Exxon Valdez **Oil Spill Trustee Council**

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

Project Number: 23120114-D

Project Title: Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf

Principal Investigator(s): Clare Ostle, Marine Biological Association

Sonia Batten, North Pacific Marine Science Organization

Reporting Period: February 1, 2023 – January 31, 2024

Submission Date (Due March 1 immediately following the reporting period): March 1, 2024

Project Website: https://gulfwatchalaska.org/

Please check all the boxes that apply to the current reporting period.

☒ **Project progress is on schedule.**

☐ **Project progress is delayed**

Not applicable

☐ **Budget reallocation request.**

None

☐ **Personnel changes.**

None

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1. Summary of Work Performed:

All 2023 tows were successfully completed as planned, completing 6 transects from May – October 2023.

The continuous plankton recorder (CPR) was deployed on six transects in 2023, monthly from May to October (with two transects occurring in October, one at the start and one at the end of the month). All six transects were successful in their sampling. Location of the ship's transect continues to be consistent from month to month (Fig. 1). At the time of writing, provisional

plankton data for May and June are available and the samples are undergoing QC. Annual sea surface temperature (SST) in 2023 was warmer than average (over the period 2004 - 2023) in the Alaskan shelf region but not as high as the 2016 and 2019 heatwave years (red lines plotted in Fig. 2).

