## ATTACHMENT B. Annual Project Report Form (Revised 11.21.19)

**1. Project Number:**

19120114-O

**2. Project Title:**

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

**3. Principal Investigator(s) Names:**

John Moran, NOAA Fisheries AFSC/Auke Bay Laboratories

Jan Straley, University of Alaska Southeast

**4. Time Period Covered by the Report:**

February 1, 2019-January 31, 2020

**5. Date of Report:**

March 2019

**6. Project Website (if applicable):**

www.gulfwatchalaska.org

**7. Summary of Work Performed:**

The objectives of the long-term monitoring of humpback whale predation on herring in Prince William Sound (PWS) project include the following:

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

During this reporting period we secured the last of the National Oceanic and Atmospheric Administration (NOAA) funds to cover vessel costs for our spring 2019 survey. Spring surveys for 2020-2022 (the remainder of this 5-year funding period) will be supported by additional funds received from the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC). These surveys will allow us

to continue our monitoring efforts during the herring spawn within PWS and maintain the time series which began in 2007. All fieldwork was completed during FY19 and chemical analysis for prey samples will be complete in the first quarter of FY20.

**Trends in humpback whale abundance, diet, and distribution**

We completed the fall Integrated Marine Predator-Prey (IMPP) survey with the fall/winter marine bird (19120114-E) and forage fish (19120114-C) projects and a NOAA funded spring whale-prey survey in April. We did not see a recovery in whale numbers during the spring survey, however, we did see an increase in fall numbers when compared to 2017 and 2018 (Fig. 1).

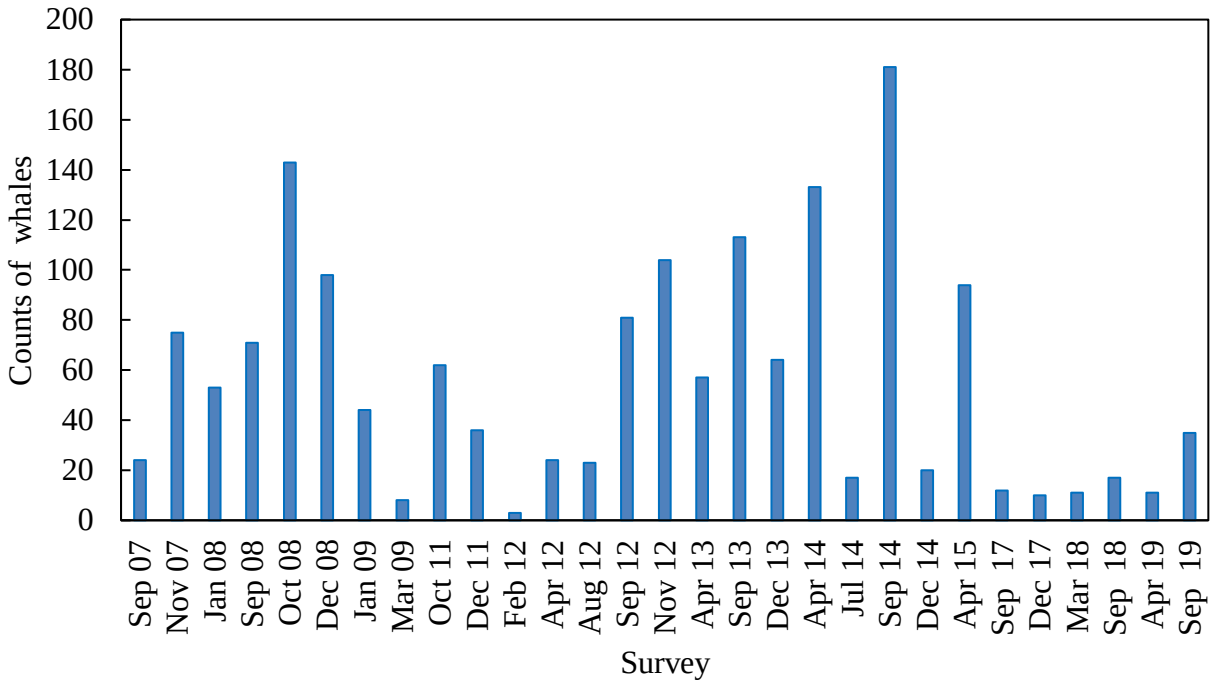


*Figure 1. Counts of humpback whales during Exxon Valdez Oil Spill Trustee Council and National Oceanic and Atmospheric Administration funded surveys in Prince William Sound.*

Humpback whale numbers have failed to rebound in Prince William Sound (PWS) following a decline associated with the 2014-2016 marine heatwave in the Gulf of Alaska. Encounter rates for humpback whales during fall surveys were 6.7 times higher in the years preceding the heatwave (2008, 2011-2014), than during the years following (2017-2019). The reduction of humpback whales is related to a decline in the biomass of herring in PWS. There was an increase in humpback whale encounter rates during fall of 2019 when compared to 2017 and 2018. However, they have not returned to pre-heatwave abundance (Table 1). Encounter rates allow us to account for variation in effort between years. Fall surveys are consistent in the area searched that allows for comparisons between years to establish trends. Spring and winter surveys tend to have more variation in duration, which captures seasonal variation in humpback whale numbers.

