

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY18 CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Project Number and Title

Gulf Watch Alaska: Environmental Drivers Component Project

18120114-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 17 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 which have been impacted by the *Exxon Valdez* oil spill. Recent results show that interannual variability in plankton dynamics is high and plankton responded clearly and rapidly to the recent warm conditions, with changes evident in abundance, composition and timing. We are not proposing any major changes to this project for FY18.

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. 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 (Figure 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. 2017). 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).

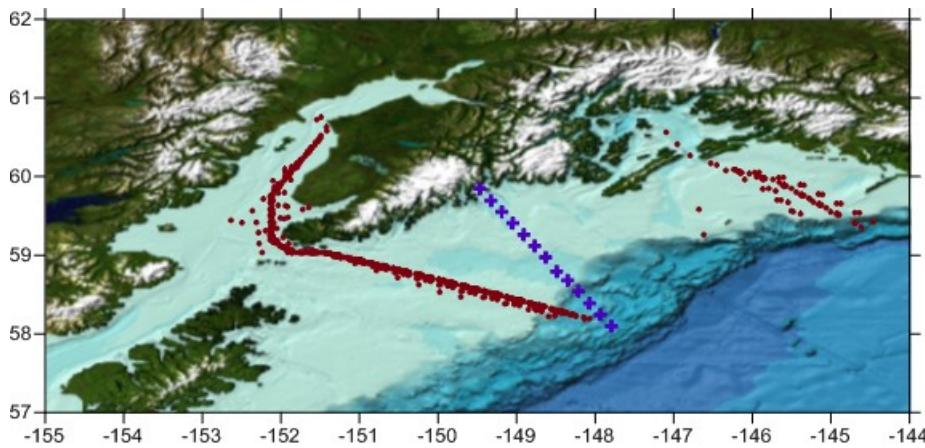


Figure 1. Location of historic CPR samples on the shelf (red dots) from 2000 to 2016 and the Seward Line stations (blue +). Since 2004, the transect has sampled into Cook Inlet and has a very consistent location.

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. In autumn 2013, the transition from cool conditions to unusually warm conditions occurred and changes in the plankton were quite dramatic (Figure 2). There was a change in the large diatom community to species more favored by low nutrients, and cell counts were low in spring, especially in 2016. The zooplankton community in summer was dominated by small species (Figure 2) which do better in warm conditions.

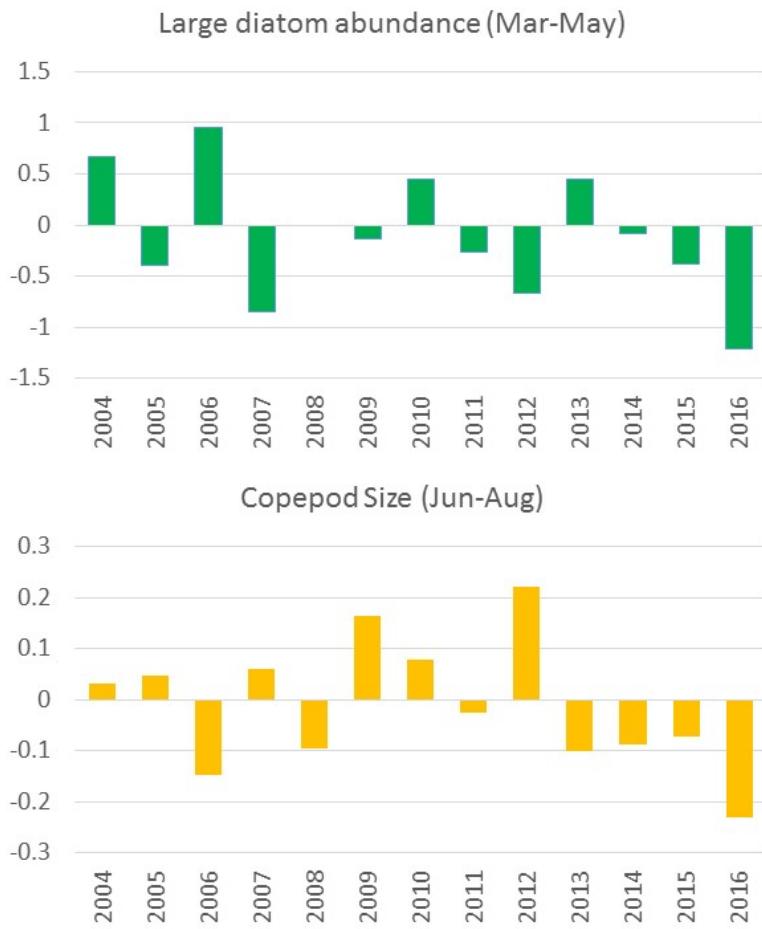


Figure 2. Mean anomaly time series of large diatom abundance in spring (top) and the mean size of the summer copepod community (bottom).

