August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-O. Long-term Monitoring of Humpback Whale Predation on Pacific Herring in Prince William Sound

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the humpback whale project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$161,900	$155,000	$157,900	$154,900	$147,600	$777,400

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$146,000	$146,000	$146,000	$146,000	$146,000	$730,000

Science Panel comment: *There are no project specific comments.*

PI Response:

- The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-O—Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-O—Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

Primary Investigator(s) and Affiliation(s)

John R. Moran, National Oceanographic and Atmospheric Administration

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Date Proposal Submitted

24 August 2016

Project Abstract

INTEGRATED PREDATOR-PREY SURVEYS 2017-2021: HUMPBACK WHALES, MARINE BIRDS, FORAGE FISH

Under the next five year monitoring program, we are proposing to integrate predator-prey survey efforts by combining monitoring work from three of the Prince William Sound (PWS) Pelagic Component projects and collaborating with the Herring Research and Monitoring program. We propose to combine the humpback whale, marine bird and forage fish (including euphausiids) projects into a single, integrated predator-prey survey. The integrated survey would be conducted during the fall, providing insight into predator-prey interactions at a crucial time when forage fish energy is maximized while marine birds and humpback whales are provisioning for the upcoming winter. In addition, the survey would estimate the availability, including species composition, density and depth distribution of prey near seasonally predictable predator aggregations in PWS. The survey would include concurrent habitat and nutrient measurements in conjunction with acoustic measurements of nekton biomass and predator density. A midwater trawl (max depth ~ 100 m) will be used to sample acoustic sign and collect samples of forage fish for further analysis (e.g., diet, energy). Marine bird observations will be conducted concurrent with acoustic transects and humpback whale distribution and abundance will be assessed at the same time and area from a smaller vessel. The simultaneous surveys will reduce vessel cost for the three projects while combining expertise with spatial and temporal consistency, allowing a more comprehensive understanding of the pelagic ecosystem. In addition to a planned research cruise in September/October, the proposed approach may also allow for in-kind contributions from National Oceanic and Atmospheric Administration (NOAA) for vessel charter and an additional survey in March, when humpback whales are returning from their migrations to feed and when we can assess the winter severity on forage fish. The NOAA funds will be applied for and awarded on an annual basis, and a March NOAA cruise, if awarded a second cruise would be an added value to the GWA pelagic monitoring program.

HUMPBACK WHALES: LONG-TERM MONITORING OF PREDATION ON PACIFIC HERRING IN PRINCE WILLIAM SOUND:

The humpback whale monitoring project is a component of the integrated fall/winter predator-prey survey. We will continue to evaluate the impact by humpback whales foraging on Pacific herring

populations in PWS. Following protocols established during the winters of 2007/08 and 2008/09 (EVOSTC project PJ090804). Prey selection by humpback whales will be determined through acoustic surveys, visual observation, scat analysis and prey sampling. Chemical analysis of skin and blubber biopsy samples will provide a longer term perspective on shifts in prey type (trophic level from stable isotopes) and quality (energy content). These data will be combined in a bioenergetic model that will allow us to assess the impact of recovering humpback whale populations on the PWS ecosystem. By integrating with the forage fish and winter seabird components, we will be able to provide a comprehensive understanding of bottom-up influences and top-down controls on herring abundance.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$161.9	$155	$157.9	$154.9	$147.6	$777.4

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$146	$146	$146	$146	$146	$730

1. Executive Summary

PELAGIC COMPONENT

In the aftermath of the 1989 *Exxon Valdez* oil spill (EVOS) it was difficult to distinguish between the impacts of the spill and natural variability in affected animal populations. The main problem for assessing impacts on pelagic species was that long-term baseline data were largely absent. As a result, managers struggled to make informed decisions regarding estimation of damages and recommendations for recovery. Ten years after the spill it became widely recognized that there had been a major climatic regime shift (from colder to warmer than average) that altered the marine ecosystem prior to the spill, including marine birds, marine mammals, groundfish, and the shared forage species they all consumed. As we begin to close the second decade of the 2000s we are experiencing anomalous ocean warming events driven by changing atmospheric conditions at both inter-decadal (i.e., Pacific Decadal Oscillation) and shorter (e.g., El Niño Southern Oscillation) time scales. These changes may have profound effects on pelagic ecosystems such as unusual mortality events, harmful algal blooms, and fishery closures.

During the first five years of the Gulf Watch Alaska (GWA) program, the pelagic component research team addressed two main questions: 1) What are the population trends of key pelagic species groups in Prince William Sound, and, 2) How can forage fish population trends in PWS be monitored most effectively? To answer these questions, five projects focused on species that play a pivotal role in the pelagic ecosystem as trophic indicators for short and long-term ecosystem change: forage fish, marine birds, humpback whales and killer whales. Monitoring of killer whales and marine birds benefitted from having pre-existing long-term data sets as a result of the damage assessment process following the EVOS (>25 year time series).

Moving forward for the next five years, the pelagic research team re-evaluated their primary objectives. The group's primary objective— to determine the long-term population trends of key pelagic species groups in PWS — will remain the same. The second primary objective was fundamentally different:

Develop a means to effectively monitor forage fish. Based on knowledge gained in the first five years of the pelagic program, we have developed a broader focus that includes an integrated study of forage fish using marine bird and mammal predators as samplers of the forage base. In addition to providing a means to effectively monitor indices of forage fish trends, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. Ultimately, the integrated surveys along with information from the GWA Environmental Drivers Program will provide a way to evaluate climate variability and climate change on the PWS pelagic ecosystem.

Thus, the two over-arching questions for the pelagic component to answer in the next five years are:

1. What are the population trends of key upper trophic level pelagic species groups in Prince William Sound – 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 Prince William Sound and Middleton Island?

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. Ultimately this will provide more information to the EVOS Trustee Council (EVOSTC), agency resource managers, non-governmental organizations (NGOs), and the public.