*Table 1. Encounter rates of humpback whales in Prince William Sound during fall surveys. * The 2007 survey did not cover Montague Entrance, an area known for the highest concentration of whales and herring during early fall. Gulf Watch Alaska sampling began in 2012, no surveys were conducted in 2015-16, but resumed in 2017 and will continue annually as funding allows.*

| Month/year | Counts of whales | Nautical miles surveyed | Encounter rate Whale/NM |
|---|---|---|---|
| Sep 2007* | 24 | 370 | 0.06 |
| Sep 2008 | 71 | 412 | 0.17 |
| Oct 2011 | 62 | 441 | 0.14 |
| Sep 2012 | 81 | 444 | 0.18 |
| Sep 2013 | 113 | 355 | 0.32 |
| Sep 2014 | 181 | 427 | 0.42 |
| Sep 2017 | 12 | 543 | 0.02 |
| Sep 2018 | 17 | 541 | 0.03 |
| Sep 2019 | 32 | 527 | 0.06 |

Humpback whale calf production continues to remain low within PWS, supporting the hypothesis that the reduction in whale numbers is nutritionally based (Fig. 2). Most humpback whales that feed seasonally in the Gulf of Alaska migrate to Hawaii for mating and calving. The 2015 North Pacific marine heatwave appears to have derailed recovery of this species causing starvation, mortality, reduced fecundity and local population declines. In PWS the decline in numbers of whales and calves seen in the fall pre and post marine heatwave was significant (Fig. 1 and Fig. 2). In 2008, a high of 140 unique whales and 17 calves were documented. Only one calf was seen during our surveys from 2015-2019. The discovery curve of individual whales in PWS flattens in 2014, the result of fewer new whales and lower calf production (Fig. 3).

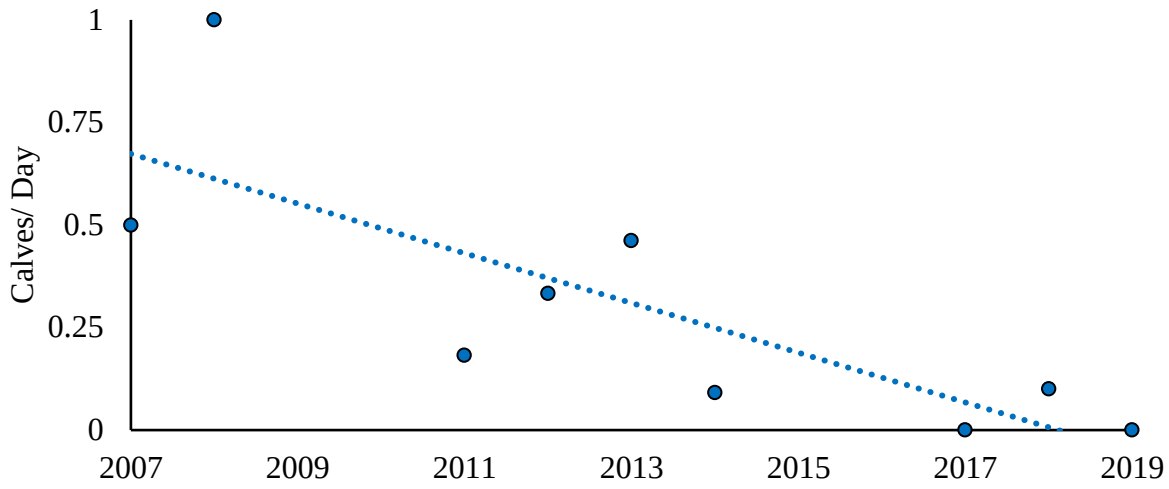


*Figure 2. The number of humpback whale calves seen /survey day in Prince William Sound.*

