FY 22-31 *PROJECT* PROPOSAL
LONG-TERM RESEARCH AND MONITORING PROGRAM

Does this proposal contain confidential information? ☐Yes ☒No

Project Number and Title

Gulf Watch Alaska Long-Term Research and Monitoring Program: Environmental Drivers Component

20120114-D Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf

Primary Investigator(s) and Affiliation(s)

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Date Proposal Submitted

August 13, 2021

Project Abstract (maximum 300 words)

As the base of marine food-webs, plankton are a fundamentally important functional group in marine ecosystems, and a reflection of current environmental conditions due to their rapid generation times and short lifecycles. 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 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. Data 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 and sizes of plankton). Variability in any, or all, of these indices can cascade through to higher trophic levels such as herring, salmon, birds, and mammals that forage across the region. Recent results show that interannaul variability in plankton dynamics is high and that the plankton has responded to the recent warm conditions, with changes evident in abundance, sizing, composition, and timing. The CPR is designed to be easy to deploy on commercial maritime vessels and sample autonomously. Thus, CPR sampling has been unimpacted by the COVID-19 pandemic, with the tried and tested longevity of the CPR methodology ensuring that the samples and data are collected analysis. As climate change, and the likely associated changes in environmental conditions, continues to impact the Gulf of Alaska ecosystem it is more important than ever to maintain consistent time-series that depict these changes.

EVOSTC Funding Requested* (must include 9% GA)

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$85,567	$87,736	$89,928	$92,175	$94,477	$449,884
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$96,837	$99,256	$101,736	$104,277	$106,882	$508,988
				FY22-31 Total	*$958,871*

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Non-EVOSTC Funds to be used, please include source and amount per source:

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$128,351	$131,605	$134,892	$138,262	$141,715	$674,825
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$145,256	$148,884	$152,603	$156,416	$160,323	$763,481
				FY22-31 Total	*$1,438,307*

Please see the attached letter from PICES (22120114-D_CPR-funding-PICES.pdf) describing the non-EVOSTC funds in more detail.

1. EXECUTIVE SUMMARY (maximum ~1500 words, not including figures and tables)

Plankton are a fundamentally important functional group in marine ecosystems, encompassing the base of the food web. They are capable of sustaining whole fisheries and support almost all other marine organisms (including many sea birds and marine mammals that are in the International Union for Conservation of Nature Red List). Phytoplankton provides half of global primary production (Falkowski et al. 1998) and both phytoplankton and zooplankton exert a central role in biogeochemical cycles (e.g., the carbon cycle, and consequent carbon sequestration via the biological carbon pump). Variability in the environment is passed rapidly through plankton and influences higher trophic level productivity. Coupled with fast generation times and short lifecycles, planktonic organisms are thus proficient indicators of the environment and have been used to assess several climatic (e.g., biogeographical shifts, Beaugrand 2005, regime shifts, Reid et al. 2016) and anthropogenic impacts (e.g., sewage pollution, Tett et al. 2007, eutrophication, HELCOM 2012).

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. CPR sampling began in 2000 so there

is now a >20-year time-series available to assess the impacts of climate variability. 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 been identified as a marine heatwave (DiLorenzo and Mantua 2016), and caused widespread impacts on Alaskan marine ecosystems that are still being noted and assessed.

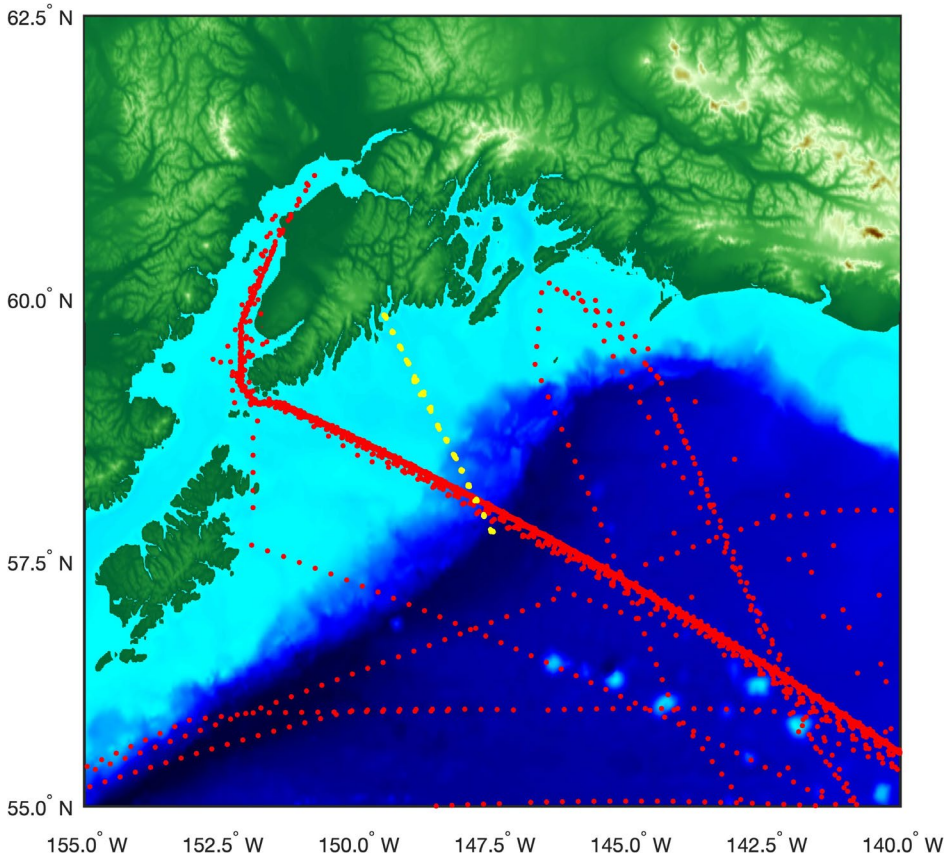

Figure 1. Location of historic Continuous Plankton Recorder (CPR) samples in the Gulf of Alaska (red dots) from 2000 to 2020 and the Seward Line stations (yellow). Since 2004 the CPR transect has sampled into Cook Inlet and has a very consistent location.

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 (Richardson 2008), 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. During the most recent period of funding, we have observed unusually warm conditions in the area and the changes in the plankton have reflected these conditions (Batten et al. submitted). Specifically, there was a change in the diatom community to species more favored by low nutrients, and cell counts were low. Although we see an increase in zooplankton abundance during recent warm years, this increase is dominated by smaller species (Fig. 2). In 2019, which was a significantly warm year, we saw the zooplankton community index of copepod length decrease to levels we have not recorded before, this trend associated with temperature was also apparent in 2016 (Fig. 2). This is a significant result as smaller organisms are a less efficient food source for important organisms that feed on the plankton, such as the local fisheries and seabirds. Strong relationships between plankton indices from the CPR and first year Prince William Sound (PWS) herring growth have 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 during some heatwave years were not favorable for young herring, and we are currently writing a paper on this in collaboration with the Herring Research and Monitoring program.

