

**EVOSTC FY17-FY21 INVITATION FOR PROPOSALS  
FY21 (YEAR 10) CONTINUING PROJECT PROPOSAL SUMMARY PAGE**

**Project Number and Title**

Gulf Watch Alaska: Pelagic Component Project

**21120114-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)**

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**Date Proposal Submitted**

August 14, 2020

**Project Abstract**

The fall-winter marine bird surveys in Prince William Sound (PWS) will continue to build upon a 13-year time series (2007-2020) of marine bird abundance and habitat associations. Surveys occur onboard research vessels conducting oceanographic, fisheries, or marine mammal surveys, thereby increasing opportunities for cross-project collaboration and reducing project costs. Our September surveys are integrated with Gulf Watch Alaska (GWA) pelagic component's forage fish assessments of prey availability (21120114-C) and humpback whale monitoring (2120114-O) with all three projects sharing logistics, timing, and location of sampling. These integrated surveys allow us to estimate forage biomass at the same locations in which marine birds and humpback whales are feeding, thereby providing comparable information on both predator density and prey availability. This is the one survey that may be cancelled due to the COVID-19 pandemic in fall of 2020. Our November and March surveys are in conjunction with the GWA project monitoring of oceanographic conditions in PWS (21120114-G) and enable us to extend our long-term dataset of marine bird observations within juvenile herring bays of PWS. For all surveys we use established protocols employed by all other GWA marine bird survey efforts (Kachemak Bay/Cook Inlet, Seward Line/Gulf of Alaska, PWS summer). 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 have unknown recovery status. 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 distribution. Finally, with new funding from the PWS Regional Citizens' Advisory Council, we will conduct additional and complementary marine bird surveys in the tanker escort zone and adjacent bays during February. Survey data will be combined with GWA data. We are proposing no major changes to this project in FY21.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$90,100	\$92,700	\$121,900	\$124,800	\$127,900	\$557,300

**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	\$0	\$0	\$39,000	\$145,000

## 1. PROJECT EXECUTIVE SUMMARY

### *Pelagic Component*

The pelagic component research team proposed for FY17-21 to continue monitoring key pelagic species groups in Prince William Sound (PWS) using the same five projects focused on killer whales (20120114-N), humpback whales (20120114-O), forage fish (19120114-C), and marine birds (20120114-E, 20120114-M). 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 5-year period (2017-2021), our project will: a) continue to conduct systematic surveys to document the fall-winter abundance and distribution of marine birds in PWS, with 4 surveys identified for FY21; and, b) investigate 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). Using two vessel platforms (one for acoustic and forage fish trawls and marine bird surveys, 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, distribution, and quality).

Furthermore, 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 is conducting marine bird surveys throughout PWS in September, November, February, and March. September surveys are conducted during the Integrated Predator-Prey (IPP) survey. November, February, and March surveys will be conducted using a dedicated charter vessel. The second hypothesis will be addressed during marine bird surveys conducted as part of the Pelagic Component's IPP Surveys. Marine bird observations will be recorded aboard the acoustic-trawl vessel and observations will include fish schools when bird and mammal predators are both present and absent. There are no major changes to sampling expected for this project in FY21.

### *Background*

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). Most of the marine bird monitoring in areas affected by EVOS has occurred around breeding colonies during the

reproductive season 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 (PIs) 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 13 winters (2007/08 - 2019/20) a total of 50 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 typically 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 Trustee Council (EVOSTC) funded GWA Pelagic- Humpback Whale and Forage Fish projects (ongoing), GWA Oceanographic Conditions in PWS (since 2019), Herring and Research Monitoring (HRM) program juvenile herring hydroacoustic surveys (2007-2016), as well as Alaska Department of Fish and Game (ADF&G) spot shrimp surveys (2013-2018), PWS Science Center (PWSSC) Ocean Tracking Network (OTN) maintenance cruises (2014-2018), and National Oceanic and Atmospheric Administration (NOAA) pollock cruises (2017-2018).

From 2007-2016, our surveys included sampling in a series of bays in collaboration with the HRM program’s Juvenile Herring Nursery Bay project (16120111-F). Since the termination of this project, most marine bird survey efforts have occurred in open water and within passages of PWS. However, our research has shown that compared to open waters, marine birds are more likely to be present and in greater abundance in protected bays during winter. Thanks to additional EVOSTC funding, in FY19 we began conducting dedicated marine bird surveys in juvenile herring bays of PWS during March and November. These surveys are enabling us to extend our long-term, consistent dataset and continue identifying shifts in the winter marine bird community of PWS, as well as the potential impact on juvenile herring. These dedicated marine bird surveys are conducted using PWSSC’s vessel, the RV New Wave, in conjunction with the Monitoring of Oceanographic Conditions in PWS project (20120114-G).

We recently received year one of an initial three-year request from PWS Regional Citizens’ Advisory Council (PWSRCAC) to conduct marine bird surveys in and around the PWS tanker escort zone that will complement our GWA surveys. Marine bird distribution and abundance in and around much of the tanker lane during winter is largely unknown as current surveys do not cover this area. Survey transects will include areas such as the nearshore, open waters, and adjacent bays in and around Port Valdez, Valdez Arm, Tatitlek Narrows, Port Fidalgo, and Port Etches. Survey data will be combined with GWA survey data. Continued and increased monitoring of this area will help determine marine bird vulnerability to environmental change and future perturbations, including oil spills, and will guide spill response efforts.

