

**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-M—Continuing the Legacy: Prince William Sound Marine Bird Population Trends

Primary Investigator(s) and Affiliation(s)

Robb Kaler and Kathy Kuletz, US Fish and Wildlife Service

Date Proposal Submitted

August 2, 2020

Project Abstract

We will carry out small boat surveys to monitor the abundance of marine birds in Prince William Sound (PWS), Alaska. The survey is conducted biennially (July of every other year; July 2018 and July 2021) during the current Gulf Watch Alaska (GWA) funding cycle (FY17-21). Fifteen July surveys over a 30-year period have monitored population trends of marine birds in PWS after the *Exxon Valdez* oil spill. These surveys are the primary means to determine whether populations injured by the spill are recovering. Data collected from 1989 to 2018 indicated that pigeon guillemots (*Cephus columba*), marbled murrelets (*Brachyramphus marmoratus*), Kittlitz's murrelets (*B. brevirostris*) are exhibiting long-term declines in PWS. Black-legged kittiwake (*Rissa tridactyla*) densities have also declined in PWS, at that same time that nearly complete breeding failures have been observed (2016-2018). We will continue to examine overall population trends for all marine birds in PWS, which benefit the nearshore and forage fish components of GWA, the Herring Research and Monitoring program, and the pigeon guillemot restoration project at the Naked Island Group. Owing to the COVID-19 pandemic, the July 2020 marine bird survey was postponed until July 2021. The FY20 funds will be carried over and used in 2021. We were unable to include a seabird observer on the spring Seward Line cruise because of COVID-19 health mandate restrictions. However, we did participate in the summer cruise instead of spring and an observer will be on the September survey as planned.

EVOSTC Funding Requested* (must include 9% GA)

FY17	FY18	FY19	FY20	FY21	TOTAL
\$24,900	\$222,200	\$24,900	\$233,400	\$36,200	\$541,600

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$23,000	\$56,000	\$23,000	\$57,100	\$118,800	\$277,900

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, humpback whales, forage fish, and marine birds (two projects: summer and fall-winter). 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?

PWS Summer Marine Bird Monitoring

Boat-based marine bird surveys have been conducted on randomized transects in PWS (Fig. 1), Alaska, over a 31-year period following the 1989 *Exxon Valdez* oil spill (EVOS). To understand the dynamics of a marine bird community that has experienced the simultaneous effects of a major oil spill and climate variability, this project collects additional information to monitor the distribution and abundance of marine birds in PWS. In order to assess population trends in the years following the EVOS, the objectives of this project are to: (1) determine the abundance of marine bird populations in PWS during July 2021 in both oiled and unoiled regions; and (2) determine population abundance of marine bird populations in PWS during July 2021 for PWS as a whole.

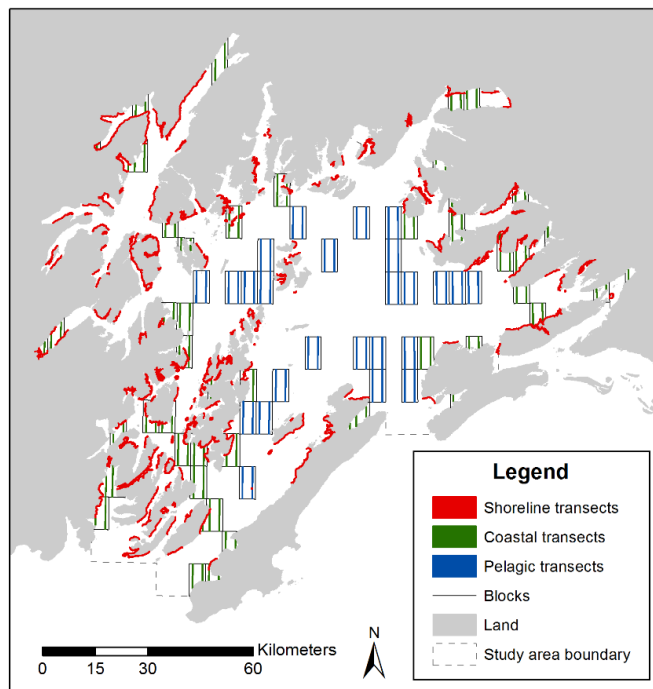


Figure 1. Location of marine bird survey transects using three strata (shoreline, coastal, pelagic) within Prince William Sound, Alaska.