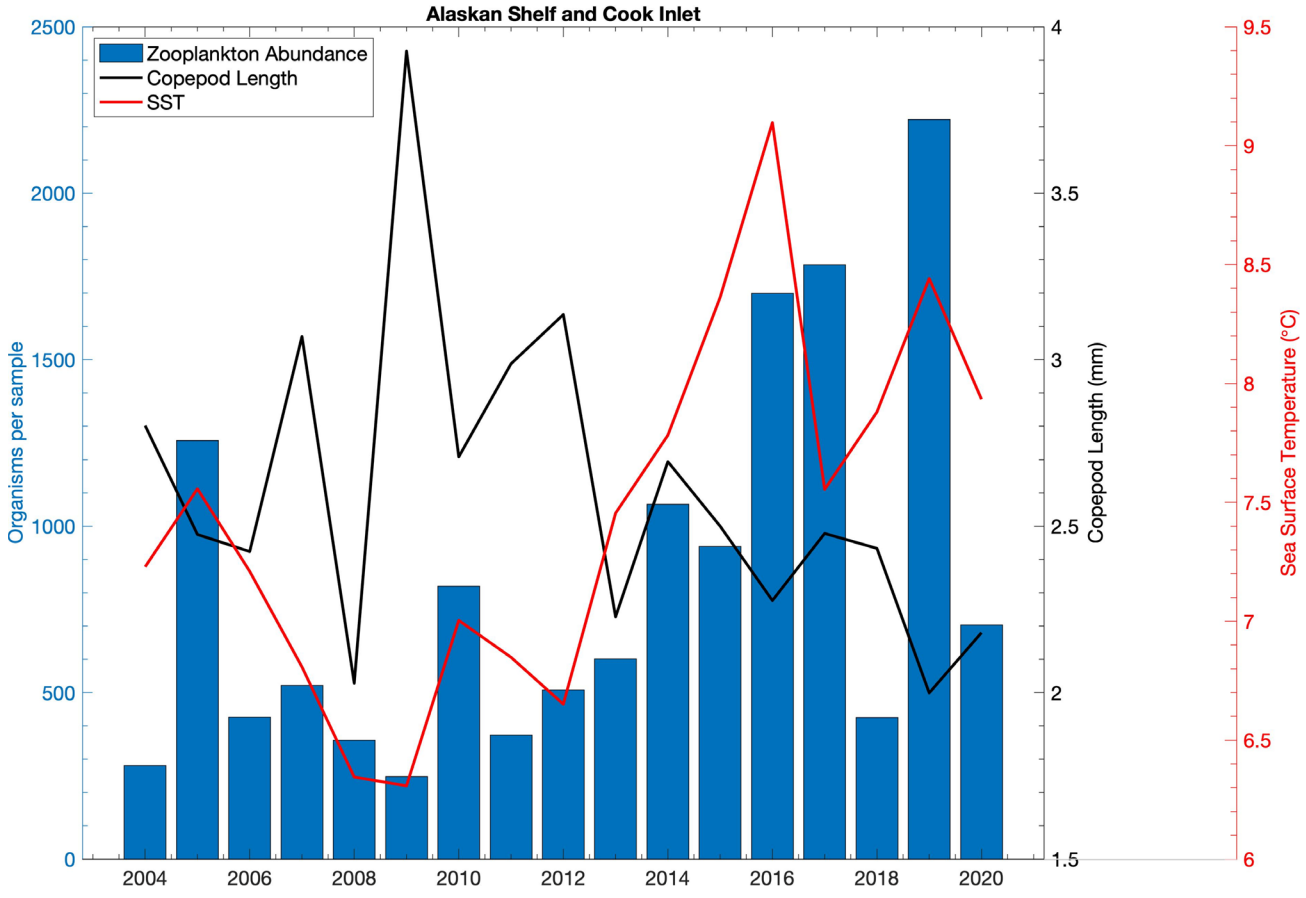

Figure 2. Annual measurements of zooplankton abundance (blue bars), copepod length (black line), and sea surface temperature (SST, red line) in the Alaskan Shelf and Cook Inlet from 2004 to 2020.

Continued sampling of the CPR transect over the next 10 years will further consolidate the hypothesis that plankton communities have changed 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 component, that of the Seward Line (Fig. 1) and in Kachemak Bay, to provide a larger-scale context for these more intensive regional projects. With similar sampling frequency to the GAK-1 and 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. The project has a proven track record with a high sampling success rate, all past deliverables have been fully met and there is a strong record of primary publications resulting from the program (see the list of publications in Batten's resume below).

The CPR is designed to be easy to deploy on maritime vessels, it is therefore not necessary to have scientific personnel involved in the deployment, and once deployed it can sample autonomously. It is for this reason that sampling using the CPR has not been impacted by the COVID-19 pandemic, and the tried and tested longevity of the CPR methodology ensures that the data are collected and preserved for long-term monitoring and analysis. As climate change, and the likely associated changes in environmental conditions, continues to impact the Gulf of Alaska ecosystem it is more important than ever to maintain consistent time-series that depict these changes.

2. RELEVANCE TO THE INVITATION (maximum 300 words)

This project addresses the Council's goal to "*provide sound scientific data and products that inform management agencies and the public of changes in the environment and the impact of these changes on injured resources*" as plankton underpin most marine food webs and reflect environmental changes, and the CPR has a proven track record of long-term data provision and consistency (robust methodology unchanged since 1958). More specifically this project addresses the goal to determine "*how factors other than oil may inhibit full recovery or adversely impact recovering resources*" since the results will demonstrate how ocean climate variability, mediated through physical processes, causes variability in lower trophic levels. Plankton support the recovering resources either directly as a food source, as in the case of juvenile herring, or indirectly with intermediate trophic levels, but an assessment of plankton variability is essential to understanding fluctuations in resources of concern. This study contributes to "*An assessment of…. the effects on biological production over time*". The addition of a further 10 years of data will extend the dataset to almost 30 years; a duration where relationships with longer-lived higher trophic levels can be determined and important long-term trends can start to be validated. CPR data are already provided as an annual summery to the National Oceanic and Atmospheric Administration Ecosystems Status Report, a synthesis report used by fisheries managers, and the Ecosystem and

Socioeconomic Profiles to form individual stock-specific assessments (e.g., walleye pollock, Pacific cod and sablefish in the Gulf of Alaska). This contribution will be continued. See https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-status-reports-gulf-alaska-bering-sea-and-aleutian-islands for previous reports.

