

ATTACHMENT B. Annual Project Report Form (Revised 11.21.19)

1. Program Number:

19120114-E

2. Project Title:

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

3. Principal Investigator(s) Names:

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

Report prepared by Anne Schaefer, Prince William Sound Science Center

4. Time Period Covered by the Report:

February 1, 2019-January 31, 2020

5. Date of Report:

March 2020

6. Project Website (if applicable):

www.gulfwatchalaska.org

<http://pwssc.org/seabirds>

<http://pwssc.org/monitoring-marine-birds/>

7. Summary of Work Performed:

This project monitors marine bird abundance and distribution in Prince William Sound (PWS), Alaska, during fall and winter (September through March). These time periods are critical for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels and day length reduced, and water temperatures cooler. By monitoring marine birds during fall and winter, we improve our predictive models of species abundance and distribution across PWS in relation to biological and physical environmental factors. Furthermore, continued monitoring will help determine marine bird recovery from and vulnerability to natural and anthropogenic environmental change.

The specific objectives of this study are to:

1. Characterize the spatial and temporal distribution of marine birds in PWS 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.

In FY19, all cruises were completed as expected. Thanks to additional *Exxon Valdez* Oil Spill Trustee Council funding, in FY19 (and continuing through FY21) we added dedicated marine bird surveys within bays of PWS. In addition to within-bay transects, we also surveyed within the southwest passages of PWS as well as select nearshore transects coinciding with U.S. Fish and Wildlife Service (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. In this FY19 report, we summarize 2019 field work and provide preliminary results addressing objectives 1 and 2. Objective 3 is addressed in a manuscript recently submitted for peer review.

2019 Field Work and Preliminary Analyses

During FY19 (1 February 2019 – 31 January 2020), one observer with the Prince William Sound Science Center (PWSSC) performed three marine bird surveys in PWS covering a total of 1,184 km (Fig. 1, Table 1). In March and November 2019, we conducted dedicated marine bird surveys in conjunction with the Monitoring of Oceanographic Conditions in Prince William Sound Project (Table 2; principal investigator [PI] Campbell, project 19120114-G). In March, we counted 1293 birds representing 25 species over 306 km of survey effort. 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, we counted 2088 birds of 34 species over 328 km of survey effort. 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.

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) were sitting on the water, and most made little or no attempt to avoid the vessel as we approached. There are reports of another marine heatwave forming in the Gulf of Alaska, which can upset marine food web dynamics. These shearwaters may be responding to the warming

conditions in the Gulf similarly to how murres responded during the heatwave of 2014-2016, by shifting their distributions nearshore 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 1. Fall through winter marine bird surveys, Prince William Sound, Alaska, FY19.

Cruise	Km surveyed	Observer	FY19 Cruise Dates
PWSSC Marine Bird	306	A. Schaefer	Mar 4-7, 2019
NOAA, USGS, PWSSC IPP	550	A. Schaefer	Sep 16-24, 2019
PWSSC Marine Bird	328	A. Schaefer	Nov. 2-6, 2019