#### *FY20 Update*

In a recently published paper (Schaefer et al. 2020), we characterized the factors influencing marine bird response to forage fish during early (November) and late (March) winter at two spatial scales within bays juvenile herring (*Clupea pallasii*) nursery bays of PWS. Over 40% of observed marine birds were associated (within 150 m) of a fish school, while only 20% of fish schools were associated with birds. Seasonally, we recorded significantly more fish schools during November compared to March. The marine bird community also shifted from primarily being comprised of marbled murrelets (*Brachyramphus marmoratus*) and large gulls

(*Larus* spp.) in early winter to common murre ( *Uria aalge*) in late winter. At the school-level, marine birds were more likely to be associated with shallow fish schools within 500 m of shore and within smaller prey patches. At the bay-level, gull abundance was positively associated with the total number of fish schools recorded in the bay, while diving birds were more abundant when fish schools were higher in the water column, in shallower bottom depths, and in areas with more eel grass habitat. Our results indicate the importance of temporal, habitat, and fish school variables as drivers of marine bird presence and abundance, underscoring the complexity of predator-prey dynamics during winter.

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, Stocking et al. 2018). 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 (Stocking et al. 2018). 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. 2018).

Furthermore, we have identified areas of persistent, high marine bird concentrations, including northeast PWS, Montague Strait, and the southwest passages, which are also areas in which humpback whales concentrate. Similarly, Montague Strait is a known hotspot for killer whales, suggesting that environmental drivers in these areas, such as currents and nutrients, are creating dependable, favorable foraging conditions for marine birds and marine mammals.

We also 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). This relationship is especially important considering the recent historically low estimates of the Pacific herring population in PWS (P. Rand, PWSSC, unpubl. data).

#### *FY19 and FY20 field work summary*

During FY19, one observer with the PWSSC performed three marine bird surveys in PWS, resulting in 1,185 km of survey effort: March 2019 PWSSC Marine Bird survey (1293 birds, 25 species), September 2019 IPP survey (2511 birds, 28 species), and November 2019 PWSSC Marine Bird survey (2088 birds, 34 species). So far in FY20, we have conducted one >305 km survey effort: March 2020 PWSSC Marine Bird Survey (1355 birds, 25 species). Still to be completed in FY20 are the IPP survey and PWSSC Marine Bird survey in September and November 2020, respectively. (Table 1, Fig. 1). Because of the COVID-19 pandemic, the fall IPP survey may be cancelled; the decision on whether to conduct this survey will be made in late August.

Table 1. Fall and winter marine bird surveys in Prince William Sound, Alaska during FY19 and FY20.

Fiscal Year	Cruise	Km surveyed	Observer	FY19 & FY20 Cruise Dates
FY19	PWSSC Marine Bird	306	A. Schaefer	Mar 4-7, 2019
FY19	NOAA, USGS, PWSSC EVOS GWA IPP	551	A. Schaefer	Sep 16-24, 2019
FY19	PWSSC Marine Bird	328	A. Schaefer	Nov 2-6, 2019
FY20	PWSSC Marine Bird	305	A. Schaefer	27 Feb – 3 March, 2020
FY20	NOAA, USGS, PWSSC EVOS GWA IPP			To be completed Sep. 2020 on agency shared platform (depending on COVID-19 pandemic)
FY20	PWSSC Marine Bird			To be completed Nov. 2020

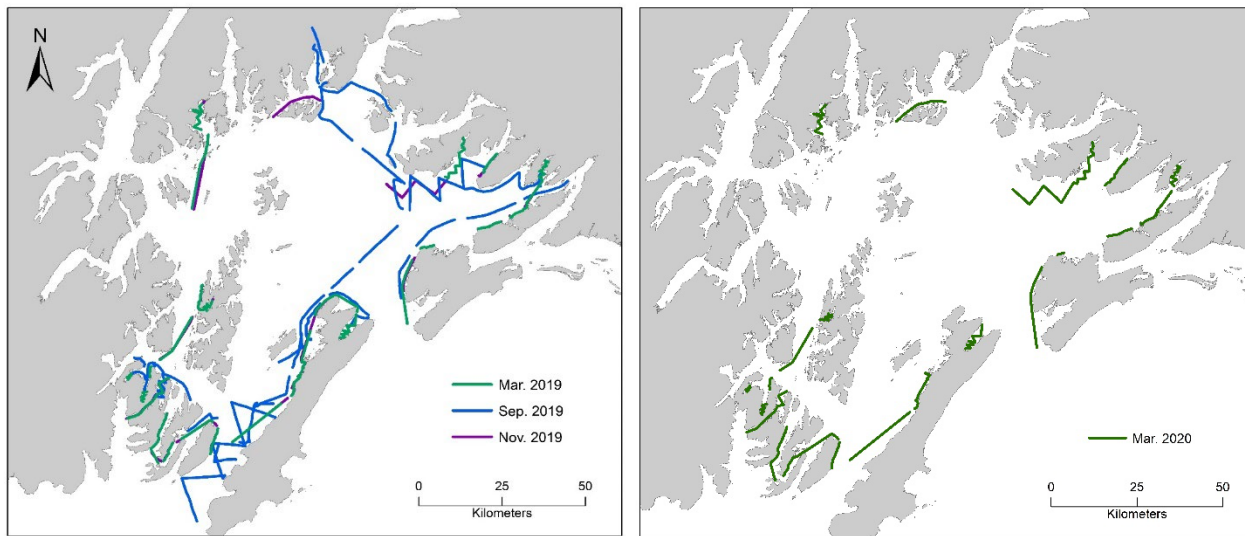


Figure 1. Spatial coverage of marine bird surveys in Prince William Sound. Left: Location of three marine bird surveys completed during FY19. Right: Location of March 2020 marine bird survey. March and November surveys are replicated as much as possible depending on observation and weather conditions.

