

**EVOSTC FY17-FY21 INVITATION FOR PROPOSALS  
 FY19 (YEAR 8) CONTINUING PROJECT PROPOSAL SUMMARY PAGE**

**Project Number and Title**

Gulf Watch Alaska: Pelagic Component Project

**19120114-O**—Long-term Monitoring of Humpback Whale Predation on Pacific Herring in Prince William Sound

**Primary Investigator(s) and Affiliation(s)**

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**Date Proposal Submitted**

August 17, 2018

**Project Abstract**

The humpback whale monitoring project is part of the Gulf Watch Alaska (GWA) pelagic component’s integrated predator-prey survey. Humpback whale predation has been identified as a significant source of mortality on over-wintering Pacific herring in Prince William Sound (PWS) and a likely top-down force constraining their recovery. Humpback whales in PWS have a higher percentage of herring in their diet and forage longer on herring during non-summer months than their counterparts in Southeast Alaska. Currently, North Pacific humpback whales in the Gulf of Alaska may be experiencing nutritional stress and increased use of inland waters like PWS could result in increased predation on herring. We will continue to evaluate the impact by humpback whales foraging on Pacific herring populations in PWS following protocols established during 2007/08 and 2008/09 (EVOSTC project PJ090804). Prey selection by humpback whales is determined through acoustic surveys, visual observation, scat analysis, and prey sampling. Chemical analyses of skin and blubber biopsy samples provide a longer term perspective on shifts in prey type (trophic level from stable isotopes) and quality (energy content). These data are combined in an updated bioenergetic model that allows us to assess the impact of recovering humpback whale populations on the PWS ecosystem. By integrating with the forage fish and fall/winter marine bird components, we contribute to a comprehensive understanding of bottom-up influences and top-down controls on the PWS herring population. Our project has conducted three cruises per year: a September cruise funded by GWA, and December and March cruises funded (\$100K) by NOAA Alaska Fisheries Science Center. The December and March surveys during FY19-21 will no longer be funded by NOAA. Our research has demonstrated that humpback whale predation on herring peaks in the fall and spring when fish are aggregated. With the fall survey funded by GWA, we are requesting additional funding to maintain the spring cruise. A spring survey, in particular, provides an important assessment of whale abundance and predator-directed impact on pre-spawning herring schools.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$161,900	\$155,000	\$187,400*	\$184,370*	\$177,000*	\$865,700

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$220,000	\$220,000	120,000	120,000	120,000	\$800,000

\* Totals in FY19-21 include additional annual requests of \$29,400 that will be used to conduct an early spring survey (March). Funding for this survey has previously funded by NOAA. Please see Sections 2C and 6B for details.

## 1. PROJECT EXECUTIVE SUMMARY

### *Pelagic Component*

The pelagic component research team proposed for FY18-21 to continue monitoring key pelagic species groups in Prince William Sound (PWS) using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. 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 *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), agency resource managers, non-governmental organizations, and the public.

Thus, the two over-arching questions for the pelagic component to answer during this 5-year period are:

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

### *Humpback Whale Predation on Herring Surveys in PWS*

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 (Barlow et al. 2011), and parallel increases in whale abundance have been documented in PWS. Over much of the same period the abundance of the dominant forage fish, Pacific herring (*Clupea pallasii*), shifted from an abundant to a diminished state. The suspension of the commercial fishery in the early 1990s 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) estimated 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.

This study addresses the lack of recovery of Pacific herring in PWS and compares the influence of foraging humpback whales upon herring populations in the Gulf of Alaska. Information on whale distribution, abundance, diet and the availability of herring as prey, are used to evaluate the relationship between overwintering herring and humpback whales. In PWS, the spatial and temporal distribution of whales are synchronized with the formation of the large shoals of overwintering herring observed in the late fall and winter. Thus, it appears that humpback whales in PWS are maximizing the exploitation of over-wintering herring prior to their southbound migration to the breeding grounds. PWS has had the smallest biomass of herring but the most whales relative to Southeast Alaska (Moran et al. 2018). This makes the impact of predation potentially more severe in PWS, suggesting that top-down forcing may be limiting the recovery of herring in PWS. However, since 2013, major natural perturbations in the marine ecosystem (regime shift, Pacific Decadal Oscillation and the 'Blob') has occurred (Straley and Moran 2018). 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. Counts of humpback whales have dropped in our recent surveys (Fig 1.). This is likely the result of reduced prey availability. Humpback

whales will continue to have an impact on PWS herring but to what extent is unknown. 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 the Gulf of Alaska for over 50 years, rebounded and now is in a potential decline.

