southern Alaska. **Oral Presentation**. Kayak Adventures guide training, May 2018.

Olsen, D. 2018. Killer whales of Alaska. Kenai Fjords National Park interpretive guide training. **Oral Presentation**. May 2018.

Olsen, D. 2018. Mother knows best: Killer whale culture in Alaska. Annual Kenai Fjord Tourboat Operators and Boaters meeting. **Oral Presentation**. May 2018.

Olsen, D. 2018. Killer whales of the world. Zegrahm Expeditions, Antarctica. **Oral Presentation**. January 2018

Olsen, D. 2018. Killer whales of Prince William Sound. Prince William Sound Science Center Brown Bag presentation. **Oral Presentation**. May 2018.

Olsen, D.W. 2018. Killer whales of the world. **Oral Presentation** to Zegrahm Expeditions July 2018.

Olsen, D.W. 2018. Life of the Killer Whale. **Oral Presentation** to Seabourne Sojourn August 2018.

Olsen, D.W. 2018. Mom knows best: Killer whale culture in Prince William Sound. **Oral Presentation** to Kenai Peninsula College. November 2018.

2019

Matkin, C.O., Olsen D.W. and Ellis, G. 2019. An unfortunate legacy: Continuing effects of the *Exxon Valdez* oil spill on killer whales. Alaska Marine Science Symposium, Anchorage Alaska. **Poster Presentation**

Olsen, D. 2019. Killer whales of Kenai Fjords. Seward naturalists and boat operators, Seward, Alaska. **Oral Presentation**. May,2019.

Olsen, D. 2019. Killer whales of Kenai Fjords. Kayak Adventures Worldwide guide training, Seward, Alaska. **Oral Presentation**. May 2019.

Olsen, D. 2019. Killer whales of Kenai Fjords. Kenai Fjords National Park interpretive staff training, Seward, Alaska. **Oral Presentation**. May 2019.

Olsen, D. 2019. Killer Whale Acoustic Identification. Kenai Fjords National Park staff and general Seward naturalists. Seward, Alaska. **Oral Presentation**. June 2019.

Olsen, D. 2019. Killer whales of Alaska. Lindblad Expeditions, Southeast Alaska. **Oral Presentation**. July 2019.

Outreach

Matkin, C. O. 2017. Tracking whales with hydrophones. Delta Sound Connections, PWS Science Center. March 10, 2017.

Matkin, C. 2018. A Sense of What Is. Interview in: Pillsbury, R.A. Guided by Whales. Duende Press.

Matkin, C. 2018. Beyond Delta-Sound Connections. Delta Sound Connections. Prince William Sound Science Center. http://pwssc.org/wp-content/uploads/2018/05/DSC-2018-FINAL_WEB.pdfOlsen, D. 2019. Killer whales of the world. Zegrahm Expeditions, Antarctica. Oral presentation. January, 2019.

North Gulf Oceanic Society. 2017 Updates to Facebook page during field season with descriptions of field activities. https://www.facebook.com/NorthGulfOceanicSociety/

North Gulf Oceanic Society. 2018. Updates to Facebook page during field season with descriptions of field activities. https://www.facebook.com/NorthGulfOceanicSociety/

North Gulf Oceanic Society. 2019. Updates to Facebook page during field season with descriptions of field activities. https://www.facebook.com/NorthGulfOceanicSociety/

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

Matkin, C.O., J.W. Durban, E.L. Saulitis, R.D. Andrews, J.M. Straley, D.R. Matkin, and G.M. Ellis. 2012. Contrasting abundance and residency patterns of two sympatric populations of transient killer whales (*Orcinus orca*) in the northern Gulf of Alaska. Fishery Bulletin 110:143–155.

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 DOI: 10.1111/mms.12049

Yurk, H., O. Filatova, C.O. Matkin, L.G. Barrett-Lennard, M. Brittain. 2010. Sequential habitat use by two resident killer whale (*Orcinus orca*) clans in Resurrection Bay, Alaska as determined by remote acoustic monitoring. Aquatic Mammals 36:67-78.

Kim M Parsons Jul 18, 2019, 1:30 PM

to me

Hi Craig -

I estimate that the cost for processing the 2016 & 2017 samples last year (extracting DNA, genotyping, and genetic prey ID) was probably ~$22k (including the cost of my time invoiced to the NOAA contracts).

Let me know if you want a more specific breakdown.

Best,

Kim.

Kim M. Parsons, Ph.D

Research Biologist
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Costs for 2020 and 2021 will be about double this 22K per year due to doubling of number of samples