#### *Dedicated PWSSC Marine Bird Surveys*

In March and November 2019 and March 2020, we conducted dedicated marine bird surveys in conjunction with the Monitoring of Oceanographic Conditions in PWS project (PI Campbell, project 19120114-G). In March 2019, the marine bird community was dominated by three species found in nearshore habitats: surf scoter (26%), Barrow’s goldeneye (14%), and harlequin duck (10%). In November 2019, although we surveyed slightly more nearshore and within bay habitats (Table 2), the bird community was dominated by a mix of open water and nearshore species. Approximately 27% of the total counts were black-legged kittiwakes, 17.5% were murrelets (*Brachyramphus* spp.), and (9.5% were glaucous-winged gulls). In March 2020, the marine bird community was similar to that of March 2019 and was comprised primarily of murrelets (19%), surf scoters (13%), and Barrow’s

goldeneye (12%). Of note were the high numbers of murrelets during March 2020 ( $n = 327$ ) compared to the March 2019 survey ( $n = 124$ ).

During the November 2019 survey, a large group of shearwaters (~300) in Montague Strait (plus another shearwater in Port Gravina) were observed while off-effort. The shearwaters (likely mostly sooty shearwaters, *Ardenna grisea*) were sitting on the water, and most made little or no attempt to avoid the vessel as we approached. There were reports of another marine heatwave forming in the GOA during the fall of 2019 which can upset marine food web dynamics. These shearwaters may have been responding to the warming conditions in the GOA similarly to how murrelets responded during the heatwave of 2014-2016, by shifting their distributions in search of food. Prior to this survey, only 28 shearwaters total had been recorded (including observations beyond the 150 m survey strip) during months other than September (October, November, December 2008 – 2017).

Table 2. Survey effort by transect-type for the PWSSC marine bird surveys, March and November 2019, March 2020.

<b>Cruise</b>	<b>Bay</b>	<b>Nearshore</b>	<b>Transit</b>	<b>Total</b>
March 2019	80.6	75.8	149.4	305.8
November 2019	81.3	78.4	168.6	328.3
March 2020	80.8	71.2	153.1	305.1

#### *Gulf Watch Alaska Integrated Predator-Prey Survey*

In September 2014 and 2017- 2019 we have conducted marine bird surveys as part of the GWA IPP survey (NOAA, U.S. Geological Survey [USGS], PWSSC), which also included surveys for humpback whales, forage fish, and euphausiids. These integrated surveys allow us to estimate forage biomass at the same locations in which marine birds and humpback whales are feeding, thereby providing comparable information on both predator density and prey availability. Results from the FY19 survey are summarized below:

*Hydroacoustic/Marine Bird Transects:* During the IPP surveys, marine bird observations are recorded concurrent with hydroacoustic fish and krill surveys along fixed transect lines. These transects were designed to sample areas of historic humpback whale feeding locations in Montague Strait, Bainbridge Passage, and Port Gravina. In September 2019, bird observations were collected simultaneously with hydroacoustic surveys over 145 km of effort.

In September 2019, marine bird densities on both the acoustic transects as well as the in-transit transects were higher than densities observed in our three previous predator-prey surveys (2014, 2017, 2018, Fig. 2). Murre densities were higher than our most recent two surveys, but less than 2014 survey densities (Fig. 3). Interestingly, in addition to increased densities, we also observed 14 subadult murrelets during the survey, potentially indicating signs of recovery from the 2015-16 die off. Puffin densities were similar to those recorded during our previous September cruises; however, we did note shifts in puffin distribution in 2019 (Fig. 3). Puffins are usually only seen in Montague Strait and near the entrances to the GOA. In 2019, puffins were recorded inside PWS all the way up in Port Gravina. Along the same lines, we recorded a notable increase in shearwater densities inside PWS, including in Port Gravina (Fig. 3). Again, shearwaters are typically recorded near the interface between PWS and the GOA.

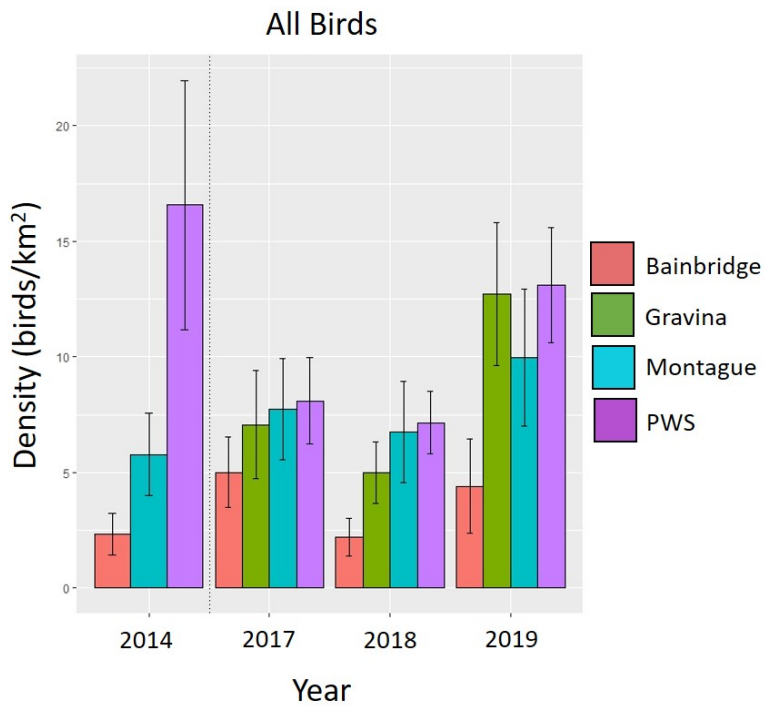


Figure 2. September marine bird densities in 2019 on acoustic transects and overall in PWS were higher than densities observed in 2017 & 2018. The 2014 survey was a pilot and coverage in Montague Strait was less than subsequent surveys.