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

In our initial GWA efforts, we have been able to identify several areas in PWS with seasonally predictable predator-prey aggregations. Given limited resources and patchy predator-prey distribution in the Sound, we propose using a combination of systematic transects in conjunction with predator guided surveys to hone in on important marine mammal and marine bird foraging areas with significant aggregations of prey. Our new proposed integrated predator-prey surveys will allow us to monitor the status and trends of individual pelagic ecosystem elements as a primary goal. Predator-prey indices will be measured concurrently, thus we will also be able to examine spatial and temporal covariance among indices to better understand the effects of perturbations in the environment. Our framework includes the following hypotheses:

1. *Predator distribution and abundance varies with prey availability (quantity and quality)*
2. *Changes in prey availability and quality occur in response to changes in habitat quality (phytoplankton/zooplankton and environment/temperature)*
3. *Variation in prey availability occurs in response to predation pressure*

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

Monitoring humpback whales and their diets is important to understanding predator prey interactions in the pelagic waters of PWS. Because humpback whales are significant predators in the ecosystem, they may have the potential to control the distribution and abundance of forage fish. The humpback whale

population in the North Pacific has rebounded from near extinction in the late 1960s to over 22,000 individuals, and parallel increases in whale abundance have been documented in PWS (Teerlink 2014). This rapid recovery has coincided with major natural and anthropogenic perturbations in the marine ecosystem (regime shift, Pacific Decadal Oscillation, EVOS). Over much of the same period the abundance of the dominant forage fish, Pacific herring, shifted from an abundant state to a diminished state. The lack of commercial fishery has not restored this population to their former abundance. Pacific herring were identified as an injured species following the EVOS. Understanding the mechanisms behind their failed recovery requires a comprehensive understanding of both top-down and bottom-up processes in the context of a changing ecosystem. Our previous work in PWS (EVOSTC project PJ090804) estimates that humpback whales are consuming 15% to 20% of the pre-spawning biomass of adult herring, roughly equivalent to the percentage of herring removed during the final years of the commercial herring fishery (Rice et al. 2011). In PWS humpback whales during 2007 to 2009 had a higher percentage of herring in their diet during the winter months and foraged longer on wintering herring shoals than their counterparts in Southeast Alaska, suggesting that top-down forcing may be limiting the recovery of herring in PWS. There is a need to continue evaluating predation pressure on herring stocks in PWS and to understand the ecosystem impacts of a humpback whale population that has been functionally absent from Gulf of Alaska for over 50 years.

This project specifically addresses a "project of interest" identified in the EVOSTC FY 17-21 Invitation for Proposals. However, we believe by integrating the humpback whale component with the forage fish and winter bird survey we can provided a more cost effective and scientifically sound survey, while still achieving the goals of the individual projects. Warmer water temperatures over the past two years combined with seabird and marine mammal die-offs, emphasize that the Gulf of Alaska is still undergoing major perturbations that impact species at the population level. Shifts in prey, predators, and environmental drivers identified through this collaborative effort will be instrumental in interpreting these changes.

2. Relevance to the Invitation for Proposals

This project specifically addresses HRM section, Interest Statement, Page 9 #8: The continued examination of the role of humpback whale population growth, changes in foraging behavior and consequent predation on herring and whether it is a potential limitation of herring recovery.

Humpback whales both prey upon and compete with forage fish. Long-term monitoring of humpback whales and their diet is relevant to the invitation because it ties a key upper trophic level predator to the pelagic component as described in the Invitation. These data will contribute to the long term baseline allowing us to not only address recovery of herring in PWS but to speculate on changes due to long-term oceanographic change, climate change or sudden perturbations. Information provided by this project will be crucial to NOAA Protected Resource managers in the implementation of the De-Listing Monitoring Plan for humpback whales.

Data collected during this project will be Public Access to Research Results (PARR) compliant and available at http://portal.aoos.org/gulf-of-alaska.php#metadata/54adceab-74cb-4419-b02c-bacb6d2acb8b/project/files

3. Project Personnel

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Please see 2 page CVs at end of this document

4. Project Design

A. OBJECTIVES

Pelagic Component

The following lists the two over-arching questions for the pelagic component to address in the next five years:

1. *What are the population trends of key pelagic species groups in PWS - killer whales, humpback whales, marine birds, and forage fish?*
2. *How do predator-prey interactions function as a mechanism underlying change in the PWS pelagic ecosystem?*

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

Fundamental to ecosystem monitoring is a basic understanding of the status and trends of individual biological components within the system. It is increasingly clear, however, that an understanding of the mechanisms underlying change requires knowledge of interactions among predators, prey and habitat. The main objectives of forage fish monitoring program are to:

1. Monitor the status and trends of co-occurring pelagic marine ecosystem components during Fall/Winter in areas with known seasonally predictable aggregations of predators and prey

   a. Estimate humpback whale abundance, diet, and distribution

   b. Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.

      i. relate marine bird presence to prey fields identified during hydroacoustic surveys.

ii. characterize marine bird-humpback whale foraging dynamics

c. Estimate an index of forage fish availability

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

iii. energy density

d. Estimate an index of krill availability

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

iii. energy density

e. Relate whale, marine bird and forage fish indices to marine habitat

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound:
This project will directly address the following integrated predator-prey surveys objectives:

1. Estimating trends in humpback whale abundance, diet, and distribution
2. Evaluate prey quality and trophic position through chemical analysis (using bomb calorimetry and stable isotopes)
3. Estimating the impact of humpback whale predation on herring

B. Procedural and Scientific Methods

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish
To meet the goals of the program we propose an integrated survey design that brings together predator and prey components of the pelagic ecosystem. We propose to conduct an annual hydroacoustic-trawl survey that targets persistent humpback whale feeding locations in Montague Strait, Bainbridge passage and Port Gravina (Figure 1). As proposed, the survey will be conducted during the fall of each year. However, potential in-kind contributions from NOAA may facilitate expansion of the survey into two time periods: fall and winter (September/October and March). Proposed time periods will coincide with periods of high whale abundance in PWS. The pending in-kind contributions would support the charter costs for the vessels. For the humpback whale component the in-kind contributions would free up Trustee funds that would be applied towards the additional data management, field work and processing the increased number samples resulting from an additional survey. For the acoustic survey component, U.S. Geological Survey (USGS) will contribute further in-kind support to ensure that the second survey was staffed and the acoustic data analyzed. The fall/winter marine bird component will ensure that observers are aboard all surveys, however funded.

We propose to focus our survey on locations where whales have historically been observed foraging in PWS during the fall and winter. In September, this location is where herring can be found entering Montague Strait, as well as Bainbridge Passage and Port Gravina (Figure 2). The basic structure of the survey is for a vessel to conduct acoustic estimates along fixed transect lines, the locations of which are based on recent historical data on whale foraging locations (Figure 1). While the acoustic vessel is conducting transects a second smaller vessel will be used to assess whale abundance. The smaller vessel will depart from the acoustic vessel and work independently in the area where the acoustic data are being collected. This gives the whale vessel the ability to census and sample whales and scout for whales outside

the fixed areas. At the end of the day the two vessels will join and share information. Data collected by the whale vessel include photograph the flukes of individual whales for identification, blubber and skin biopsies, observations of whale diets, and samples of tissues left by whales (e.g., stunned fish, scats, scales etc.). Onboard GPS and acoustics on the whale vessel will be used to identify layers to which whales may be diving and locations. These data will be compared with data from the acoustic vessel.