Using data collected during small boat surveys from 1989 to 2012, Cushing (2018) used taxon- and community-centric approaches to examine patterns of marine bird distribution and abundance in PWS and found marine

bird communities as a whole to be spatially structured along a primary onshore-offshore environmental gradient, and secondarily structured along an estuarine-marine environmental gradient. Cushing (2018) also investigated spatial habitat associations and temporal change of *Brachyramphus* murrelets and found that abundance estimates for both marbled murrelets (*Brachyramphus marmoratus*) and Kittlitz's murrelets (*B. brevirostris*) decreased by more than two-thirds over the study period. There was no evidence that rates of change differed along environmental or geographic gradients and no evidence that changes in seasonal patterns of abundance occurred. Density (birds/km²) of marbled and Kittlitz's murrelets continued a long-term pattern of decline in 2018 (Fig. 2A, 2B). Additionally, densities of pigeon guillemots (*Cepphus columba*) continued to decrease Sound wide (Fig. 2C). Also notable, complete or nearly-complete breeding failures of black-legged kittiwakes (*Rissa tridactyla*) occurred in PWS 2016-2018 (Dragoo et al. 2017, 2018) and density of kittiwakes have trended downward during the same period (Fig. 2D). In 2021, we will continue to explore the hypothesis that climate variability has differentially affected nearshore and offshore components of PWS food webs, and how this may have contributed to the failure of some taxa to recover from the population injury caused by the EVOS.

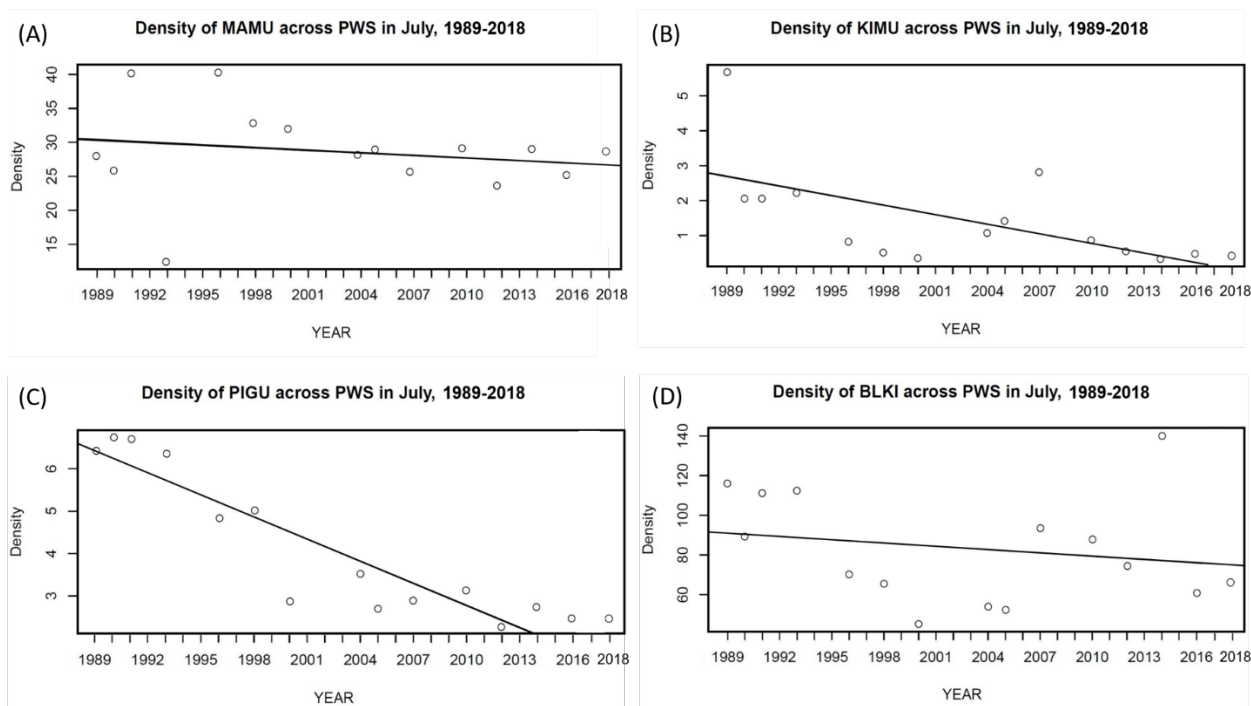


Figure 2. Density (birds/km²) estimated for (A) marbled murrelet [MAMU], (B) Kittlitz's murrelet [KIMU], (C) pigeon guillemot [PIGU], and (D) black-legged kittiwake [BLKI] across Prince Williams Sound, Alaska, 1989-2018.