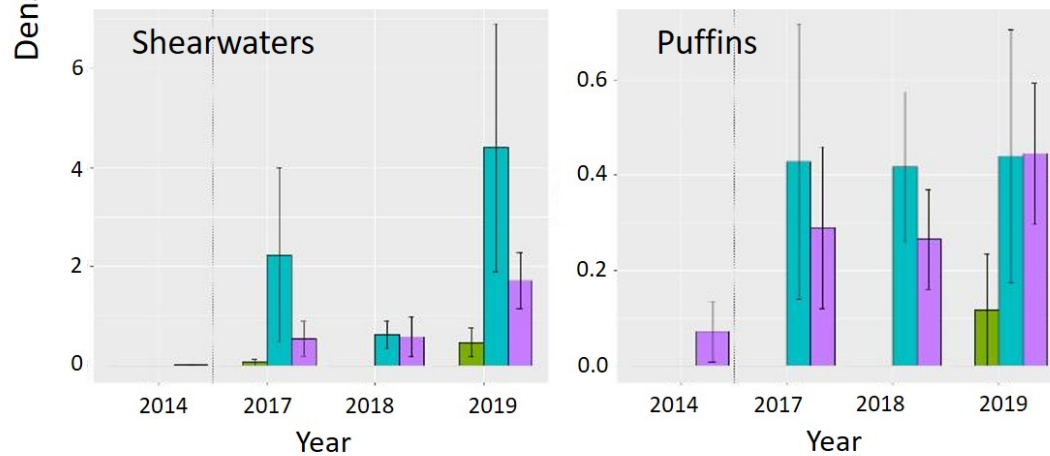
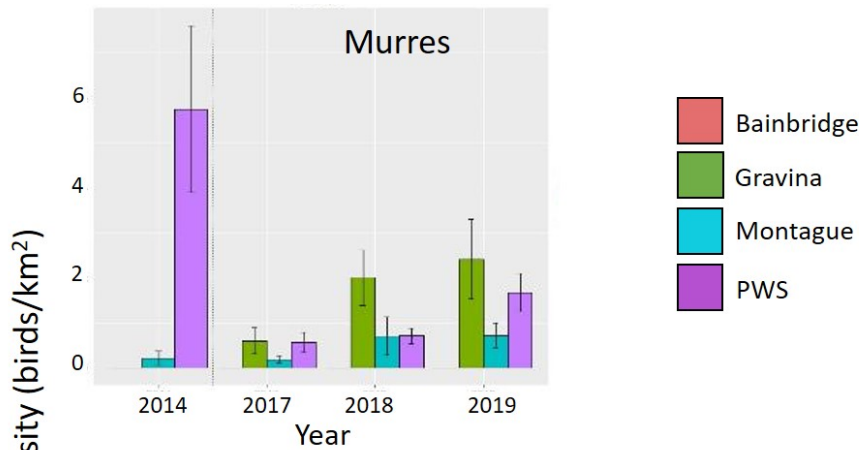


Figure 3. Densities of murres, shearwaters, and puffins during September Integrated Predator-Prey Surveys, PWS. In 2019, we documented increased densities of murres and distribution shifts of shearwaters and puffins.

*Flock/Humpback Whale Foraging Dynamics:* When a forage flock is encountered during surveys, the marine bird observer records if there are any marine mammals associated (within 150 m) with the flock, the time and position of the encounter, species composition, and number of individuals per species in the forage flock. During the 2019 cruise, we recorded the highest number of forage flocks and the highest number of forage flock-whale interactions so far for IPP surveys. In 2019, 14 foraging flocks were recorded, with 3 forage flock-whale interactions. All three flock-whale interactions occurred outside the mouth of Port Gravina near Knowle's Head. One flock-whale interaction was recorded during a focal follow of an individual whale, during which the whale surfaced in the middle of a flock of 30 black-legged kittiwakes. The kittiwakes quickly dispersed after the interaction. The second flock with an associated whale consisted of 50 kittiwakes, 9 murrelets, 4 Pacific loons, and 2 glaucous-winged gulls. The third flock was composed of 30 kittiwakes and 8 murrelets. In previous years, we recorded 11 flocks with 2 flock-whale interactions (2018) and 5 flocks with 1 flock-whale interaction (2017).

