ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 9.14.17

1. Project Number:

17120114-G

2. Project Title:

Monitoring of oceanographic conditions in PWS

3. Principal Investigator(s) Names:

Robert W. Campbell, Prince William Sound Science Center

4. Time Period Covered by the Report:

February 1, 2017-January 31, 2018 (Year 6)

5. Date of Report:

March 2018

6. Project Website (if applicable):

www.gulfwatchalaska.org

http://pwssc.org/research/?research_topic=oceanography

7. Summary of Work Performed:

The goal of this project is to provide environmental driver data to assess temporal and spatial changes in the marine environment in Prince William Sound (PWS). The data are depth-specific (water column stability is important to ecosystem productivity), of sufficient frequency to capture timing changes (weeks), and give an idea of spatial variability in the region. The specific objectives include

1. Conducting regular surveys in PWS and its entrances to continue the ongoing time series of physical, biogeochemical, and biological parameters while also supporting continued herring research by maintaining the existing time series (hydrography, plankton and nutrients) at the four Sound Ecosystem Assessment bays.

2. Installing and maintaining an autonomous profiling mooring in PWS that will conduct frequent (at least daily) profiles of the same physical, biogeochemical and biological parameters as the surveys, plus in situ observations of zooplankton, large phytoplankton and other particles.

The planned surveys of PWS were conducted during the reporting period (Table 1), and all 12 standard stations (Fig. 1) were occupied. All conductivity and temperature at depth (CTD) data collected to date have been processed, and seasonally detrended anomalies of temperature and salinity at selected depths in central PWS are shown in Figs. 2 and 3. Temperatures in central PWS have been above average since late 2013, as has been observed elsewhere in the

Gulf of Alaska (see GAK1 [17120114-I] and Seward Line [17140114-L] reports). It appears that PWS exhibited the same "warm blob" anomaly seen throughout the Gulf with approximately the same timing, although PWS remains slightly above average while the Gulf of Alaska appears to be returning to an average or perhaps cooler than average state as a result of the 2017-18 La Niña. Salinity anomalies in central PWS were less informative and more variable, but have for the most part tended towards saltier anomalies in 2017, following several years of fresh anomalies that occurred during "Blob" years.

Plankton, nutrient, and chlorophyll-a samples were collected from all stations with no incidents. As of January 2018, plankton samples have been enumerated from the first two cruises (analysis of Lower Cook Inlet samples will begin in Q1 of 2018), and all chlorophyll-a filters have been run (chlorophyll analysis is done shortly after each cruise to minimize storage artefacts). Analysis of nutrient samples is progressing and should be completed by March 2018.

The profiling mooring was deployed in late March, well ahead of the spring bloom (Fig. 4). The profiler stopped profiling after several casts, and it was several days before the weather abated and allowed a service visit. The profiler again malfunctioned twice in early May. The problem was eventually traced to a defective cable supplied by the manufacturer. Some corrosion on the power adapter and cables was noted following retrieval of the mooring in 2016, and a new adapter and cables ordered. It turned out that one of the new cables was not sealed properly by the manufacturer and was allowing seawater to enter, which was shorting the power system and disabling the profiler. A temporary adapter was fabricated with local spare parts and a new adapter and cables eventually sent from the manufacturer. The profiler operated well through the summer months and into autumn, with three short gaps caused by battery failures; 2017 was unusually stormy, and there were multiple periods when it was not safe to venture out to service the profiler when necessary. The profiler stopped checking in in mid-November and was retrieved. The pins on the power system were again corroded, and following a dialog with the manufacturer, the power adapter and cables were returned to be replaced. The corrosion problems appear to have been an issue with the manufacturer of the bulkhead and wet-pluggable connectors (Teledyne Impulse) related to a change in their manufacturing methods. They assure us that the issue has been resolved.

The 2017 time series from the profiler shows the annual cycle of stratification and productivity at very fine scales (Fig. 4). Profiles were done twice daily, at the solar minima and maxima. Thermal stratification began in late May, and was very strong into late July/August. The profiler recorded the pre-bloom conditions in March, and the onset of the spring bloom in mid-April, which was approximately on schedule. Following the onset of the seasonal pycnocline in June-July, productivity was centered on the nitricline, at approximately 20 m depth. The breakdown of stability in October-November coincided with a modest autumn bloom near the surface.