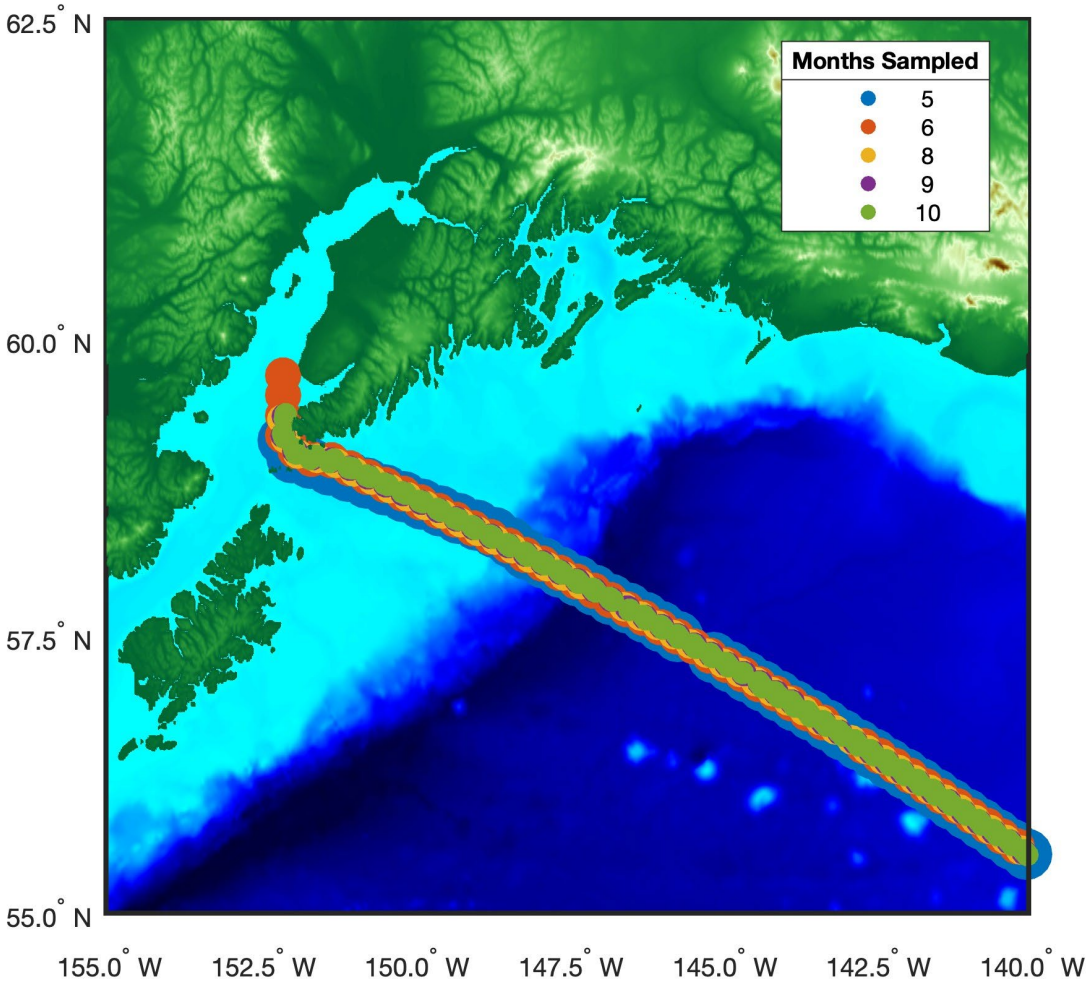

Figure 1. Location of monthly continuous plankton recorder transects in 2023.

Figure 2. Left panel shows the mean annual percentage of the total phytoplankton (green=round diatoms, yellow=rod-like diatoms, orange=dinoflagellates, grey=all other phytoplankton). Right panel shows the mean annual percentage of the total zooplankton (pink = small copepods, yellow = large copepods, orange = Euphausiids, dark red = Pteropods). 2023 only includes data from May and June and are preliminary. Red line is the annual Sea Surface Temperature (SST) within the Alaskan Shelf region (Fig. 1) from 2004 to 2023, obtained from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS).

Although only some of the data are available at this time (May-June 2023) these preliminary analyses suggest that in 2023 (and for all years after 2019, 2020-2023) the plankton have returned to levels that were more similar to those found during pre-heatwave conditions (Fig. 2). There are a higher proportion of large-round diatoms in the phytoplankton, and fewer small copepods and a higher proportion of Euphausiids in the zooplankton in 2023 than previous years.

Other evidence that supports this suggestion is shown in Fig. 3 and Fig. 4. First, we recorded unusually high numbers of diatoms in May, these were made up of mostly *Chaetoceros* spp. and *Thalassiosira* spp. (Fig. 3, left panel). Often heatwave years are associated with more smaller phytoplankton species such as dinoflagellates; however, it is important to note that the annual mean is likely to decrease as the rest of the samples for the year are analyzed.