Hydroacoustic-trawl. The fixed transect layout was chosen to sample areas of persistent humpback whale habitat use identified in surveys conducted in 2006-2014. To estimate depth distribution and biomass of prey in the water column a calibrated SIMRAD 38-120 kHz split beam EK60 system will be towed beside the boat along pre-determined transects, and each transect will serve as a sample to estimate the abundance using the area each subregion (Figure 1).

We will use a midwater trawl and other means as necessary to verify species and size (length in mm, weight to 0.01 g) of organisms (krill and schooling fish) that contribute to hydroacoustic backscatter in each subregion. The net has an approximately 154 m^2 mouth (14 m x 11m) and is 22 m long. Mesh size diminishes from 38 mm at the mouth to 12 mm at the cod end (Innovative Net Systems, Inc.). The net is held open by two 0.4 m^2, series 2000 steel mid-water trawl doors (Nor 'Eastern, Inc.); each weighing approximately 76 lbs. The net will be towed at approximately 1.8 kt, trawl duration will depend on the vertical and horizontal distribution of acoustic targets. Depth of the headrope will be managed with a TrawlMaster system. Although we will try to accomplish ground-truthing of acoustic sign on daytime transects, logistical constraints (daylight hours, trawl depth limitations, etc.) may require that trawls occur at night when the scattering layer ascends in the water column. We will also attempt to ground truth untrawlable (e.g., shallow nearshore areas) acoustic backscatter with other means (e.g., underwater video, jigs, dipnets, cast nets).

Trawl catches will be enumerated, lengthed (TL and FL, mm) and weighed (0.01 g) by species. Fish samples will be taken for sex, diet, energetics, and isotope analysis. A subsample of the euphausiid catch will be preserved in 3-5% formaldehyde solution for laboratory analysis of species proportion and weight. Krill samples will also be analyzed for energetics.

In addition to fixed transects in persistent predator aggregation areas, we will also characterize prey density more closely associated with individual or groups of whales in each subregion (Montague, Bainbridge and Gravina). This will involve focal follows of individual whales, or prey mapping near groups of feeding whales.

Marine habitat. At six fixed stations in the study area we will measure oceanographic variables with a SBE19 plus v2 conductivity-temperature depth profiler (CTD). After each CTD cast we will also collect zooplankton samples with a 100 m vertical haul of a 150 μ-mesh zooplankton net. Concurrent sampling of ocean and zooplankton indices will provide spatial and temporal overlap of environmental and predator-prey indices.

During each cruise we will sample 80 km of transects, with associated trawls (max depth 100 m) to collect fish and krill and 6 CTD/zooplankton stations. We anticipate a typical survey will occur as follows (subject to changes as necessary for logistics and weather conditions):

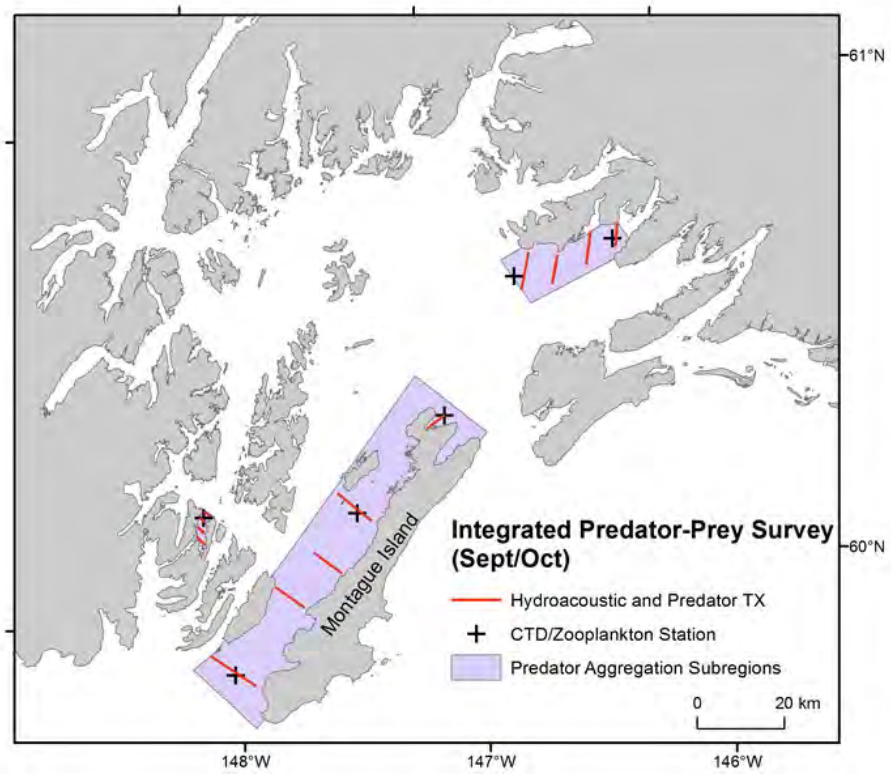

Figure 1. Proposed integrated marine bird - humpback whale - forage fish survey design. Marine bird and whale density will be assessed in conjunction with hydroacoustic transects for fish and krill. We will also assess changes in associated marine habitat with zooplankton tows and conductivity-temperature-depth profiles (CTD).

A typical survey schedule will consist of:

Day 1. Load, travel, calibrate hydroacoustics, passive noise test
Day 2. Zaikof/Montague (44 km/5 tx, 2 trawl, 3 CTD/zoop)
Day 3. Zaikof/Montague (44 km/5 tx, 2 trawl, 3 CTD/zoop)
Day 4 Finish Montague, focal follows or adaptive tx (2-3 hours). Transit.
Day 5. Bainbridge (8.3 km/ 4 tx, 1 trawl, 1 CTD/zoop, 1-2 hour focal/adaptive). Transit.
Day 6. Knowles/Gravina (28.7 km/4 tx 1-2 trawls, 2 CTD/zoop)
Day 7. Knowles/Gravina (28.7 km/4 tx 1-2 trawls, 2 CTD/zoop, 2-3 hour focal/adaptive)
Day 8. Weather or focal/adaptive effort
Day 9. Weather or focal/adaptive effort
Day 10. Transit. Unload.

