

**EVOSTC FY17-FY21 INVITATION FOR PROPOSALS  
FY18 CONTINUING PROJECT PROPOSAL SUMMARY PAGE**

**Project Number and Title**

Gulf Watch Alaska: Pelagic Component Project

**18120114-E**—Long-term Monitoring of Marine Bird Abundance and Habitat Associations during Fall and Winter in Prince William Sound

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

Mary Anne Bishop, Ph.D., Prince William Sound Science Center

**Date Proposal Submitted**

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**Project Abstract**

The fall-winter marine bird surveys in Prince William Sound (PWS) will continue to build upon a 10-year time series of marine bird abundance and habitat associations (2007-2017) and are further integrated with forage fish assessments of prey availability and humpback whale prey consumption and population monitoring. All three projects will share logistics, timing, and location of sampling. Marine bird surveys occur onboard research vessels conducting oceanographic, fisheries, or marine mammal surveys, thereby increasing opportunities for cross-project collaboration and reducing project costs. We use established protocols employed by all other Gulf Watch Alaska marine bird survey efforts (Kachemak Bay/Cook Inlet, Seward Line/Gulf of Alaska, PWS summer). For FY18, we have identified four fall-winter marine bird cruises: PWS Science Center Ocean Tracking Network maintenance cruise (February), Gulf Watch Alaska Pelagic Integrated Predator Prey Surveys (September), Alaska Department of Fish and Game spot shrimp survey (October), and a NOAA pollock cruise (November).

Of the marine birds that overwinter in PWS, nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered or their recovery is unknown (pigeon guillemot, marbled murrelet, and Kittlitz’s murrelet). Fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels and day length reduced, and water temperatures colder. By monitoring marine birds during fall and winter we will improve our predictive models of species abundance and distribution across PWS in relation to biological and physical environmental factors. Our long-term monitoring has shown that the nonbreeding season cannot be characterized as a single time period when describing marine bird distribution and suggests that multiple surveys are required to quantify wintering populations and understand changes in marine bird distribution.

Our participation in the Gulf Watch Alaska pelagic integrated predator-prey surveys will allow us to identify and estimate the forage biomass at the same locations in which marine birds and humpback whales are feeding, which will provide comparable information on both predator density and prey availability. We are not proposing any major changes to this project for FY18.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$90,100	\$92,700	\$95,700	\$98,600	\$101,700	\$478,800

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$53,000	\$53,000 in-kind	\$53,000	\$53,000	\$53,000	\$265,000

## 1. EXECUTIVE SUMMARY

### *Pelagic Component*

The pelagic component research team proposed for FY17-21 to continue monitoring key pelagic species groups in Prince William Sound (PWS) using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. Thus, the two 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?

### *Fall-Winter Marine Bird Monitoring*

During the current, 2017-2021 5-year period, our project will: a) continue to conduct systematic surveys to document the fall-winter abundance and distribution of marine birds in PWS using regularly-scheduled vessels of opportunity, with 4 surveys identified for FY18; and, b) investigate the trophic linkages in areas with high marine bird concentrations by expanding and integrating our efforts with two other projects in the pelagic component - the forage fish and humpback whale projects. Predator-prey surveys that combine the marine bird, humpback whale, and forage fish (including euphausiids) projects will be conducted each fall (September/October). Using the same vessel platforms in time and space (two vessels: one for acoustic-trawl forage fish and marine birds and a second for humpback whale sampling), concurrent surveys will provide quantitative measures of the density and distribution of marine bird and humpback whale predators relative to forage fish availability and will facilitate an integrated analysis of how predator communities respond to changes in prey availability (quantity and quality).

We are not proposing any major changes to this project for FY18. Our marine bird study will gather data to improve our ability to monitor status and trends of marine bird populations during fall and winter. Additionally, this research will address the following hypotheses:

1. Marine bird distribution and abundance varies with physical and biological habitat characteristics within the fall/winter season.
2. Marine bird distribution and abundance varies with prey availability (quantity and/or quality).
  - a. Marine bird forage flocks signal the presence of prey aggregation to humpback whales.