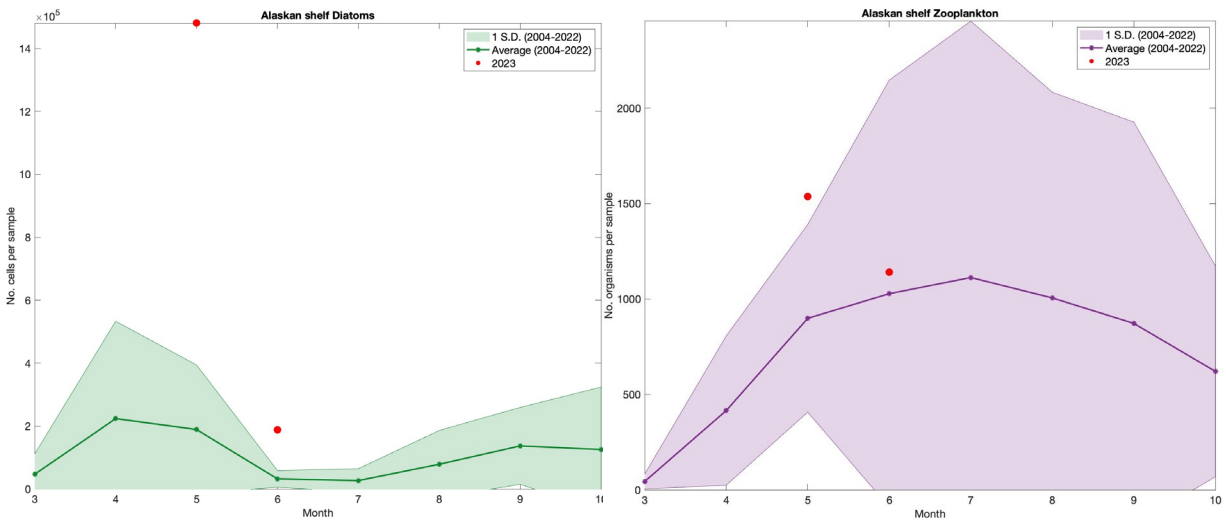

Figure 3. Left panel shows the seasonal mean monthly diatom abundance 2004-2022 with red circles showing the 2023 values (higher abundance than average in the spring) and right panel shows the seasonal mean number of zooplankton. 2023 data are preliminary.

Second, the abundance of a particular copepod species indicative of warmer conditions in the Gulf of Alaska (*Calanus pacificus*) looks to be low in 2023 (and in the last 3 years (2020-2023) see Fig. 4).

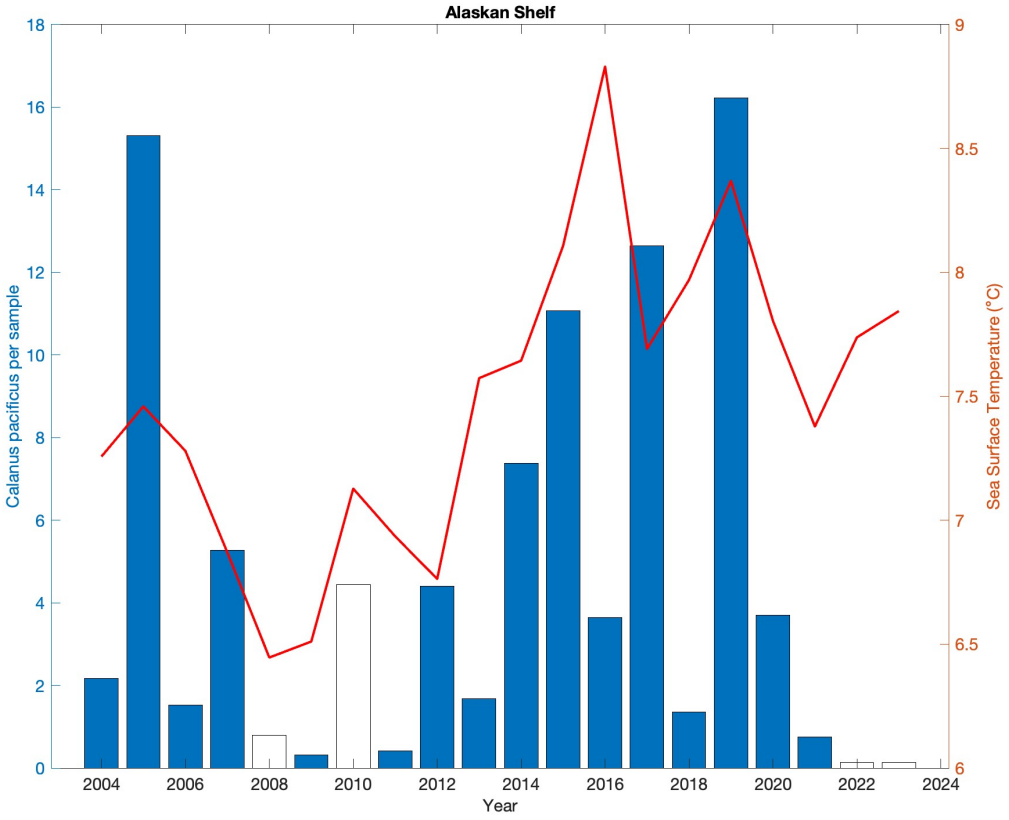

Figure 4. The mean annual abundance of the warm water indicator, Calanus pacificus, (blue bars) together with annual sea surface temperature (red line). 2023 data are preliminary. Unfilled bars indicate years with reduced sampling.