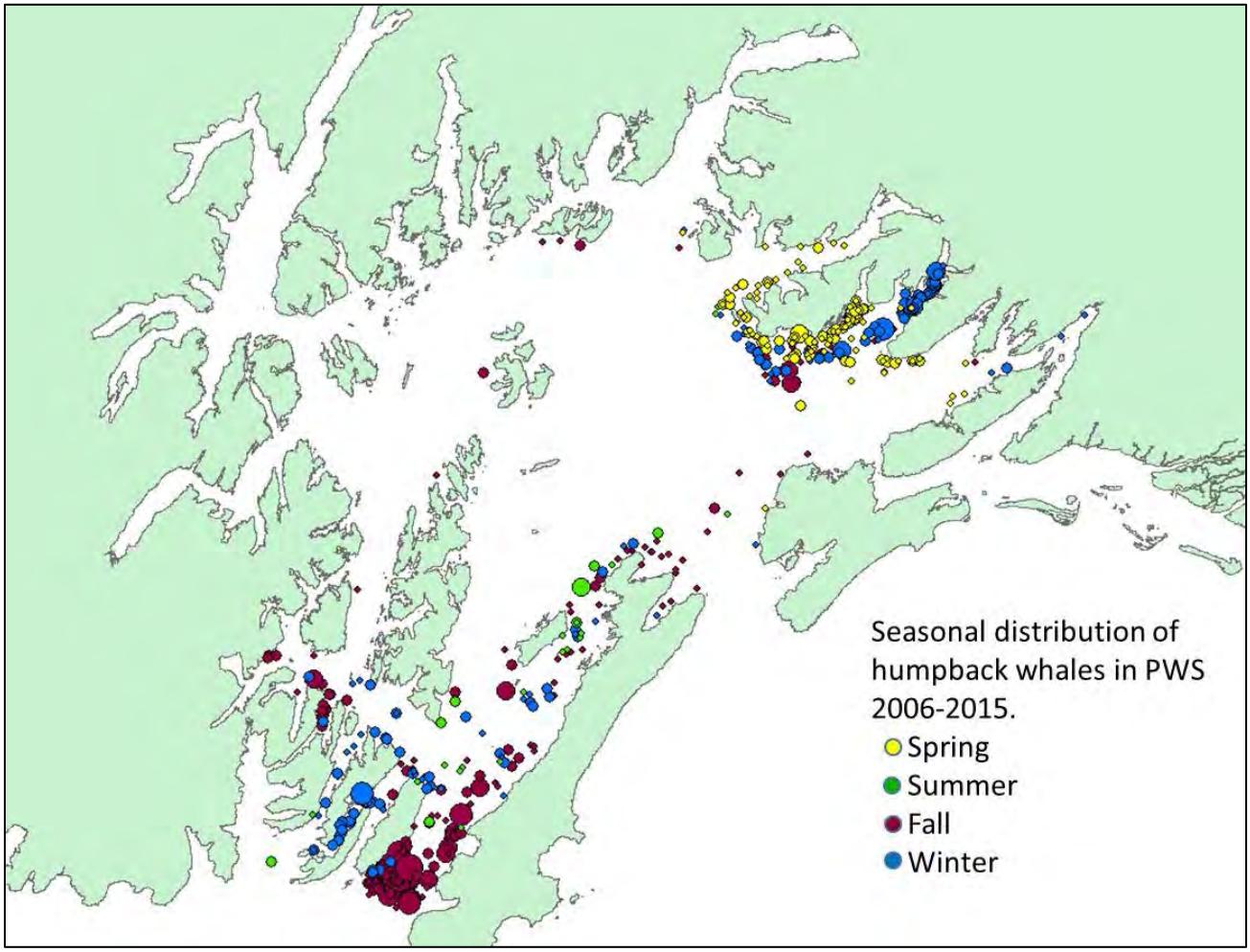

Figure 2. The seasonal distribution of humpback whales sighted on surveys conducted between 2006 and 2015. The diameter of the points reflects the relative abundance of whales present. Note that effort is not shown and includes areas where whales were not seen.

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

When groups of whales are located and determined to be feeding, effort will made to determine the identities of the whales and what they are eating. Whales will be identified from the patterns on the ventral sides of their flukes. The patterns will be recorded using Nikon D-300, D-200, and D-700 cameras with 80-200 mm zoom or fixed 300mm lenses to capture digital images. The photos will be compared with the PWS catalog and sighting history database 511 whales managed by PI Straley at UAS. Direct observations of prey being consumed, remains after feeding, and sonar mapping of the prey fields observed on a dual 38/120 kHz frequency echosounder will be used to determine presumed target prey of humpback whales (see Arimitsu and Piatt forage fish proposal for details). Confirmation of target prey will be accomplished using herring jigs, trawls, zooplankton tows, and cast nets to collect surface fish near feeding whales. Scales and zooplankton will be collected behind whales feeding at the surface with a 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.

Biopsies of whale skin will be collected for isotopic analysis to independently derive estimates of whale diets from the trophic level. Direct observation of diets provides only a "point-in-time" estimate and does not provide information on periods when whales are not being observed. Stable isotope analysis can provide a more time-integrated measure of whale diet. In addition stable isotope analysis can be used to estimate the trophic position of organisms. If whales in PWS consume large amounts of herring they should occupy a higher trophic position than herring. We will use both methods to better describe the impact of whales on forage fish including herring. Biopsies will be collected using a crossbow bolt with a coring tip. Samples will be recovered immediately, labeled, and placed in an ice chest. At the end of the day the contents of the ice chest will be transferred to a freezer on the acoustic vessel. At the end of the survey the biopsy samples will be transported to Auke Bay and stored at -80 °C until they are processed. Primary consumers will be collected and analyzed to establish an isotopic baseline for inter-annual trophic comparisons.

Sample Processing

Isotopic analysis will be conducted using a Thermo Delta V gas chromatograph/isotope ratio mass spectrometer. Prior to stable isotope analysis, tissues will be archived at -80 deg. F in freezers at NOAA Auke Bay Laboratories Juneau, Alaska. Pilot analyses showed that lipid content in tissues influenced $\delta^{13}C$ values; therefore, tissues will be lipid-extracted prior to quantification of stable isotope ratios. Stable isotope values (expressed in δ notation) will be generated for samples using the methods described in Seymour et al. (2014). The isotope ratio mass spectrometer is calibrated using certified standards from the International Atomic Energy Agency and US Geological Survey, which produce the international reference materials (reference standard for carbon is VPD and air for nitrogen) All sample analyses will be conducted with certified quality control standards for precision and accuracy] interspersed throughout the analytical run. If the quality assurance standard results differ from certified values by more than the known standard deviation of the reference material, the sample will be re-analyzed until results of quality assurance standards are within the expected tolerances.