Dr. Kuletz and Mr. Kaler are working with Axiom Data Science staff to ensure data management requirements are met. Dr. Kuletz and Mr. Kaler are also working with FWS Migratory Bird biometricians (Dr. Eric Osnas and Dr. Charles Frost) to streamline QA/QC process, data analysis, and report creation using applications created using Program R (www.r-project.org). We are also working with other GWA investigators to integrate marine bird datasets across GWA. Marine birds are the only taxa where species are represented across all three GWA components. We expect data integration to be completed in FY21, which will allow GWA region-wide analysis of marine bird data.

Because of the COVID-19 pandemic and federal agency health mandates implemented to protect employees and the public, the PWS survey planned for FY20 has been postponed to FY21.

Seward Line and Northern Gulf of Alaska Long-term Ecological Research (Funded in FY20 & FY21)

In 2019, we proposed an addition of \$25.8K per year (including 9% GA) in FY20 and FY21 to add extended Seward Line – Long Term Ecosystem Research (LTER) seabird surveys. Currently seabird surveys are funded by the North Pacific Research Board for the Seward Line (Fig. 3; one line, spring and fall cruises); this project has been extended to four lines, spring, summer, fall (Fig. 3) but without funding for the additional time at sea for seabird observers. Because the Seward Line is now part of the LTER, it is not possible to conduct only the Seward Line portion of the cruises.

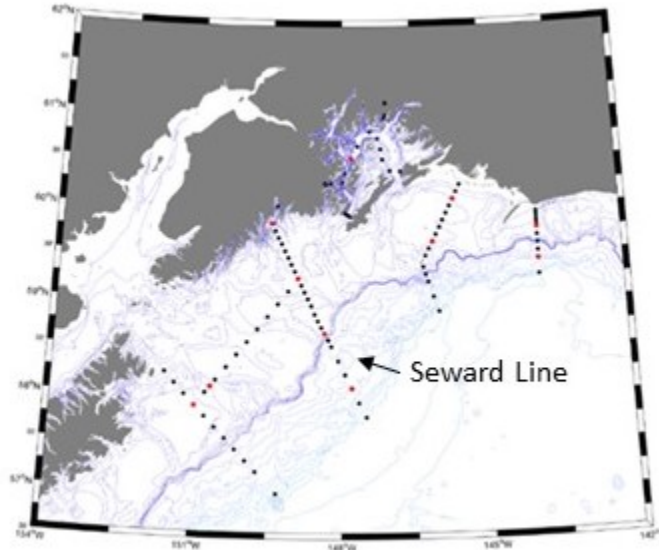


Figure 3. Northern Gulf of Alaska LTER and Seward Line monitoring stations to be surveyed annually in April/May, July, and September. Seabird surveys are conducted during transit among stations and ports of call.

The additional funding allowed us to maintain a 20-year time series sampling of the Seward Line. Previous analyses of Seward Line data from 2007-2015 found that during warm years, species that tend to be on the inner shelf (murrelets, murre, kittiwakes) moved farther inshore and into PWS. Species that tend to be more pelagic (albatrosses, storm-petrels) were less influenced by the warm water conditions. The unprecedented murre die-off that occurred in the GOA in 2015/2016 (Piatt et al. 2020) was presaged by a sharp increase in murre density in the inner shelf and PWS during the Seward Line surveys in fall 2014 and spring 2015. These results illustrate the value of monitoring offshore patterns of distribution and abundance of seabirds to better understand population trends in inshore waters. The expanded LTER sampling allows us to assess how abundance and distribution of seabirds changes over a larger portion of the Gulf of Alaska and links to ecological process studies of the LTER.