In summary, these results suggest that the marine heatwave effects on zooplankton appear to have ended. This is likely to have positive effects on ecosystem functioning.

2. Products:

Peer-reviewed publications:

Li, K., J. C. Naviaux, S. S. Lingampelly, L. Wang, J. M. Monk, C. M. Taylor, C. Ostle, S. Batten, and R. K. Naviaux. 2023. Historical biomonitoring of pollution trends in the

North Pacific using archived samples from the Continuous Plankton Recorder Survey. Science of the Total Environment 865:161222. https://doi.org/10.1016/j.scitotenv.2022.161222.

Ratnarajah, L., R. Abu-Alhaija, A. Atkinson, S. Batten, N. J. Bax, K. S. Bernard, G. Canonico, A. Cornils, J. D. Everett, M. Grigoratou, N. H. A. Ishak, D. Johns, F. Lombard, E. Muxagata, C. Ostle, S. Pitois, A. J. Richardson, K. Schmidt, L. Stemmann, K. M. Swadling, G. Yang, and L. Yebra. 2023. Monitoring and modelling marine zooplankton in a changing climate. Nature Communications 14:564. https://doi.org/10.1038/s41467-023-36241-5.

Sydeman, W. J., S. A. Thompson, M. García-Reyes, C. Kroeger, B. Hoover, S. D. Batten, and N. A. Rojek. 2023. Effects of currents and temperature on ecosystem productivity in Unimak Pass, Alaska, a premier seabird and biodiversity hotspot. Progress in Oceanography 16:103082. https://doi.org/10.1016/j.pocean.2023.103082.

Reports:

Ferris, B. editor. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-gulf-alaska.

Ortiz, I., and S. Zador, editors. Ecosystem Status Report 2023: Aleutian Islands, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-aleutian-islands.

Ostle, C., and S. Batten. 2023. Continuous plankton recorder data from the Eastern Bering Sea. Pages 90-92 *in* E. Siddon, editor. Ecosystem Status Report 2023: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-eastern-bering-sea.

Ostle, C., and S. Batten. 2023. Continuous plankton recorder data from the Northeast Pacific, 2002-2022. Pages 79-81 *in* B. Ferris, editor. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-gulf-alaska.

Ostle, C. and S. Batten. 2023. Lower trophic levels in the Northeast Pacific. Pages 97-100 *in* J. L. Boldt, E. Joyce, S. Tucker, and S. Gauthier, editors. State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2022. Canadian Technical Report of Fisheries and Aquatic Sciences. https://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2022/technical-report-rapport-technique-eng.html.

Ostle, C., and S. Batten. 2023. Zooplankton: Continuous plankton recorder data from the Aleutian Islands and southern Bering Sea: Lower trophic levels in 2022. Pages 49-51 *in* I. Ortiz and S. Zador, editors. Ecosystem Status Report 2023: Aleutian Islands, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-aleutian-islands.

Siddon, E. editor. Ecosystem Status Report 2023: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, Anchorage, Alaska. https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2023-eastern-bering-sea.

Popular articles:

Powell, K., and C. Ostle. 2023. Where I work. Nature 613:406. https://doi.org/10.1038/d41586-023-00024-1

Ostle, C., and P. Hélaouët. 2023. The Continuous Plankton Recorder as a platform for sensor development. PICES Press 31:64-65.

Conferences and workshops:

Kléparski, L., C. Ostle, S. Batten, and N. Djeghri. 2024. Consequences of the North Pacific Marine Heatwave on phytoplankton abundance in the Gulf of Alaska. Oral presentation. Alaska Marine Science Symposium, Anchorage, Alaska, January.