The energy content of prey will be measured from each survey in order to estimate the number of prey consumed by humpback whales. Energy content will be measured using calorimetric methods as outlined in by Siddon et al. (2013). Putative prey will be obtained from trawls conducted on the acoustic vessel and samples collected by the whale vessel. Samples of prey will be weighed, dried, and the homogenized tissue will be pressed into pellets. The pellets will be combusted in a Parr Instrument 6725 Semimicro Bomb Calorimeter to measure the energy released. Quality assurance (QA) procedures include the use of duplicate samples to evaluate precision, reference materials to evaluate accuracy and blanks (benzoic acid) to evaluate cleanliness. Predetermined limits for variation observed in QA samples were set, where precision estimates from duplicate tissue and reference samples must not vary by more 15% CV.

C. Data Analysis and Statistical Methods

Analysis of the data collected during the surveys is aimed at fulfilling objectives 1, 2 and 3 listed under the heading *Long-term monitoring of humpback whales predation on Pacific herring in Prince William Sound*. This includes assessing trends in the abundance and spatial distribution of whales, evaluating their diets and assessing their impact on PWS herring populations.

Estimating humpback trends in humpback whale abundance, diet, and distribution (Obj. 1)

Whale abundance will be estimated using mark-recapture techniques using the black and white pattern on the ventral surface of each whale's flukes as natural marks. 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. However, we will likely will employ the Huggins closed-capture model (White and Burnham 1999) using the program MARK. This is the approach employed in our previous efforts and those used by Teerlink et al. (2015). Photographs will be quality ranked for percent of flukes visible, angle of the flukes to the water surface and to the camera, clarity of the image and other attributes to reduce sampling bias. A poorly photographed distinctive whale with spectacular flukes would be a biased data point hence this quality control makes all patterns on the flukes equal. Photographs deemed poor or of insufficient quality will be excluded from the mark-recapture analysis to avoid this bias. Further, photographs of humpback whale calf flukes will also excluded, because 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. Abundance estimates will represent the number of whales present in PWS in a given winter. Whale distributions will be examined by plotting whale observations on maps for each survey to identify locations where whales were most abundant and evaluate seasonal movements. These maps can be overlaid with maps derived from the forage fish survey to relate whale distributions to prey availability. Determining the number of humpback whales foraging in PWS a will require the full suite of sighting histories and covariates. Thus, final estimate will not be available until the all surveys have been completed, however, we will be able to provide preliminary abundance estimates that may be useful in determining whale population trends.

Evaluate whale diets, prey quality and trophic position (Obj. 2)

Direct observations of whale diets will be summarized to estimate whale diets for each winter. The proportion of prey type in the diet of observed feeding groups of whales will be determined for each survey. The survey design calls for identifying groups of foraging whales. Consequently, diets will be summarized for individual groups. Multiple groups are likely to be seen on a given day. Each group of whales associating together on a given day will be tallied across a survey to determine the total number of groups observed. The number observed eating a particular prey item (e.g., herring, krill, unknown) will be tallied for each survey to estimate the proportional contribution of each prey type to whale diets during a given survey. Pearson chi-square tests will be used to identify differences among the diets of groups in different parts of PWS during a survey (where there are sufficient data) and between surveys.

Estimating the impact of humpback whale predation on herring (Obj. 3)

Estimates of the number of herring consumed by whales over winter will be compared with estimates of the herring abundance to evaluate the impact of whale predation on PWS herring. Estimates of herring abundance will be taken from the pre-spawning biomass as estimated by the age-structured stock assessment to be produced by the Herring Monitoring Program. Estimates of herring consumption by humpback whales will combine estimates of the averaged daily metabolic demand by humpback whales with estimates of the number of whales present, the proportion of herring in their diet and the average energy content of the herring to determine the number of herring consumed following equation 1:

$$C = \sum_{t=1}^{182} \frac{p_t \sum_{i=1}^{100} K\left(\frac{n_t}{100} w_i\right)^{\beta}}{ED_t} \qquad \text{[Equation 1]}$$

In equation (1) C is the total biomass removed by whales over the course of 182 days of winter; pt is the proportion of the whales known to be eating herring on day t of winter, nt is the number of whales foraging

on day t, wi is the weight of a whale in the i-th size class, K and β are allometric parameters describing the metabolic rate of whales in the i-th size class and EDt is the energy density of herring on day t of winter. We propose to use historic whaling records to estimate the size distribution of humpback whales, and allometric parameters from published literature. Our observations of diet will be used to provide the estimate for pt and our calorimetric data will be used to estimate EDt.

The time step for the model is one day and the duration of winter is estimated to be the time between surveys. In the example of the equation 1 it is 182 days, but that may not be the case for each year. We will interpolate the number of whales present on a given day from a whale-day model. Previous surveys between 2006 and 2015 have provided observations of the number of unique whales present on different days of the winter. We will plot the number of whales present by Julian day and fit a curve describing the whale attendance pattern in PWS. For each winter we will scale the curve upward so that the maximum number of whales present in PWS equals the point estimate from our mark-recapture analysis. This will model the number of whales present on each day, and the integral from day 1 to day n is the number of whale days.

D. Description of Study Area

This study will occur in the waters PWS. In addition to the core transects depicted in Figure 2, a small boat will be deployed from the larger survey vessel to expand the humpback whale survey throughout the Sound. The season distribution of humpback whales (Figure 3) served as a guide in establishing these transects.

5. Coordination and Collaboration

Within the Program

Collaboration of GWA pelagic team principal investigators (PIs) will facilitate a broader understanding of humpback whale and seabird foraging dynamics and forage fish availability in PWS (Table 1). High concentrations of humpback whales and seabirds have been observed in the waters around Green Island and Montague Strait, Bainbridge Passage and Port Gravina during fall/winter. Unlike other areas of the Sound, where herring and euphausiids are identified as prey, determining diet in these waters has proven to be particularly challenging. An integrated survey will characterize the distribution, composition, and density of humpback whale prey to better understand interannual variability in whale population (numbers and distribution). Likewise, we will use predators as indicators of prey distribution in order to increase the sampling encounter rate of patchy forage fish schools in deep offshore waters. Combining efforts will lead to greater integration of the pelagic monitoring program. Additionally, killer whale and humpback whale photos, locations and counts will be exchanged with the killer whale project (Matkin). This collaboration expands the temporal and spatial scope of both projects.

Table 1. Integrated predator-prey collaborations by objective.

