1. Project Number:

20120114-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, 2020-January 31, 2021

5. Date of Report:

March 2021

6. Project Website (if applicable):

www.gulfwatchalaska.org

http://pwssc.org/seabirds-2/

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 will 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.

Our fall/winter marine bird surveys consist of three cruises conducted during September, November, and March. FY20 was our second winter of fully dedicated marine bird cruises in which we survey consistent, repeated transects that cover open waters, bays, passages, and nearshore transects that coincide with historical U.S. Fish and Wildlife Service (USFWS) survey transects. These surveys are replicated every November and March and extend our long-term and most consistent (2007-2016) dataset of wintering marine bird abundance and distribution. The dedicated marine bird surveys are conducted onboard the PWS Science Center's (PWSSC) R/V New Wave and are in conjunction with the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) project "Monitoring of Oceanographic Conditions in Prince William Sound" (principal investigator [PI] Campbell, project 20120114-G). Unfortunately, in FY20 the September 2020 Integrated Predator Prey survey (a collaboration with U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA) EVOSTC-funded projects) was canceled due to COVID-19 governmental restrictions on fieldwork.

Here in this FY20 report, we summarize 2020 field work and provide preliminary results addressing objective 1. We addressed aspects of objectives 2 and 3 in a recently published paper (Schaefer et al. 2020) that is also summarized here.

2020 Field Work and Preliminary Analyses

During FY20 (1 February 2020 – 31 January 2021), one observer (A. Schaefer) with the PWSSC performed two marine bird surveys in PWS covering a total of 633 km (Fig. 1, Table 1) while onboard the R/V New Wave.

In March, we counted 1355 birds representing 25 species over 305 km of survey effort. The marine bird community was dominated by a mix of open water and nearshore species: marbled murrelets (19%), surf scoters (13%), and Barrow's goldeneye (12%). In November, we counted 1605 birds of 26 species over 323 km of survey effort. The survey counts were dominated by the same species as the March 2020 survey: surf scoter (16%), marbled murrelets (14%), and Barrow's goldeneye (10%).

Table 1. Fall through winter marine bird surveys, Prince William Sound, Alaska, FY20.

Cruise	Km surveyed	Observer	FY20 Cruise Dates
PWSSC Marine Bird survey	305	A. Schaefer	27 Feb-3 Mar 2020
NOAA, USGS, PWSSC Integrated Predator Prey Survey			Canceled, COVID-19
PWSSC Marine Bird survey	323	A. Schaefer	3, 6-7, 10-12 Nov 2020