We were unable to include a seabird observer on the spring Seward Line cruise because of COVID-19 health mandate restrictions. The May Seward Line cruise occurred with a minimal scientific crew (3 scientists) to ensure the health and safety of those on the vessel. However, we did participate in the summer cruise instead of spring.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Table 1. Project 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			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1: admin & logistics																				
Contracting & hiring					C	C							P	P			X	X		
Recruit volunteers, housing/travel & permits					C	C							P	P			X	X		
Survey vessel Preparation & Winterization		C	C			C		C						P	P			X	X	
Milestone 2: data acquisition & processing																				
Boat-based marine bird survey						C								P				X		
Marine bird data processing								C	C						P	P			X	
Milestone 3: data management																				
Database mgmt./QAQC	C	C	C	C	C	C	C	C	C	C	C	C	C	C	X	X	X	X	X	X
Metadata	C								C								X			
Workspace upload		C								C								X		
Milestone 4: analysis & reporting																				
Analysis and summary	C				C								C				X			
Annual Reports	C				C				C				C				X			
Annual PIs meeting				C				C				C				X				X
FY Work Plan			C				C				C				C					
Permit reports				C				C				C				X				X
Milestone 5: Seward Line & LTER																				
Seward Line & LTER surveys														C	C			X	X	
Seward Line & LTER data processing															C	X			X	X

B. Explanation for not completing any planned milestones and tasks

The COVID-19 pandemic and lock-down resulted in postponing the July 2020 marine bird survey. Seward Line and LTER survey obligations were achieved, but instead of the spring cruise, an observer participated in the summer cruise.

C. Justification for new milestones/tasks

No new milestones or tasks are proposed in FY21 for the PWS surveys or the Seward Line and LTER surveys.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Gulf Watch Alaska

The proposed project will collaborate closely with the Forage Fish project (M. Arimitsu, Pelagic Component Lead Investigator, project 20120114-C) and the Fall-Winter Marine Bird surveys (M. Bishop, Principal Investigator [PI], project 20120114-E) to collect comparable marine bird data, allowing us to compare summer and winter seabird communities and distributions. The shoreline surveys of our project will also be complimentary to the Nearshore component of GWA (H. Coletti, Nearshore Component Lead Investigator, project 20120114-H) and the pelagic surveys complimentary to the Environmental Drivers component (K. Kuletz, PI). Integration of GWA marine bird datasets will allow for comparisons across marine habitats and regions.

The extended LTER surveys expands collaborations with physical and biological oceanographic sampling throughout the Gulf of Alaska (20120114-L PI Hopcroft, 20120114-I PI Danielson, and 20120114-D PI Batten) and assessing the abundance and distribution of seabirds offshore of the focal colony-based Middleton Island seabird studies (20120114-C, PI Arimitsu).

Herring Research and Monitoring

This project provides relevant data on marine bird abundance, distribution, and foraging activities to the Herring Research and Monitoring program.

Data Management

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

B. With Other EVOSTC-funded Projects

This PWS marine bird project complements the EVOS Trustee Council (EVOSTC) funded effort to restore pigeon guillemot to the Naked Island Complex (Naked, Peak, and Storey islands; control island for comparison: Fool, Little Smith, and Smith Islands). Dr. Kuletz, Mr. Kaler, and Dr. David Irons are co-PIs for the pigeon guillemot restoration study. Data collected on marine birds from the Naked Islands region, as well as population and productivity data collected at black-legged kittiwake colonies in PWS will be used to quantify population trends of species anticipated to benefit from mink removal efforts. Populations of marine birds anticipated to increase following mink suppression include pigeon guillemots, tufted and horned puffins, parakeet auklets, Arctic terns and dusky Canada geese.

C. With Trustee or Management Agencies

The project supports the US Fish and Wildlife Service's (USFWS's) Migratory Bird Management mission to advance the conservation of migratory birds. The project will also inform other management agencies (US

Forest Service, National Park Service, Alaska Department of Fish and Game) with lands and waters adjacent to our study area. The continuation of the Seward Line seabird surveys and LTER surveys complement the PWS marine bird surveys and allow us to examine oceanographic and plankton data in conjunction with seabird distribution and relative abundance, with a seasonal component, across the Gulf Watch Alaska study area. Including these offshore waters and linking them to the inshore studies will also inform the fisheries management process in the Gulf of Alaska. Data on population trends are provided to the Alaska Maritime National Wildlife Refuge for inclusion in their annual report (Dragoo et. al 2020) on status and trends of seabirds in Alaska.

4. PROJECT DESIGN

A. Overall Project Objectives

Objective 1. Determine population abundance, with 95% confidence limits, of marine bird populations in Prince William Sound during July 2021 in both oiled and unoled regions.