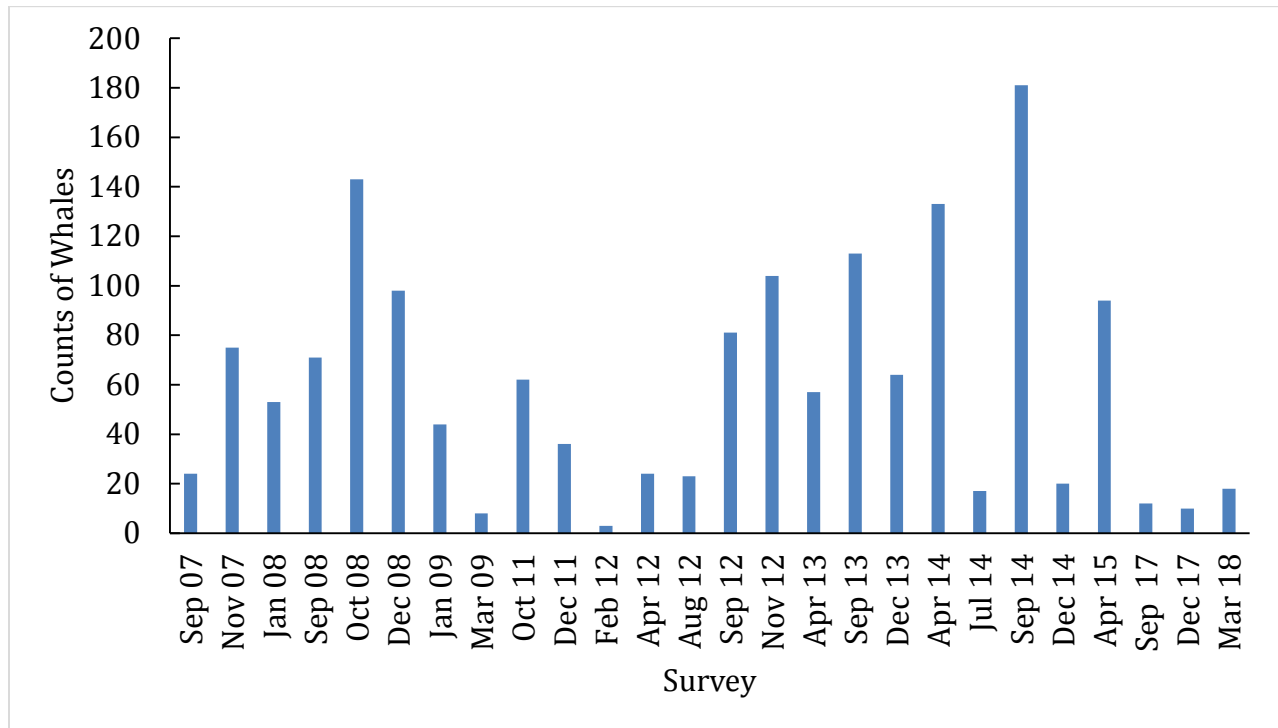


Figure 1. Counts of humpback whales in Prince William Sound provide an index of whale abundance, recent declines in whale numbers correspond to declines in herring biomass.

From 2005-2015, NOAA funds were used for vessel charters for PWS whale survey cruises in December (winter) and March (early spring) and will no longer be available after FY19-21. We are requesting vessel charter funds to support one of the lost cruises. We would drop the December cruise, but maintain the March cruise. While whales were found in December, inclement weather can prevent good data collection. March survey allows for an important assessment of spring conditions prior to herring spawning, an assessment of whale abundance, and quantification of predator consumption of pre-spawning herring schools. Maintaining the combined fall (September) and spring (March) surveys provides the best estimate of consumption given that whale predation on herring peaks in the fall and spring when fish are aggregated (Straley et al. 2018), which will help achieve the goals of this project.