Public presentations:

An update on the North pacific CPR survey was presented to the North Pacific Marine Science Organization (PICES) Monitor Technical Committee annual meeting in September 2023.

Data and/or information products developed during the reporting period:

The data have been included in the International Group for Marine Ecological Time Series (IGMETS) effort led by the Intergovernmental Oceanographic Commission of UNESCO (IOC), the International Ocean Carbon Coordination Project (IOCCP) and the Ocean Carbon and Biogeochemistry Program (OCB) which seeks to integrate a suite of in situ biogeochemical variables from time-series stations, together with satellite-derived information, to look at holistic changes within different ocean regions. The website http://igmets.net/ has a Time Series Explorer which allows the user to construct time series of available variables and investigate trends. North. Pacific CPR data provide much of the plankton information for the region. The data are also stored in the Ocean Biodiversity Information System (OBIS): https://obis.org/dataset/e981eab6-f849-4891-8fac-495852829456.

Monthly abundances for selected plankton can be generated for user-specified regions sampled by the CPR using this extraction tool:

https://www.dassh.ac.uk/lifeforms/
https://doi.mba.ac.uk/data/3086

Data sets and associated metadata:

Ostle, C. and S. Batten. 2023. Continuous plankton recorder and temperature data, Gulf of Alaska, 2012-2022, Gulf Watch Alaska environmental drivers component. Gulf of Alaska Data Portal. https://gulf-of-alaska.portal.aoos.org/#metadata/87f56b09-2c7d-4373-944e-94de748b6d4b/project/folder_metadata/2510313.

Additional Products not listed above:

No new contributions for this reporting period.

3. Coordination and Collaboration:

The Alaska SeaLife Center or Prince William Sound Science Center

Funding has been provided to the North Pacific CPR Survey Consortium through the Alaska Sea Life Center (from the North Pacific Research Board) and the Prince William Sound Science Center (PWSSC; from the *Exxon Valdez* Oil Spill Trustee Council [EVOSTC] as part of the Gulf

Watch Alaska Long-Term Monitoring program [GWA-LTRM]) for over a decade. Thus, we have developed good working relationships with the administrators in these organizations. We have participated in the PWSSC outreach program by giving talks to elementary and high school students, and at a public lecture as part of the PWSSC science lecture series in Cordova. We have also contributed articles to Delta Sound Connections. Collaborations with PWSSC researchers on juvenile herring have resulted in published papers and we are currently working on an additional collaborative manuscript.

EVOSTC Long-Term Research and Monitoring Projects

Environmental Drivers Component

This project provides a spatial link between the locally more intensive (but less seasonally resolved) sampling of lower trophic levels from the Seward Line within the Environmental Drivers Component. Although there are differences in sampling design necessitated by the different sampling conditions, there are techniques available to facilitate integration, as mentioned above. 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 group.

Pelagic Monitoring Component

Productivity of plankton populations directly influences the organisms monitored by the Pelagic Component and will be a necessary contribution to their studies. The recent collaborative paper, Arimitsu et al. (2021), describes some of these relationships with forage fish, and we expect such collaboration to continue, particularly as the time-series becomes long term and trends can become validated.

Nearshore Monitoring Component

Nearshore studies are perhaps harder to link directly, but many benthic invertebrates have a planktonic phase. We provided a subset of CPR data to other Gulf Watch Alaska principal investigators summarizing the meroplankton to examine the long-term variability in larvae.

Lingering Oil Monitoring Component

Nothing to report at this time.

Herring Research and Monitoring component

We have actively collaborated with the Herring Research and Monitoring Component, including previous publications. 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. We currently have a further collaborative publication with the Herring research and Monitoring group in preparation.

Synthesis and Modeling Component

Suryan et al. (2021) provides an example of the collaborative efforts of the group with a synthesis report in Scientific Reports on the ecosystem response as a whole to the marine heatwave in the Gulf of Alaska. Such collaborations will continue and results will become more significant as the time series involved are continued and post-heatwave trends can be described.