Objective	Index	Task	PI
a. Estimate humpback whale abundance, diet, and distribution			
	Whale counts by subregion	Integrated Surveys: whale counts, biopsies	Moran (NOAA)/ Straley (UAS)
	Whale Identification	Integrated Surveys: Photo ID	Moran (NOAA)/ Straley (UAS)
	Whale Diet	Integrated Surveys: scales, scat, biopsies, visual observations, hydroacoustics	Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)
b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas			
	Georeferenced marine bird counts, group size, behavior by species	Integrated Surveys: marine bird transects	Bishop (PWSSC)
b.i. Relate marine bird presence to prey fields identified during hydroacoustic surveys.			
	Spatial coherence of bird presence/ absence, acoustic estimates of forage fish and euphausiid biomass	Integrated Surveys: hydroacoustic and marine bird transects	Arimitsu-Piatt (USGS)/ Bishop (PWSSC)
b.ii. Characterize marine bird-humpback whale foraging dynamics			
	Georeferenced marine bird and whale counts, group size, behavior by species	Data Collection Integrated Surveys: marine bird transects; whale focal follows	Bishop (PWSSC)/ Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)
c. Estimate index of forage fish availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Diet, energy density	Sample Analysis: forage fish	Moran (NOAA)
d. Estimate an index of euphausiid availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
e. Relate whales, marine birds and forage fish indices to marine habitat			
	Oceanographic parameters and zooplankton biomass	Integrated Surveys: CTD and zooplankton samples	Arimitsu-Piatt (USGS)/ Moran (NOAA)/ Straley (UAS)/ Bishop (PWSSC)

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

As in the past, we will work closely with the Herring Research and Monitoring program, samples will be provided to the HRM for analysis of age at maturity and we are dependent on estimates of herring abundance developed through the age-structured assessment conducted by the Herring Research and Monitoring program.

WITH TRUSTEE AND MANAGEMENT AGENCIES

The unique timing and focus of this project provides Trustee and Management Agencies with valuable data and platforms for both management and research. The acoustic component of this project is the only directed forage fish survey in the Gulf of Alaska. These data will be consumed directly into the North Pacific Fishery Management Council's annual forage fish stock assessment. Data collected on humpback whale abundance will be of direct value to NOAA Protected Resource managers in the implementation of the De-Listing Monitoring Plan for humpback whales. NOAA is required by statute to evaluate the whale population to ensure that delisting was warranted. Collections of juvenile forage fish, particularly age-0 pollock, are of direct interest to the NOAA Alaska Fisheries Science Center, which is actively engaged in understanding how winter influences pollock survival. We anticipate working with the Alaska Fisheries Science Center when they conduct winter acoustic surveys in PWS as part of their normal pollock assessment work for the Gulf of Alaska. During our surveys we will also photograph Steller sea lion brands whenever possible. These data represent brand re-sights and are of interest to both the Alaska Department of Fish and Game and NOAA and are used in identifying movements of SSL.

WITH NATIVE AND LOCAL COMMUNITIES

When possible we will work in collaboration with the PWS Science Center to seek local and traditional ecological knowledge.

6. Schedule

PROJECT MILESTONES

- **Task 1**
  Annually prepare for and launch field collection of core project data including: identification photos, observation of predation and sampling of prey. Collect annual biopsy samples for feeding habits.
- **Task 2**
  Conduct analysis of identification photos, annually update photographic catalogue. Preliminary estimates of whale abundance. Annual report.
- **Task 3**
  Chemical analysis of skin and blubber, and prey samples. Conducted annually, completion date for all laboratory analysis is February 2022.
- **Task 4**
  Estimations of the impact of humpback whale predation on herring from all years of the project to be included in final report and/or other publication (draft by April 2022). All required reporting will be completed on an annual basis in addition to final report and publications.

MEASURABLE PROJECT TASKS

Measurable program tasks for monitoring humpback whale predation on herring include tasks involving administration and logistics, data acquisition and processing, dedicated data management, analysis and reporting (Table 2).

Table 2. Task schedule for monitoring humpback whale predation on herring.

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1																				
Integrated predator-prey surveys (EVOSTC funded)			X				X				X				X				X	
Alternate Survey schedule (with additional NOAA funds)	X		X		X		X		X		X		X		X		X		X	
Task 2																				
Photographic analysis			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Annual reports/data upload to portal					X				X				X				X			
Task 3																				
Chemical analysis			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Task 4 Reporting																				
Estimate whale impact																				X
Final report and publications																				X
Data management, QAQC, workspace upload				X	X			X	X			X	X			X	X			X
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 17 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
March: *Secure vessel charter*

FY 17, 2nd quarter **(May 1, 2017 - July 31, 2017**
May-June: *Field gear preparation*

FY 17, 3rd quarter **(August 1, 2017 - October 31, 2017)**
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 17, 4th quarter **(November 1, 2017 - January 31, 2018)**
November: *10 day integrated survey of PWS*
December: *Data entry QA/QC*
January: *Alaska Marine Science Symposium*

FY 18 (Year 7)

FY 18, 1st quarter **(February 1, 2018 - April 30, 2018)**
February-April: *Data entry QA/QC*
February-April: *Chemical analysis*
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May-July: Data entry QA/QC
May-July: Chemical analysis

FY 18, 3rd quarter (August 1, 2018 - October 31, 2018)
August-October: Chemical analysis
October: FY Work Plan (DPD)
October: Field logistics

FY 18, 4th quarter (November 1, 2018 - January 31, 2019)
November: 10 day integrated survey of PWS
January: Alaska Marine Science Symposium

FY 19 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 30, 2019)
February: Annual Report/data upload to portal
March: Secure vessel charter

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May-July: Data entry QA/QC
May-July: Chemical analysis

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
August-October: Chemical analysis
October: FY Work Plan (DPD)
October: Field logistics

FY 19, 4th quarter (November 1, 2019 - January 31, 2020)
November: 10 day integrated survey of PWS
January: Alaska Marine Science Symposium

FY 20 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 30, 2020)
February: Annual Report/data upload to portal
March: Secure vessel charter

FY 20, 2nd quarter (May 1, 2020 - July 31, 2020)
May-July: Data entry QA/QC
May-July: Chemical analysis

FY 20, 3rd quarter (August 1, 2020 - October 31, 2020)
August-October: Chemical analysis
October: FY Work Plan (DPD)
October: Field logistics

FY 20, 4th quarter **(November 1, 2020 - January 31, 2021)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium*

FY 21 (Year 10)

FY 21, 1st quarter **(February 1, 2021 - April 30, 2021)**
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 21, 2nd quarter **(May 1, 2021 - July 31, 2021)**
May-July: *Data entry QA/QC*
May-July: *Chemical analysis*

FY 21, 3rd quarter **(August 1, 2021 - October 31, 2021)**
August-October: *Chemical analysis*
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 21, 4th quarter **(November 1, 2021 - January 31, 2022)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium. Final report.*

7. Budget

BUDGET FORMS (ATTACHED)
Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING
Over the life of this project, NOAA will make a substantial contributions: salary ($350 K) for PI Moran (7 months, GS-12), all field and laboratory equipment required ($50 K), and small vessel/charters ($330 K). Total in-kind by NOAA for this project is $730 K.

