

**EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY19 (YEAR 8) CONTINUING PROJECT PROPOSAL SUMMARY PAGE**

Project Number and Title

Gulf Watch Alaska: Environmental Drivers Component Project

19120114-D—Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf

Primary Investigator(s) and Affiliation(s)

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Project Abstract

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf from lower Cook Inlet across the slope into the open Gulf of Alaska, providing a now 18-year record of taxonomically resolved, seasonal, near-surface zooplankton and large phytoplankton abundance over a wide spatial scale. Sampling takes place approximately monthly, six times per year, usually between April and September. Outputs from the project include indices of plankton abundance (e.g., large diatom abundances, estimated zooplankton biomass), seasonal cycles (phenology of key groups) and community composition (e.g., appearance of warm water species, change in dominance by some groups). Variability in any, or all, of these indices might be expected to flow-through to higher trophic levels such as herring, salmon, birds and mammals that forage across the region, some of which have been impacted by the *Exxon Valdez* oil spill. Results show that interannual variability in plankton dynamics is high and plankton responded clearly and rapidly to the warm conditions of 2014-2016, with changes evident in abundance, composition and timing. We are not proposing any major changes to this project for FY19.

EVOSTC Funding Requested* (must include 9% GA)

FY17	FY18	FY19	FY20	FY21	TOTAL
\$76,500	\$78,800	\$81,200	\$83,600	\$86,100	\$406,200

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$183,700	\$183,900	\$186,300	\$188,300	\$190,300	\$932,500

1. PROJECT EXECUTIVE SUMMARY

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf across the slope into the open Gulf of Alaska, providing a record of taxonomically resolved, seasonal, near-surface zooplankton and large phytoplankton abundance over a wide spatial scale (Fig. 1). Many important species, including herring, salmon, birds, and marine mammals, forage in these regions of the shelf and Gulf of Alaska for at least some of their life history so an understanding of the productivity of these areas is important to understanding and predicting fluctuations in resource abundance, including those recovering from the *Exxon Valdez* oil spill. CPR sampling began in 2000 and there is now an adequate time series available to assess the impacts of climate variability (Batten et al. 2018). Natural, as well as human-related, processes known to influence this region are numerous. For example, on seasonal and interannual time scales the strength of the Alaskan shelf and Alaskan Coastal currents are mediated by freshwater run-off and winds (Royer, 1979; Stabeno et al., 2004; Weingartner et al., 2005), persistent coastal down-welling in contrast to most eastern Pacific boundary regions, and eddy-mediated cross-shelf transport of organisms and nutrients (Okkonen et al., 2003; Ladd et al., 2005). Moderate to strong El Niño and La Niña events are also felt on the Alaskan Shelf (Weingartner et al., 2002). Regime shifts, which may be triggered by the climate processes described above, have periodically occurred with lower frequency, such as the 1976/77 shift which changed Alaskan fisheries from shrimp to fish dominated (Francis and Hare 1994). The sudden and unusual warming in the North Pacific in 2014-2016 has also caused widespread impacts on Alaskan marine ecosystems which are still being noted and assessed (Di Lorenzo and Mantua, 2016).

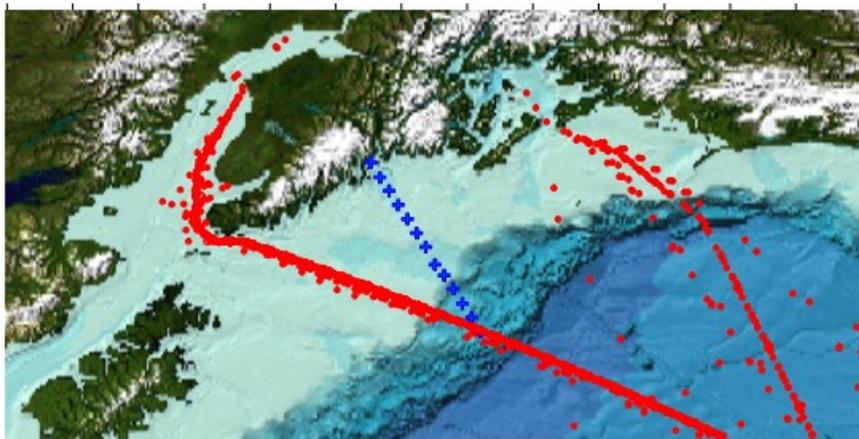


Figure 1. Location of historic CPR samples on the shelf (red dots) from 2000 to 2017 and the Seward Line stations (blue +). Since 2004 the transect has sampled into Cook Inlet and has a very consistent location.