A plankton camera was developed and deployed on the profiler in 2016, with funding from the North Pacific Research Board. The plankton camera collected 531,950 images during the 2017

deployment, occupying just under 20 gigabytes on disk. The highest particle concentrations were during the spring bloom in late April (Fig. 4, bottom panel), and there were a large number of particles in the surface mixed layer in late June / early July. The highest particle concentrations were in the near-surface mixed layer into autumn when stability broke down. Pronounced diel differences were also notable, with "banding" (i.e., alternating bright and dark coloring in adjacent profiles) evident from profile to profile, particularly in May-June and mid-July–August. The banding effect was caused by diel differences in the number of plankton in the surface layer, with more plankton observed during profiles done during the solar minimum. A manual perusal of the images suggests that the differences are largely due to calanoid copepods, particularly of the genus *Metridia* (which are known to undertake large diurnal migrations). This will be examined in detail in the future, once automated identification routines have been produced to classify the images.

Sampling methods for this project have remained the same since its inception in 2009 and no changes are planned for FY18.

Table 1. Status of project milestones for FY17.

Deliverable/Milestone	Status
PWS Survey	Conducted 10-11 March 2017
PWS Survey / deploy mooring	Conducted 10-11 April 2017
Service mooring	Conducted 5 May 2017
Service mooring	Conducted 11 May 2017
PWS Survey	Conducted 18-20 May 2017
Mooring service	Conducted 13 June 2017
PWS Survey	Conducted 20-21 June 2017
Mooring service	Conducted 21 July 2017
Mooring service	Conducted 18 August 2017
PWS Survey	Conducted 9-11 September 2017
PWS Survey	Conducted 25-26 September 2017
Mooring Service	Conducted 30 September 2017
PWS Survey	Conducted 10-11 October 2017
Retrieve mooring	Conducted 2 November 2017
CTD data processed	Completed January 2018
Chlorophyll-a samples processed	Completed January 2018
Plankton samples enumerated	Ongoing (this project & Lower Cook Inlet oceanography [17120114-J])