**2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS**

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**A. Project Milestones and Tasks**

Table 1. Project milestone and task progress by fiscal year and quarter, beginning February 1, 2017. The requested new task is indicated in red. C = completed, X = not completed or planned. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

Milestone/Task	FY17				FY18				FY19				FY20				FY21			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<b>Milestone 1: Surveys</b>																				
Integrated predator-prey surveys (EVOSTC funded)			C				X				X				X				X	
Alternate Survey schedule (with additional NOAA funds)	C		C		C															
New task: Early spring survey (EVOSTC funded)									X				X				X			
<b>Milestone 2: Data Processing</b>																				
Photographic analysis			C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Annual reports/data upload to portal					C				X				X				X			
<b>Milestone 3: Analyses</b>																				
Chemical analysis			C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<b>Milestone 4: Reporting</b>																				
Estimate whale impact																				X
Final report and publications																				X
Data management, QAQC, workspace upload					C	C		X	X			X	X			X	X			X
Annual PI meeting					C			X				X				X				X
FY Work Plan (DPD)			C				C				X				X					

**B. Explanation for not completing any planned milestones and tasks**

All milestones and tasks were completed on schedule.

### C. **Justification for new milestones/tasks**

We are not adding new milestones, but requesting additional funds to maintain one milestone. Our December and March surveys during FY19-21 will no longer be funded by NOAA. Given that our research has demonstrated humpback whale predation on herring peaks in the fall and spring when fish are aggregated (Straley et al. 2018), we would like to maintain the March (spring) survey. We, therefore, are requesting additional EVOSTC funds to allow the March PWS whale survey cruises to continue in FY19-21. March surveys also provide an important assessment of spring conditions prior to herring spawning, an assessment of whale abundance, and quantification of predator consumption of pre-spawning herring schools. We feel that it is critical to maintain the combined fall (September) and spring (March) surveys to provide the best estimate of whale consumption on aggregated herring schools in PWS and achieve the goals of this project.

## **3. PROJECT COORDINATION AND COLLABORATION**

### **A. *Within an EVOSTC-funded Program***

#### *Gulf Watch Alaska*

This study is part of the pelagic component of the integrated Gulf Watch Alaska (GWA)-Long-term Monitoring of Marine Conditions and Injured Resources and Services as. The GWA pelagic projects share research platforms and common goals of the integrated predator-prey surveys that include our project (humpback whale; Moran and Straley), marine bird (Bishop, project 19120114-E), and forage fish (Arimitsu and Piatt, project 19120114-C). Our project also collects data for the killer whale project (Matkin, project 19120114-N).

#### *Herring Research and Monitoring*

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.

#### *Data Management*

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

### **B. *With Other EVOSTC-funded Projects***

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

### **C. *With Trustee or Management Agencies***

The unique timing and focus of this project provides Trustee and Management Agencies with valuable data and platforms for both management and research. Data collected on humpback whale abundance will be of direct value to National Oceanic and Atmospheric Administration (NOAA) Protected Resource Division 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. Our collaboration within the GWA

pelagic component is the only directed whale foraging and prey study in the Gulf of Alaska. Protected Resource Division (Aleria Jensen) is funding the Survey of Population Level Indices for Southeast Alaska (SPLISH), a collaborative survey of humpback whales in northern Southeast Alaska. The objectives of this study were to establish baseline conditions for indices that are slated to be monitored for the 10 year post-delisting period. SPLISH builds on work conducted during Exxon Valdez Oil Spill Restoration Project: 100804 and compliment the GWA survey. Data from the GWA surveys and SPLISH were provided to the Humpback Whale Critical Habitat Review Team (Lisa Manning) and are included in the North Pacific Fishery Management Council’s annual forage fish stock assessment.

This project is also working with NOAA to develop a humpback whale index as an indicator in ecosystem assessments for reports to the North Pacific Fisheries Management Council (Stephani Zador, NMFS AFSC REFM Division, Resource Ecology and Ecosystem Modeling Program). Collections of juvenile forage fish, particularly age-0 pollock, are of direct interest to the NOAA Alaska Fisheries Science Center (AFSC), which is actively engaged in understanding how winter influences pollock survival (Recruitment Processes Alliance – FOCI, EMA, RECA, REFM programs). We anticipate working with the NOAA 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 for Lauri Jemison (Alaska Department of Fish and Game). 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 and survival rates of Steller sea lions. We also collect data (location, number, species, and behavior) on other cetacean species sighted in PWS.

**4. PROJECT DESIGN**

**A. Overall Project Objectives**

This project directly address the following integrated predator-prey survey objectives (see also Table 2):

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

Table 2. Integrated predator-prey collaborations by objective. Bolded text highlights humpback whale objectives.