With short generation times, limited mobility and lack of a commercial harvest, plankton often respond to changes in their environment more rapidly and less ambiguously than higher trophic levels, so that a relatively short time series of plankton information can provide insights into the responses of the shelf ecosystem to some of the processes described above. Any of, or a combination of, the physical processes described above can influence water column stability and nutrient availability which in turn affects plankton timing, composition and productivity. The unusually warm conditions from 2014-2016 and consequent changes in the plankton were quite dramatic; There was a change in the large diatom community to species more favored by low nutrients and the summer zooplankton community was dominated by small species which do better in warm conditions.

Continued sampling of the CPR transect will now determine whether a return to more average conditions in 2017-2018 also sees a return to more typical sub-arctic plankton communities. Fig. 2 shows some preliminary data from 2017 and early 2018.

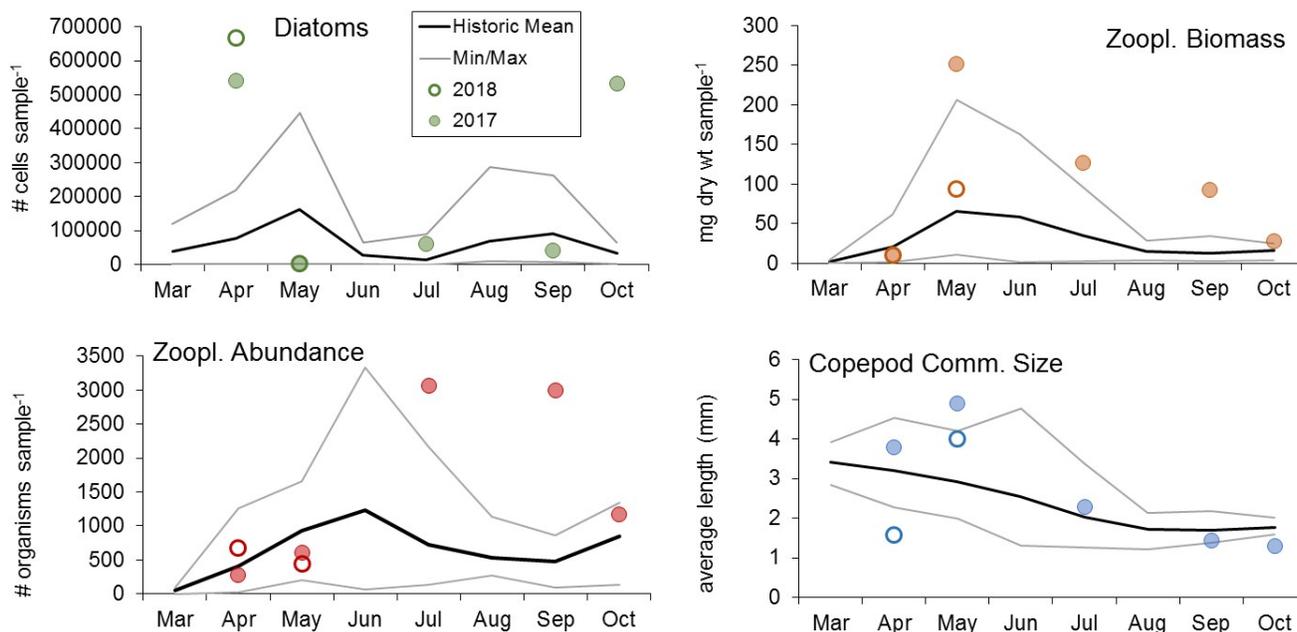


Figure 2. Mean monthly values of 4 plankton indices (circles), compared to the historic (2004-2016) values from the shelf region shown in Figure 1 (mean shown by black line, min and max values shown by light grey lines). The filled circles are values from 2017 and the open circles values from 2018. Data from July 2017 onwards are provisional at this time.