Strong relationships between plankton indices from the CPR and first year PWS herring growth have recently been documented as a product of collaboration between the Gulf Watch Alaska and Herring Research and Monitoring programs (Batten et al. 2016). It is likely that the conditions in 2015 and 2016 will not have been favorable for young herring.

Continued sampling of the CPR transect will test the hypothesis that plankton communities change in response to several years of warming, and will additionally determine whether any returns to cool conditions also see a return to more typical sub-arctic plankton communities. The CPR will 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 (Figure 1) and in Kachemak Bay, to provide a larger-scale context for these more intensive regional projects. With similar sampling frequency to the PWS 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 FY18.

2. 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 Kachemak Bay within the Environmental Drivers Group. Although there are differences in sampling design in each place, necessitated by the different sampling conditions, 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 PWS 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 group.

Productivity of the plankton populations directly influences the organisms monitored by the Pelagics Group, 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 PIs 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 Group (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, especially in light of the unusually warm conditions currently being experienced.

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 NOAA 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).

3. PROJECT DESIGN – PLAN FOR FY18

A. Objectives for FY18

Objective 1. Plankton samples will be collected on the transect between Cook Inlet and Puget Sound approximately monthly from about April to September 2018 (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 2018 will be available by July 2019.

B. Changes to Project Design

None

4. SCHEDULE

A. Project Milestones for FY18

Objective 1. Sample collection on the transect from Cook Inlet to Puget Sound will begin in spring 2018 (March or April depending on the ship's schedule) and continue approximately monthly through to August/September 2018 (6 transects will be sampled). All shelf samples will be processed and every 4th oceanic sample.

Objective 2. A subset of samples (25%) will be processed within 3 months of collection at the Institute of Ocean Sciences (DFO, Canada) and results from this processing (e.g., estimated mesozooplankton biomass and comparisons with data from previous years) will be available in progress reports and on the project website as soon as practicable. Full, quality controlled data from 2018 will be available by July 2019, and in a similar fashion in subsequent years (e.g., July 2020 for data collected within 2019). Data will be publicly available through the GWA data portal:

<http://portal.aoos.org/gulf-of-alaska.php#metadata/87f56b09-2c7d-4373-944e-94de748b6d4b/project/files>

Also, data directly from S. Batten on request.

B. Measurable Project Tasks for FY18

FY 2018 (Year 7)

FY 18, 1st quarter	(Feb 1, 2018 - April 30, 2018)
<i>February:</i>	<i>Shipping of serviced CPR from UK to Matson Kodiak</i>
March 1:	<i>Submit annual report</i>
<i>Mar/April:</i>	<i>First transect sampled</i>
FY 18, 2nd quarter	(May 1, 2018 - July 31, 2018)
<i>May-July:</i>	<i>Three transects sampled</i>
<i>June:</i>	<i>First results from 2018 sampling, ongoing hereafter</i>
<i>July:</i>	<i>Finalized data from previous year completed</i>
FY 18, 3rd quarter	(August 1, 2018 - October 31, 2018)
August 23:	<i>Submit annual work plan (FY19)</i>
<i>Aug-Sept:</i>	<i>Two transects sampled, CPR shipped back to UK for winter overhaul</i>
<i>August:</i>	<i>Submit progress report</i>
FY 18, 4th quarter	(November 1, 2018 -January 31, 2019)
<i>Oct.-Nov.:</i>	<i>Attend annual PI meeting</i>
<i>December:</i>	<i>Processing and initial analysis of samples collected in summer/fall 2018 will be completed</i>

January:

*Attend Alaska Marine Science Symposium and PI meeting
Prepare annual report*

5. PROJECT PERSONNEL – CHANGES AND UPDATES

No changes.

6. BUDGET

A. Budget Forms (See GWA FY18 Budget Workbook)

Please see project budget forms compiled for the program.