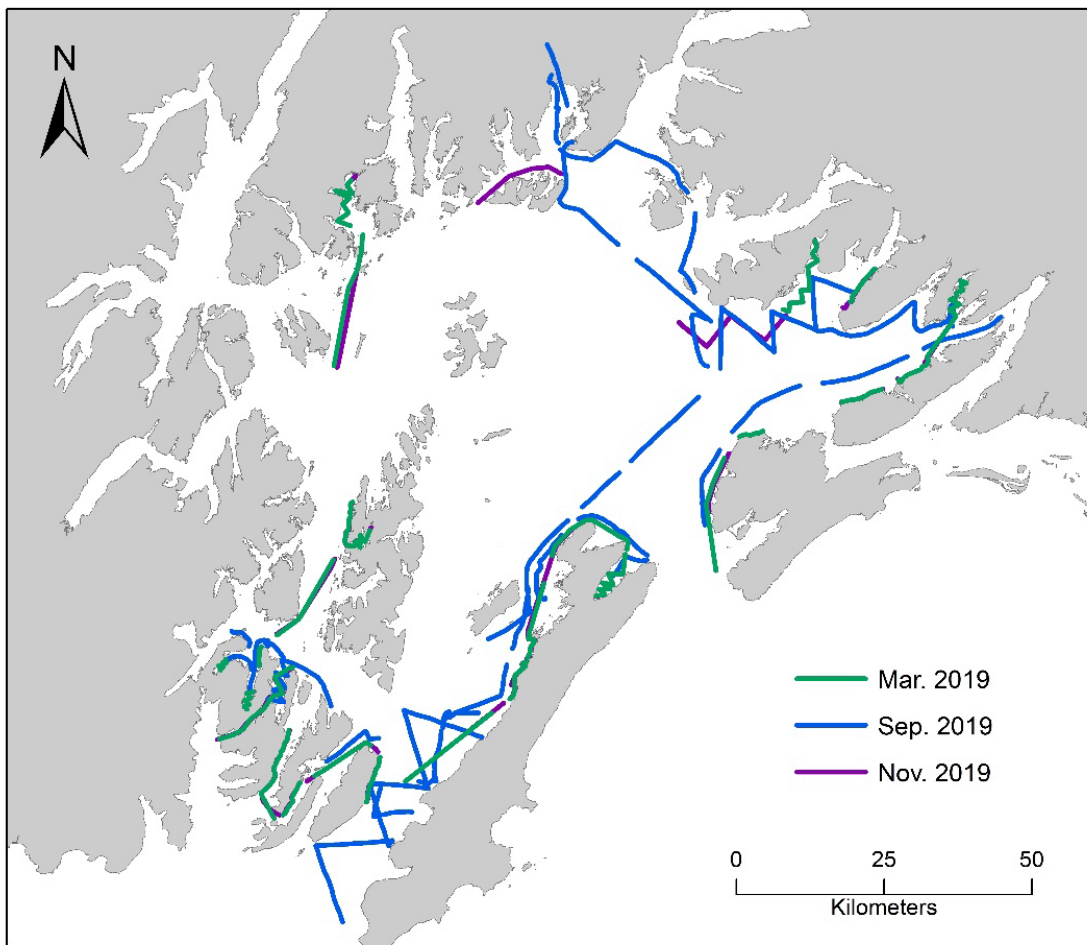


Figure 1. Spatial coverage of the three marine bird surveys completed in Prince William Sound, Alaska during FY19. March and November surveys are replicated as much as possible depending on observation and weather conditions.

Table 2. Survey effort by transect-type for the Prince William Sound Science Center marine bird surveys, March and November 2019.

Cruise	Bay	Nearshore	Transit	Total
March 2019	80.6	75.8	149.4	305.8
November 2019	81.3	78.4	168.6	328.3

In September 2019, we conducted marine bird surveys as part of the Gulf Watch Alaska Integrated Predator-Prey (IPP) Survey (PWSSC/National Oceanic and Atmospheric Administration [NOAA]/U.S. Geological Survey [USGS]). The multi-project effort also surveyed 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, bird observations were conducted simultaneously with hydroacoustic surveys over 145 km of effort. Observations from these surveys (in addition to observations recorded while transiting between sampling locations) are included in Figs. 2, 3, & 4.