Results suggest that in both 2017 and 2018 the phytoplankton spring bloom was early, in April (Fig. 2, upper left panel). By May of both years (when historically the spring bloom has been more common) the cell counts were very low. 2017 saw a late fall bloom. The zooplankton had unusually high numbers in summer 2017, mostly small copepods (abundance shown in Fig. 2 lower left and mean copepod size shown in lower right). Zooplankton biomass was above average through much of the year (Fig. 2, upper right), perhaps fueled by the early and high spring diatom bloom. In spring 2018 the large copepods were very low in April and more abundant in May, though not unusually so. These results do suggest that lower trophic levels were faring better in 2017-18 than in the prior warm period.

The CPR will continue to sample the same transect approximately monthly, 6 times per year, between about April and September, providing sufficient temporal resolution to detect seasonal shifts as well as community composition changes. The transect links two of the other plankton sampling regions within the Environmental Drivers group, that of the Seward Line (Fig. 1) and in lower Cook Inlet and Kachemak Bay, to provide a larger-scale context for these more intensive regional projects. With similar sampling frequency to the Prince William Sound oceanographic and zooplankton sampling, comparisons of lower trophic level fluctuations across the wider region will be made to examine responses to local and regional forcing.

The funding requested for CPR sampling is modest because of the consortium approach (the North Pacific CPR program is funded through a consortium managed by the North Pacific Marine Science Organization, PICES)

and is less than half the actual cost of the data collection. We are not proposing any major changes to this project for FY19.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Table 1. Project milestone and task progress by fiscal year and quarter, beginning February 1, 2017. Yellow highlight indicates proposed fiscal year Work Plan. Additional milestones and tasks may be added.

C = completed, X = not completed or planned. 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
Sample collection																				
CPR shipment	C				C								X							
Transect sampling	C	C	C		C	C	X		X	X	X		X	X	X		X	X	X	
CPR winter overhaul			C				X				X				X				X	
Sample Processing																				
Sampling results		C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	
Reporting																				
Progress reports			C				X				X				X				X	
Annual reports					C				X				X				X			
Annual PI meeting				C				X				X				X				X
FY work plan (DPD)			C				C				X				X					

B. Explanation for not completing any planned milestones and tasks

At the time of writing, sampling during the 3rd quarter of FY18 is still planned. Four of the six transects were sampled in April, May, June and July 2018, leaving two to be sampled in mid-August and September. Provisional data are available from the April and May transects (see Fig. 2 above) and analysis is ongoing for the June and July transects.

C. Justification for new milestones/tasks

No new tasks are proposed.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Gulf Watch Alaska

This project provides a spatial link between the locally more intensive (but less seasonally resolved) sampling of lower trophic levels from the Seward Line and Lower Cook Inlet and Kachemak Bay within the Environmental Drivers component. Although there are differences in sampling design in each place, necessitated by the different sampling strategies, there are techniques available to facilitate integration.

The CPR data can also provide information on seasonal timing changes which will help with interpretation. The time series in Prince William Sound offers a chance to compare variability across the wider region and examine the degree to which the outer shelf may influence the Sound. There is thus strong collaboration within the Environmental Drivers component. Productivity of the plankton populations directly influences the organisms monitored by the Pelagic component, and will be a necessary contribution to their studies. Nearshore studies are perhaps harder to link directly, but many benthic invertebrates have a planktonic phase. We have already provided a subset of CPR data to other Gulf Watch Alaska principal investigators summarizing the meroplankton to examine the long-term variability in larvae, and we expect such collaboration to continue.

Herring Research and Monitoring

We have actively collaborated with the Herring Research and Monitoring program (Pegau and Moffitt) in the first 5-year funding period, and a publication has been produced (Batten et al. 2016). These time series will be updated during this project, and as they lengthen we expect further insights.

Data Management

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

B. With Other EVOSTC-funded Projects

This project will coordinate with other EVOSTC-funded projects as appropriate by providing data, discussing the relevance and interpretation of data, and collaborating on reports and publications.