No changes have been made to the FY18 budget for this project. However, an error was found in a cell formula (G7) for FY20 under commodities. The number in the cell should have calculated a subtotal of \$3.5K instead of 0, and does affect the indirect for that year. This has now been corrected on the summary page in this FY18 work plan and budget workbook.

B. Changes from Original Proposal

None

C. Sources of Additional 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 Figure 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, 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. RECENT PUBLICATIONS AND PRODUCTS

Publications

- 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.
- Batten, S.D., Raitsos, D.E., Danielson, S., Hopcroft, R.R., Coyle, K. and McQuatters-Gollop, A. In press. Interannual variability in lower trophic levels on the Alaskan Shelf. *Deep Sea Research Part II: Topical Studies in Oceanography*, Spatial and temporal ecological variability in the northern Gulf of Alaska: what have we learned since the Exxon Valdez oil spill? Published online at <http://www.sciencedirect.com/science/article/pii/S0967064516302806>
- Batten, S. D. 2017. Continuous Plankton Recorder Data from the Northeast Pacific: Lower Trophic Levels in 2016. Contribution in the 2017 NOAA Ecosystems Considerations Report to the North Pacific Fisheries Management Council.

Published datasets

Batten, S. D. 2017. Continuous Plankton Recorder and Temperature Data, Gulf of Alaska, 2011-2016, 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/rw1k112>.

Presentations

- Batten, S. D., M. Hipfner, S. Moffitt, and S. Pegau. 2016. "A comparison of trophic linkages across the PICES region, based on Continuous Plankton Recorder data." Oral presentation. Annual North Pacific Marine Science Organization (PICES) meeting in San Diego, in November 2016.
- Batten, S. D., S. Chiba, T. M. Yoshiki and H. Sugisaki. 2016. "Highlights from 16 years of the North Pacific CPR program, a PICES MONITOR project." Poster. Annual North Pacific Marine Science Organization (PICES) meeting in San Diego, in November 2016.
- Batten, S. D., G. Ruggerone and I. Ortiz. 2017. "Lower trophic level variability near the Aleutian Islands and the influence of Pink salmon." Poster. Alaska Marine Science Symposium, January 23-26.

Outreach

Batten, S. D. 2017. "Gulf Watch Alaska, Mystery of the Blob." Interview. Available at http://www.alaskasealife.org/gulfwatchblobvt_investigation

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.
- Batten, S.D., Raitsos, D.E., Danielson, S., Hopcroft, R.R., Coyle, K. and McQuatters-Gollop, A. (in press). Interannual variability in lower trophic levels on the Alaskan Shelf. *Deep Sea Research II*. Published online at <http://www.sciencedirect.com/science/article/pii/S0967064516302806>.
- 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.
- Francis, R. C. and Hare, S.R. 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. *Fish. Oceanogr.* 3:279-291.
- 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.
- Okkonen, S.R., Weingartner, T.J., Danielson, S.L., and Musgrave, D.L. 2003. Satellite and hydrographic observations of eddy-induced shelf-slope exchange in the northwestern Gulf of Alaska. *Journal of Geophysical Research*, 108 (C2), 3033, doi:10.1029/2002JC001342.
- Royer, T.C. 1979. On the effect of precipitation and runoff on coastal circulation in the Gulf of Alaska. *J. Phys. Oceanogr.* 9:555–563.
- Stabeno, P.J., Bond, N.A., Hermann, A.J., Kachel, N.B., Mordy, C.W. and Overland, J.E. 2004. Meteorology and oceanography of the Northern Gulf of Alaska, *Continental Shelf Research*, 24, 859-897.
- Weingartner, T.J., Danielson, S.L. and Royer, T.C. 2005. Freshwater variability and predictability in the Alaska Coastal Current, *Deep Sea Research Part II* 52:169-191.
- Weingartner, T. J., K. O. Coyle, B. Finney, R. Hopcroft, T. Whitledge, R. D. Brodeur, M. Dagg, E. Farley, D. Haidvogel, L. Haldorson, A. Herman, S. Hinckley, J. M. Napp, P. J. Stabeno, T. Kline, C. Lee, E. Lessard, T. Royer, S. Strom. 2002. The Northeast Pacific GLOBEC Program: Coastal Gulf of Alaska. *Oceanography* 15:48-63.