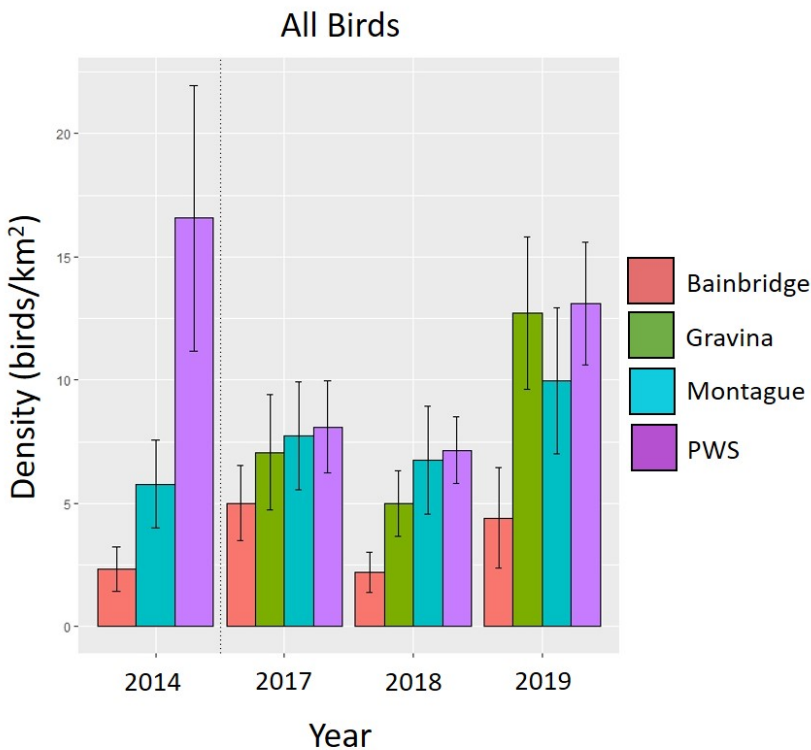


Figure 2. September marine bird densities in 2019 on acoustic transects and overall in Prince William Sound were higher than densities observed in 2017 & 2018. The 2014 survey was a pilot study and coverage in Montague Strait was less than subsequent surveys.

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 Gulf of Alaska. 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 Gulf of Alaska.