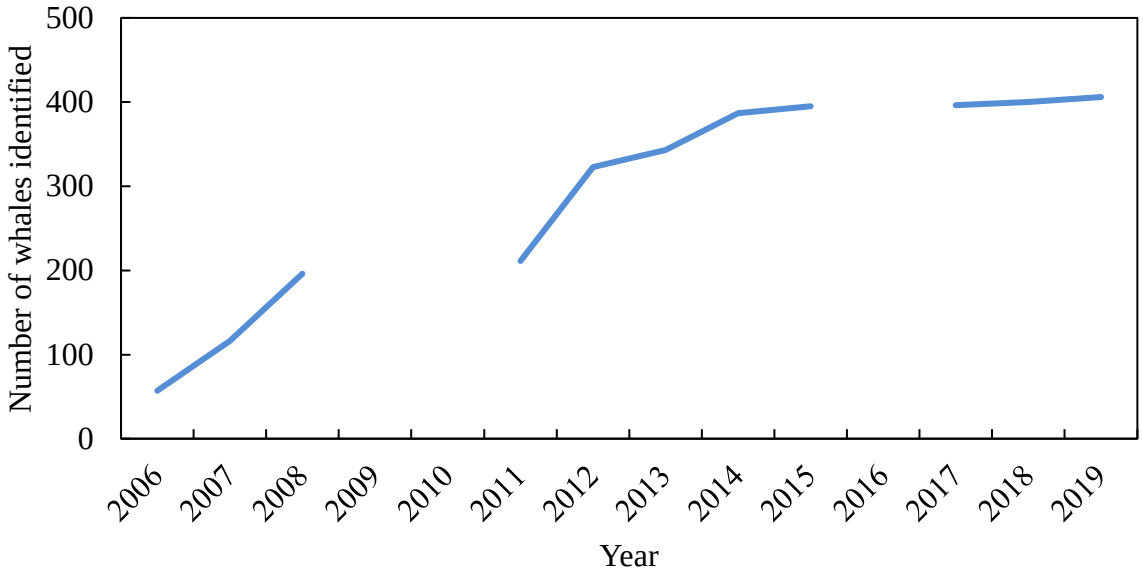


*Figure 3. Discovery curve for humpback whales in Prince William Sound. The curve flattens in 2014, the result of reduced immigration and lower calf production.*

The fate of the missing whales remains unknown. We have joined a collaborative research effort across the North Pacific Basin was initiated in winter of 2019 by Happywhale (happywhale.com) and the North Pacific Humpback Whale Photo ID Study Group (North Pacific Group). Multiple research groups are contributing their catalogs of whale flukes to Happywhale to increase the

understanding of movements of humpback whales across the North Pacific. Happywhale compared images of ~400 whales in the PWS catalog using automated image recognition, with images managed within the Happywhale system. This system provides rapid automated comparisons of, at present, photos of more than 24,000 individual humpbacks, thus greatly reducing the time required from labor-intensive manual matching. The catalogs (some incomplete) that have been compared to date are from Russia, Hawaii, Mexico, California, Oregon, Washington, British Columbia, Southeast Alaska, summer PWS, Gulf of Alaska, Kodiak, and Alaska Peninsula. Happywhale matching will be ongoing as catalogs are completed and updated and new catalogs are submitted. Preliminary new findings have found one match with Russia and strong connections to the Kodiak area. In time, missing whales should show up on the breeding grounds or in other feeding areas if they are still alive.

**Prey quality and trophic position through chemical analysis (using bomb calorimetry and stable isotopes)**

We continued to monitor trophic level and energy density for forage species in PWS. As in 2017 and 2018, based on plankton net sampling, we found that there may have been a shift it the species composition during 2019 to *T. spinifera* and *E. pacifica* replacing the typical common species (*T. longipes, T. inermis, and T. raschii*) seen before the 2105 marine heatwave. A similar shift was observed in the inside waters of Southeast Alaska (Emily Ferguson personal communication 21 Feb. 2020). Young of the year herring continued to be targeted by humpback whales as well as minke whales in 2019. Whales were observed lunging at the surface through flocks of seabirds foraging on herring. These small schools, usually less than 0.5 m in diameter, low quality prey that may incur higher foraging cost when compared to large shoals of adult herring (Fig. 4).

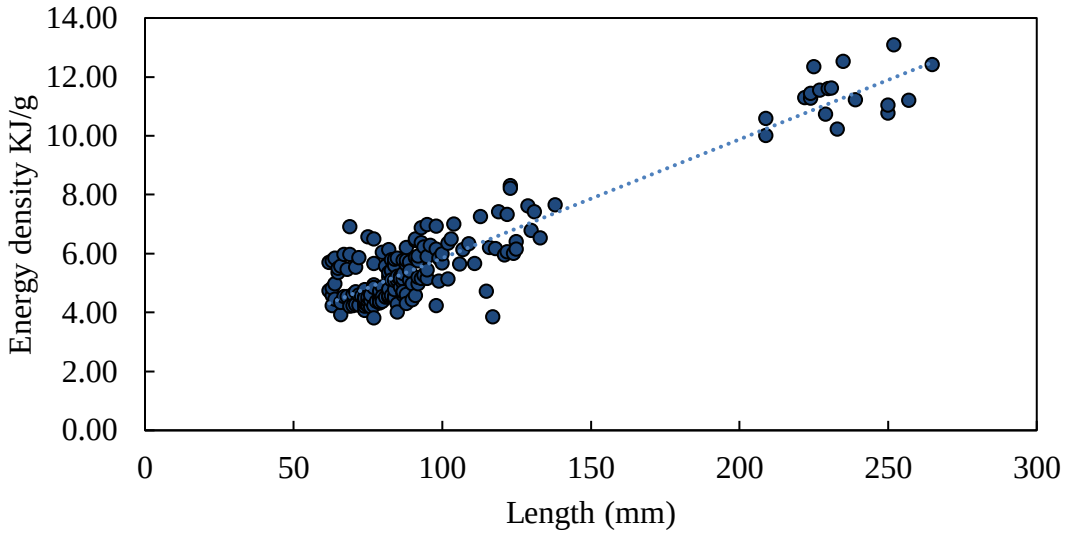


*Figure 4. Energy density (KJ/g) of Pacific herring by length collected in Prince William Sound.*

**Estimating the impact of humpback whale predation on herring**

We found a correlation between the numbers of individual whales identified each year in PWS (this includes data from both standardized surveys and opportunistic efforts) and the mile-days of milt as reported by Alaska Department of Fish and Game surveys (Haught and Moffitt) and the Herring Research and Monitoring program (Fig. 5).