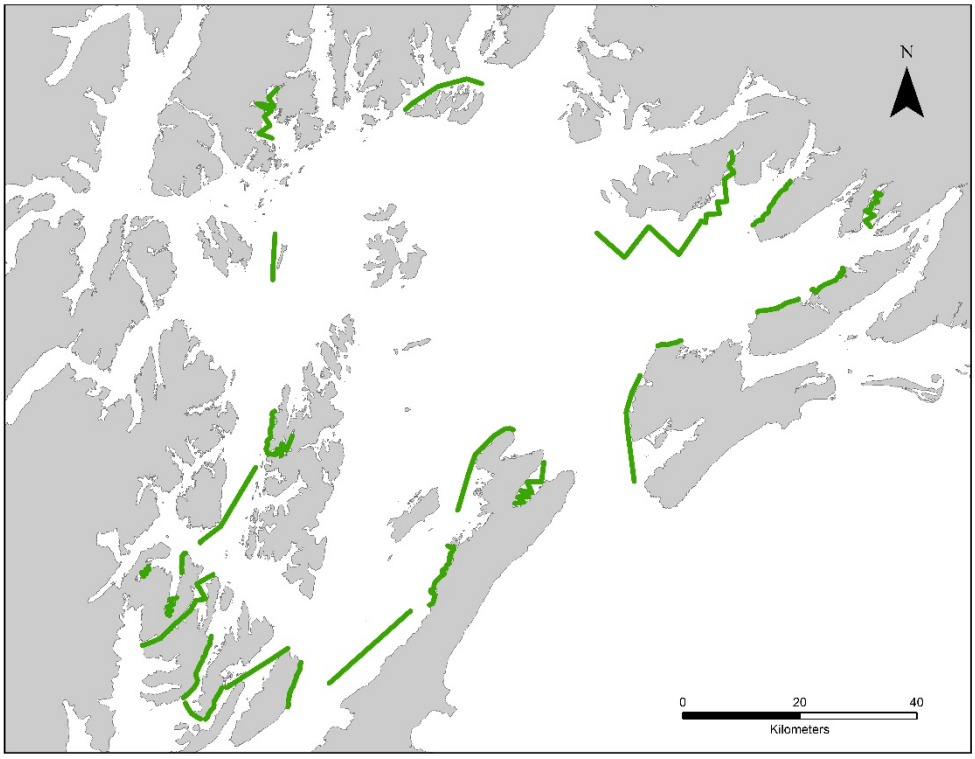

Figure 1. Spatial coverage of the two marine bird surveys completed in Prince William Sound, Alaska during FY20 (green lines). March and November surveys are replicated as much as possible depending on observation and weather conditions.

Temporal patterns in marine bird density

As of January 2021, we have completed 51 marine bird surveys over 14 fall/winters in PWS. From these surveys, we have documented consistent temporal patterns in density and distribution for the most abundant marine bird species, including common murre, marbled murrelet, black-legged kittiwake, and large gulls (Zuur et al. 2012, Dawson et al. 2015, Stocking et al. 2018). Variation from these patterns can provide insight as to current status and identify years with anomalous marine bird densities. For example, when considering all marine birds (Fig. 2), we consistently see higher densities in nearshore habitats, emphasizing the importance of protected PWS habitats as a winter

refugia. Across both habitat types (nearshore vs open), marine bird densities also consistently increase as winter progresses. In FY20, March 2020 surveys were below the long-term mean in both nearshore and open water habitats (Fig. 2: see arrows). In November 2020, marine bird densities were above the mean in nearshore habitats, but slightly below the mean in open water habitats (Fig. 2: see arrows).