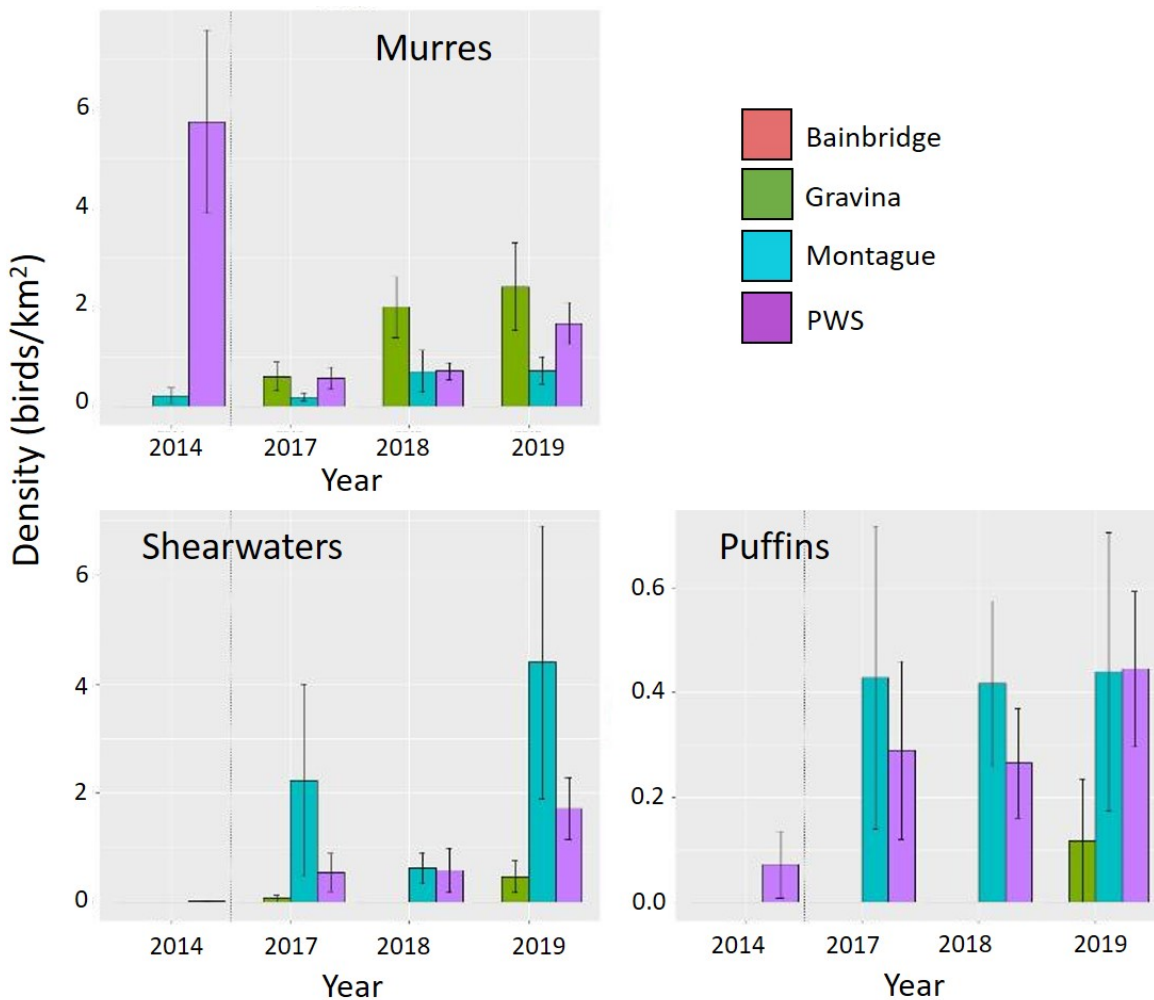


Figure 3. Densities of murres, shearwaters, and puffins during September Integrated Predator-Prey Surveys, Prince William Sound. In 2019, we documented increased densities of murres and distribution shifts of shearwaters and puffins.

Forage Flock/Humpback Whale Foraging Dynamics: When a forage flock is encountered during surveys, the marine bird observer records any marine mammals associated with the flock (within 150 m of 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 Knowles 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 murres, 4 Pacific loons, and 2 glaucous-winged gulls. The third flock was composed of 30 kittiwakes and 8

murres. 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 murres as a useful indicator because, as piscivorous seabirds, murres are particularly sensitive to changes in the marine ecosystem. Murre densities appear to be highly variable within months and across winters (Fig. 4). For murres, our surveys detected changes in densities and distribution in PWS during the months leading up to a prolonged die-off event occurring along the Gulf of Alaska beginning during the winter of 2014-15 and ending in the spring of 2016. Our surveys recorded anomalously high densities in February 2015 (immediately preceding the onset of the die-off) and fall 2015 (immediately prior to the peak of the die-off in December 2015). The increased use of PWS by murres during the 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 in PWS through 2017 and 2018 in PWS (PI Campbell 19120114-G).

Since the die-off and dissipation of the heatwave, murre densities have been lower than the long-term monthly average, with the exception of September 2019, when murre densities were approximately equal to the long-term mean (Fig. 4). Total bird density is also highly variable within and across years (Fig. 4). Similar to murres, total marine bird density was anomalously low. However, densities increased during fall 2019, which is potentially a sign of ecosystem recovery. Continued sampling 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.