PERMITS
Authorization for all whale related activities are permitted under J. Straley's research permit (#14122) issued by NOAA Office of Protected Resources under and the University of Alaska Fairbanks Institutional Animal Care and Use Committee (157884-14). NOAA (Moran) retains all permits for collecting fish with the State of Alaska. Permit numbers subject to change as study progresses and permits are renewed.

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PROJECT DATA ONLINE

Data collected during this project will be Public Access to Research Results (PARR) compliant and available at http://portal.aoos.org/gulf-of-alaska.php#metadata/54adceab-74cb-4419-b02c-bacb6d2acb8b/project/files

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EDUCATION

University of Alaska Fairbanks, M.S. in Fisheries, August 2003.
University of New Hampshire, B.A. in Zoology, minor in Marine Biology, May 1989.

PROFESSIONAL EXPERIENCE

Research Fisheries Biologist, *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Juneau AK. August 2006- present*
Research Associate, *University of Alaska Southeast, Juneau, AK.* September 2003- August 2006
Research Assistant, *University of Alaska Fairbanks, Juneau, AK*. January 2002-May 2003
Weir Crew Leader, *SWCA, Salt Lake City, UT.* September 2001-November 2001
Graduate Intern, *Alaska Department of Fish and Game, Juneau, AK.* April 2000-April 2001
Teaching Assistant, *University of Alaska Fairbanks, Juneau, AK.* September 1999-December 2000
Biological Technician (Fisheries), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK***.** April 1998-August 1999
Biological Science Technician (Wildlife), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK*
Fisheries Technician/Tagger/Diver, *Prince William Sound Aquaculture, Cordova, AK.* February 1992-April 1993

RELAVENT PUBLICATIONS

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Haggblom, L., and J. Moran 1995. The status of kittiwakes, murres, and cormorants at Cape Peirce, Bristol Bay, Alaska, Summer 1994. USFWS report, 14 pp. Dillingham, AK.

Haggblom, L., and J. Moran. 1994. The status of kittiwakes, murres, and cormorants at Cape Peirce, Bristol Bay, Alaska, Summer 1993. USFWS report, 20 pp. Dillingham, AK.

Recent Collaborators:

Adkinson, Shannon UAF
Andrews,Russel UAF
Arimitsu, Mayumi USGS
Barton, Mark FIU
Bishop, Mary Anne, PWSSC
Blackburn, Jason UF
Boswell, Kevin FIU
Cates, Kelly UAF
Chenoweth, Ellen UAF
Csepp, David AFSC
Fauquier, Deborah Marine Mammal Health and Stranding Response Program
Heintz, Ron AFSC
Hodgkiss, William Scripps Inst Oceanography
Jensen, Aleria AKRO
Jones, Meagan, Maui Whale Trust
Kuerman, William Scripps Inst Oceanography
Lunsford, Chris AFSC
Mathias, Delphine Scripps Inst. Oceanography
Matikin, Craig, NGOS
Nammack, Marta NMFS' National ESA Listing Coordinator
Pearson, Heidi UAS
Rice, Stanley AFSC
Quinn, Terry UAF
Rieucau, Guillaume FIU
Savage, Kate AKRO
Sheffield, Gay Marine Advisory Program
Sarkar, Jit Scripps Inst Oceanography
Straley, Janice UAS
Thode, Aaron Scripps Inst Oceanography
Verlinden, Chris Verlinden, Chris
Vollenweider, JJ AFSC
Zenone, Adam FIU

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Professional Preparation

University of Washington, Seattle, WA BS Fisheries and Wildlife 1975
University of Alaska Fairbanks, Fairbanks, AK. MS, Biological Oceanography, 1994

Thesis: Straley, J. M. 1994. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. pp. 121. University of Alaska Fairbanks, Fairbanks, Alaska.

Appointments and Honors

2015	Professor, University of Alaska Southeast
2013	Meritorious Service Award, University of Alaska Board of Regents
2013	Pew Fellows Program in Marine Conservation nominee
2012	Ocean Leadership Award for Excellence in Marine Science, Alaska SeaLife Center
2005-P	Joint Faculty, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences
2010-P	Associate Professor of Biology, University of Alaska Southeast-Sitka Campus
1994-2014	Assistant Professor, University of Alaska Southeast-Sitka and University of Alaska Fairbanks, College of Rural Alaska, Rural Alaska Science and Math Network.
1988-1992	Marine Biologist, Humpback Whale Monitoring Program, Glacier Bay National Park, AK
1987-1988	Biology Instructor, University of Alaska Southeast-Sitka Campus
1980-1984	Fisheries Biologist, Northern Southeast Regional Aquaculture Assn., Sitka, AK
1979-1999	Independent Marine Biologist, humpback and killer whale research in Alaskan waters
1979	Wildlife Biologist, U.S. Forest Service, Sitka, Alaska
1977-1978	Biological Technician, U.S. Fish and Wildlife Service, Sitka, Alaska

Activities related to proposed project: Ms. Straley has conducted independent research on large whales in Alaskan waters since 1979. Her research focus over the past 14 years has been to work with industry to understand sperm whales depredation on longlines and humpback whale predation at hatchery release sites on juvenile salmon. She actively works on realistic recommendations to fishermen to minimize interactions with marine mammals.

Products

Relevant:

Straley, J, Schorr, G., Calambokidis, J., Thode, A., Lunsford, C., Chenoweth, E., O'Connell, V. and Andrews, R. (2014). Depredating sperm whales in the Gulf of Alaska: local habitat use and long distance movements across putative population boundaries. Endangered Species Research vol.24 124-135.

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Herman DP, Matkin CO, Ylitalo GM, Durban JW B. Hanson, M.Dahlheim, J. Straley, P. Wade, K. Tilbury, R. Boyer, R. Pearce1, M. Krahn 2008. Assessing age-distributions of killer whale (Orcinus orca) populations from the composition of endogenous fatty acids in their outer-blubber layers. Mar Ecol Prog Ser 372:289–302.