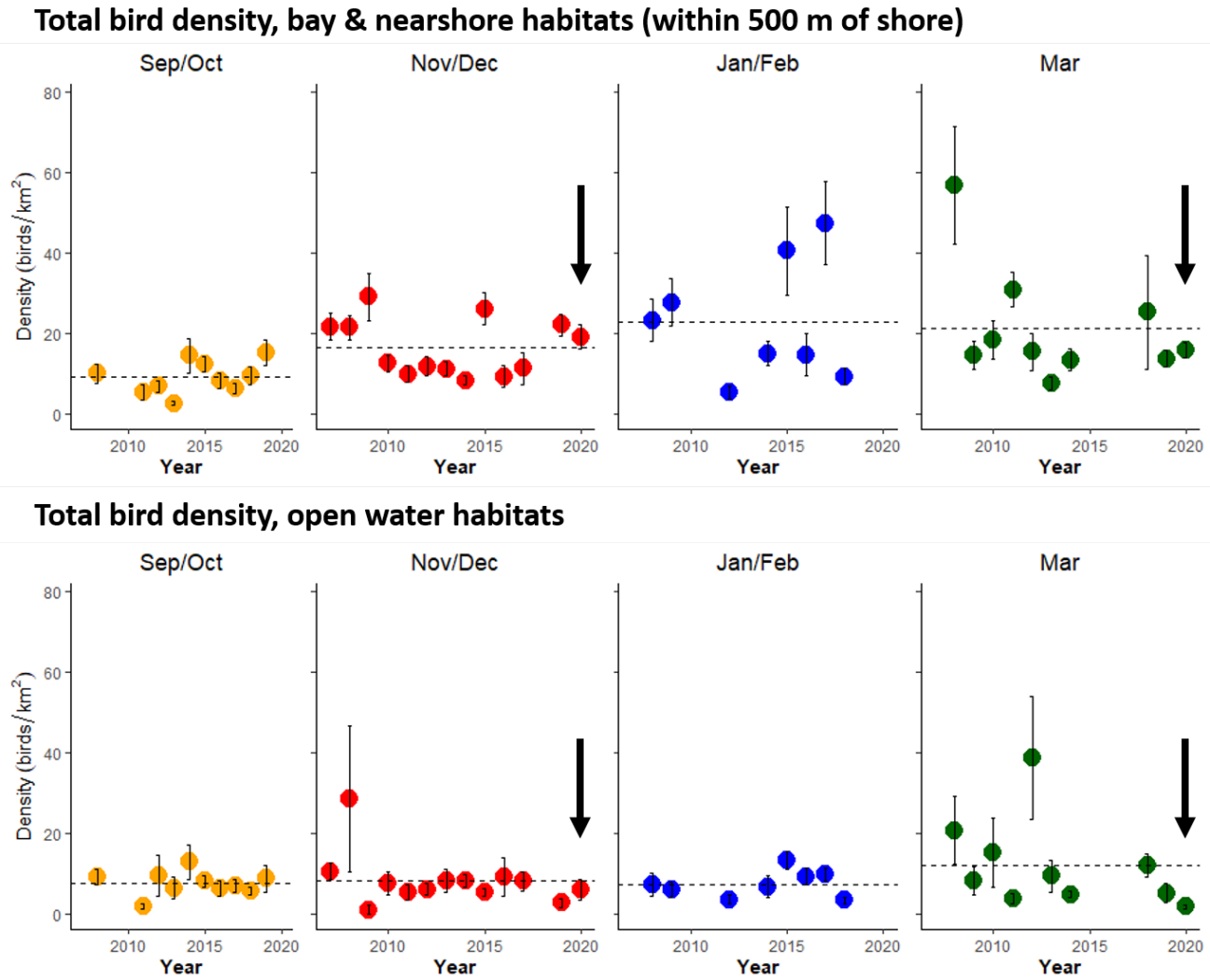

Figure 2. Mean intra-seasonal densities for all marine birds in bay & nearshore habitats (within 500m of shoreline) and open water habitats recorded during fall and winter surveys in Prince William Sound, 2007-2020. The dashed horizontal line shows the mean density for each time period across all years. Arrows indicate data points from FY20. March 2020 densities were below the long-term mean across both habitat types, while November 2020 densities were slightly above the long-term mean in the nearshore but slightly below the mean in open waters.

The common murre is a diving seabird that experienced a massive die-off event during the recent marine heatwave (see "Ecosystem Indicators" section below for further context). Murre densities are typically low during early winter (September-December), increasing through March when murres are the dominant species observed during surveys in PWS. During our surveys, we detected a

distribution shift of murres into nearshore waters of PWS in February, just prior to the March 2015 onset of the murre die-off (Fig. 3: see circled point for Jan/Feb 2015) and again in November 2015, immediately preceding the December 2015 peak of the die-off (Fig. 3: see circled point for Nov/Dec 2015). In FY20, murre densities were below the long-term mean across both habitat types during both March and November 2020 surveys.