Objective 2. Determine population abundance, with 95% confidence limits, of marine bird populations in Prince William Sound as a whole during July 2021.

B. Changes to Project Design and Objectives

No changes to project design.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

No changes to project personnel.

6. PROJECT BUDGET

A. Budget Forms (See GWA FY21 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	\$22.9	\$108.1	\$22.9	\$108.1	\$22.9	\$284.8	
Travel	\$0.0	\$12.5	\$0.0	\$12.5	\$0.0	\$25.1	
Contractual	\$0.0	\$37.1	\$0.0	\$47.4	\$10.3	\$94.8	
Commodities	\$0.0	\$40.1	\$0.0	\$40.1	\$0.0	\$80.2	
Equipment	\$0.0	\$6.0	\$0.0	\$6.0	\$0.0	\$12.0	
SUBTOTAL	\$22.9	\$203.8	\$22.9	\$214.1	\$33.2	\$496.9	\$0.0
General Administration (9% of	\$2.1	\$18.3	\$2.1	\$19.3	\$3.0	\$44.7	N/A
PROJECT TOTAL	\$24.9	\$222.2	\$24.9	\$233.4	\$36.2	\$541.6	
Other Resources (Cost Share Funds)	\$23.0	\$56.0	\$23.0	\$57.1	\$118.8	\$277.9	

B. Changes from Original Project Proposal

While no changes of been made to the project budget, due to the COVID-19 pandemic, the July marine bird survey was postponed until July 2021, with FY20 funds carried over to FY21.

C. Sources of Additional Project Funding

For the PWS marine bird surveys, Dr. Kathy Kuletz salary (GS-13, \$11.5K per month) for 2 months/year) and one month of GS-11 (\$6.5K) are provided as in-kind support per year. Dr. Kuletz will provide the project

leader guidance and assist with data analysis and reporting. In-kind support from USFWS also includes travel to professional meetings to present results of this study (\$2K/year) and survey supplies (survey laptops, survey software, electronics, safety equipment) for \$12K. The Seward Line and LTER surveys leverages additional funding from the North Pacific Research Board (\$34.1K in FY20 and \$30.8K in FY21), as well as the in-kind in personnel time that was contributed to the Seward Line (Dr. Kuletz, 1 month/year and GS-11, 1 month/year).

7. FY17-20 PROJECT PUBLICATIONS AND PRODUCTS

Publications

- Cushing, D., D. Roby, and D. Irons. 2018. Patterns of distribution, abundance, and change over time in a subarctic marine bird community. *Deep Sea Research Part II* 147:148-163. <https://doi.org/10.1016/j.dsr2.2017.07.012>
- Dragoo, D., H.M. Renner, and R.S.A. Kaler. 2018. Breeding status and population trends of seabirds in Alaska, 2017. U.S. Fish and Wildlife Service Report AMNWR 2018/02. Homer, Alaska.
- Dragoo, D., H.M. Renner, and R.S.A. Kaler. 2019. Breeding status and population trends of seabirds in Alaska, 2018. U.S. Fish and Wildlife Service Report AMNWR 2019/03. Homer, Alaska.
- Dragoo, D., H.M. Renner, and R.S. A.Kaler. 2020. Breeding status and population trends of seabirds in Alaska, 2019. U.S. Fish and Wildlife Service Report AMNWR 2020/01. Homer, Alaska.
- Esler, D., B.E. Ballachey, C. Matkin, D. Cushing, R. Kaler, J. Bodkin, D. Monson, G. Esslinger, and K. Kloeker. 2018. Timelines and mechanisms of wildlife population recovery following the *Exxon Valdez* oil spill. *Deep Sea Research Part II* 147:36-42. <https://doi.org/10.1016/j.dsr2.2017.04.007>
- Kuletz, K., and R. Kaler. 2018. Continuing the legacy: Prince William Sound marine bird population trends. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-M.
- Kuletz, K., and R. Kaler. 2019. Continuing the legacy: Prince William Sound marine bird population trends. FY18 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 18120114-M.
- Kaler, R., E. Labunski, and K. J. Kuletz. 2018. Prince William Sound marine bird surveys. *Exxon Valdez* Oil Spill Long-Term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 16120114-K), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.
- Stephensen, S., D. Irons, W. Ostrand, and K. Kuletz. 2016. Habitat selection by Kittlitz's *Brachyramphus brevirostris* and Marbled Murrelets *B. marmoratus* in Harriman Fjord, Prince William Sound, Alaska. *Marine Ornithology* 44:31-42. <http://www.marineornithology.org/content/get.cgi?rn=1152>