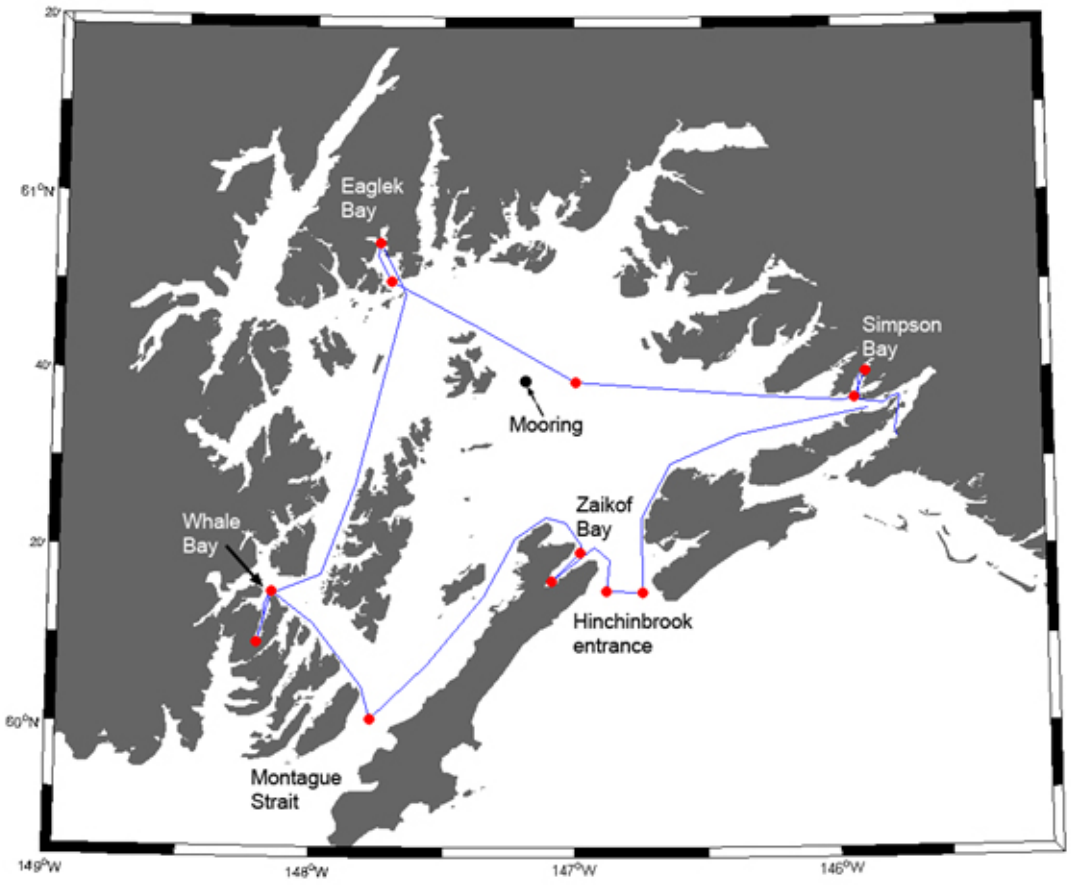

Figure 1. Map of the standard cruise track and stations, and the location of the autonomous moored profiler.

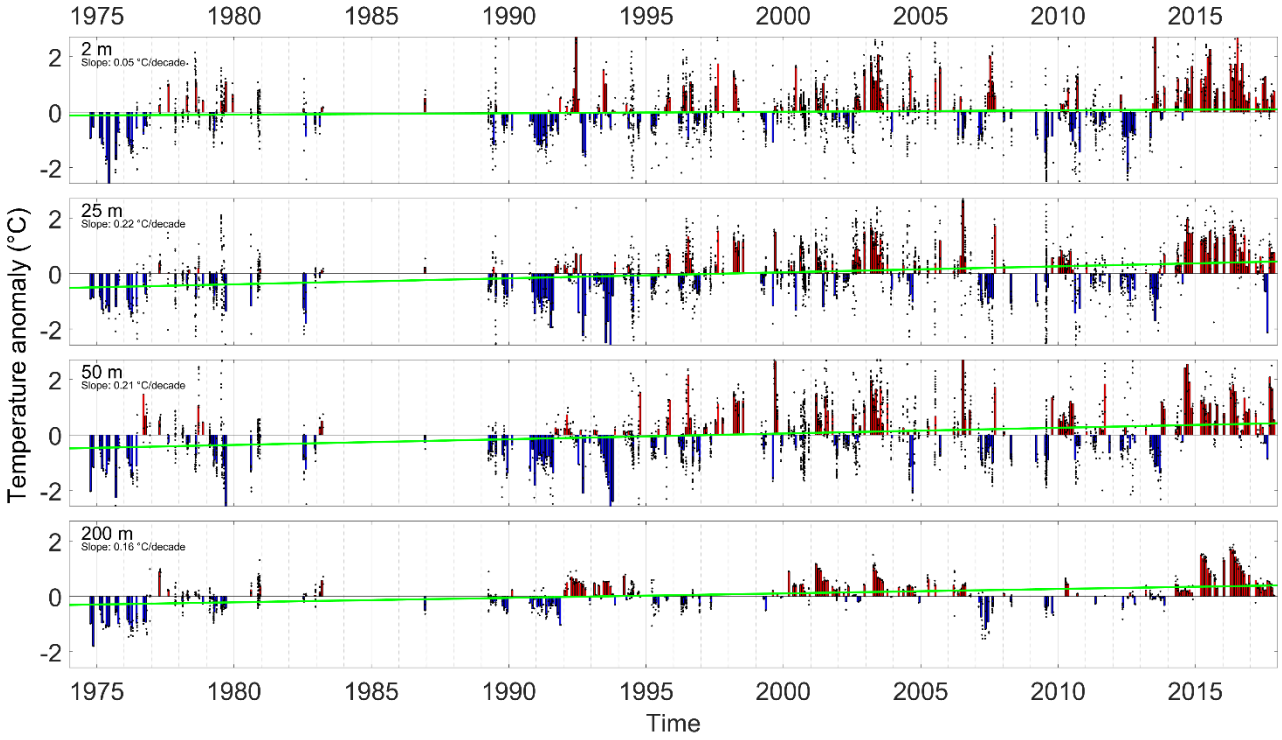

Figure 2. Temperature anomaly time series at selected depths in central Prince William Sound. Anomalies were calculated as the residual from a second order cosine fit to Julian day (for all years data) and thus represent seasonally detrended values. Vertical bars indicate quarterly average anomalies, black dots represent individual observations, the green line indicates the linear trend. Red text for the slope indicates that the slope is not significantly different from zero ($p>0.05$).