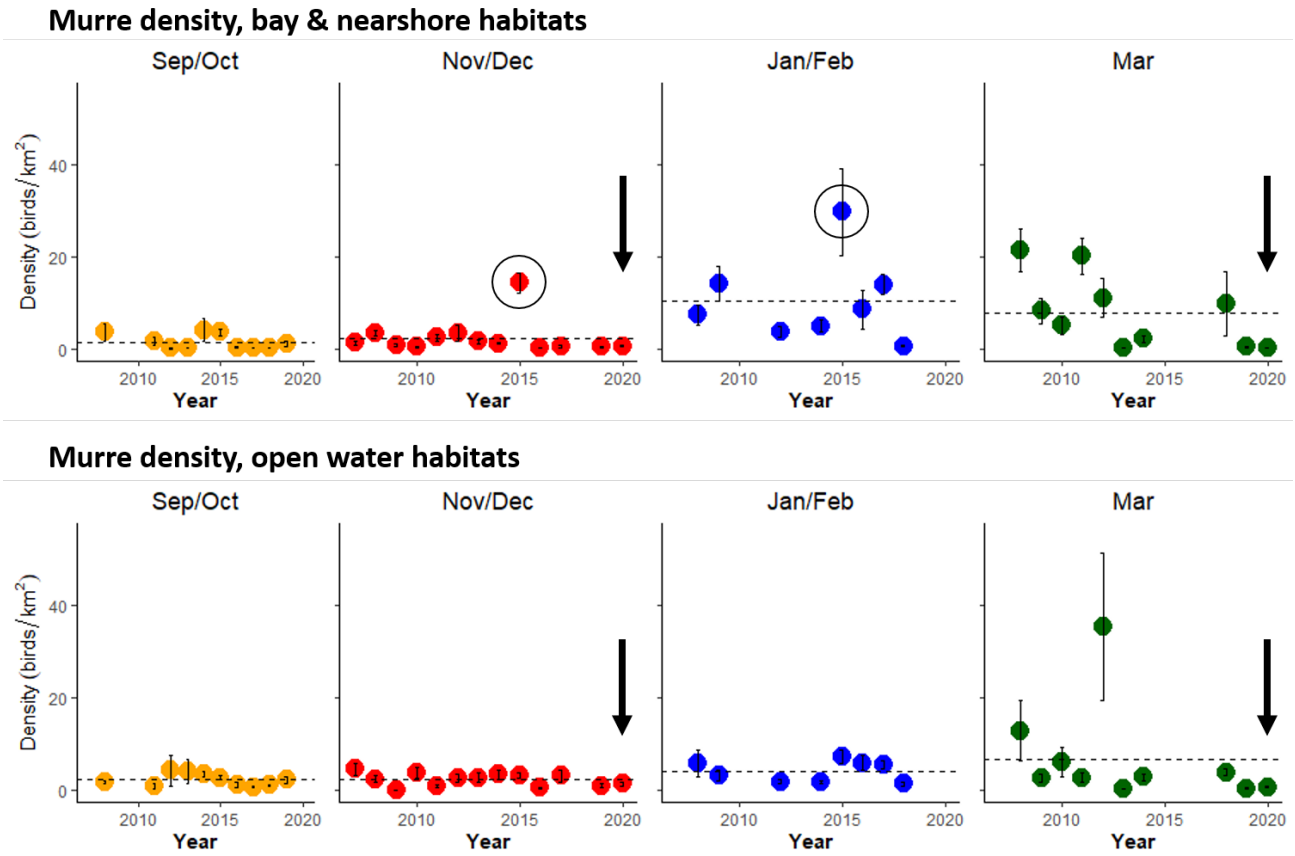

Figure 3. Mean intra-seasonal densities of murres in bay & nearshore habitats (within 500m of shoreline) and open water habitats recorded during fall and winter surveys in Prince William Sound, 2007-2020. The dashed horizontal line shows the mean murre density for each time period across all years. Arrows indicate data points from FY20. Circled data points emphasize the anomalous nearshore densities observed in Prince William Sound prior to the onset and peak of the massive die-off event experienced in 2015-2016. In FY20, murre densities were below the long-term mean for both surveys (March & November) and both habitat types.

Ecosystem Indicators

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 murre density as a potentially 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). As described above, 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 2014-2015 and ending in the spring of 2016 (Piatt et al. 2020). Our surveys recorded unusually high densities in late winter 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 murres during winter coincided with persistently high ocean temperatures in the North Pacific Ocean that occurred from the winter of 2013-14 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 (Campbell 2019).

Since the die-off and dissipation of the heatwave, murre densities during our fall/winter surveys have been lower than the long-term monthly average. Similarly, the total marine bird density was also anomalously low immediately after the dissipation of the heatwave. However, densities increased during fall 2019 and 2020, 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.