#### *Temporal patterns in marine bird density*

We have recently examined the use of ecosystem indicators to understand the influence of environmental variability on marine bird populations in PWS. We identified anomalies in monthly densities of murrelets as a useful indicator because, as piscivorous seabirds, murrelets are particularly sensitive to changes in the marine ecosystem. Murrelet densities appear to be highly variable within months and across winters (Fig. 4). For murrelets, our surveys detected changes in densities and distribution in PWS during the months leading up to a prolonged die-off event occurring along the GOA beginning during the winter of 2014-2015 and ending in the spring of 2016. Our surveys recorded unusually high densities in February 2015 (immediately preceding the onset of the die-off in March 2015) and fall 2015 (immediately prior to the peak of the die-off in December 2015) (Fig. 4). The increased use of PWS by murrelets during winter coincided with persistently high ocean temperatures in the North Pacific Ocean beginning during the winter of 2013-14 and persisting through 2016 in the northeast Pacific (with regional variability) (Di Lorenzo and Mantua 2016), with positive temperature anomalies continuing through 2017 and 2018 in PWS (PI Campbell 20120114-G). Since the die-off and dissipation of the heatwave, murrelet densities have been lower than the long-term monthly average, except for September 2019, when murrelet densities were approximately equal to the long-term mean. Total bird density is also highly variable within and across years (Fig. 4). Similar to murrelets, the total marine bird density has been anomalously low since the heatwave. However, densities increased during fall 2019, which is potentially a sign of ecosystem recovery. Continued sampling in FY21 will allow us to assess how recovery from or persistence of the recent marine heatwave (the Blob and El Niño) is affecting marine bird abundance, prey associations, and habitat use.



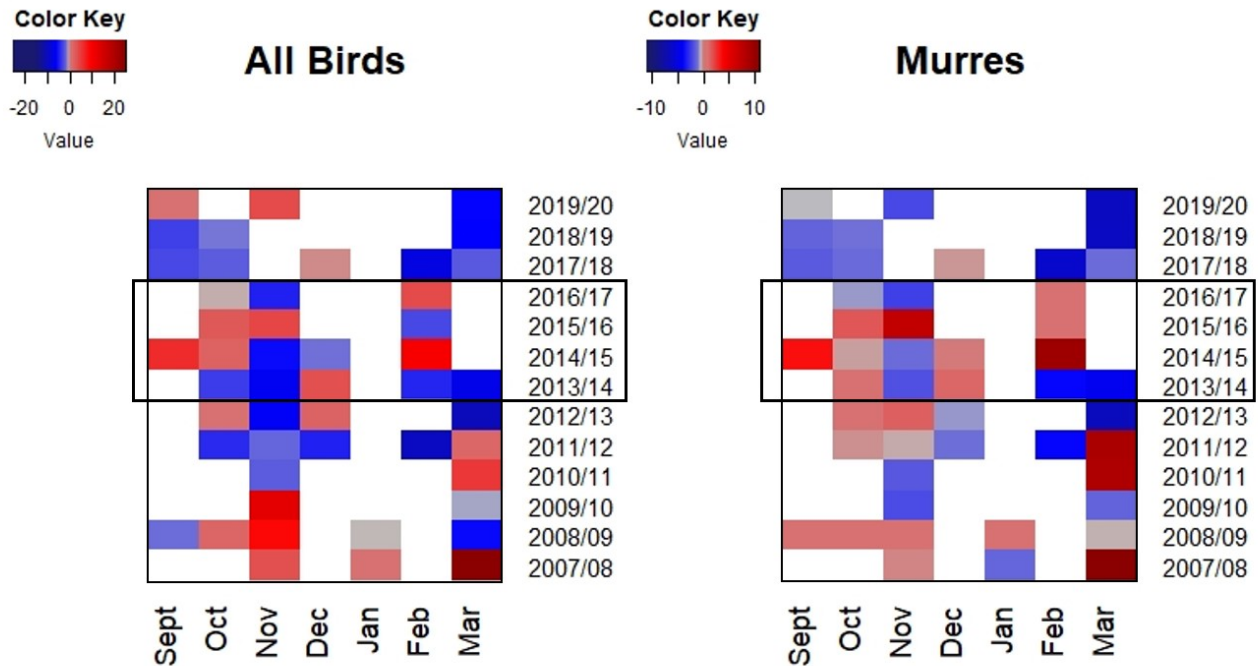


Figure 4. Monthly total marine bird and murre density anomalies observed during fall and winter bird surveys in Prince William Sound, 2007 – 2020. A marine heatwave event occurred throughout the Northeast Pacific Ocean beginning in the winter of 2013/14 and was strongest (with regional variability) through 2017 (indicated by black box). However, positive temperature anomalies persisted through 2018 in the Gulf of Alaska, including coastal regions (PI Danielson, project 20120114-I) and Prince William Sound (PI Campbell, project 20120111-G).

## 2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

### A. Project Milestones and Tasks

Table 3. This table breaks down project deliverables and their status into milestones and task progress by fiscal year and quarter, beginning February 1, 2017. C = completed, X = planned or not completed, V = cancelled due to COVID-19, P = partially completed, due to constraints of COVID-19. 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				FY22
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
<b>Milestone 1: Data Collection</b>																					
Field cruises (Feb RCAC, Sep IPP)	C		C		C		C				C				X		X		X		
Dedicated surveys Mar & Nov (new EVOSTC funding, FY19 & onward)									C			C	C			X	X			X	X
Alternative Survey Schedule (NOAA funds lost after FY18)	C			C	C																

Milestone/Task	FY17				FY18				FY19				FY20				FY21				FY22
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
<b>Milestone 2: Data Processing/Mgmt</b>																					
Data summary/analysis	C	C		C	C	C		C	C			C	C			X	X			X	
Upload data workspace	C				C				C				C				X				X
Metadata/data published	C				C				C				C				X				X
<b>Milestone 3: Reporting</b>																					
Annual Reports	C				C				C				C				X				
Annual PI meeting				C				C			C					X				X	
FY Work Plan (DPD)			C				C				C				C						
5-Year Final Report																					X

In addition to the primary project deliverables in Table 3, during the past year we contributed to two chapters in the GWA Long-Term Monitoring Program Draft Synthesis report, contributed one outreach article to Delta Sound Connections, and had a paper published in Fisheries Oceanography (see Section 7). We anticipate completing FY20 and FY21 milestones and tasks as planned with the one exception of the FY20 fall IPP survey which may be cancelled due to COVID-19.