3. PROJECT HISTORY (maximum 400 words)

The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) awarded one year of funding for two CPR transects in 2002, one north-south and one east-west across the Gulf of Alaska (Project 02624-BAA). Funding for the north-south transect was continued through the EVOSTC's Gulf Ecosystem Monitoring program for four more years (until 2008) via projects 030624 and 040624. After the Gulf Ecosystem Monitoring program ended, the value of the plankton data to herring restoration efforts was acknowledged with an additional year of funding as Restoration Project 070624 and, subsequently, as a contract under the Integrated Herring Research Program for 3 years (2010-2012), project 12100624. At about this time, a funding consortium for the North Pacific CPR survey was established under the auspices of the PICES, so that several agencies (including the North Pacific Research Board [NPRB] and Department of Fisheries and Oceans [DFO], Canada) contributed to the survey's costs and thereby reduced the request to the EVOSTC. From 2012 to present, the CPR project became part of the Long-Term Monitoring Program of the EVOSTC (Gulf Watch Alaska) under the project numbers 12120114-D, 13120114-D, 14120114-D, 15120114-D, 16120114-D, 17120114-D, 18120114-D, 19120114-D, and 20120114-D. Table 1 summarizes the various accomplishments of these funded projects since 2002.

Table 1. Summary of accomplishments of this project since its initiation in 2002 by the Exxon Valdez Oil Spill Trustee Council (EVOSTC).

Accomplishment	Number	Details
Total samples collected (shown in Fig. 1)	7,115	Spring/Summer/Fall 2002-2020
Number of months sampled	120	Spring/Summer/Fall 2002-2020
Peer-reviewed project publications	6	Batten et al. (submitted), Pinchuk et al. 2021, Hoover et al. 2021, Litzow et al. 2020, Batten et al. 2018, Batten et al. 2016
Peer-reviewed synthesis publications	2	Arimitsu et al. 2021, Suryan et al. 2021
EVOSTC final reports	5	Batten and Brown 2003, Batten and Brown 2008, Batten and Brown 2011, Batten and Brown 2013, Batten and Brown 2018
EVOSTC syntheses	3	Bishop 2015; Suryan et al. 2020; Arimitsu et al. 2020
EVOSTC annual reports	20	FY00-FY20 (2002-2021)
Professional conference oral presentations	5	Batten et al. 2019, Batten et al. 2018, Batten et al. 2017, Batten et al. 2016, Batten et al. 2015

Accomplishment	Number	Details
Professional conference poster presentations	8	Alaska Marine Science Symposium (8)
Popular articles	8	PICES Press (6), The Guardian (1), Delta Sound Connections (1)
Public presentations	4	Prince William Sound Science Center lecture series, high school talk, elementary school talk, public lecture in Cordova
Education outreach	2	Virtual Field Trips: Long-term monitoring and The mystery of The Blob
Gulf Watch Alaska annual Principal Investigator meetings	10	

4. PROJECT DESIGN

A. Objectives and Hypotheses

Objective 1. Sample collection on the transect from Cook Inlet to Puget Sound will begin in spring 2022 and continue approximately monthly through to August/September 2022 (6 transects will be sampled). This schedule will be repeated each year to 2031. All shelf samples will be processed and every 4th oceanic sample.

Objective 2. A subset of samples (25%) will be processed within three 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.

Objectives are unchanged from the previously funded project. The fundamental goal of this program is to provide consistent large spatial scale data on plankton populations of the Alaskan Shelf to extend the existing time series and integrate the data with other regional sampling. More specifically, we will provide monthly (spring to fall – typically April to September) sampling of zooplankton and large phytoplankton along the transect from the oceanic Gulf of Alaska to Cook Inlet, analyzing every 4th oceanic and every shelf sample to provide taxonomically resolved abundances.

The plankton data provided through this program are justified through the use of the data for publications and presentations that have been listed in Table 1, and the scientific evidence they provide on the environment and ecosystem. The addition of a further 10 years of data will extend the dataset to almost 30 years; a duration where relationships with longer-lived higher trophic levels can be determined and important long-term trends can start to be validated.

B. Procedural and Scientific Methods

We do not propose to make any changes to the sampling regime that has been operating so successfully. The cargo vessel Matson (formerly Horizon) Kodiak will tow a CPR northbound towards Cook Inlet approximately once per month between about April and September each year to provide six samplings per year. The samples will be unloaded and the gear serviced each time by Alaskan technicians who have been trained by the CPR survey. The Marine Biological Association parent organization of the CPR survey and is the world authority on CPR sampling. Sample processing will be carried out at the DFO laboratory in Sidney, BC and at the CPR survey laboratory in the UK, as before. Briefly, the CPR is deployed from the stern of the volunteer vessel once it has cleared port and is underway (or when the Captain deems it is safe to do so) and is towed behind the vessel on a fixed length cable so that it samples the surface mixed layer at a depth of about 7 m. Water enters the front of the CPR, passes along a tunnel and through a silk filtering mesh (with a mesh size of 270 μm) which retains the plankton and allows the water to exit at the back of the machine. The movement of the CPR through the water turns an external propeller which, via a drive shaft and gearbox, moves the filtering mesh across the tunnel. As the filtering mesh leaves the tunnel it is covered by a second band of mesh so that the plankton are sandwiched between these two layers, which then wind on into a storage chamber containing preservative. The CPR is normally deployed in Juan de Fuca Strait and recovered in Cook Inlet at around 60°N or at the Captain's discretion. The ship's officers record launch and recovery times and positions and all course changes. At the end of the tow the machine is returned to the laboratory and using the information from the ship's log the transect is reconstructed and the mesh is marked into separate samples, each representing 18.5 km of tow and about 3 m^3 of seawater filtered.