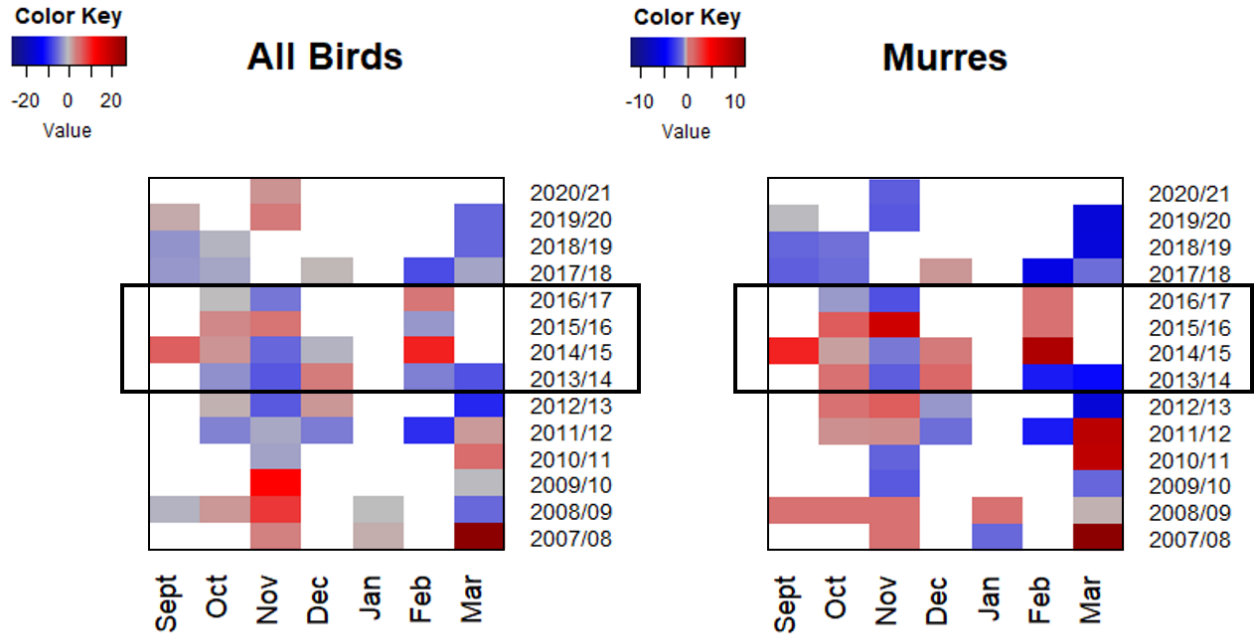

Figure 4. Monthly total marine bird and murre density anomalies observed during fall and winter bird surveys in Prince William Sound, 2007-2020. A marine heatwave event occurred throughout the Northeast Pacific Ocean beginning in the winter of 2013/14 and remained strong (with regional variability) through 2016 (indicated by black box). However, in the Gulf of Alaska, including coastal regions such as Prince William Sound, positive temperature anomalies persisted through 2018 (Campbell 2019, Danielson and Weingartner 2019).

Relationships of marine bird presence and abundance to prey fields identified during concurrent hydroacoustic surveys

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 juvenile Pacific herring nursery bays of PWS. More than 40% of observed marine birds were associated with a fish school (within 150 m), 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 and large gulls in early winter to common murres 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.

8. Coordination/Collaboration:

A. Long-term Monitoring and Research Program Projects

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

Since FY19 we have shared a vessel with the Gulf Watch Alaska project Monitoring of Oceanic Conditions in Prince William Sound (PI Campbell, 20120114-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 U.S. Fish and Wildlife Service (USFWS) (PIs Kuletz and Kaler, project 20120114-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 20120114-J), PWS, Kenai Fjords, Kachemak Bay, and Katmai (PI Coletti, project 20120114-H), and Seward Line/Gulf of Alaska (PIs Hopcroft and Kuletz, project 20120114-L).

2. Across Programs

a. Herring Research and Monitoring

In the past, we placed an observer onboard vessels associated with the PWS Herring Research and Monitoring (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 complement the suite of data collected by this program, 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 Complex. The PWS Regional Citizens' Advisory Council (PWSRCAC) promotes the environmentally safe operation of the Alyeska pipeline terminal in Valdez and the associated oil tankers.