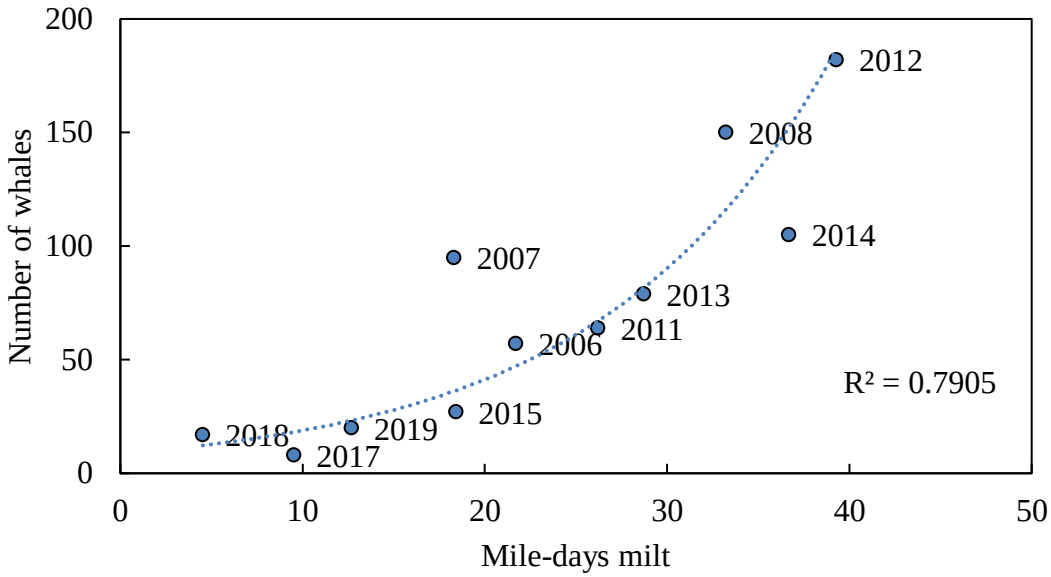


*Figure 5. The number of individually identified humpback whales and mile-days of milt for Prince William Sound, 2007-2019. Herring data are courtesy of Scott Pegau (Prince William Sound Science Center) and Stormy Haught (Alaska Department of Fish and Game).*

In September of 2019, the majority of whales observed appeared to be feeding on euphausiids with a few targeting schools of juvenile rather than adult herring. We located a group of humpback whales and fin whales feeding in Montague Entrance. This is the first time since the onset of the 2015 marine heatwave that we have seen concentrations of humpback whales and prey. During our spring survey whales were not as tightly associated with spawning herring shoals as they had been in the past. If environmental conditions are conducive to herring growth and survival, lower whale numbers combined with a switch to alternate prey should benefit struggling herring populations by reducing top-down pressure.

## 8. Coordination/Collaboration:

### A. Long-term Monitoring and Research Program Projects

#### 1. Within the Program

Our September 2019 IMPP survey was a collaborative effort with the forage fish (18120114-C) and fall and winter marine bird (18120114-E) projects.

Samples were collected for the forage fish project (18120114-C) in April.

Killer whales were photographed for the killer whale project (18120114-N).

Contributed data two GWA science synthesis report manuscripts, Arimitsu et al. 2019 (Chapter 3) and Suryan et al. 2019 (Chapter 4).

#### 2. Across Programs

##### a. Herring Research and Monitoring

We are coordinating with Dave McGowan and Scott Pegau with predation by whales on herring.

##### b. Data Management

This project works 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. Individual Projects

Provided fluke photographs to Ted Cheeseman (the North Pacific humpback whale photo ID study group).

### C. With Trustee or Management Agencies

Harbor porpoise eDNA was collected for stock structure in collaboration with Kim Parsons (National Marine Fisheries Service [NMFS]/Marine Mammal Laboratory).

Young of the year pollock were collected for Louise Copeman (NOAA Cooperative Institute for Marine Resources Studies, Oregon State University).

Sea lion brands were photographed for Lauri Jemison (Alaska Department of Fish and Game).

Collected a dead Steller sea lion pup for Kate Savage (NMFS/Alaska Regional Office/Protected Resources Division).

Contributed a whale abundance indicator to NOAA's Gulf of Alaska Ecosystem Status Report to the North Pacific Fisheries Management Council (Zador et al. 2019; https://access.afsc.noaa.gov/REFM/REEM/ecoweb/index.php): Fall Surveys of Humpback Whales in Prince William Sound.