The first step is the assessment of phytoplankton color (the greenness of the sample) which is a representation of the total phytoplankton biomass and includes the organisms that are too fragile to survive the sampling process intact, but which leave an impression on the mesh (see Raitsos et al. 2013 for more information on this index). The assessment is made against a standard color chart, into one of four color categories. The mesh is then cut into separate samples, which are randomly distributed amongst a team of analysts for taxonomic assessment. Hard-shelled phytoplankton are semi-quantitatively determined under a microscope by viewing 20 fields of view and recording the presence of all the different taxa in each field. Small zooplankton are identified and counted from a subsample (1/49 of the sample) whilst all zooplankton larger than about 2 mm are counted with no subsampling, unless numbers are very large. Identification is carried out to the highest practicable taxonomic level and is a compromise between speed of analysis and scientific interest. Since copepods make up the majority of the zooplankton most copepods are identified to species level whilst other groups are generally identified to a lower level. Although CPR sampling is continuous, the midpoint of the sample is used to label it with latitude, longitude, time, and date. Quality Control of analysis also follows the CPR survey standard protocols; briefly, results from adjacent samples are compared and inconsistencies checked, and if necessary corrected, before the sample data are finalized and released. All of the samples are archived after analysis so that they can be re-examined at any time, or used for additional analyses (molecular studies and stable isotope analyses are now possible, for example).

Summary indices such as 'mesozooplankton biomass' and 'total diatom abundance' are routinely calculated from the abundance data. Temperature loggers have been fitted to the CPRs since 2011 and we are endeavoring to maintain in situ temperature data collection on this transect. It is important that the sampling remains consistent as a break in the time-series can impact any phenological studies and descriptions of inter-annual variability. The CPR has a proven track record for consistent methodology and maintenance of quality-controlled datasets.

C. Data Analysis and Statistical Methods

The sampling frequency and spacing is suitable to characterize seasonal, interannual and spatial variability in the plankton at the mesoscale. Large scale patchiness (on the order of 10s to 100s of kms) needs to be considered as a factor that may contribute to observed variability in the plankton data. The greatest resolution possible from CPR data is 18.5 km, however, to maximize coverage with the resources available we process samples spaced 74 km in the open ocean (every fourth sample being processed) but all samples on the shelf. An individual sample will pass through small patches of plankton and so provide an 'average' of the small-scale patchiness. We have established the decorrelation length-scales for common taxa from data collected early in the survey (2000) and determined that samples that are spaced well apart, such as every 74 km, are likely to be representative and not likely to be within or outside of a patch.

Our methodology has remained unchanged since the survey's inception so comparisons with previously collected CPR data are straightforward. Comparisons with other plankton sampling are more problematic as each sampling system has a bias of some sort caused by, for example, mesh size, depth of sampling, taxonomic resolution. However, by using indices such as anomalies and pooling taxa to create functional groups useful comparisons can be made. The Environmental Drivers component has made progress in this regard and as the individual time series lengthen such comparisons will become more robust and informative.

D. Description of Study Area

The project will sample waters on a transect leaving from the Straits of Juan de Fuca outside of Puget Sound (48.45°N, 125°W, Captain's discretion) across the Gulf of Alaska to Cook Inlet and Anchorage. Sampling will end at about 60°N, 151.9°W (at Captain's discretion). See Fig. 1 above for a map of the northern end of the transect. It intersects with the outermost Seward Line stations and samples outside of Kachemak Bay in Cook Inlet, thereby linking with two other Environmental Drivers component sampling locations. Ship tracks vary minimally from month to month.

5. COORDINATION AND COLLABORATION

A. With the Alaska SeaLife Center or Prince William Sound Science Center

Funding has been provided to the North Pacific CPR Survey Consortium through the Alaska SeaLife Center (from NPRB) and the Prince William Sound Science Center (PWSSC; from Gulf Watch Alaska) for more than a decade. We have thus already 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 an article to Delta Sound Connections which is published by PWSSC. Collaborations with PWSSC researchers on juvenile herring have resulted in published papers (Batten et al. 2016) and we are currently working on an additional collaborative manuscript. We participated in two Virtual Field Trips developed by the Alaska SeaLife Center in collaboration with the Gulf Watch Alaska program (https://gulfwatchalaska.org/resources/educational-resources/virtual-field-trips/): Long-term monitoring and Mystery of The Blob.

B. Within the EVOSTC LTRM Program

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 and Kachemak Bay within the Environmental Drivers Component. Although there are differences in sampling design in each place, 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 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.

Pelagic Monitoring Component

Productivity of the 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 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.

Lingering Oil Monitoring Component

As above, the coastal component of lingering oil is harder to link directly, but we do see some connections with planktonic larval stages and are hoping to explore this further.

Herring Research and Monitoring component

We have actively collaborated with the Herring Research and Monitoring component, 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. We currently have a further collaborative publication with Herring Research and Monitoring component principal investigators 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 heat wave in the Gulf of Alaska. Such collaborations will continue and results we become more significant as the time-series involved are continued and long-term 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 team. This data are quality controlled and provided in a consistent format for ease of use and dissemination.

C. With Other EVOSTC-funded Projects (not within the LTRM Focus Area)

Current EVOSTC-funded projects not within the Long-Term Research and Monitoring Focus Area have not intersected with this project so far. As the EVOSTC funds future projects outside the Gulf Watch Alaska long-term research and monitoring program we will evaluate their applicability to our project and coordinate as appropriate. As plankton underpin many important food webs and reflect the environmental conditions, we envisage that our data will be of significant use to a number of the other projects involved, and we are open to such collaboration.

D. With Proposed EVOSTC Mariculture Focus Area Projects

We look forward to working with the EVOSTC's Mariculture Program and projects they embark on. We anticipate they will be interested in Gulf Watch Alaska long-term research and monitoring program datasets and we expect there will be opportunities for coordination and collaboration. As above, the 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.

E. With Proposed EVOSTC Education and Outreach Focus Area Projects

The Gulf Watch Alaska long-term research and monitoring program will develop an outreach plan that includes coordination and collaboration with the Trustee's Education and Outreach Program and projects. We look forward to participating in education and outreach opportunities where our project findings can contribute to a better understanding of the Gulf of Alaska ecosystem by the general public. 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, given a public lecture in the area as well as a presentation as part of the PWSSC lecture series, and participated in two Virtual Field Trips developed by the Alaska SeaLife Center in coordination with the Gulf Watch Alaska program. We very much enjoy this aspect of the work and will look to continuing to contribute.

F. With Trustee or Management Agencies

CPR data are provided as an annual summary to the NOAA Ecosystem Considerations Report (CPR contributed since 2016), a synthesis report used by fisheries managers, and the Ecosystem and Socioeconomic Profiles (CPR contributed since 2020) to form individual stock-specific assessments (e.g.,

walleye pollock, Pacific cod and sablefish in the Gulf of Alaska). This contribution will be continued. See https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-status-reports-gulf-alaska-bering-sea-and-aleutian-islands for previous reports.

G. With Native and Local Communities

The Gulf Watch Alaska Long-Term Research and Monitoring 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 project (2222LTRM), and project-level engagement. During the first year of the funding cycle (FY22), the Gulf Watch Alaska Long-Term Research and Monitoring program will reach 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 principal investigators 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 some local involvement.