Synergistic Activities (P = present)

2011	University of Alaska statewide invitational speaker Science in Alaska lecture series winter 2011
2010	Invitational workshop the review of maximum sustainable yield rate for baleen whales, International Whaling Commission, 20-24 April, Seattle, WA.
2007	Founding board member Sitka Sound Science Center
2006-P	Steering committee to develop a research strategy for a study of North Pacific killer whales with a focus on predation and the impact upon marine mammal populations.
2004-P	Southeast Alaska Sperm Whale Avoidance Project-designed and implemented fishermen network to collect behavioral data on sperm whales removing fish from longline gear
2004-P	Regional coordinator for North Pacific humpback whale study (SPLASH).
2002-P	Steering committee to develop a basin wide study of North Pacific humpback whales
1997-P	Science Director, Sitka WhaleFest, dedicated to celebrating marine wildlife in the North Pacific through community and educational events. Annual budget $100,000.
1996-P	Appointment by NMFS to the Alaska Regional Scientific Review group for marine mammals.
1985-P	Alaska Stranding Network Member and Large Whale Disentanglement Team

Collaborators: Baker, Scott; Barrett-Lennard, Lance; Behnken, Linda; Calambokidis, John; Cerchio, Sal; Craig, Allison; Darling, Jim; Deecke, Volker; Ellis, Graeme; Gabriele, Christine; Glockner-Ferrari, Debbie; Hills, Sue; Herman, Lou; Jurasz, Charles; Kohler, Nikki; Liddle, Joe; Lunsford, Christopher; Matkin, Craig; Matkin, Dena; Mesnick, Sarah; Mizroch, Sally; Neilson, Janet; O'Connell, Victoria; Quinn, Terrence III; Sigler, Mike; Thode, Aaron; Teloni, Valeria; Trites, Andrew; Riley, Heather; Witteveen, Briana; Wynne, Kate; Von Ziegesar, Olga

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$6.0	$0.6	$0.6	$0.6	$0.6	$8.4	
Travel	$7.8	$7.8	$7.8	$7.8	$7.8	$39.0	
Contractual	$119.7	$119.8	$122.5	$119.7	$109.5	$591.3	
Commodities	$15.0	$14.0	$14.0	$14.0	$17.5	$74.5	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$148.5	$142.2	$144.9	$142.1	$135.5	$713.2	
General Administration (9% of subtotal)	$13.4	$12.8	$13.0	$12.8	$12.2	$64.2	N/A
PROJECT TOTAL	$161.9	$155.0	$157.9	$154.9	$147.6	$777.4	
Other Resources (Cost Share Funds)	$146.0	$146.0	$146.0	$146.0	$146.0	$730.0	

COMMENTS:
Over the life of this project, NOAA will make a substantial contributions: salary ($350 K) for PI Moran (7 mos. GS-12), all field and laboratory equipment required ($50 K), and small vessel/charter ($330 K). Total in kind by NOAA for this project is $730 K.

FY17-21

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			6.0	6.0
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
			Subtotal	0.0	6.0	
				Personnel Total	$6.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.2
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$119.7

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	2.5
Commodities Total	$15.0

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates, etc.	1	NOAA
NOAA large vessel charter - Cobb funds (2 surveys = 24 days @ $3,200/day	1	NOAA
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.3
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$119.8

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley

FORM 4B
EQUIPMENT DETAIL

	Agency: NMFS	

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY19	**Project Title: Monitoring of humpback whale predation on Pacific herring in PWS** **Primary Investigator: John Moran & Jan Straley**	**FORM 4B** **PERSONNEL & TRAVEL DETAIL**

	Agency: NMFS	**DETAIL**

Contractual Costs: Description		Contract Sum
Grant (UAS Straley)		47.0
Lager Vessel charter (3,200/day at 10 days)		32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)		10.0
Sample processing:		
Plankton (AFSC) - forage fish & humpback whale		
CTD (AFSC?) - forage fish		
Prey/Diet (ABL) - forage fish & humpback whale		15.0
Nutritional health (ABL) - forage fish & humpback whale		10.0
Isotopes - forage fish & humpback whale		6.0
Genetics - humpback whales		2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$122.5

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

FY19	**Project Title: Monitoring of humpback whale predation on Pacific herring in PWS**	**FORM 4B CONTRACTUAL &**

FY19	Primary Investigator: John Moran & Jan Straley Agency: NMFS	CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY19	Project Title: Monitoring of humpback whale predation on Pacific herring in PWS	FORM 4B

FY19	Primary Investigator: John Moran & Jan Straley Agency: NMFS	EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY20	Project Title: Monitoring of humpback whale predation on Pacific herring in PWS	FORM 4B PERSONNEL & TRAVEL

FY20	Primary Investigator: John Moran & Jan Straley Agency: NMFS	PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description		Contract Sum
Grant (UAS Straley)		44.2
Lager Vessel charter (3,200/day at 10 days)		32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)		10.0
Sample processing:		
Plankton (AFSC) - forage fish & humpback whale		
CTD (AFSC?) - forage fish		
Prey/Diet (ABL) - forage fish & humpback whale		15.0
Nutritional health (ABL) - forage fish & humpback whale		10.0
Isotopes - forage fish & humpback whale		6.0
Genetics - humpback whales		2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$119.7

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

FY20	Project Title: Monitoring of humpback whale predation on Pacific herring in PWS	FORM 4B CONTRACTUAL &

FY20	Primary Investigator: John Moran & Jan Straley Agency: NMFS	CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY20	Project Title: Monitoring of humpback whale predation on Pacific herring in PWS	FORM 4B

FY20	Primary Investigator: John Moran & Jan Straley Agency: NMFS	EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY21	Project Title: Monitoring of humpback whale predation on Pacific herring in PWS	FORM 4B PERSONNEL & TRAVEL

FY21	Primary Investigator: John Moran & Jan Straley Agency: NMFS	PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.0
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	
Nutritional health (ABL) - forage fish & humpback whale	15.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$109.5

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
supplies	5.0
Commodities Total	$17.5

	Project Title: Monitoring of humpback whale predation on	FORM 4B

FY21	Pacific herring in PWS Primary Investigator: John Moran & Jan Straley Agency: NMFS	FORM 4D CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day = $76.8K)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

	Project Title: Monitoring of humpback whale predation on	

FY21	Pacific herring in PWS Primary Investigator: John Moran & Jan Straley Agency: NMFS	FORM 4B EQUIPMENT DETAIL