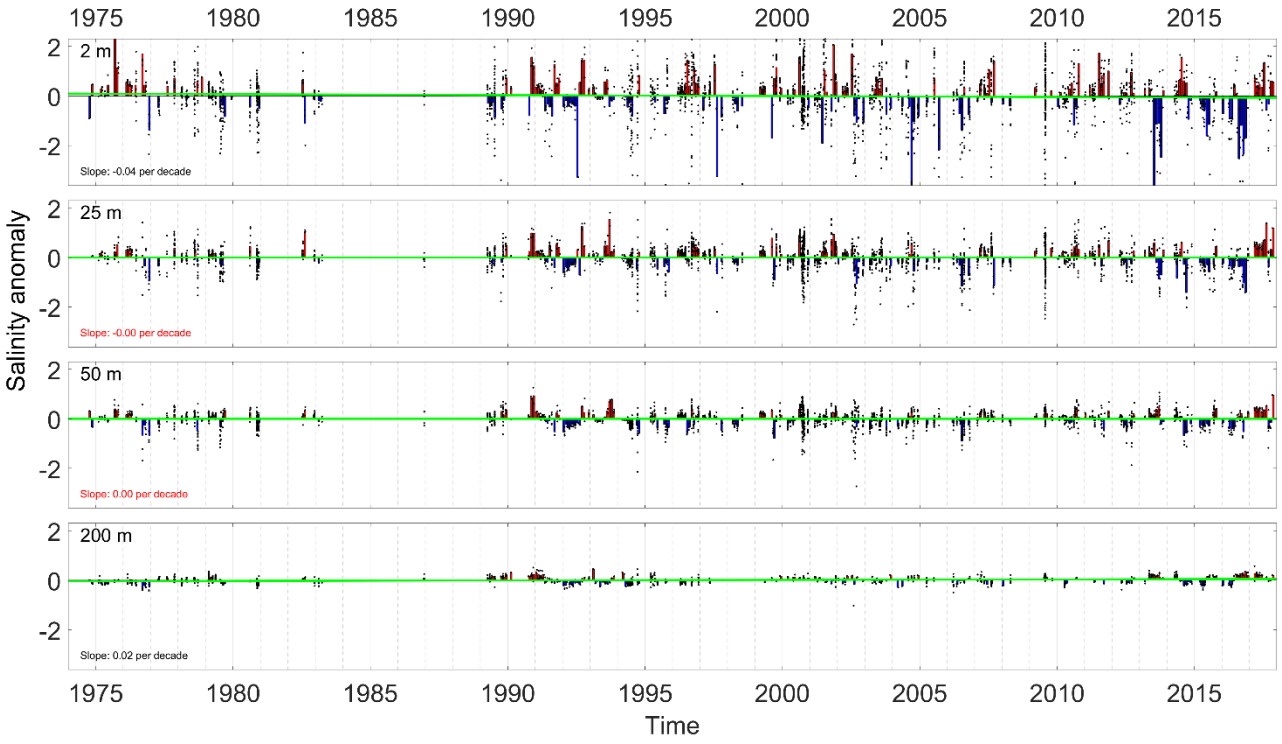

Figure 3. Salinity anomaly time series at selected depths in central Prince William Sound. Anomalies were calculated as described in Fig. 2.