## 9. Information and Data Transfer:

### A. Publications Produced During the Reporting Period

#### 1. Peer-reviewed Publications

No new contributions this reporting period.

#### 2. Reports


Arimitsu, M., J. Piatt, R. Suryan, S. Batten, M.A. Bishop, R. Campbell, H. Coletti, D. Cushing, K. Gorman, S. Hatch, S. Haught, R. Hopcroft, K. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, W.S. Pegau, A. Schaeffer, S. Schoen, J. Straley, and V. von Biela. 2019. Synchronous collapse of forage species disrupts trophic transfer during a prolonged marine heatwave. *In*: The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska. Long-Term Monitoring Program (Gulf Watch Alaska) Synthesis Report *Exxon Valdez* Oil Spill Trustee Council Program 19120114 (Eds: Suryan, R.M., M.R. Lindeberg, and D.R. Aderhold). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Moran, J., and J. Straley. 2019. Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Project 18120114-O), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, AK.

Moran, J., and J. Straley. 2019. Fall Surveys of Humpback Whales in Prince William Sound *in* Zador, S. G., and E. M. Yasumiishi. 2019. Ecosystem Status Report 2018: Gulf of Alaska. Report to the North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99301Reports. https://access.afsc.noaa.gov/REFM/REEM/ecoweb/pdf/2019GOAecosys.pdf

Moran, J., and J. Straley provide data and input for; Draft Biological Report for the Proposed Designation of Critical Habitat for the Central America, Mexico, and Western North Pacific Distinct Population Segments of Humpback Whales (*Megaptera novaeangliae*). Prepared by: National Marine Fisheries Service U.S. Department of Commerce National Oceanic and Atmospheric Administration May, 2019 https://www.fisheries.noaa.gov/action/proposed-rule-designate-critical-habitat-central-america-mexico-and-western-north-pacific

Moran, J., and J. Straley provide data for; Endangered and Threatened Wildlife and Plants: Proposed Rule To Designate Critical Habitat for the Central America, Mexico, and Western North Pacific Distinct Population Segments of Humpback Whales. 9 October 2019 https://www.govinfo.gov/content/pkg/FR-2019-10-09/pdf/2019-21186.pdf

Suryan, R., M. Arimitsu, H. Coletti, R. Hopcroft, M. Lindeberg, S. Batten, M.A. Bishop, R. Brenner, R. Campbell, D. Cushing, S. Danielson, D. Esler, T. Gelatt, S. Hatch, S. Haught, K. Holderied, K. Iken, D. Irons, D. Kimmel, B. Konar, B. Laurel, J. Maniscalco, C.

Matkin, C. McKinstry, D. Monson, J. Moran, D. Olsen, S. Pegau, J. Piatt, L. Rogers, A. Schaeffer, S. Straley, K. Sweeney, M. Szymkowiak, B. Weitzman, J. Bodkin, S. Zador. 2019. Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska. *In*: The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska. Long-Term Monitoring Program (Gulf Watch Alaska) Synthesis Report *Exxon Valdez* Oil Spill Trustee Council Program 19120114 (Eds: Suryan, R.M., M.R. Lindeberg, and D.R. Aderhold). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

### 3. Popular articles

No new contributions this reporting period.

## B. Dates and Locations of any Conference or Workshop Presentations where EVOSTC-funded Work was Presented

### 1. Conferences and Workshops

Arimitsu, M., M. Bishop, D. Cushing, S. Hatch R. Kaler, K. Kuletz, C. Matkin, J. Moran D.Olsen, J. Piatt, A. Schaeffer, J. Straley. 2019. Changes in Marine Predator and Prey Populations in the Northern Gulf of Alaska: Gulf Watch Alaska Pelagic Update 2019. Poster Presentation. Alaska Marine Science Symposium, Anchorage, AK. 27-31 January.

Boswell, K., R. Heintz, J. Vollenweider, J. Moran, and S. LaBua. 2020. The decline of acoustic backscatter associated with overwintering Pacific herring (*Clupea pallasii*) in Lynn Canal, Alaska. Poster Presentation. Alaska Marine Science Symposium, Anchorage, AK. 27-31 January.

Lyman, E., R. Finn, J. Moran, K. Savage, C. Gabriele, J. Straley, N. Davis, F. Sharpe, J. Neilson, A. Jensen, D. Schofield, S. Wright, P. Cottrell, T. Rowles, S. Wilkin, M. Lammers, E. Zang. 2019. Are recent population level changes in the central North Pacific humpback whales, *Megaptera novaeangliae*, affecting entanglement threat and reporting rate? Poster Presentation. World Marine Mammal Conference, Barcelona, Spain. 9-12 December.

Moran, J. 2019. Upper Trophic Conditions: Humpback whales. Oral Presentation. Spring PEEC 2019 [Preview of Ecosystem and Economic Conditions] An Alaska IEA activity AFSC/PMEL, Seattle, WA. 6-7 June.