Published and updated datasets

DataONE Published Datasets

- Kaler, R., and K. Kuletz. 2017. Prince William Sound Marine Bird Data, Alaska, 2012-2016, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. <https://doi.org/10.24431/rw1k113>
- Kuletz, K., D. Cushing, E. Labunski. 2020. Marine bird survey observation and density data from Northern Gulf of Alaska LTER cruises, 2018. Research Workspace. [doi number to be assigned]

Gulf of Alaska Data Portal Datasets

The Seward Line data (2006-2017) were uploaded to the Gulf Watch Alaska Research Workspace. The marine bird studies constitute part of the 'Pelagic Component' of the program. Information at: <http://www.gulfwatchalaska.org/monitoring/pelagic-ecosystem/>

Research Workspace

Kaler, R., and K. Kuletz. 2019. Prince William Sound Marine Bird Data, Alaska, 2018, Gulf Watch Alaska Pelagic Component. Dataset. *Exxon Valdez* Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace.

Presentations

- Arimitsu, M., M. Bishop, D. Cushing, S. Hatch, B. Heflin, R. Kaler, K. Kuletz, C. Matkin, J. Moran, D. Olsen, J. Piatt, A. Schaefer, 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, Anchorage, AK. 22-26 January.
- Cushing, D., K. Kuletz, R. Hopcroft, S. Danielson, and E. Labunski. 2017. Shifts in cross-shelf distribution of seabirds in the northern Gulf of Alaska under different temperature regimes, 2007-2015. **Poster Presentation**. The 44th Meeting of the Pacific Seabird Group, Tacoma, WA. 21-25 February.
- Cushing, D.A., K.J. Kuletz, R.R. Hopcroft, S.L. Danielson, and E.A. Labunski. 2017. Shifts in cross-shelf distribution of seabirds in the Northern Gulf of Alaska under different temperature regimes, 2007-2016. **Poster presentation**. Annual meeting of the Pacific Seabird Group, Tacoma, Washington.
- Esler, D., B. Ballachey, C. Matkin, D. Cushing, R. Kaler, J. Bodkin, D. Monson, G. Esslinger, and K. Kloecker. 2016. Long-term data provide perspective on ecosystem recovery following the *Exxon Valdez* oil spill. **Oral presentation**. Gulf of Mexico Oil Spill and Ecosystem Science Conference, Tampa, Florida.
- R. Kaler. 2019. Population estimates and trends for Marbled and Kittlitz's Murrelets in Prince William Sound, Alaska. **Oral presentation**. Marine Stewardship Council meeting, Anchorage, Alaska, 12 December.
- R. Kaler. 2019. Sentinels of the seas: Seabirds, die-offs, and ecosystem changes in the Gulf of Alaska. **Invited presentation** to undergraduate environmental studies course at the University of Alaska, Anchorage, 18 November.
- R. Kaler. 2020. Alaska seabird update in Gulf of Alaska. **Invited presentation** at the Kodiak Regional Management Meeting of the Alaska Migratory Bird Co-management Council, 24 March.
- R. Kaler. 2020. Prince William Sound loon population trends. **Invited presentation** at the Loons in Northern Alaska information exchange and coordination meeting, Anchorage, Alaska, 25 February.
- R. Kaler. 2020. Alaska's ocean sentinels seabirds as ecosystem indicators, Part I and II. **Invited presentation** for the Opportunities for Lifelong Education, Anchorage, Alaska, 23 & 30 January.
- R. Kaler. 2020. Pacific Seabird Group Seabird Monitoring Committee, 2019 summary. **Oral presentation**. Portland, Oregon, 12 February.
- R. Kaler. 2020. Alaska's ocean sentinels seabirds as ecosystem indicators in Prince William Sound. **Invited presentation** at the Prince William Sound Natural History Symposium, 18 May.
- Kuletz, K.J., D.A. Cushing, R.R. Hopcroft, S.L. Danielson, and E.A. Labunski. 2017. Running hot and cold: Shifts in seabird distribution in the Northern Gulf of Alaska under different temperature regimes, based on Seward Line surveys, 2017-2015. **Poster presentation**. Alaska Marine Science Symposium, Anchorage, Alaska.
- Kuletz, K., R. Hopcroft, S. Danielson, J. Santora, W. Sydeman, B. Hoover, and D. Cushing. 2018. Seabird distribution relative to biophysical oceanographic properties in North Pacific ecosystems: a comparison

of the Gulf of Alaska and California Current Ecosystem LTERs. **Poster presentation.** All Scientist Meeting of Long-term Ecosystem Research projects, sponsored by the National Science Foundation, Pacific Grove, California, September 30 – October 4.