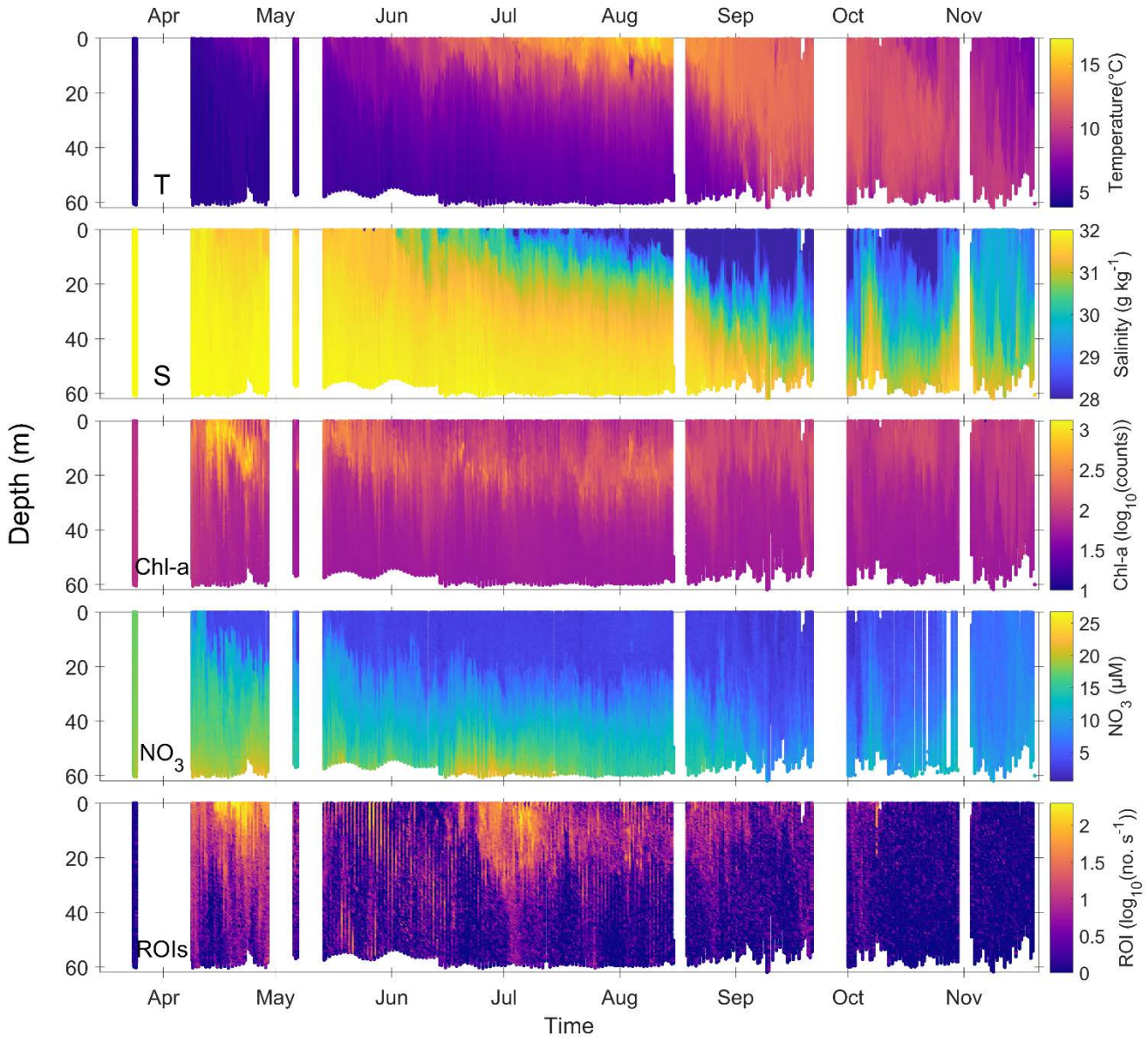

Figure 4. Time series from the 2017 deployment of the profiling mooring, including temperature (top panel), salinity (2nd panel) chlorophyll-a fluorescence (3rd panel), nitrate concentration (4th panel), and number of plankton images captured per second (bottom panel). Each vertical line represents a single profile, and colors correspond to values of each observation. Fluorescence is presented as digital counts from the fluorometer, and is linearly proportional to chlorophyll-a concentration. Note that chlorophyll-a concentrations and plankton images have been log10 transformed to show finer details.

8. Coordination/Collaboration:

A. Projects Within a Trustee Council-funded program

1. Within the Program

- All plankton samples collected as part of project 17120114-J (Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay) are processed and identified by this project.
- Campbell contributed data and collaborated with Dan Monson of the Nearshore project (17120114-H) and Rob Suryan (17120114-A) on an analysis of nearshore and open water temperature records. That collaboration produced a poster presented at the 2018 Alaska Marine Science Symposium and is ongoing.
- A hydrophone was deployed on the profiling mooring in 2017 to collect observations of killer whale vocalizations for project 17120114-N (Long-term killer whale monitoring). This collaboration has been ongoing since 2016 and has collected several terabytes of sonograms that are being analyzed to identify vocalizations by different pods.