Beginning in 2021, the PWSRCAC has awarded the first year of funding for complementary avian surveys that will be conducted during late February/early March in and around the oil tanker escort zone, including under-surveyed areas such as the nearshore, open waters, and adjacent bays in and around Port Valdez, Valdez Arm, Port Fidalgo, and Port Etches (Fig. 5). Importantly, this survey data will be combined with the Gulf Watch Alaska survey data.

Figure 5. Map of late February/early March marine bird survey transects in Prince William Sound. The blue lines indicate transects already surveyed as part of the Gulf Watch Alaska dedicated marine bird surveys. The red lines show the newly funded Prince William Sound Regional Citizens' Advisory Council transects designed to survey understudied areas in and around the oil tanker escort lane.

C. With Trustee or Management Agencies

Data from this project is incorporated into the North Pacific Pelagic Seabird Database (NPPSD), a database that is maintained by USFWS and USGS.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

1. Peer-reviewed 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. *In press.* Heatwave-induced synchrony within forage fish portfolio disrupts energy flow to top pelagic predators. Global Change Biology XX:XX-XX.

Schaefer, A., M.A. Bishop, and R. Thorne. 2020. Marine bird response to forage fish during winter in subarctic bays. Fisheries Oceanography 29:297-308. https://doi.org/10.1111/fog.12472

Suryan, R. M., M. L. Arimitsu, H. A. Coletti, R. R. Hopcroft, M. R. Lindeberg, S. J. Barbeaux, S. D. Batten, W. J. Burt, **M. A. Bishop**, J. L. Bodkin, R. E. Brenner, R. W. Campbell, D. A. Cushing, S. L. Danielson, M. W. Dorn, B. Drummond, D. Esler, T. Gelatt, D. H. Hanselman, S. A. Hatch, S. Haught, K. Holderied, K. Iken, D. B. Iron, A. B. Kettle, D. G. Kimmel, B. Konar, K. J. Kuletz, B. J. Laurel, J. M. Maniscalco, C. Matkin, C. A. E. McKinstry, D. H. Monson, J. R. Moran, D. Olsen, W. A. Palsson, W. S. Pegau, J. F. Piatt, L. A. Rogers, N. A. Rojek, A. Schaefer, I. B. Spies, J. M. Straley, S. L. Strom, K. L. Sweeney, M. Szymkowiak, B. P. Weitzman, E. M. Yasumiishi, and S. G. Zador. In press. Ecosystem response persists after a prolonged marine heatwave. Scientific Reports.

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. 2020. Chapter 3 Synchronous collapse of forage species disrupts trophic transfer during a prolonged marine heatwave. *In:* R.M. 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 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 19120114-E.

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. Sweeney, M. Szymkowiak, B. Weitzman, J. Bodkin, and S. Zador. 2020. Chapter 4 Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska. *In:* R.M. 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 Synthesis Report (*Exxon Valdez* Oil Spill Trustee Council Program 19120114). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

3. Popular articles

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

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

1. Conferences and Workshops

Arimitsu, M., J. Piatt, S. Hatch, R.M. Suryan, S. Batten, M.A. Bishop, R.W. Campbell, H. Coletti, D. Cushing, K. Gorman, R.R. Hopcroft, K.J. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, W.S. Pegau, A. Schaefer, S. Schoen, J. Straley, and V.R. von Beila. 2020. Heatwave-induced synchrony within forage fish portfolio disrupts energy flow to top pelagic predators. **Poster Presentation**. Alaska Marine Science Symposium, January 2021, Anchorage, AK.

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, W.S. Pegau, A. Schaefer, S. Schoen, J. Straley, and V.R. von Beila. 2020. Synchronous collapse of forage species disrupts trophic transfer during a prolonged marine heatwave. **Oral Presentation**. Pacific Seabird Group, March 2020. Portland, OR.