Objective	Index	Task	PI
<b>a. Estimate humpback whale abundance, diet, and distribution</b>			
	<b>Whale counts by sub-region</b>	<b>Integrated Surveys: whale counts, biopsies</b>	<b>Moran (NOAA)/ Straley (UAS)</b>
	<b>Whale Identification</b>	<b>Integrated Surveys: Photo ID</b>	<b>Moran (NOAA)/ Straley (UAS)</b>
	<b>Whale Diet</b>	<b>Integrated Surveys: scales, scat, biopsies, visual observations, hydroacoustics</b>	<b>Moran (NOAA)/ Straley (UAS)/ Arimitsu &amp; Piatt (USGS)</b>
<b>b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas</b>			
	Georeferenced marine bird counts, group size, behavior by species	Integrated Surveys: marine bird transects	Bishop (PWSSC)
<b>b.i. Relate marine bird and humpback whale presence to prey fields identified during hydroacoustic surveys.</b>			

Objective	Index	Task	PI
	<b>Spatial coherence of bird and whale presence/ absence, acoustic estimates of forage fish and euphausiid biomass</b>	<b>Integrated Surveys: hydroacoustic and marine bird transects, whale focal follows</b>	Arimitsu & Piatt (USGS)/ Bishop (PWSSC)/ <b>Moran (NOAA)/ Straley (UAS)</b>
<b>b.ii. Characterize marine bird-humpback whale foraging dynamics</b>			
	<b>Georeferenced marine bird and whale counts, group size, behavior by species</b>	<b>Integrated Surveys: marine bird transects; whale focal follows</b>	Bishop (PWSSC)/ <b>Moran (NOAA)/ Straley (UAS)/</b> Arimitsu & Piatt (USGS)
<b>c. Estimate index of forage fish availability in seasonally predictable predator foraging areas</b>			
	<b>Species composition and biomass within persistent predator foraging areas</b>	<b>Integrated Surveys: hydroacoustic-trawl data</b>	Arimitsu & Piatt (USGS)/ <b>Moran (NOAA)</b> Bishop (PWSSC)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu & Piatt (USGS)
	<b>Diet, energy density</b>	<b>Sample Analysis: forage fish</b>	<b>Moran (NOAA)</b>
<b>d. Estimate an index of euphausiid availability in seasonally predictable predator foraging areas</b>			
	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)
<b>e. Relate whale, marine bird and forage fish indices to marine habitat</b>			
	<b>Oceanographic metrics and zooplankton biomass</b>	<b>Integrated Surveys: CTD and zooplankton samples</b>	Arimitsu & Piatt (USGS)/ <b>Moran (NOAA)/ Straley (UAS)/</b> Bishop (PWSSC)

## **B. Changes to Project Design and Objectives**

We will no longer conduct the December survey due to loss of in-kind funds for vessel support from NOAA. If our request for additional EVOTC funds is not granted, then we will also no longer conduct the March survey and only the September integrated predator-prey survey will remain.

## **5. PROJECT PERSONNEL – CHANGES AND UPDATES**

There are no personnel changes or updates.

## **6. PROJECT BUDGET FOR FY19**

### **A. Budget Forms (See GWA FY19 Budget Workbook)**

Please see project budget forms compiled for the program.

### **B. Changes from Original Project Proposal**

NOAA funds for winter and spring surveys in PWS are no longer available for FY19-21 (\$100K per year). We are therefore requesting funds for 1 additional survey in early spring (March, 6 days) for \$27K/year for the next three years. Reduced funding is required for the spring survey because a smaller vessel will be used, no trawling or acoustics will be conducted, and the survey is planned for fewer days compared with the original proposal using NOAA funds.

Table 3. Request for additional funding (in thousands of dollars) by budget category including GA. Funds will support an early spring (March) survey in PWS through FY21.

Budget Category	New Request FY19	New Request FY20	New Request FY21	Total New Request
Personnel	\$0.0	\$0.0	\$0.0	\$0.0
Travel	\$0.0	\$0.0	\$0.0	\$0.0
Contractual	\$27.0	\$27.0	\$27.0	\$81.0
Commodities	\$0.0	\$0.0	\$0.0	\$0.0
Equipment	\$0.0	\$0.0	\$0.0	\$0.0
Annual Subtotal	<b>\$27.0</b>	<b>\$27.0</b>	<b>\$27.0</b>	<b>\$81.0</b>
9% GA	\$2.4	\$2.43	\$2.43	\$7.3
Total with GA	\$29.4	\$29.4	\$29.4	\$88.3

### C. Sources of Additional Project Funding

For FY19-21, NOAA will make the following in kind annual contributions: salary (\$70 K) for PI Moran (7 mos. GS-12), and all field and laboratory equipment required (\$50 K) for an annual total of \$120K.