Piatt, J., T. Jones, K. Kuletz, H. Renner, J. Parrish, R. Corcoran, S. Schoen, B. Bodenstein, R. Kaler, M. Garcia-Reyes, H. Coletti, M. Arimitsu, R. Duerr, K. Lindquist, J. Lindsey, and W. Sydeman. 2018. Unprecedented scale of seabird mortality in the NE Pacific during the 2015-2016 marine heat wave. **Oral Presentation.** Alaska Marine Science Symposium, Anchorage, AK. 22-26 January.

Kuletz, K., and R. Kaler. 2019. Data from GWA-funded marine bird surveys and LTER surveys were presented at the Marbled Murrelet Technical Committee, Kittlitz's Murrelet Technical Committee, Tufted Puffin Technical Committee, Seabird Monitoring Committee, and Short-tailed Albatross Recovery Team meeting. Pacific Seabird Group annual conference, Kauai, Hawaii, 27 February-2 March.

Kuletz, K., and R. Kaler. 2020. Data from GWA-funded marine bird surveys and LTER surveys were presented at the Marbled Murrelet Technical Committee, Kittlitz's Murrelet Technical Committee, Tufted Puffin Technical Committee, Seabird Monitoring Committee, and Short-tailed Albatross Recovery Team meeting. Pacific Seabird Group annual conference, Portland, Oregon, 12-15 February.

Outreach

Kaler, R., K. Kuletz, D. Dragoo, and H. Renner. 2017. Unusual observations of seabirds in the Gulf of Alaska following the 2015-2016 mass die-off. Delta Sound Connections. Prince William Sound Science Center <http://pwssc.org/wp-content/uploads/2017/06/DSC-2017-web2.pdf>.

Robinson, R., A. Rademacher, R. Kaler, and D. Aderhold 2018. Coastal Observation and Seabird Survey Team die off alert training in Seldovia, AK, May 18.

Naked Island Seabird Restoration, Youth Marine Expedition, Organized by Lisa Matlock, Prince William Sound Regional Citizen's Advisory Council. The youth on this trip are a mix of grades 6-8 and included both diverse urban Anchorage kids (some of whom had never been on a hike or on a boat before this trip) and kids from the EVOS region (this year included Cooper Landing, Seward, Girdwood, and Whittier). The EVOS funded seabird restoration effort at the Naked Islands group provided the youth a chance to learn about field biology, social attraction efforts to expedite the recovery of extirpated seabirds and learn about what seabirds feed their young. Special thanks to Sam Stark and Alexa Piggot (Oregon State University) for making time to connect kids with nature.

8. LITERATURE CITED

Cushing, D., D. Roby, and D. Irons. 2018. Patterns of distribution, abundance, and change over time in a subarctic marine bird community. *Deep Sea Research Part II* 147:148-163. <https://doi.org/10.1016/j.dsr2.2017.07.012>

Dragoo, D., H.M. Renner, and R.S.A. Kaler. 2020. Breeding status and population trends of seabirds in Alaska, 2019. U.S. Fish and Wildlife Service Report AMNWR 2020/01. Homer, Alaska.

Piatt, J.F., J.K. Parrish, H.M. Renner, S.K. Schoen, T.T. Jones, M.L. Arimitsu, K.J. Kuletz, B. Bodenstein, M. García-Reyes, R.S. Duerr, R.M. Corcoran, R.S.A. Kaler, G.J. McChesney, R.T. Golightly, H.A. Coletti, R.M. Suryan, H.K. Burgess, J. Lindsey, K. Lindquist, P.M. Warzybok, J. Jahncke, J. Roletto, and W.J. Sydeman. 2020. Extreme mortality and reproductive failure of common murrelets resulting from the northeast Pacific marine heatwave of 2014-2016. *PLoS ONE* 15:e0226087.