Moran, J., and J. Straley. 2020. Humpback whale numbers have not recovered in Prince William Sound following the 2014 – 2016 marine heatwave. Poster Presentation. Alaska Marine Science Symposium, Anchorage, AK. 27-31 January.

Moran, J., and J. Straley. 2019 Trends in humpback whale (*Megaptera novaenagliae*) abundance, distribution, and health in Hawaii and Alaska Meeting Report. Workshop. NOAA Fisheries Pacific Islands Regional Office, Honolulu, Hawaii. 27-28 November.

Straley, J., J. Moran, B. Witteveen, O. Titova, O. Filatova, C. Gabriele, J. Neilson, C. Matkin, O. von Ziegesar, and T. Cheeseman. 2020. Local collapse of a humpback whale population during the 2014-2016 marine heatwave: Where have all the whales gone? Poster Presentation. Alaska Marine Science Symposium, Anchorage, AK. 27-31 January.

Suryan, R., M. Arimitsu, H. Coletti, R. Hopcroft, M. Lindeberg1, S. Batten, J. Bodkin, M. Bishop, R. Campbell, D.l Cushing, .S Danielson, D. Esler, S.Hatch, S. Haught, K. Holderied, K. Iken, D. Irons, R. Kaler, B. Konar, K. Kuletz, C. Matkin, C. McKinstry, D. Monson, J. Moran, D. Olsen, S. Pegau, J. Piatt, A. Schaefer, J. Straley, B. Weitzman. 2019. Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska: Seabirds are the tip of the iceberg. Oral Presentation. The Wildlife Society and American Fisheries Society Conference, Reno, Nevada. 28 September - 3 October.

Suryan, R., S. Zador, M. Lindeberg , Mayumi Arimitsu , J.Piatt, J. Moran, J. Straley, H. Coletti , D. Monson S. Hatch , T. Dean, R. Hopcroft , S. Batten, S. Danielson, B. Konar, K. Iken, B. Laurel, R, Campbell, M. Bishop, A. Shaefer, S. Pegau, K. Kuletz, R. Kaler, D. Irons. 2019. Ecosystem response to a marine heat wave in the Gulf of Alaska: seabirds are the tip of the iceberg. 2019 Oral Presentation. Pacific Seabird Group 46th Annual Meeting Kaua'i Beach Resort Lihue, Kaua'i, Hawai'i. 27 February – 3 March.

**2. Public presentations**

John Moran and Mayumi Arimitsu presented on whales and forage fish to the Chenega Bay School on 20 September 2019. Both students and members of the public attended.

**C. Data and/or Information Products Developed During the Reporting Period, if Applicable**

All Data and metadata have been uploaded to the Research Workspace and made available on the Gulf of Alaska data portal on schedule (https://portal.aoos.org/gulf-of-alaska#metadata/54adceab-74cb-4419-b02c-bacb6d2acb8b/project).

The Prince William Sound Fluke Catalog has been updated through September of 2019.

Our PWS Fluke Catalog has been up loaded to Happywhale (Ted Cheeseman), the North Pacific humpback whale photo id study group, for a basin wide study on humpback whales. https://happywhale.com/home.

**D. Data Sets and Associated Metadata that have been Uploaded to the Program's Data Portal**

Moran, J. R. and J. M. Straley, 2019. Lipid Analyses for Pacific Herring, Invertebrates and Humpback Whales in the Gulf of Alaska, 2017-2019, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

Moran, J. R. and J. M. Straley, 2019. Significance of Whale Predation On Natural Mortality Rate of Pacific Herring in Prince William Sound, Alaska: 2017-2019, Gulf Watch Alaska Pelagic

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

Moran, J. R. and J. M. Straley, 2019. Dall's and Harbor Porpoise Survey Data, Prince William Sound, Alaska: 2017-2019, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

Moran, J. R. and J. M. Straley, 2019. Castaway CTD Data, Prince William Sound, Alaska: 2017-2019, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

**10. Response to EVOSTC Review, Recommendations and Comments:**

**Science Panel Comment (FY20):** *The Panel would like the PIs to discuss: if there's a decrease in predation of herring in humpback whales, what age-class of herring would that affect and when would one expect to see a response in the herring population? These questions should be addressed and interpreted, not just in these comments but in future proposals and reports. We emphasize the inclusion of interpretation and discussion of data (not necessarily analyses), in the proposal.*

*In Figure 1 of the proposal regarding the index on whale abundance: has there been a shift in whale distribution in recent years? It is important to try to distinguish changes in abundance with changes in distribution to the extent possible. The high variability in whale counts between sampling periods cannot be explained by whale population dynamics alone. There appears to be a seasonal signal in the counts, although this may not be a fixed effect. We would like to see mark and recapture methods applied to generate population estimates with confidence intervals, such as those used in Teerlink et al. (2015) to assess population estimates.*

**PI Response (FY20 9.27.19)**: This is an interesting question and knowledge of the biology of herring and whales is needed to fully address this question. Adult herring have a higher energy density than juveniles and form large, dense shoals during spawning and overwintering. Adult herring have been the preferred prey for humpback whales in Prince William Sound (PWS). Humpback whales follow overwintering herring into PWS in September through Montague Strait and then to Port Gravina through the winter and spring when spawning occurs. We have found ~200 whales feeding on large schools of herring in the early study years (2007-2014) and have more than 400 individual whales in our catalog. We have documented all age classes of herring being consumed by whales. The 2017-18 decrease in herring predation by whales parallels the dramatic decline of herring in PWS (Fig. 1 below).