Total in kind contribution by NOAA for the life of this project will now be \$800 K.

## 7. FY18 PROJECT PUBLICATIONS AND PRODUCTS

### Publications / reports

Moran, J. R. and J. M. Straley. 2018. Long-term Monitoring of Humpback Whale Predation on Pacific Herring in Prince William Sound). *Exxon Valdez Oil Spill Long-Term Monitoring Program (Gulf Watch Alaska) Annual Report (Exxon Valdez Oil Spill Trustee Council Project: 18120114-O)*, Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

Moran, J. R. and J. M. Straley. 2018. Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound. *Exxon Valdez Oil Spill Long-Term Monitoring Program (Gulf Watch Alaska) Final Report (Exxon Valdez Oil Spill Trustee Council Project: 16120114-O)*, Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

### Published and updated datasets

**Research Workspace:** 2017 fluke id catalog data uploaded to Research Workspace and undergoing QC. Data will be added to Gulf of Alaska Data Portal on schedule. 2017 energetic/stable isotope and whale survey data still being processed per schedule as surveys began in the fall.

### Presentations

Arimitsu, M., M. A. Bishop, S. Hatch, R. Kaler, K. Kuletz, C. Matkin, J. Moran, D. Olsen, A. Schaefer, J. Straley  
Changes in marine predator and prey populations in the aftermath of the North Pacific Heat Wave: Gulf Watch Alaska Pelagic update 2017. Anchorage, Alaska. January 21-28, 2018.

Moran, J. R. and J. M. Straley. Recent observations of humpback whales in the Gulf of Alaska: carrying capacity or a cause for concern? 2018 Ocean Science Meeting. Portland, OR, February 11-16, 2018.



Straley, J. M. and J. R. Moran. Have Gulf of Alaska Humpback Whales Reached Carrying Capacity or Has the Blob Made the Food Web Screwed? Alaska Marine Science Symposium. Anchorage, Alaska. January 21-28, 2018.

Straley, J. M. and J. R. Moran. Have Gulf of Alaska Humpback Whales Reached Carrying Capacity or Has the Blob Made the Food Web Screwed? 2018 Ocean Science Meeting. Portland, OR, February 11-16, 2018.

Weiss, C., J. R. Moran, T. Miller. Fine-scale trophic ecology and bioenergetics of euphausiids in Prince William Sound, Alaska. Alaska Marine Science Symposium. Anchorage, Alaska. January 21-28, 2018.

#### *Outreach*

Moran, J. R. Dall's Porpoise: Life in the fast lane. Delta Sound Connections. Prince William Sound Science Center. [http://pwssc.org/wp-content/uploads/2018/05/DSC-2018-FINAL\\_WEB.pdf](http://pwssc.org/wp-content/uploads/2018/05/DSC-2018-FINAL_WEB.pdf)

Moran, J. R. What do predators tell us about prey? 11th annual Juneau Naturalist Symposium. Juneau, AK, May 10, 2018.

Moran, J. R. Humpback whales in Alaska. Auke Bay Lab. Mini seminar series. Juneau, AK, April 13, 2018.

#### **LITERATURE CITED**

Barlow, J., Calambokidis, J., Falcone, E.A., Baker, C.S., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D.K., Quinn, T.J., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán R., J., Wade, P., Weller, D., Witteveen, B.H., Yamaguchi, M., 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Mar. Mammal. Sci.* 27:793-818.

Moran, J. R., R. A. Heintz, J. M. Straley, and J. J. Vollenweider. 2018. Regional variation in the intensity of humpback whale predation on Pacific herring in the Gulf of Alaska. *Deep Sea Research Part II* 147:187-195. DOI: <http://dx.doi.org/10.1016/j.dsr2.2017.07.010>.

Straley, J. and J. Moran. 2018. Have Gulf of Alaska Humpback Whales Reached Carrying Capacity or Has the Blob Made the Food Web Screwed? 2018 Ocean Science Meeting 11-16 February Portland OR, poster presentation.

Straley, J. M., J. R. Moran, K. M. Boswell, R. A. Heintz, T. J. Quinn II, B. Witteveen, and S. D. Rice. 2018. Seasonal presence and potential influence of foraging humpback whales upon Pacific herring wintering in the Gulf of Alaska. *Deep Sea Research Part II* 147:173-186. DOI: <http://dx.doi.org/10.1016/j.dsr2.2017.08.008>.