6. DELIVERABLES

Deliverable 1. Annual progress reports will be produced.

Deliverable 2. A final project report will be produced.

Deliverable 3. Full, quality-controlled data from 2022 will be available by July 2023, and in a similar fashion in subsequent years (e.g., July 2023 for data collected within 2022). Data along with full metadata documentation will be publicly available through the Gulf of Alaska portal:

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

Requests can also be made directly to project principal investigator C. Ostle.

7. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

Project milestones and tasks by fiscal year and quarter, beginning February 1, 2022. 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	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Sample collection																				
CPR shipment	X				X				X				X				X			
Transect sampling	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
CPR winter overhaul			X				X				X				X				X	
Sample Processing																				
Sampling results	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reporting/Deliverables																				
Annual reports					X				X				X				X			
Data/Deliverables																				
Data posted online (for previous year samples)				X				X				X				X				X

Milestone/Task	FY27				FY28				FY29				FY30				FY31			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Sample collection																				
CPR shipment	X				X				X				X				X			
Transect sampling	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
CPR winter overhaul			X				X				X				X				X	
Sample Processing																				
Sampling results	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reporting/Deliverables																				
Annual reports	X				X				X				X				X			
Final report																				X
Data/Deliverables																				
Data posted online (for previous year samples)				X				X				X				X				X

Measurable Program Tasks

FY 22, 1st quarter (Feb 1, 2022-April 30, 2022)

February: Shipping of serviced CPR from UK to Matson Kodiak

Mar/April: First transect sampled

FY 22, 2nd quarter (May 1, 2022-July 31, 2022)

May-July: Three transects sampled

June: First results from 2022 sampling, ongoing hereafter.

July: Finalized data from previous year completed.

FY 22, 3rd quarter (August 1, 2022-October 31, 2022)

Aug-Sept: Two transects sampled, CPR shipped back to UK for winter overhaul.

FY 22, 4th quarter (November 1, 2022-January 31, 2023)

November: Attend PI meeting

December: Processing and initial analysis of samples collected in summer/fall 2022 will be completed

January: Attend Alaska Marine Science Symposium and PI meeting.
Prepare annual report.

Subsequent years will follow the same pattern.

8. BUDGET

A. Budget Forms (Attach)

Please see Gulf Watch Alaska Long-Term Research and Monitoring workbook.

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	
Travel	$1,316	$1,366	$1,399	$1,433	$1,467	$6,980	
Contractual	$9,304	$9,537	$9,775	$10,020	$10,270	$48,906	
Commodities	$5,837	$5,985	$6,134	$6,287	$6,445	$30,688	
Equipment	$0	$0	$0	$0	$0	$0	
Indirect Costs Rate = 40%	$22,429	$22,998	$23,572	$24,161	$24,765	$117,925	
SUBTOTAL	$78,502	$80,492	$82,503	$84,564	$86,676	$412,737	
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	

Budget Category:	Proposed FY 27	Proposed FY 28	Proposed FY 29	Proposed FY 30	Proposed FY 31	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE	TEN YEAR TOTAL
Personnel	$44,823	$45,943	$47,092	$48,269	$49,476	$235,604		$443,842
Travel	$1,503	$1,539	$1,576	$1,614	$1,653	$7,885		$14,866
Contractual	$10,527	$10,790	$11,060	$11,336	$11,620	$55,333		$104,238
Commodities	$6,606	$6,771	$6,940	$7,114	$7,292	$34,722		$65,410
Equipment	$0	$0	$0	$0	$0	$0		$0
Indirect Costs Rate = 40%	$25,383	$26,017	$26,667	$27,333	$28,016	$133,417		$251,342
SUBTOTAL	$88,841	$91,061	$93,335	$95,667	$98,057	$466,961		$879,698
General Administration (9% of subtotal)	$7,996	$8,195	$8,400	$8,610	$8,825	$42,026	N/A	$79,173
PROJECT TOTAL	$96,837	$99,256	$101,736	$104,277	$106,882	$508,988		**$958,871**
Other Resources (In-Kind Funds)	$145,256	$148,884	$152,603	$156,416	$160,323	$763,481		**$1,438,307**

B. Sources of Additional Funding

Non-EVOSTC Funds to be used, please include source and amount per source:

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$128,351	$131,605	$134,892	$138,262	$141,715	$674,825
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$145,256	$148,884	$152,603	$156,416	$160,323	$763,481
				FY22-31 Total	***$1,438,307***

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 transects costs are:

The 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 7 of a 20-year commitment.

The Canadian DFO contributes $70k annually as well as in-kind support by providing laboratory facilities at the DFO lab in Sidney, BC.

The CPR Survey parent organization, the Marine Biological Association 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 EVOSTC fiscal year from each source have been estimated as best we can. Please see the attached letter from PICES (22120114-D_CPR-funding-PICES.pdf) describing the non-EVOSTC funds in more detail.

9. LITERATURE CITED

Arimitsu, M., J. Piatt, S. Hatch, R. Suryan, S. Batten, M. A. Bishop, R. Campbell, H. Coletti, D. Cushing, K. Gorman, R. Hopcroft, K. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, W. S. Pegau, A. Schaeffer, S. Schoen, J. Straley, and V. von Biela. 2021. Heatwave-induced synchrony within forage fish portfolio disrupts energy flow to top pelagic predators. Global Change Biology.

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. *Exxon Valdez* Oil Spill Trustee Council. Final Report.

Batten, S.D., and R. Brown. 2013. Long-term Monitoring of Plankton Populations on the Alaskan Shelf and in the Gulf of Alaska using Continuous Plankton Recorders. *Exxon Valdez* Oil Spill Trustee Council. Final Report.

Batten, S.D., and R. Brown. 2011. Long-term Monitoring of Plankton Populations on the Alaskan Shelf and in the Gulf of Alaska using Continuous Plankton Recorders. *Exxon Valdez* Oil Spill Trustee Council. Final Report.

Batten, S.D., and R. Brown. 2008. Long-term Monitoring of Plankton Populations on the Alaskan Shelf and in the Gulf of Alaska using Continuous Plankton Recorders. *Exxon Valdez* Oil Spill Trustee Council. Final Report.

Batten, S.D., and R. Brown. 2003. Long-term Monitoring of Plankton Populations on the Alaskan Shelf and in the Gulf of Alaska using Continuous Plankton Recorders. *Exxon Valdez* Oil Spill Trustee Council. Final Report.

Batten, S.D., C. Ostle, P. Helaouet, and A. Walne. submitted. Responses of Gulf of Alaska plankton communities to a marine heat wave. Deep-Sea Research Part II.