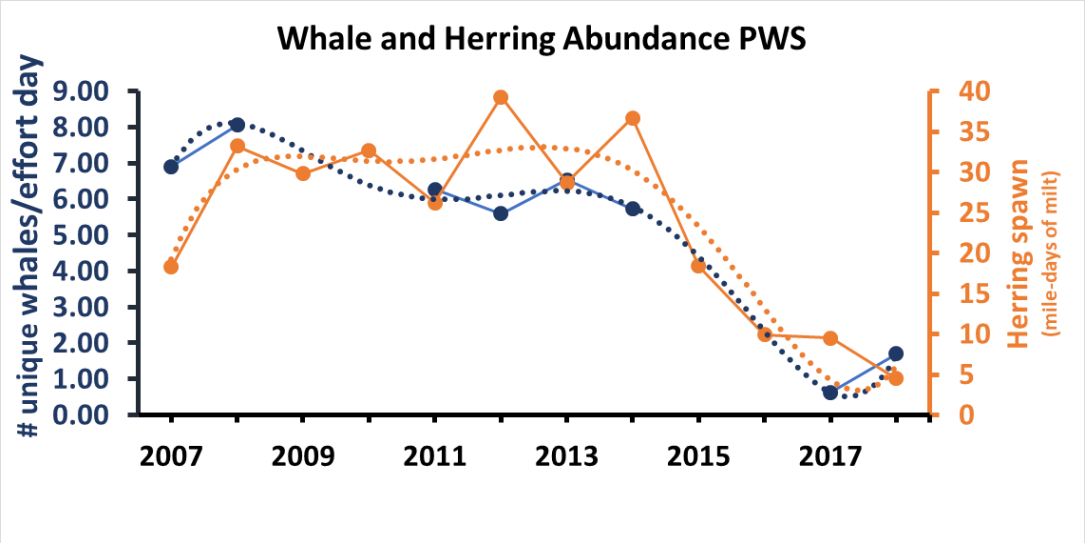


*Figure 1 (Fig. 7 in our 2018 annual report). In PWS the humpback whale decline parallels the herring decline, their major food source. Miles-day herring spawn is used as an annual indicator for change in herring abundance. The trajectory could indicate a carrying capacity with a plateau, then steep decline (with a bit of a lag) during the marine heatwave (that never fully dissipated in the Gulf of Alaska and re-intensified in 2018).*

Humpback whales in PWS rely on adult herring as their primary prey in the fall and winter. With herring biomass at record lows in 2017-2018 far fewer whales (less than 20) were present in the same areas where up to ~200 whales had been documented feeding each year on herring during 2007-2014. However, when adult herring are scarce, we see a switch to age zero, one, and two year old herring. Younger herring form small, disperse schools which require increased foraging cost for the whales resulting in a lower energetic return. Whales increased their predation on juvenile herring beginning in 2015.

There has been insufficient recruitment of herring to determine what age structure would be most impacted by whale predation. The Gulf Watch Alaska integrated predator-prey surveys and the Herring Research and Monitoring program will discuss the possibility of determining answers to some of these questions. In the future, further discussion and the inclusion of interpretation of data will be addressed in proposals.

There has not been a shift in distribution within PWS, but an actual decline in numbers of whales sighted. Our effort and track lines have been consistent and cover most of the sound. Similar declines in humpback whale numbers have also been documented in Southeast Alaska. Neither of these regions are closed populations and there is potential that whales that generally feed in PWS are foraging elsewhere in the Gulf of Alaska. We are connected with a network of researchers in the North Pacific, including Hawaii and the California Current to determine if whales that formerly fed in PWS are now feeding elsewhere, or potentially deceased. We recently submitted the PWS humpback whale catalog to an automated matching program (happywhale.com) to see if these

whales have been feeding elsewhere in the North Pacific. Both PIs are leading working groups to determine declines in humpback whale numbers on the breeding grounds and in Alaska are the result of migration or mortality.

The variability among surveys is due to the behavior and biology of humpback whales. These are seasonal migrants that generally winter in tropical waters and feed in higher latitudes. The departure from feeding areas is staggered with some whales leaving early and some later, with some returning from the wintering areas earlier and some later. There also are some whales overwintering in higher latitudes. On the feeding areas, humpback whales are dispersed in summer and aggregate in the fall when herring come into deep bays and fjords to overwinter. Thus, a seasonal peak is evident in the fall and a seasonal low is evident in the winter, with numbers increasing in spring as whales return. The very low numbers in 2017 in September were alarming and persisted into 2018. A September survey is currently underway and we will soon know if conditions are staying the same or changing.