To address the first hypothesis, our project will continue to conduct marine bird surveys in collaboration with three to four marine research cruises every winter, including the Alaska Department of Fish and Game (ADF&G) spot shrimp survey, the PWS Science Center Ocean Tracking Network maintenance cruise, the Pelagic Component's Integrated Predator-Prey Surveys, and a National Oceanic and Atmospheric Administration (NOAA) pollock cruise. The second hypothesis will be addressed during marine bird surveys conducted as part of the Pelagic Component's Integrated Predator-Prey Surveys. Marine bird surveys will occur aboard the acoustic-trawl vessel and observations will include fish schools when bird and mammal predators are both present and absent. A vessel used for synoptic humpback whale surveys will ensure an adequate sampling of fish schools when humpback whales are present.

## *Background and Findings*

Of the marine birds that overwinter in PWS, nine species were initially injured by the *Exxon Valdez* oil spill (EVOS). As of 2014, two species that overwinter in PWS have not yet recovered (marbled murrelet and pigeon guillemot) and a third species, Kittlitz's murrelet, has an unknown recovery status (EVOSTC 2014). The vast majority of marine bird monitoring in areas affected by EVOS has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful. Long-term monitoring of marine birds in PWS during fall and winter is needed to understand how post-spill ecosystem recovery and changing physical and biological factors are affecting marine bird abundance and species composition, as well as marine bird distribution and habitat use.

Systematic fall and winter marine bird surveys began in 2007 under the direction of co-principal investigators (PI) Bishop and Kuletz. In 2012 this research project became part of the Gulf Watch Alaska (GWA) Pelagic Component under the direction of PI Bishop. Over the past ten winters (2007-2008 through 2016-2017) a total of 39 marine bird surveys, typically 6-9 days in duration, have been conducted across PWS following established U.S. Fish and Wildlife Service (USFWS) survey protocols adapted for GPS-integrated data entry (USFWS 2007). Observers are placed on "ships of opportunity" that include research vessels already conducting oceanographic, fisheries, or marine mammal surveys, thereby enabling integration of data across projects. Collaborators have included the EVOS funded GWA Pelagic- Humpback Whale Project and the Herring and Research Monitoring- Juvenile Herring Hydroacoustic Surveys, as well as ADF&G spot shrimp surveys, and the PWS Science Center Ocean Tracking Network maintenance cruises.

We have documented consistent temporal patterns in density and distribution from fall through winter for the most abundant marine bird species, including common murre, marbled murrelet, black-legged kittiwake, and large gulls (primarily glaucous-winged gull) (Zuur et al. 2012, Dawson et al. 2015, Bishop and Kuletz, unpubl. data). Our surveys have also identified patterns in the spatial distribution of marine birds in the Sound. When we modeled the relationship between spatial covariates and bird distributions over nine seasons, seasonal differences were important for seven of nine species groups, illustrating movement patterns into and out of PWS. We found that piscivorous birds have an overwhelming preference for shallower, warmer, and increasingly protected waters closer to shorelines. This supports the assertion that birds are seeking refuge during winter, which could render PWS superior winter habitat relative to the harsher Gulf of Alaska (GOA; Stocking et al. in press).

Interestingly, our surveys detected changes in common murre densities and distribution in PWS during the months leading up to a prolonged common murre die-off event occurring along the Gulf of Alaska. During our February 2015 surveys, which immediately preceded the onset of the die-off (March 2015), we recorded a dramatic increase in the number of common murre using the southwest passages of PWS. Immediately prior to the peak of the die-off in December 2015, we again recorded significantly higher murre densities in PWS (November 2015 surveys; Bishop unpubl. data).