Batten, S.D., S. Moffitt, W.S. Pegau, and R. Campbell. 2016. Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fisheries Oceanography 25:420-432.

Batten, S.D., R.A. Clarke, J. Flinkman, G.C. Hays, E.H. John, A.W.G. John, T.J. Jonas, J.A. Lindley, D.P. Stevens, and A.W. Walne. 2003a. CPR sampling – The technical background, materials and methods, consistency and comparability. Progress in Oceanography 58:193-215.

Bishop, M.A., J.T. Watson, K. Kuletz, and T. Morgan. 2015. Pacific herring (Clupea pallasii) consumption by marine birds during winter in Prince William Sound, Alaska. Fisheries Oceanography 24:1–13.

DiLorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nature Climate Change 6, 1042.

Falkowski, P.G. 1998. Biogeochemical Controls and Feedbacks on Ocean Primary Production. Science, 281(5374):200-206.

Francis, R.C., and S.R. Hare. 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. Fisheries Oceanography 3:279-291.

HELCOM. 2012. HELCOM Heads of Delegation 39-2012. https://portal.helcom.fi/Archive/Shared%20Documents/HOD%2039-2012_Minutes%20of%20HELCOM%20HOD%2039%202012.pdf

Hoover, B.A., M. García-Reyes, S.D. Batten, C. Gentemann, and W. Sydeman. 2021. Spatio-temporal persistence of zooplankton communities in the Gulf of Alaska. PLOS ONE 16,e0244960.

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.

Litzow, M.A., M.E. Hunsicker, E.J. Ward, S.C. Anderson, J. Gao, S.G. Zador, S. Batten, S.C. Dressel, J. Duffy-Anderson, E. Fergusson, R.R. Hopcroft, B.J. Laurel, and R. O'Malley. 2020. Evaluating ecosystem change as Gulf of Alaska temperature exceeds the limits of preindustrial variability. Progress in Oceanography 186, 102393.

Okkonen, S.R., T.J. Weingartner, S.L. Danielson, and D.L. Musgrave. 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.

Pinchuk, A.I., S.D. Batten, and W.W. Strasburger. 2021. Doliolid (Tunicata, Thaliacea) blooms in the southeastern Gulf of Alaska as a result of the recent heat wave of 2014-2016. Frontiers in Marine Science 8, 159.

Raitsos, D.E., A. Walne, S.J. Lavender, P. Licandro, P.C. Reid, and M. Edwards. 2013. A 60-year ocean colour data set from the Continuous Plankton Recorder. Journal of Plankton Research 35:158-164.

Reid, P.C., R.E. Hari, G. Beaugrand, D.M. Livingstone, C. Marty, D. Straile, … and Z. Zhu. 2016. Global impacts of the 1980s regime shift. Global Change Biology, 22:682-703.

Richardson, A. J. 2008. In hot water: zooplankton and climate change. ICES Journal of Marine Science 65:279-295.

Royer, T.C. 1979. On the effect of precipitation and runoff on coastal circulation in the Gulf of Alaska. Journal of Physical Oceanography. 9:555-563.

Stabeno, P.J., N.A. Bond, A.J. Hermann, N.B. Kachel, C.W. Mordy, and J.E. Overland. 2004. Meteorology and oceanography of the Northern Gulf of Alaska, Continental Shelf Research, 24:859-897.

Suryan, R. M., M. L. Arimitsu, H. A. Coletti, R. R. Hopcroft, M. R. Lindeberg, S. J. Barbeaux, S. D. Batten, W. J. Burt, M. A. Bishop, J. L. Bodkin, R. Brenner, R. W. Campbell, D. A. Cushing, S. L. Danielson, M. W. Dorn, B. Drummond, D. Esler, T. Gelatt, D. H. Hanselman, S. A. Hatch, S. Haught, K. Holderied, K. Iken, D. B. Irons, A. B. Kettle, D. G. Kimmel, B. Konar, K. J. Kuletz, B. J. Laurel, J. M. Maniscalco, C. Matkin, C. A. E. McKinstry, D. H. Monson, J. R. Moran, D. Olsen, W. A. Palsson, W.

S. Pegau, J. F. Piatt, L. A. Rogers, N. A. Rojek, A. Schaefer, I. B. Spies, J. M. Straley, S. L. Strom, K. L. Sweeney, M. Szymkowiak, B. P. Weitzman, E. M. Yasumiishi, and S. G. Zador. 2021. Ecosystem response persists after a prolonged marine heatwave. Scientific Reports 11:6235 https://www.nature.com/articles/s41598-021-83818-5.

Suryan, R. M., M. L. Arimitsu, H. A. Coletti, R. R. Hopcroft, M. R. Lindeberg, S. J. Barbeaux, S. D. Batten, W. J. Burt, M. A. Bishop, J. L. Bodkin, R. E. Brenner, R. W. Campbell, D. A. Cushing, S. L. Danielson, M. W. Dorn, B. Drummond, D. Esler, T. Gelatt, D. H. Hanselman, S. A. Hatch, S. Haught, K. Holderied, K. Iken, D. B. Iron, A. B. Kettle, D. G. Kimmel, B. Konar, K. J. Kuletz, B. J. Laurel, J. M. Maniscalco, C. Matkin, C. A. E. McKinstry, D. H. Monson, J. R. Moran, D. Olsen, W. A. Palsson, W. S. Pegau, J. F. Piatt, L. A. Rogers, N. A. Rojek, A. Schaefer, I. B. Spies, J. M. Straley, S. L. Strom, K. L. Sweeney, M. Szymkowiak, B. P. Weitzman, E. M. Yasumiishi, and S. G. Zador. 2021. Ecosystem response persists after a prolonged marine heatwave. Scientific Reports.

Tett, P., R. Gowen, D. Mills, T. Fernandes, L. Gilpin, M. Huxham, … and S. Malcolm. 2007. Defining and detecting undesirable disturbance in the context of marine eutrophication. Marine Pollution 55:282-297.

Weingartner, T.J., S.L. Danielson, and T.C. Royer. 2005 Freshwater variability and predictability in the Alaska Coastal Current, Deep Sea Research Part II: Topical Studies in Oceanography 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, and S. Strom. 2002. The Northeast Pacific GLOBEC Program: Coastal Gulf of Alaska. Oceanography 15:48-63.