2. Across Programs

a. Herring Research and Monitoring

- Plankton samples for herring disease studies (PI: Paul Hershberger, 17120111-E) were collected from several locations during 2017 surveys. We have been collecting samples for Paul for several years, and he has asked us to discontinue sampling for now because he has not identified any pathogen vectors in the samples collected thus far.
- Technicians from project 17160111-B (Annual Herring Migration Cycle) have ridden along on surveys done by this project to upload data from the tracking arrays.

b. Data Management

CTD and chlorophyll-a data from FY2017 have been uploaded to the data workspace.

c. Lingering Oil

N/A

B. Projects not Within a Trustee Council-funded program

N/A

C. With Trustee or Management Agencies

- Photos were taken at two long-term study locations for Alan Mearns (National Oceanic and Atmospheric Administration).
- We generally endeavor to conduct a spring cruise around the time of herring spawning when Alaska Department of Fish and Game (ADF&G) are doing their surveys (contact: Stormy Haught, ADF&G Cordova). However, herring spawn was minimal in 2017.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

Campbell, R.W. 2018. Hydrographic trends in Prince William Sound, Alaska, 1960–2016. Deep-Sea Res II. doi:10.1016/j.dsr2.2017.08.014

Campbell, R. W. 2018. Long term monitoring of oceanographic conditions in Prince William Sound. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 16120114-E). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

McKinstry, C.A.E., and R.W. Campbell. 2018. Seasonal variation of zooplankton abundance and community structure in Prince William Sound, Alaska, 2009–2016. Deep-Sea Res II. doi:10.1016/j.dsr2.2017.08.016.

Crusius, J., A.W. Schroth, J.A. Resing, J. Cullen, and R.W. Campbell. 2017. Seasonal and spatial variabilities in the northern Gulf of Alaska surface water iron concentrations driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust. Global Biogeochemical Cycles. doi:10.1002/2016GB005493

Schroth, A.W., J. Crusius, S. Gassó, C.M. Moy, N.J. Buck, J.A. Resing, and R.W. Campbell. 2017. Aleutian Low position drives dramatic inter-annual variability in atmospheric transport of glacial iron to the Gulf of Alaska. Geophys. Res. Lett. 44. doi:10.1002/2017GL073565.

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

Campbell, R. 2018. A profiling observatory for high resolution oceanographic, biogeochemical, and plankton observations in Prince William Sound. Alaska Marine Science Symposium, Anchorage. **Oral Presentation**.

McKinstry, C., and R. Campbell. 2018. Zooplankton community structure and seasonal abundance in Prince William Sound. Alaska Marine Science Symposium, Anchorage. **Poster Presentation**.

Mearns, A, D. Janka, P. Marloff, R. Campbell, S. Pegau, and D. Esler. 2018. Twenty-eight years of intertidal biological variability based on volunteer visits to photo sites in Western Prince William Sound. Alaska Marine Science Symposium, Anchorage. **Poster Presentation**.

Monson, D., K. Holderied, R. Campbell, S. Danielson, R. Hopcroft, B. Ballachey, J. Bodkin, H. Coletti, T. Dean, K. Iken, K. Kloecker, B. Konar, M. Lindeberg, B. Robinson, B. Weitzman, and R. Suryan. 2018. Congruence of intertidal and pelagic water and air temperatures during an anomalously warm period in the northern Gulf of Alaska; the "Blob" washes ashore. Alaska Marine Science Symposium, Anchorage. **Poster Presentation**.

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

Campbell, R. W. 2017. Oceanographic Conditions in Prince William Sound, CTD, Chlorophyll-a, and Zooplankton Data: 2013-2016, Gulf Watch Alaska Environmental Drivers Component. Dataset. Exxon Valdez Oil Spill Trustee Council Long-Term Monitoring program, Gulf Watch Alaska. Research Workspace. https://doi.org/10.24431/rw1k19.

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

2017 CTD and chlorophyll data have been uploaded to the workspace as scheduled.

10. Response to EVOSTC Review, Recommendations and Comments:

Science Panel Comments and Responses on Revised FY17-21 Proposal, September 2016

In September 2016, the Science Panel had no comments.

Science Panel Comments and Responses on FY18 Work Plans, September 2017

Program specific comments by EVOSTC Science Panel September 2017: The Panel believes the PI is conducting important work that supports the goals of the EVOSTC. The Panel was happy to see that there are peer-reviewed publications in press and encourages the PI to keep publishing.

PI Response: Thank you for your comments.

11. Budget

Please see provided program workbook.

Spending is slightly behind schedule, more of Campbell's time than expected was occupied by other projects in FY17. Nutrient analysis also did not begin until January 2018 because the nutrient technician was not available until then. Salary and supplies funds for those analyses will be billed in Q1 of FY18.