Based on surveys conducted between November 2007 and March 2017 (ten winters) we have identified areas of persistent, high marine bird concentrations including northeast PWS, Montague Strait, and the southwest passages. These are also areas in which humpback whales concentrate. Similarly, Montague Strait is a known hotspot for killer whales. This suggests that in these areas environmental drivers such as currents and nutrients are creating dependable, favorable foraging conditions for marine birds and marine mammals.

Finally, we developed a bioenergetics model for marine birds in winter. Our model results highlight the importance of herring to marine birds in PWS during winter and suggest that predation by marine birds may have an important top-down effect on the PWS herring population. Our model shows that in winters with relatively high numbers of marine birds or with relatively low adult herring biomass, as much as 10% (1,864 t) of the adult biomass can be removed by avian predators (Bishop et al. 2015).

During initial sampling in Feb of FY17 we saw an influx of crested auklets (*Aethia cristatella*) into PWS, which is highly unusual. We coordinated with USFWS, NOAA, and GWA personnel to staff a seabird observer on leg 1 of the NOAA Gulf of Alaska cruise (NOAA Ship Oscar Dyson) that covers much of the GWA sampling area. Continued sampling in FY18 will allow us to assess how recovery from or persistence of the recent marine heat wave (the Blob and El Niño) is affecting marine bird abundance, prey associations, and habitat use.

## 2. COORDINATION AND COLLABORATION

### A. Within an EVOSTC-funded Program

#### Gulf Watch Alaska

This project is a component of the integrated GWA-Long-term Monitoring of Marine Conditions and Injured Resources and Services. This long-term monitoring program is composed of three ecosystem components (Environmental Drivers, Pelagic, and Nearshore) with a series of projects in each component led by principal investigators from a number of institutions.

The fall and winter marine bird project is headed by Dr. Mary Anne Bishop, and is part of the Pelagic monitoring component. This project shares research vessels associated with the Integrated Predator-Prey Surveys (Table 1). Marine bird observations from this project are integrated into the whale surveys (PIs Moran and Straley) and forage fish surveys (PIs Piatt and Arimitsu) through the Integrated Predator-Prey Surveys. This collaboration will afford efficiencies in field work, as well as facilitate greater understanding of predator-prey interactions in the Sound. Our program also complements the Pelagic Component's PWS Marine Bird Summer surveys conducted by US Fish & Wildlife Service (Kuletz & Kaler) and allows for regional comparisons of marine bird densities and environmental drivers with Kachemak Bay/Lower Cook Inlet (PIs Doroff and Holderied), PWS, Kenai, and Katmai (PI Coletti), and Seward Line/Gulf of Alaska (PIs Hopcroft and Kuletz).

Table 1. Integrated predator-prey collaborations by objective. Objectives related to this work plan are bolded.

Objective	Index	Task	PI
<b>a. Estimate humpback whale abundance, diet, and distribution</b>			
	Whale counts by sub-region	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>b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas</b>			

Objective	Index	Task	PI
	<b>Georeferenced marine bird counts, group size, behavior by species</b>	<b>Integrated Surveys: marine bird transects</b>	<b>Bishop (PWSSC)</b>
<b>b.i. Relate marine bird and humpback whale presence to prey fields identified during hydroacoustic surveys.</b>			
	<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)/ <b>Bishop (PWSSC)/</b> Moran (NOAA)/ Straley (UAS)
<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>	<b>Bishop (PWSSC)/</b> Moran (NOAA)/ Straley (UAS)/ 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)/Moran (NOAA) <b>Bishop (PWSSC)</b>
	<b>Density and depth distribution</b>	<b>Integrated Surveys: hydroacoustic-trawl data</b>	Arimitsu & Piatt (USGS)
	Diet, energy density	Sample Analysis: forage fish	Moran (NOAA)
<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)/ Moran (NOAA)/ Straley (UAS)/ <b>Bishop (PWSSC)</b>

### Herring Research and Monitoring

In the past, we have had observers onboard vessels associated with the PWS Herring Research and Monitoring Program. As currently designed for FY17-21, the fall/winter marine bird project will not be working directly with the PWS Herring Research and Monitoring Program. However, our data will complement the suite of data collected by this program, including insertion of key predator data into the population modeling of herring. As part of the integrated predator-prey surveys we will collect forage fish for PI Kristin Gorman's Herring Age at Maturity project.