C. With Trustee or Management Agencies

This project is working with the National Oceanic and Atmospheric Administration to include CPR time series data as indicators in ecosystem assessments and reports to the North Pacific Fisheries Management Council (Stephani Zador, NMFS AFSC REFM Division, Resource Ecology and Ecosystem Modeling Program).

4. PROJECT DESIGN

A. Overall Project Objectives

Objective 1

Plankton samples will be collected on the transect between Cook Inlet and Puget Sound approximately monthly from about April to September 2019 (6 transects will be sampled). All shelf samples will be processed and every 4th oceanic sample. A CTD-F will be fitted to the CPR and used to collect environmental data (temperature, salinity and chlorophyll a fluorescence at the depth of the sampler).

Objective 2

A subset of samples (25%) will be processed within 3 months of and results from this processing will be available in progress reports and on the project website as soon as practicable. Full, quality controlled data from 2019 will be available by July 2020 as in previous years.

Changes to Project Design and Objectives

None.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

No changes.

6. PROJECT BUDGET FOR FY19

A. Budget Forms (See GWA FY19 Budget Workbook)

Please see project budget forms compiled for the program.

No changes have been made to the FY19 budget for this project.

B. Changes from Original Project Proposal

None.

C. Sources of Additional Project Funding

The North Pacific CPR survey is supported by a Consortium managed by the North Pacific Marine Science Organization (PICES), of which the EVOSTC is a member. There are two CPR transects in the survey, one of which is not in the EVOS area of interest and which is supported by the other Consortium members. Costs included in the budget are estimated at 40% of the full costs of acquiring data along the north-south transect shown in Fig. 1. Other members of the Consortium which contribute to this transect's costs are:

- The North Pacific Research Board (NPRB) contributes funding at a similar annual level to that requested here, through the NPRB's Long-term Monitoring Program. We are currently in Year 4 of a 20-year commitment.
- The Canadian Department of Fisheries and Oceans (DFO) contributes \$50-60k annually as well as in-kind support by providing laboratory facilities at the DFO lab in Sidney, BC.
- The CPR parent organization, The CPR Survey at the Marine Biological Association (formerly the Sir Alister Hardy Foundation for Ocean Science, SAHFOS) is also providing salary support for some of the UK-based personnel, and in-kind support through sample archiving and curation.

Owing to the differing financial year cycles of each Organization, contributing funds per EVOS fiscal year from each source have been estimated as best we can.

7. FY18 PROJECT PUBLICATIONS AND PRODUCTS

Publications

Batten, S.D., and R. Brown. 2018. Long-term monitoring of plankton populations on the Alaskan shelf and in the Gulf of Alaska using Continuous Plankton Recorders. Long-Term Monitoring Program (Gulf Watch Alaska) Final Report, (*Exxon Valdez* Oil Spill Trustee Council Project 16120114-A), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Batten, S.D., and R. Brown. 2018. Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-D.

Published and updated datasets

DataONE: <https://doi.org/10.24431/rw1k112>, published data updated in August 2018 with final 2016 plankton data.

Research Workspace: 2017 temperature data uploaded to Research Workspace and undergoing QC. Data will be added to Gulf of Alaska Data Portal on schedule. 2017 plankton data still being processed per schedule.

Presentations

Batten, S.D. 2018. Lower Trophic Level Variability Across the Subarctic North Pacific, From Continuous Plankton Recorder Sampling. Presentation at Ocean Sciences, Portland, OR, February.

Outreach

None.

LITERATURE CITED

- Batten, S.D., Moffitt, S., Pegau, W.S., and Campbell, R. (2016). Plankton indices explain interannual variability in Prince William Sound herring first year growth. *Fisheries Oceanography* 25, 420-432.
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- DiLorenzo, E., and Mantua, N. (2016). Multi-year persistence of the 2014/15 North Pacific marine heatwave. *Nature Climate Change*, published online:11 July 2016 DOI:10.1038/nclimate3082
- Ladd, C., N. B. Kachel, C. W. Mordy, and P. J. Stabeno (2005), Observations from a Yakutat eddy in the northern Gulf of Alaska, *Journal of Geophysical Research - Oceans*, 110, C03003, doi: 03010.01029/02004JC002710.
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