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

All sampling, milestones and tasks for 2019 and first two quarters of 2020 were completed in accordance with our proposal and with sampling protocols available on the GWA Research Workspace.

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

No new milestones or tasks proposed.

**3. PROJECT 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 PIs 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 IPP surveys in September. Marine bird observations from this project are integrated into the humpback whale surveys (PIs Moran and Straley, project 20120114-O) and forage fish surveys (PIs Piatt and Arimitsu, project 20120114-C). This collaboration affords efficiencies in field work, as well as facilitates greater understanding of predator-prey interactions in the Sound.

Our annual winter sampling program in PWS also complements the Pelagic Component’s PWS Marine Bird Summer surveys conducted every two years by USFWS (PIs Kuletz & Kaler, project 20120114-M). Beginning in March 2019, portions of our March and November surveys will replicate select USFWS nearshore

transects, allowing comparisons with historic data. Collectively, marine bird surveys cross all seasons and survey regions of GWA and allow for regional comparisons of marine bird densities and environmental drivers from PWS (PIs Bishop and Kaler) to Kachemak Bay/Lower Cook Inlet (PI Holderied, project 20120114-J), PWS, Kenai, and Katmai (PI Coletti, project 20120114-H), and Seward Line/GOA (PIs Hopcroft and Kuletz, project 20120114-L).

Beginning in FY19, the fall and winter marine bird project also shares a research vessel with the Monitoring of Oceanographic Conditions in PWS Project (PI Campbell, project 20120114-G). In addition to sharing a research platform, these surveys will enable us to evaluate patterns in marine bird abundance and distribution in juvenile herring bays relative to *in situ* measurements of sea surface temperature and zooplankton abundance.

#### Herring Research and Monitoring

In the past, we placed an observer onboard vessels associated with the PWS HRM program. As designed for FY17-21, the fall/winter marine bird project is not working directly with the HRM program, because no herring research cruises are scheduled during the fall and winter months. 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.

#### 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. From FY2008-2016 we had arrangements with the HRM program to have an onboard observer during surveys of juvenile herring nursery bays in November (2007-2016) and March (2008-2012). Funding for the nursery project has been discontinued. In the past we have also placed an observer onboard NOAA pollock cruises (2017-2018; funding since discontinued), and ADF&G October shrimp survey cruises (2013-2018).

Finally, information from this project will feed into the *North Pacific Pelagic Seabird Database* (NPPSD), a database that is maintained by USFWS and USGS. During spring 2019, we worked with Gary Drew (USGS) to prepare survey data from 2007-2016 for the NPPSD. Our data will be included in the updated version of the database (v 3.0), due to be released by the end of 2019.

#### **Collaborations with other Organizations**

Beginning in 2021, the PWS Regional Citizens' Advisory Council has awarded the first year of funding for complementary avian surveys that will be conducted during late February in the tanker escort zone, including under-surveyed areas, such as the nearshore, open waters, and adjacent bays in and around Port

Valdez, Valdez Arm, Tatitlek Narrows, Port Fidalgo, and Port Etches. Survey data will be combined with the Gulf Watch Alaska survey data.

#### 4. PROJECT DESIGN

##### A. Overall Project Objectives

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 GWA IPP surveys (FY17-21; Table 4), ADF&G spot shrimp survey cruise and the PWSSC OTN maintenance cruise (both cruises FY17-18), and the PWSSC dedicated Marine Bird Survey (FY19 onward).

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.

Table 4. 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>			
	<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>			

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)/ <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>

## B. Changes to Project Design and Objectives

In FY19 (and continuing through FY21) we added within bay surveys of PWS funded by EVOSTC. In addition to within-bay transects, we are also surveying within the southwest passages of PWS and surveying select nearshore transects coinciding with historic USFWS survey transects. These surveys will be replicated every November and March and will extend our long-term and most consistent (2007-2016) dataset of wintering marine bird abundance and distribution. With the addition of these dedicated, consistent surveys, we are no longer placing an observer onboard ships of opportunity in October (ADF&G Shrimp survey) and February (OTN Maintenance Cruise).

Thanks to funding from Prince William Sound Regional Citizens' Advisory Council, in FY21 we will have an additional cruise in February to survey marine bird surveys in and around the PWS tanker escort zone. Marine bird distribution and abundance around the tanker lane during winter is largely unknown as current surveys do not cover much of this area.

## 5. PROJECT PERSONNEL – CHANGES AND UPDATES

There are no personnel changes or updates.

## 6. PROJECT BUDGET

### A. Budget Forms (See GWA FY20 Budget Workbook)

Please see project budget forms compiled for the program.

**EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL  
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM**

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	\$80.8	\$83.2	\$86.0	\$88.7	\$91.5	\$430.1	
Travel	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	
Contractual	\$1.7	\$1.7	\$25.7	\$25.7	\$25.7	\$80.5	
Commodities	\$0.2	\$0.2	\$0.1	\$0.1	\$0.1	\$0.7	
Equipment	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	
Indirect Costs (waived)							
<b>SUBTOTAL</b>	<b>\$82.7</b>	<b>\$85.1</b>	<b>\$111.8</b>	<b>\$114.5</b>	<b>\$117.3</b>	<b>\$511.3</b>	<b>\$0.0</b>
General Administration (9% of	\$7.4	\$7.7	\$10.1	\$10.3	\$10.6	\$46.0	N/A
<b>PROJECT TOTAL</b>	<b>\$90.1</b>	<b>\$92.7</b>	<b>\$121.9</b>	<b>\$124.8</b>	<b>\$127.9</b>	<b>\$557.3</b>	
Other Resources (Cost Share	\$53.0	\$53.0	\$0.0	\$0.0	\$39.0	\$145.0	

### B. Changes from Original Project Proposal

Our FY20 workplan requested funding from EVOSTC to conduct dedicated November and March marine bird surveys within bays of PWS that were discontinued at the end of the first 5-year funding cycle. We thank EVOSTC for the additional funding (\$24K for FY19, 20, and 21 for a total of \$72K). We do not have any changes for our FY21 budget.

### C. Sources of Additional Project Funding

We were provided a berth during FY17 and FY18 onboard the ADF&G spot shrimp surveys and the OTN maintenance cruise (funded by a grant from the Alaska Ocean Observing System). These charters were valued at \$53.0K. Beginning in FY19 EVOSTC provided funding for a dedicated marine bird surveys in March and November that eliminated the need to put an observer onboard the ADF&G and OTN cruises. PWS Regional Citizens' Advisory Council has provided \$39.0K for a winter marine bird survey in and around the PWS tanker escort zone in FY21. PWS Regional Citizens' Advisory Council funds one year at a time, but our goal is for these surveys to be conducted annually so the data can be incorporated into our Gulf Watch Alaska marine bird survey data. A letter of support from PWS Regional Citizens' Advisory Council is attached as documentation.

## 7. FY17-20 PROJECT PUBLICATIONS AND PRODUCTS

### Publications

Arimitsu, M., J. Piatt, R.M. Suryan, S. Batten, M.A. Bishop, R.W. Campbell, H. Coletti, D. Cushing, K. Gorman, S. Hatch, S. Haught, R.R. Hopcroft, K.J. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, R.S. Pegau, A. Schaefer, S. Schoen, J. Straley, and V. R. von Biela. 2019. Chapter 3 Synchronous collapse of forage species disrupts trophic transfer during a prolonged marine heatwave. *In*: M.R. Suryan, M.R. Lindeberg, and D.R. Aderhold, eds. The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska. Gulf Watch Alaska Long-Term Monitoring Program Draft Synthesis Report (Exxon Valdez Oil Spill Trustee Council Program 19120114). Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

- Bishop, M. A., and A. Schaefer. 2020. Long term monitoring of marine bird abundance and habitat associations during fall and winter in Prince William Sound. FY19 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 18120114-E.
- Bishop, M. A., and A. Schaefer. 2019. Long term monitoring of marine bird abundance and habitat associations during fall and winter in Prince William Sound. FY18 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 18120114-E.
- Bishop, M. A. 2018. Long-term monitoring of seabird abundance and habitat associations during late fall and winter 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-C), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.
- Bishop, M. A., and A. Schaefer. 2018. Long term monitoring of marine bird abundance and habitat associations during fall and winter in Prince William Sound. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-M.
- Schaefer, A., M.A. Bishop, and R. Thorne. 2020. Marine bird response to forage fish during winter in subarctic bays. *Fisheries Oceanography*. <https://doi.org/10.1111/fog.12472>.
- Stocking, J. S., M. A. Bishop, and A. Arab. 2018. Spatio-temporal distributions of piscivorous birds in a subarctic sound during the nonbreeding season. *Deep-Sea Research II* 147:138–147. doi: 10.1016/j.dsr2.2017.07.017.
- Suryan, R.M., M. ARimitsu, H. Coletti, R.R. Hopcroft, M.R. 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, K. Kuletz, B. Laurel, J.M. Maniscalco, C. Matkin, C. McKinstry, D. Monson, J. Moran, D. Olsen, S. Pegau, J. Piatt, L. Rogers, A. Schaefer, J. Straey, K. Seeney, M. Szymkowiak, B. Weitzman, J. Bodkin, and S. Zador. 2019. Chapter 4 Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska. *In*: M.R. Suryan, M.R. Lindeberg, and D.R. Aderhold, eds. *The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska*. Gulf Watch Alaska Long-Term Monitoring Program Draft Synthesis Report (*Exxon Valdez* Oil Spill Trustee Council Program 19120114). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Published and updated datasets

**DataONE Published Datasets**

- Bishop, M. A., A. Schaefer, K. Kuletz, M. McCammon, and K. Hoffman. 2017. Fall and Winter Seabird Abundance Data, Prince William Sound, 2007-2017, Gulf Watch Alaska Pelagic Component. Research Workspace. 10.24431/rw1k1w.

**Gulf of Alaska Data Portal Datasets**

- Bishop, M. A., and A. Schaefer. 2019. Fall and Winter Seabird Abundance: PWS fall and winter 2018-2019 seabird observations. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Gulf of Alaska Data Portal.
- Bishop, M. A., and A. Schaefer. 2018. Fall and Winter Seabird Abundance: PWS fall and winter 2017-2018 seabird observations. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Gulf of Alaska Data Portal.