We will apply a mark-recapture model to these data, as we did for our earlier data (Straley et al. Deep-Sea Research Part II 147 (2018) pp. 173–186). As stated in our methods to assess the impact of predation more information is needed than an abundance estimate as described in our paper:

”Although mark-recapture models provide an estimate of abundance, they do not describe seasonal trends. Consequently, we used the number of unique whales seen each month for establishing seasonal patterns, then adjusted the pattern to account for the estimated number of whales present. The data used to describe the seasonal attendance pattern, included calves because by fall calves have become intermittently independent and become more independent with age (Straley, unpublished data). By fall calves were feeding on the same prey as other whales. We also included individuals identifiable in poor quality images. This number represents a lower bound to the daily attendance pattern for whales in each location. Daily attendance was estimated by fitting linear models to the observed numbers. Inflection points for linear models were determined visually. We used the attendance patterns to establish a lower bound (as described above) and the Huggins estimate of abundance to establish the upper bound to the whale attendance pattern.“

Keep in mind the Teerlink et al. (2015) data were collected in a very small area of PWS in the summer and no data on prey were collected. The purpose was very different from our study. We are addressing how many whales each day are foraging on herring. While knowing how many whales in a season are present is relevant for some questions, that number provides little detail on day to day foraging. Also, we are studying this population of whales that mostly leaves during the winter (although a few overwinter), then returning in spring and they are often different whales. Hence, immigration and emigration are huge issues, which violates the basic assumptions of mark recapture models.

**Science Panel Comment (FY19):** *The Science Panel would like to see these data linked with forage fish and seabird data. If whales aren't there is it directly correlated with herring numbers? Namely, does reduced herring biomass lead to fewer whale observations? Also, changes in whale abundance should be distinguished from shifts in whale distributions to the extent possible. Comparison of whale trends in PWS with the greater North Pacific may be helpful.*

**PI Response (FY20 9.27.19)**: Anecdotally, yes, the decline in whale abundance and several species of piscivorous seabirds mirrors the recent drop in herring biomass (Suryan et al. 2019 GWA science synthesis report). Prior to recent marine heatwave adult overwintering and spawning herring were the preferred prey for whales in PWS. Our 2017 and 2018 surveys found fewer whales in PWS and a shift in feeding behavior to more dispersed prey such as juvenile herring. We saw similar shifts in whale abundance and feeding behaviors in Southeast Alaska. Quantifying the relationship between whales, birds, and herring is one of the objectives of the Pelagic Component's integrated predator-prey surveys that were piloted in 2014 and adopted during the current five year funding cycle. We have acoustic data from herring schools in September and December of 2017 and March and September of 2018 to compare with earlier surveys. The December and March survey vessels were funded through NOAA, but with no additional support for data analysis. However, we are exploring options to have these data analyzed, which will collectively provide valuable information on the relationship between whales and herring when herring abundance is extremely low.

Yes, there are two possibilities for the decline in whale numbers within PWS: 1) they died, or 2) they moved. Unfortunately, there is no effort to determine trends for the greater population of humpback whales in Alaska or any attempts to survey offshore.

The PIs are leading the SPLISH Project (Survey of Population Level Indices for Southeast Alaska Humpback) to assess trends in abundance, calf production, spatial and temporal distribution, prey composition, and body condition for humpback whales in northern Southeast Alaska, and work closely with the Glacier Bay National Park long term monitoring program for humpback whales. These are the only projects in the state addressing humpback whale abundance trends.

Due to the lack of a comprehensive humpback whale survey in Alaska, data from our PWS and southeast Alaska surveys have been relied on by NOAA for section 7 consultations under the Endangered Species Act, establishing critical habitat, and evaluating unusual mortality events.

## 11. Budget:

Please see provided program workbook. There are no deviations from anticipated cumulative spending.

| **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 | $12.1 |
| Travel | $7.8 | $7.8 | $7.8 | $7.8 | $7.8 | $39.0 | $28.0 |
| Contractual | $119.7 | $119.8 | $149.5 | $146.7 | $136.5 | $672.3 | $288.8 |
| Commodities | $15.0 | $14.0 | $14.0 | $14.0 | $17.5 | $74.5 | $16.3 |
| Equipment | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **SUBTOTAL** | $148.5 | $142.2 | $171.9 | $169.1 | $162.4 | $794.2 | $345.2 |
| General Administration (9% of subtotal) | $13.4 | $12.8 | $15.5 | $15.2 | $14.6 | $71.5 | N/A |
| **PROJECT TOTAL** | $161.9 | $155.0 | $187.4 | $184.4 | $177.0 | $865.7 | |
| Other Resources (Cost Share Funds) | $220.0 | $220.0 | $120.0 | $127.0 | $127.0 | $814.0 | |

## LITERATURE CITED

Zador, S., E. Yasumiishi, and G.A. Whitehouse. 2019. Ecosystem Status Report 2019 Gulf of Alaska. North Pacific Fishery Management Council, Anchorage, AK.