Schaefer, A.L, M.A. Bishop, and R. Thorne. 2020. Marine bird response to forage fish during winter in bays of Prince William Sound, AK. **Oral presentation**. Alaska Marine Science Symposium, January 2021, Anchorage, AK.

2. Public presentations

Due to COVID-19, 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. 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 (NPPSD) v. 3.0: 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.aoos.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.aoos.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.aoos.org/project/23643/folder/2660866/completed-survey-data)

"PWS Fall and Winter 2019-2020 seabird observations.csv": uploaded and published to data portal.

(https://workspace.aoos.org/project/23643/folder/2660866/completed-survey-data)

10. Response to EVOSTC Review, Recommendations and Comments:

Science Panel Comment (FY21): The Science Panel would like an update on the fall survey - was it cancelled? What is the contingency plan if the survey did not happen?

GWA PI Response (FY21): We, along with our collaborators (USGS, NOAA), had agreed to assess the viability of conducting the September Integrated Predator Prey survey by mid-August 2020. At that time, infection of COVID-19 in the state of Alaska was widespread. Unfortunately, as a result, USGS was forced to cancel the survey due to crew number restrictions on the USGS vessel and commercial travel restrictions for USGS employees. For the September surveys, our marine bird observer conducts surveys while onboard the USGS vessel, as the marine bird observations are paired with the concurrent acoustic surveys for forage fish and euphausiids. We considered placing our marine bird observer onboard the NOAA whale boat. However, given the time constraint of the whale survey (6 days) and transit distance between Whittier (where vessel is docked) and Cordova (to pick up and drop off bird observer), there would not have been enough time to survey the acoustic/marine bird transects while also conducting the necessary whale fieldwork.

Given the status of the pandemic in Alaska, limited survey time, and constricted space available on the whale survey vessel, we concluded that we would not conduct the marine bird surveys this year. Instead, we decided to wait to conduct the surveys with USGS in fall 2021 and in the meantime we (along with our USGS and NOAA collaborators) would focus this fall on analyzing the data from the four previous surveys (September 2014, 2017-2019). Any cost savings remaining at the end of FY21 will be requested to roll into FY22 for analyses and manuscript preparation.

If further delays due to COVID-19 occur in FY21, any cost savings would be used to collaborate with PI Campbell's PWS oceanographic surveys (project 20120114-G). Specifically, biologist Schaefer would conduct marine bird surveys along the three acoustic forage fish/marine bird surveys transect lines (Bainbridge, Montague, Port Gravina; 2-3 d of total charter cruise) and in return would assist Campbell with his oceanographic data collection. While this field work would not replicate all the surveys that are typically conducted as part of the Integrated Predator Prey surveys, it would prevent a second consecutive year of no data from the three permanent transects.

We do not foresee having to cancel the November and late February/early March surveys as they involve only two people on one boat, both PWSSC personnel residing in Cordova (Schaefer & Campbell). The Cordova community has been successful with testing (available most days of the week with results obtained within hours) and contact tracing to maintain a low infection rate. We request that both scientists self-isolate prior to the cruise.

***Update (February 2021): The November PWSSC marine bird survey, in conjunction with PI Campbell's oceanographic surveys (project 20120114-G), was conducted successfully in November

2020. Given the low infection rate of COVID-19 and wide availability of tests in Cordova, we plan to conduct the March survey on schedule. Scientists will self-isolate prior to the cruise.

Science Panel Comment (FY21): On page 4 the proposal mentions the bioenergetics model which was published in 2015; the basis for the estimate that seabirds consume 10% of the adult herring biomass is not clear. The number reported in the proposal is different than that reported in the paper, please explain the discrepancy. Could it be that the assumptions made in the 2015 paper were not well supported because they were based on studies of common murre diets from other regions, but neglected the one winter diet study of murres and murrelets in Alaska (Kachemak Bay)?

GWA PI Response (FY21): Our proposal stated: "We also developed a bioenergetics model for marine birds in winter. Our model results highlight the importance of herring to marine birds in Prince William Sound during winter and suggest that predation by marine birds may have an important top-down effect on the Prince William Sound 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 Prince William Sound (P. Rand, PWSSC, unpubl. data)."