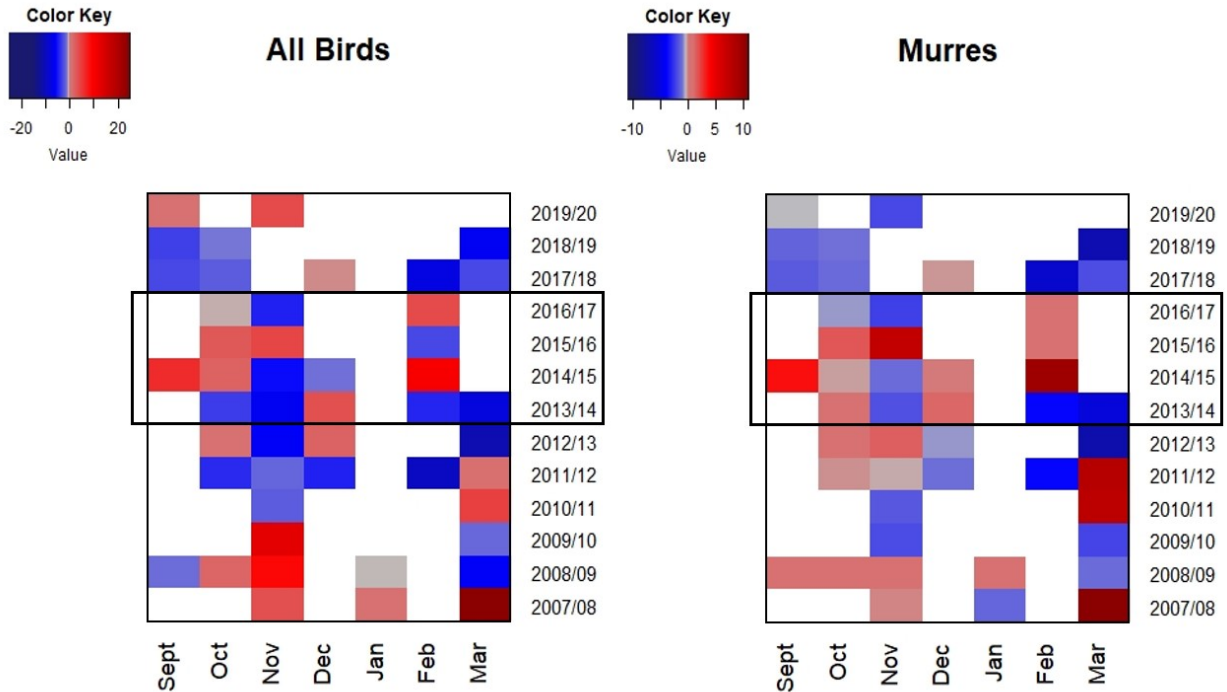


Figure 4. Monthly total marine bird and murre density anomalies observed during fall and winter bird surveys in Prince William Sound (PWS), 2007-2019. A marine heatwave event occurred throughout the Northeast Pacific Ocean beginning in the winter of 2013/14 and was strongest (with regional variability) through 2017 (indicated by black box). However, positive temperature anomalies still persisted through 2018 in the Gulf of Alaska, including coastal regions (PI Danielson, project 19120114-I) and PWS (PI Campbell, project 19120114-G).

8. Coordination/Collaboration:

A. Projects Within a Trustee Council-funded program

1. Within the Program

This project is a component of the integrated Gulf Watch Alaska-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 several 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 19120114-O) and forage fish surveys (PIs Arimitsu and Piatt, project 19120114-C). This collaboration affords efficiencies in field work, as well as facilitates greater understanding of predator-prey interactions in the Sound.

Beginning in FY19, we also share a vessel with the Gulf Watch Alaska project Monitoring of Oceanic Conditions in Prince William Sound (PI Campbell, 19120114-G) for our November and March marine bird surveys. 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.

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 and Kaler, project 19120114-M). 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 (PIs Holderied and Baird, project 19120114-J), PWS, Kenai Fjords, Kachemak Bay, and Katmai (PI Coletti, project 19120114-H), and Seward Line/Gulf of Alaska (PIs Hopcroft and Kuletz, project 19120114-L).

2. Across Programs

a. Herring Research and Monitoring

Our fall/winter observations complement the suite of data collected by HRM, including insertion of key predator data into the population modeling of herring.

b. 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. Individual Projects

This project will coordinate with other *Exxon Valdez* Oil Spill Trustee Council-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 (20110853) on the Naked Island group.

The PWS Regional Citizens Advisory Council (PWSRCAC) promotes the environmentally safe operation of the Alyeska terminal in Valdez and the associated tankers. The PWSRCAC is considering a proposal of P.I. Bishop to survey seabirds in and around the tanker lane (from Valdez to Hinchinbrook Entrance) during February. PWSRCAC is interested in this proposal because these data would be complementary to our ongoing winter seabird surveys that cover other parts of PWS. The proposal will be voted on by the PWSRCAC Board in May.

C. With Trustee or Management Agencies

Information from this project will feed into the North Pacific Pelagic Seabird Database (NPPSD), a database that is maintained by USFWS and USGS. During FY19, we worked with Gary Drew (USGS) to prepare survey data from 2007-2016 for the NPPSD. These data will be included in the updated version of the database (v. 3.0), due to be released in early 2020.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

1. Peer-reviewed Publications

Schaefer, A., M.A. Bishop, and R. Thorne. *Accepted pending revisions*. Marine bird response to forage fish during winter in subarctic bays and fjords. *Fisheries Oceanography*.

2. Reports

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. 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 17120114-M.

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. Straley, 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.

3. Popular Articles

No new contributions for this reporting period.

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

1. Conferences and Workshops

Arimitsu, M., M. 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

Monitoring Update 2019. Poster presented at Alaska Marine Science Symposium, January 2020, Anchorage, AK.

2. Public presentations

No new contributions for this reporting period.

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

Drew, G. and J. Piatt. *In prep.* 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 3.0 (NPPSD): U.S. Geological Survey data release.

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

All data and metadata for this project are up to date (<https://portal.aos.org/gulf-of-alaska#metadata/2f42dd1c-d67a-4c49-8c2e-1d63387e0ad0/project/files>)

“PWS Fall and Winter 2017-2018 seabird observations.csv”: uploaded and published to data portal (<https://workspace.aos.org/project/23643/folder/2660866/completed-survey-data>)

“PWS Fall and Winter 2018-2019 seabird observations.csv”: uploaded and published to data portal (<https://workspace.aos.org/project/23643/folder/2660866/completed-survey-data>)

“PWS Fall and Winter 2019-2020 seabird observations.csv”: uploaded to data portal and updated after each cruise; will be published summer 2020.