### 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. Of particular note, this project may share data and relevant information with the Pigeon Guillemot restoration project on the Naked Island Complex.

**C. With Trustee or Management Agencies**

This long-term marine bird monitoring project uses as observing platforms vessels associated with other agencies. We have arrangements with the following agencies and organizations to place a marine bird observer onboard during these regularly scheduled annual surveys:

Alaska Department of Fish and Game: Jan Rumble. ADF&G provides a berth for a marine bird observer during the October shrimp surveys.

Prince William Sound Science Center: Mary Anne Bishop. PWS Science Center provides a berth for a marine bird observer during the February cruise to upload data from the Ocean Tracking Network arrays.

Finally, information from this project will feed into the *North Pacific Pelagic Seabird Database*, a database that is maintained by USFWS and U.S. Geological Survey (USGS).

**3. PROJECT DESIGN – PLAN FOR FY18**

**A. Objectives for FY18**

Our long-term monitoring has shown that the nonbreeding season cannot be characterized as a single time period when describing marine bird distribution and suggests that multiple surveys are required to quantify wintering populations and understand changes in marine bird distribution. For 2017-2021 this project will continue to conduct marine bird surveys in conjunction with marine research cruises, including the Integrated Predator-Prey Surveys, the ADF&G spot shrimp survey cruise, the PWS Science Center Ocean Tracking Network maintenance cruise, and the NOAA pollock cruise.

Objectives of this study are to:

1. Characterize the spatial and temporal distribution of marine birds in Prince William Sound during fall and winter.
2. Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.
  - a. Relate marine bird presence to prey fields identified during concurrent hydroacoustic surveys.
  - b. Characterize marine bird-humpback whale foraging dynamics.
3. Model species abundance in relation to physical and biological variables across time and space.

Based on our long-term monitoring surveys, this project will provide information on fall and winter ecology of marine bird species injured by the oil spill that can be used to help restore populations or identify limitations of population recovery. In addition, the monitoring of top down forcing by marine birds and whales, which are important predators on herring and potentially other forage fish and krill, will also complement the suite of *PWS Herring Research & Monitoring* studies, including insertion of key data into the population modeling of herring.

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

There are no changes to the proposed project design. However, depending on funding, there may be a NOAA pollock cruise in November 2018 that will serve as a platform for marine bird surveys.

## **4. SCHEDULE**

### **A. Project Milestones for FY18**

- 1) Characterize the spatial and temporal distribution of marine birds in PWS during fall and winter.  
*Data on spatial and temporal distribution of marine birds will be conducted during 3-4 cruises in FY18 (February, March, September, and possibly November).*
- 2) Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.
  - a. Relate marine bird presence to prey fields identified during concurrent hydroacoustic surveys.  
*Preliminary analyses of marine bird-prey associations will occur when bird survey and fish acoustic data processing are completed following each September cruise.*
  - b. Characterize marine bird- humpback whale foraging dynamics.  
*Data will be collected during the September cruise and preliminary analyses included in the annual report.*
- 3) Model species abundance in relation to physical and environmental variables across time and space.  
This model will be used to assess and refine marine bird and environmental habitat associations through recent warm water events and improve model fit given rather high unexplained variance present in earlier models. The majority of modelling effort will occur in FY20-21. .