10. PROJECT PERSONNEL

Dr. CLARE OSTLE
Mail address: The Marine Biological Association,
The Laboratory, Citadel Hill, Plymouth,
Devon, PL1 2PB, UK
email: claost@mba.ac.uk

EMPLOYMENT

- ⇒ 2020-*present* · Coordinator Pacific CPR survey, Marine Biological Association, Plymouth, UK.
- ⇒ 2019-*2020* · Research Scientist CPR survey, Marine Biological Association, Plymouth, UK.
- ⇒ 2017-2019 · Research Fellow. SAHFOS/MBA, Plymouth, UK.
- ⇒ 2016-*2017* · Postdoctoral Research Associate. SAHFOS, Plymouth, UK.
- ⇒ 2015-2016 · Senior Research Associate. The University of East Anglia & Cefas, Norwich, UK.
- ⇒ *2007-2011* · Production Assistant. English Language Teaching dep., Oxford University Press.

EDUCATION

- ⇒ *Ph.D. 2011-2015,* The University of East Anglia (UEA), School of Environmental Sciences, Norwich, UK · Thesis: How does plankton distribution and activity influence the variability of carbon dioxide uptake in the North Atlantic? Supervisors: Carol Robinson (UEA), Martin Johnson (UEA, Cefas), Ute Schuster (Exeter), Martin Edwards (SAHFOS), Andrew Watson (Exeter) · Examiners: Stephanie Henson, Corinne Le Quéré
- ⇒ *B.Sc. Marine Biology, 2008-2011,* Swansea University, School of Biological Sciences, Swansea, UK · *First Class Honours* · Dissertation: *Calanus finmarchicus* and *Calanus helgolandicus* abundance in the northeast Atlantic region from 1958-2009.

RESEARCH INTERESTS

Clare specialises in marine biogeochemistry, data integration, and data analysis. Clare has worked with the Continuous Plankton Recorder (CPR) dataset since 2011. In particular, her interest's lie in looking at the plankton community influence on the marine carbonate system and *vice versa*. She also has experience in estimating net community production using oxygen optodes on-board volunteer ships, and is interested in the possibilities of instrument development and sampling enhancements for the CPR. Clare has been involved in a number of syntheses reports, ranging from topics such as the operationalization of ecological indicators for European marine policy, ocean warming, ocean acidification and marine plastics. In 2020 Clare became the co-ordinator of the Pacific CPR survey.

10 RECENT PUBLICATIONS

- ⇒ Bedford, J., **Ostle, C**., Johns, D. G., et al. (2020). Lifeform indicators reveal large-scale shifts in plankton across the North-West European shelf**.** *Global Change Biology. https://doi.org/10.1111/gcb.15066*
- ⇒ Bedford, J., **Ostle, C**., Johns, D. G., Budria, A., & Mcquatters-gollop, A. (2020). The influence of temporal scale selection on pelagic habitat biodiversity indicators. *Ecological Indicators*, *114*. https://doi.org/10.1016/j.ecolind.2020.106311.

⇒ Edwards, M., Atkinson, A., Bresnan, E., Helaouet, P., McQuatters-Gollop, A., **Ostle, C.,** … Widdicombe, C. (2020). Plankton, jellyfish and climate in the North-East Atlantic. *MCCIP*, 322–353. https://doi.org/10.14465/2020.arc15.plk

⇒ Batten, S. D., Abu-Alhaija, R., Chiba, S., Edwards, M., Graham, G., Jyothibabu, R., J. A. Kitchener, P. Koubbi, A. McQuatters-Gollop, E. Muxagata, **C. Ostle**, et al. (2019). A Global Plankton Diversity Monitoring Program. *Frontiers in Marine Science*. https://doi.org/10.3389/fmars.2019.00321.

⇒ **Ostle C.,** R. Thompson, D. Broughton, L. Gregory, M. Wootton, D. Johns, (2019). The rise in ocean plastics evidenced from a 60-year time series*. Nature Communications.* doi.org/10.1038/s41467-019-09506-1.

⇒ Mcquatters-gollop A., A. Atkinson, A. Aubert, J. Bedford, M. Best, E. Bresnan, K. Cook, M. Devlin, R. Gowen, D. Johns, M. Machairopoulou, A. Mckinney, A. Mellor, **C. Ostle,** C. Scherer, P.Tett. (2019) Plankton lifeforms as a biodiversity indicator for regional-scale assessment of pelagic habitats for policy. *Ecological Indicators.* 10.1016/j.ecolind.2019.02.010.

⇒ Edwards, M., Helaouet, P., **Ostle, C.**, Johns, D., Wootton, M., Strand, E., & Espen Bagoien. (2019). *The Continuous Plankton Recorder Survey – Monitoring plankton in the Nordic Sea (CPR Survey)*. The State of Environmental Science in Svalbard Report 2019.

⇒ Hartman, S. E., Humphreys, M. P., Kivimäe, C., Woodward, E. M. S., Kitidis, V., … **Ostle, C.**, … Nightingale, P. (2018). Seasonality and spatial heterogeneity of the surface ocean carbonate system in the northwest European continental shelf. *Progress in Oceanography*. https://doi.org/10.1016/j.pocean.2018.02.005

⇒ **Ostle, C**., Williamson, P., Artioli, Y., Bakker, D. C. E., Birchenough, S., Davis, C. E., … Watson, A. J. (2016). *Carbon dioxide and ocean acidification observations in UK waters*. *Synthesis report with a focus on 2010 - 2015* (Vol. 1). https://doi.org/10.13140/RG.2.1.4819.4164

⇒ **Ostle, C**., Johnson, M., Landschützer, P., Schuster, U., Hartman, S., & Robinson, C. (2015). Net community production in the North Atlantic Ocean derived from Volunteer Observing Ship data. *Global Biogeochemical Cycles*. 10.1002/2014GB004868

RESEARCH SUPERVISION

Ph.D: Co-supervisor of Guillaume Signoret - Accelerating sea temperature growth and intensified pole-ward heat transfer: global and regional risk implications.

RECENT COLLABORATORS

Through her new role (2020) as Pacific CPR co-ordinator Clare is looking forward to setting up fruitful collaborations. Clare has been leading the set up and funding of new CPR routes within the Arctic Ocean surrounding Alaska and Canada through the BEIS UK-Canada Arctic Bursary programme since 2018, developing the following collaborators: Batten Sonia, PICES, Canada, Chiba, Sanae JAMSTEC, Japan, Pegau, Scott, PWSSC, USA, Nelson, John, DFO, Canada, Melling, Humfrey, DFO, Canada, Jon, Fisher, Marine Institute, Newfoundland, Canada, Hunt, Brian, UBC, Canada, Naviaux, Robert, UCSD, USA, Helaoet, Pierre, Marine Biological Association, UK, McQuattors-Gollop, Abigail, University of Plymouth, UK, Ferriss, Bridget, NOAA, USA, Nielson, Jens, NOAA, USA, Oritz, Ivonne, NOAA, USA

Sonia Dawn Batten Ph.D.