10. Response to EVOSTC Review, Recommendations and Comments:

Science Panel Comment (FY20): *Project is making good progress in a timely manner. The Science Panel has no specific comments or questions.*

PI Response (FY20): Thank you for your comments.

Science Panel Comment (FY19): *Was the same NOAA vessel leveraged by both projects during the March cruises? The Science Panel asks that the PMT and the PIs communicate with trust agencies, such as NOAA, USFWS and ADFG, to see if they could also use this vessel for any agency activities. We understand the reason for nearshore bay surveys and would like to know if using ships of opportunity is really efficient and if effort and funds should be redirected from open water to preferred nearshore habitats. Can parts of Figure 2 surveys be eliminated if they are not proving to be useful? Is it possible to leverage ship time for surveys from project 19120114-G Campbell? Specifically, there appears to be considerable overlap in spatial sampling proposed in bays in this proposal [Fig 4] with those in Campbell [Fig 1 from 19120114-G], and Campbell proposes 6 times yearly sampling.*

PI Response (FY19): Yes, the same National Oceanic and Atmospheric Administration (NOAA) vessel was leveraged by both humpback whale and fall/winter marine bird projects (18120114-O, Moran & Straley, and 18120114-E, Bishop) during FY17 and FY18.

We will coordinate with agencies such as NOAA, U.S. Fish and Wildlife Service, and Alaska Department of Fish and Game to see if they could also use the dedicated marine bird survey vessel for additional activities.

Our surveys cover three basic habitat types: open waters, bays, and passages. The first 10 years of our surveys onboard ships of opportunity included all three habitats. However, when the juvenile herring surveys were discontinued in 2016 there was no longer coverage in the bays because the available ships of opportunity only covered open waters and passages. By using a dedicated marine bird vessel in November and March we can once again target bays for surveys in addition to continuing our data collection in open waters and passages while in transit between bays. The within-bay transects would be fixed, thus sampling within bays would not be opportunistic. The in-transit transects are while taking the shortest route between fixed bay transects and would also be relatively consistent, reducing spatial variability of the marine bird surveys. Given the geographic extent and high variability of the PWS ecosystem, sampling open-water areas while traveling between sampling locations is valuable to understanding distribution of marine birds in PWS. For example, our past surveys have identified several areas of high marine bird densities in open waters including Montague Strait and Orca Bay. Also, our current survey design is the most efficient way to sample bays distributed throughout PWS.

Finally, we are currently in communication with Dr. Campbell (project 19120114-G, PWS oceanography) regarding vessel-sharing during November and March. Dr. Campbell's sampling events typically occur over a 3-day period, while our surveys take approximately 6 days, so there would be additional personnel costs on his end. In addition, in its current configuration the vessel (R/V New Wave) would need to be modified to accommodate a marine bird observer. Specifically, a small observing platform would need to be fabricated that would be placed on top of the cabin. We recognize that combining efforts could ultimately reduce costs by ~20%, so talks are ongoing.

11. Budget:

Please see provided program workbook. Personnel for this project was underspent in FY19 as the avian research assistant took a 3-month leave of absence and the PI took more leave than expected due to health issues.

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	\$195.0
Travel	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$2.7
Contractual	\$1.7	\$1.7	\$25.7	\$25.7	\$25.7	\$80.5	\$24.2
Commodities	\$0.2	\$0.2	\$0.1	\$0.1	\$0.1	\$0.7	\$1.4
Equipment	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	
Indirect Costs (waived)							
SUBTOTAL	\$82.7	\$85.1	\$111.8	\$114.5	\$117.3	\$511.3	\$223.3
General Administration (9% of subtotal)	\$7.4	\$7.7	\$10.1	\$10.3	\$10.6	\$46.0	N/A
PROJECT TOTAL	\$90.1	\$92.7	\$121.9	\$124.8	\$127.9	\$557.3	
Other Resources (Cost Share Funds)	\$53.0	\$53.0	\$0.0	\$0.0	\$0.0	\$106.0	

LITERATURE CITED

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