*Final analyses incorporating all data collected through October 2021 will be completed by January 2022 and incorporated into the GWA LTM program report by March 2022.*

### **B. Measurable Project Tasks for FY18**

#### **FY 2018 (Year 7)**

<b>FY 18, 1st quarter</b>	(February 1, 2018 - April 30, 2018)
<i>February:</i>	<i>Marine bird survey: PWS Science Center Ocean Tracking Network cruise</i>
<b>March 1:</b>	<i>Submit annual report</i>
<i>March:</i>	<i>Marine bird survey: Integrated Predator Prey Survey (funding dependent)</i>
<i>March:</i>	<i>Publish metadata/database from winter 16/17</i>
<i>April:</i>	<i>Upload winter 2017/18 monitoring data to workspace;</i>
<i>February-April:</i>	<i>Data analyses</i>
<b>FY 18, 2nd quarter</b>	(May 1, 2018 - July 31, 2018)
<i>May-July:</i>	<i>Data analyses</i>
<b>FY 18, 3rd quarter</b>	(August 1, 2018 - October 31, 2018)
<b>August 23:</b>	<i>Submit annual program work plan</i>
<i>September:</i>	<i>Marine bird survey: Integrated Predator-Prey Survey cruise</i>
	<i>Data compliance on Research Workspace</i>
<i>October:</i>	<i>Marine bird survey: ADF&amp;G spot shrimp cruise</i>
<b>FY 18, 4th quarter</b>	(November 1, 2018 - January 31, 2019)
<i>Oct.- Nov:</i>	<i>Attend annual GWA PI meeting</i>

November:  
January:

Marine survey: NOAA pollock cruise (funding dependent)  
Data analyses

## 5. PROJECT PERSONNEL – CHANGES AND UPDATES

There are no personnel changes or updates.

## 6. BUDGET

### A. Budget Forms (See GWA FY18 Budget Workbook)

Please see project budget forms compiled for the program.

### B. Changes from Original Proposal

There are no changes from the original proposal.

### C. Sources of Additional Funding

We are using vessels of opportunity funded by other programs for seabird observations during three of four surveys. In addition to the integrated forage fish/whale/seabird cruises scheduled for September (with vessel costs included in the GWA LTM Humpback whale project), observers will also be onboard the annual ADF&G PWS shrimp survey (\$53K/yr) and the annual maintenance cruise for the Ocean Tracking Network (paid for by Alaska Ocean Observing System), and potentially the NOAA pollock survey (cruise dependent on funding by NOAA).

## 7. RECENT PUBLICATIONS AND PRODUCTS

### Publications

- Stocking, J., M. A. Bishop, and A. Arab. *In press*. Spatio-temporal distributions of piscivorous birds in a subarctic sound during the nonbreeding season. *Deep Sea Research Part II: Topical Studies in Oceanography, Spatial and temporal ecological variability in the northern Gulf of Alaska: what have we learned since the Exxon Valdez oil spill?* Accepted July 2017.
- Bishop, M. A., J. Watson, K. Kuletz, and T. Morgan. 2015. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography* 24:1–13.
- Dawson, N., M. A. Bishop, K. Kuletz and A. Zuur. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. *Northwest Science* 89:111–128.

### Published datasets

- Bishop, M. A. 2017. Fall and Winter Seabird Abundance Data, Prince William Sound, 2007-2016, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program*, Gulf Watch Alaska. Research Workspace. <https://doi.org/10.24431/rw1k1w>.

### Outreach

- Schaefer, A. 2017. Avian Invasion! *Delta Sound Connections 2017-18*. pp. 16.

## LITERATURE CITED

- Bishop, M. A., J. Watson, K. Kuletz, and T. Morgan. 2015. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography* 24:1–13.

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- USFWS. 2007. North Pacific pelagic seabird observer program observer's manual, inshore/small vessel version, November 2007. U.S. Fish and Wildlife Service, Migratory Bird Management Nongame Program, Anchorage, Alaska. Unpublished protocol manual, 25 pp.
- Zuur, A.F., N. Dawson, M.A. Bishop, K. Kuletz, A.A Saveliev and E.N. Ieno. 2012. Two-stage GAMM applied on zero inflated Common Murre density data. Pages 155-188 in A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds). *Zero Inflated and Generalized Linear Mixed Models with R*. Highland Statistics Ltd, Newburgh, United Kingdom.