North Pacific Marine Science Organization (PICES)
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Email: **sonia.batten@pices.int**

Qualifications

1990–1994. PhD. Marine Biology. 'Correlative studies of the ecophysiology and community structure of benthic macrofauna' Southampton University, UK.

1987–1990. BSc. Honours Degree in Oceanography with Biology, 2(i). Southampton University, UK

Career History

April 2000 to present. Executive Secretary, North Pacific Marine Science Organization (PICES)

2000 to April 2020. Research Fellow and Director of the North Pacific CPR Survey. Initially with the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) until their merger with the Marine Biological Association, UK and then subsequently with the CPR Survey at the MBA

2003 and 2004. Temporary Instructor, Malaspina University College, BC, Canada, Fisheries and Aquaculture program.

1996–2000. Assistant Director. SAHFOS, UK

1994–1996. Postdoctoral Research Fellow. SAHFOS, UK

Recent, Relevant Publications

- Arimitsu, M., J. Piatt, S. Hatch, R. Suryan, S. **Batten**, M. A. Bishop, R. Campbell, H. Coletti, D. Cushing, K. Gorman, R. Hopcroft, K. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, W. S. Pegau, A. Schaeffer, S. Schoen, J. Straley, and V. von Biela. (2021) Heatwave-induced synchrony within forage fish portfolio disrupts energy flow to top pelagic predators. Global Change Biology In Press.
- Pinchuk, A.I., **Batten,** S.D., and Strasburger, W.W. (2021), Doliolid (Tunicata, Thaliacea) blooms in the southeastern Gulf of Alaska as a result of the recent heat wave of 2014-2016. Frontiers in Marine Science, 8, 159. DOI=10.3389/fmars.2021.625486
- Hoover, B.A., García-Reyes, M., Batten, S.D., Gentemann, C., and Sydeman, W. (2021). Spatio-temporal persistence of zooplankton communities in the Gulf of Alaska. PLoS ONE 16(1): e0244960. https://doi.org/10.1371/journal.pone.0244960
- Litzow, M. A. Hunsicker, M.E., Ward, E.J., Anderson, S.C., Gao, J., Zador, S.G., **Batten, S**., Dressel, S.C., Duffy-Anderson, J., Fergusson, E., Hopcroft,, R.R., Laurel, B.J., O'Malley, R. (2020). Evaluating ecosystem change as Gulf of Alaska temperature exceeds the limits of preindustrial variability, Progress in Oceanography, 186,102393, ISSN 0079-6611 https://doi.org/10.1016/j.pocean.2020.102393.
- Espinasse, B., Hunt, B.P.V., **Batten**, S.D., and Pakhomov, E. (2019). Defining isoscapes in the Northeast Pacific as an index of ocean productivity. Global Ecology and Biogeography. DOI: 10.1111/geb.13022.
- Stern, R., Moore, S. K., Trainer, V. L., Bill, B. D., Fischer, A., & **Batten, S**. (2018). Spatial and temporal patterns of *Pseudo-nitzschia* genetic diversity in the North Pacific Ocean from the

Continuous Plankton Recorder survey. Marine Ecology Progress Series, 606, 7-28. Doi:10.3354/meps12711

- **Batten**, S.D., Ruggerone, G.T. and Ortiz, I. (2018). Pink Salmon induce a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands. Fisheries Oceanography. https://doi.org/10.1111/fog.12276
- **Batten**, S.D., Raitsos, D.E., Danielson, S.,Hopcroft, R.R., Coyle, K. and McQuatters-Gollop, A. (2018). Interannual variability in lower trophic levels on the Alaskan Shelf. Deep Sea Research II. 147, 58-68.
- **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.

Collaborators during the last 4 years (excludes Gulf Watch PIs)

Anderson, S. (Fisheries and Oceans Canada)
Bill, B. (NOAA)
Coyle, K. (University of Alaska)
Dressel, S. (ADF&G)
Duffy-Anderson, J. (NMFS)
Espinasse, B. ((University of British Columbia)
Fergusson, E. (NMFS)
Fischer, A. (Marine Biological Association)
Gao, J. (NMFS)
Garcia-Reyes, M. (Farallon Institute)
Gentemann, C., (Farallon Institute)
Helaouet, P. (Marine Biological Association)
Hoover, B. (Farallon Institute)
Hunsicker, M. (NMFS)
Hunt, B. (University of British Columbia)
Johns, D. (Marine Biological Association)
Kroeger, C. (Farallon Institute)
Laurel, B. (NMFS)
Litzow, M (University of Alaska)
McQuattors-Gollop, A. (University of Plymouth)
Moore, S. (NOAA)
O'Malley, R. (Oregon State University)
Ortiz, I (university of washington)
Ostle, C. (Marine Biological Association)
Pakhomov, E. (University of British Columbia)
Perry, I (Fisheries and Oceans Canada)
Pinchuk, A. (University of Alaska)
Raitsos, D. (KAUST)
Ruggerone, G. (Natural resources Consultants)
Sastri, Akash (Fisheries and Oceans Canada)
Stern, R. (Marine Biological Association)
Strasburger, W. (NOAA)
Sydeman, W. (Farallon Institute)
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Zador, S. (NMFS)

The Marine Biological Association
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21st of June 2021

To: Mandy Lindeberg - NOAA, GWA-LTRM Program Lead
Katrina Hoffman - PWSSC, President and CEO
Shiway Wang, EVOSTC Executive Director

Re: Letter of Commitment from the Marine Biological Association

The Marine Biological Association (MBA), who hosts the Continuous Plankton Recorder (CPR) Survey, are pleased to provide this letter of commitment for the proposed project "*20120114-D Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf*", led by principal investigator (PI), Dr. Clare Ostle. This proposal was drafted by the PI in response to the EVOSTC's FY22-31 Invitation for Proposals and subsequent request for final submission on August 13, 2021. The cost for this project over a ten-year period will be $879 K (without EVOSTC GA). This includes some non-EVOSTC funds that are in-kind contributions we support totaling an estimated $1,438 K for the life of the project (e.g., salaries of permanent staff, field travel, contracts, commodities, and equipment use).

This project proposal is part of the larger multi-agency Gulf Watch Alaska Long-Term Research and Monitoring (GWA-LTRM) program proposal package. This package represents a continued commitment of the successful long-term research and monitoring projects supported by the EVOSTC and various agencies and organizational investments since 2002.

Yours sincerely,

Professor William H Wilson FMBA
Director