## Research Workspace

Bishop, M. A., and A. Schaefer. 2020. Fall and Winter Seabird Abundance: PWS fall and winter 2019-2020 seabird observations. *Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska*. Research Workspace.

## North Pacific Pelagic Seabird Database

Drew, G., and J. Piatt. 2020. Fall and Winter Seabird Abundance: PWS fall and winter 2007-2016 seabird observations. Bishop, M.A., and A. Schaefer contribution to North Pacific Pelagic Seabird Database v. 3.0 (NPPSD): U.S. Geological Survey data release.

## Presentations

Arimitsu, M., M. A. Bishop, D. Cushing, S. Hatch, R. Kaler, K. Kuletz, C. Matkin, J. Moran, D. Olsen, W.S. Pegau, J. Piatt, A. Schaefer, and J. Straley. 2020. 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, January 2020, Anchorage, AK.

Cancelled due to government shutdown: Arimitsu, M., M. A. Bishop, D. Cushing, S. Hatch, B. Heflin, R. Kaler, K. Kuletz, C. Matkin, J. Moran, D. Olsen, J. Piatt, A. Schaefer, and J. Straley. 2019. Still awaiting ecosystem recovery following the North Pacific Heat Wave: Gulf Watch Alaska Pelagic Monitoring Update 2018. **Poster Presentation**. Alaska Marine Science Symposium, January 2019, Anchorage, AK.

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

Schaefer, A. L., M. A. Bishop, and R. Thorne. 2018. Non-breeding marine bird response to forage fish schools in Prince William Sound, Alaska. **Poster Presentation**. Alaska Marine Science Symposium, January 2018, Anchorage, AK.

## Outreach

Schaefer, A. 2020. Are warmer waters driving shearwaters into PWS? Delta Sound Connections. Prince William Sound Science Center.

Schaefer, A. 2018. A winter refuge for seabirds. Delta Sound Connections. Prince William Sound Science Center.

Schaefer, A. 2017. Avian invasion. Delta Sound Connections. Prince William Sound Science Center.

## 8. LITERATURE CITED

Bishop, M.A., J.T. Watson, K. Kuletz, and T. Morgan. 2015. Pacific herring (*Clupea pallasii*) 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.

Di Lorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. *Nature Climate Change* 6:1042-1047.



- Exxon Valdez* Oil Spill Trustee Council. 2014. 2014 Update, Injured Resources and Services List. Anchorage, Alaska.
- Schaefer, A., M.A. Bishop, and R. Thorne. 2020. Marine bird response to forage fish during winter in subarctic bays. *Fisheries Oceanography*. <https://doi.org/10.1111/fog.12472>.
- Stocking, J., M. A. Bishop, and A. Arab. 2018. Spatio-temporal distributions of piscivorous birds in a subarctic sound during the non-breeding season. *Deep-Sea Research Part II* 147:138-147.
- U.S. Fish and Wildlife Service. 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, Alaska Region, 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.F., A.A. Saveliev, and E.N. Ieno, editors. *Zero inflated models and generalized linear mixed models with R*. Highland Statistics Ltd., Newburgh, United Kingdom.



**Regional Citizens' Advisory Council** / "Citizens promoting environmentally safe operation of the Alyeska terminal and associated tankers."

In Anchorage: 3735 Spruce Road / Suite 100 / Anchorage, Alaska 99503 / (907) 277-7222 / FAX (907) 277-4031  
In Valdez: P.O. Box 3585 / 100 South Street / Suite 202 / Valdez, Alaska 99686 / (907) 824-5000 / FAX (907) 827-5926

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**To whom it may concern,**

I am writing this letter in regards to winter marine bird survey work that the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) is currently funding. In May 2020, PWSRCAC approved \$39,000 toward a project proposed and led by Dr. Mary Anne Bishop titled *Prince William Sound tanker escort zone: Monitoring spatial variability of marine birds during winter*. This project will involve a partnership and cost sharing between PWSRCAC and the Prince William Sound Science Center. The field work for this marine bird survey project is expected to take place in February 2021, and this study is currently planned to take place for at least three years. Subsequent funding, for field work and report writing in 2022 and 2023, will be subject to annual approval by the PWSRCAC Board of Directors.

The designated survey area is designed to complement, not duplicate, the current EVOS winter marine bird study that Dr. Bishop is conducting. The data from the tanker lane marine bird surveys would be available for incorporation into the EVOS winter study.

The PWSRCAC Board of Directors believes that monitoring marine bird distribution and relative abundance in Prince William Sound provides valuable information, especially in the winter when such data is currently sparse. Understanding where marine birds are located during the winter and other seasons is important for prioritizing their protection during an oil spill response or identifying suitable places of refuge for oil tankers, or other vessels in distress.

As you are aware, the PWSRCAC is an independent non-profit corporation whose mission is to promote environmentally safe operation of the Valdez Marine Terminal and associated tankers. Our work is guided by the Oil Pollution Act of 1990, and our contract with Alyeska Pipeline Service Company. PWSRCAC's 18 member organizations are communities in the region affected by the 1989 Exxon Valdez oil spill, as well as commercial fishing, aquaculture, Native, recreation, tourism, and environmental groups.

Please feel free to contact me if you have any questions or would like more information on PWSRCAC's work and interest in monitoring marine birds in Prince William Sound.

Sincerely,

**Donna Schantz  
Executive Director**

900.105.200812.WinterBirdSurvey