Data Management Project

The CPR data from the Gulf of Alaska region are provided as an annual data product to the Data Management program through the Gulf of Alaska data portal. These data are quality controlled and provided in a consistent format for ease of use and dissemination.

EVOSTC Mariculture Projects

As above, plankton underpin many important food webs, particularly fisheries, and also reflect the environmental conditions, it is therefore likely that our plankton time-series will be of significant use to mariculture projects within EVOSTC, and we are open to such collaboration and sharing of data.

EVOSTC Education and Outreach Projects

We have a good track record with education and outreach and enjoy getting involved. Sonia Batten has presented at the Cordova elementary and secondary schools and given a public lecture in the area as well as a presentation as part of the PWSS lecture series. We very much enjoy this aspect of the work and will look to continue to contribute.

Individual EVOSTC Projects

As plankton underpin many important food webs and reflect the environmental conditions, we envisage that our data will be of significant use to several of the other projects involved, and we are open to such collaboration.

Trustee or Management Agencies

CPR data are provided as an annual summary to the National Oceanic and Atmospheric Administration Ecosystem Status Reports for the Gulf of Alaska, Aleutian Islands, and Bering Sea (CPR has contributed since 2016), a synthesis report used by fisheries managers (https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-status-reports-gulf-alaska-bering-sea-and-aleutian-islands), and the Ecosystem and Socioeconomic Profiles within the Ecosystem Status Reports (CPR has contributed since 2020) to form individual stock-specific assessments (e.g., walleye pollock, Pacific cod and sablefish in the Gulf of Alaska). These contributions will be continued.

Native and Local Communities

The GWA-LTRM program and this project are committed to involvement with local and Alaska Native communities. Our vision for this involvement will include active engagement with the Education and Outreach Focus Area (see above), program-directed engagement through the Program Management II project (22120114-B, PI Hoffman), and project-level engagement. The GWA-LTRM program has reached out to local communities and Alaska Native organizations in the spill affected area to ask what engagement they would like from us and develop an approach that invites involvement of PIs from each project, including this one. Our intent as a program is to provide effective and meaningful community involvement that complements the work of the Education and Outreach Focus Area and allows communities to engage directly with scientists based on local interests.

In addition, this project will continue engaging with local communities as we have during the first 10 years of the program. Servicing is provided in Anchorage by Kinnetic Laboratories, the volunteer vessel officers and crew are strong supporters of the project and pleased to be participating, providing local involvement and engagement.

4. Response to EVOSTC Review, Recommendations and Comments:

No comments for FY23.

5. Budget:

Budget Category:		Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel		$39,616	$40,607	$41,622	$42,663	$43,730	$208,238	$66,687
Travel		$1,316	$1,366	$1,399	$1,433	$1,467	$6,980	$2,226
Contractual		$9,304	$9,537	$9,775	$10,020	$10,270	$48,906	$15,662
Commodities		$5,837	$5,985	$6,134	$6,287	$6,445	$30,688	$9,827
Equipment		$0	$0	$0	$0	$0	$0	$0
Indirect Costs	Rate = 40%	$22,429	$22,998	$23,572	$24,161	$24,765	$117,925	$37,761
	SUBTOTAL	$78,502	$80,492	$82,503	$84,564	$86,676	$412,737	$132,163
General Administration (9% of subtotal)		$7,065	$7,244	$7,425	$7,611	$7,801	$37,146	N/A
	PROJECT TOTAL	$85,567	$87,736	$89,928	$92,175	$94,477	$449,884	
Other Resources (In-Kind Funds)		$128,351	$131,605	$134,892	$138,262	$141,715	$674,825	

Cumulative spending through FY23 appears low. This is due to the delay in the release of project funding at the start of the funding cycle and because MBA invoices for the project quarterly and the most recent spending is available through November 2023.