The bioenergetics model was developed and published in 2015 in Fisheries Oceanography using USFWS data from 10 winters collected over an 18-year period (winter 1989/90 – 2006/07). The sentence mentioned by the Science Panel is an abbreviated version from the original Bishop et al. (2015) publication (page 6, results, second paragraph) that stated: "Our model showed that in winters with relatively low adult herring biomass, such as 1999–2000, or winters with relatively high numbers of marine birds, such as 1992–93, as much as 10% (1864 t) of the adult biomass can be removed by avian predators …".

In the Bishop et al. (2015) publication, we outline our assumptions in the methodology, and we do discuss the Kachemak Bay study (Sanger 1987) and their results for common murre and murrelet diet studies during the 1977-78 winter within the context of murrelet diet studies that occurred in PWS during the summer. It seems that further empirical data on winter marine bird diets and a fuller grasp of forage fish availability would improve our understanding of top-down impacts of marines on forage fish.

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. https://doi.org/10.1111/fog.12073

Sanger, G. A. 1987. Winter diets of common murres and marbled murrelets in Kachemak Ba, Alaska. Condor 89:426-430. DOI: 10.2307/1368499

Science Panel Comment (FY21): Additionally, the paper reports impact of seabird predation on juveniles and adults and only adult biomass is highlighted in the proposal. Why?

GWA PI Response (FY21): Marine birds consumed more biomass of juvenile herring than adult herring. Unfortunately, as stated in the Bishop et al. (2015) publication, there were no data for total available juvenile herring in Prince William Sound, so we were unable to estimate the proportion of juvenile herring consumed relative to total available biomass. In the discussion section of the paper,

we discuss the potential impacts of marine bird consumption on juvenile herring, such as exacerbation of low juvenile survival. In the future, we will clarify this point in our proposal.

Science Panel Comment (FY21): Also, the HRM acoustic project proposal reports changes in winter herring biomass which agrees with data from this proposal. However, the data reported here do not seem to translate to the summer and fall herring distributions reported in the acoustic project. Please reconcile.

GWA PI Response (FY21): In the current funding cycle, our PWS fall/winter marine bird surveys occur annually during September, November, and late Feb/early March. The September survey is a collaborative Integrated Predator Prey survey that includes marine bird observations (this project), whale sampling (PIs Moran and Straley, project 20120114-O), and acoustic forage fish surveys (PIs Piatt and Arimitsu, project 20120114-C). During the September survey, we relate our marine bird observations to prey fields identified as part of the concurrent hydroacoustic sampling. As designed for FY17-21, the September Integrated Predator Prey survey is the only survey for which we have simultaneous sampling of marine birds and forage fish. The November and late Feb/early March marine bird surveys are conducted in collaboration with Dr. Rob Campbell (project 20120114-G).

In the past, we collected marine bird observations concurrent with Juvenile Herring Acoustic surveys in November and March (PI Rand, 16120111-F). However, the juvenile herring acoustic surveys were discontinued after 2016. Data from those past surveys (specifically 2007-2012) were used for the analysis and recent publication (Schaefer et al. 2020) referred to on page 3 of our proposal. Acoustic surveys for adult herring do still occur as part of the HRM program, but those typically occur during late March/early April, 2-3 weeks after completion of our marine bird surveys. Other acoustic forage fish surveys occur during the summer (PIs Piatt and Arimitsu, project 20120114-C), but we only survey marine birds during fall and winter (September – early March).

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.

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

Science Coordinator Comment (FY20): PI continues to make good progress. I appreciate the detailed summary of results from FY18 and FY19. No specific comments or questions.

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

11. Budget:

Please see provided program workbook. Personnel for this project was underspent in FY20 for two reasons, COVID-19 caused some delays so we did not spend at the expected rate and the avian research assistant took a leave of absence.

***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	$318.7
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	$44.2
Commodities	$0.2	$0.2	$0.1	$0.1	$0.1	$0.7	$2.7
Equipment	$0.0	$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	$368.3
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	$39.0	$145.0	

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