Demonstrating Operational Readiness of AUV-Based Ecosystem Monitoring Through a Field Program Supporting the International Year of the Salmon

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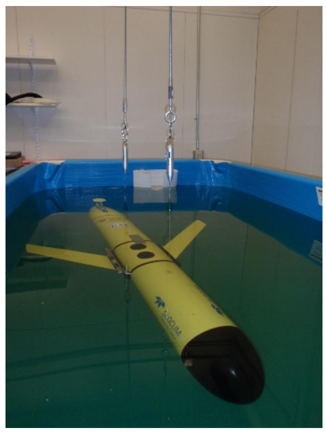

Figure 1: Slocum glider being checked out in tank at University of Alaska Fairbanks.

Pacific salmon spend most of their life history within the rapidly changing North Pacific Ocean (NPO). To successfully manage salmon and other ecosystem components, it is critical to account for biological responses to changing environmental conditions and to understand the physical mechanisms that cause these changes. The high latitude NPO is quickly warming. Recent anomalous warming in the Gulf of Alaska (GOA) has been linked to phytoplankton and zooplankton community shifts, reductions in Pacific salmon returns to coastal regions, a large die-off of marine birds, collapse of Pacific cod stocks and subsequent closures of commercial fisheries. Winter is a critical period for salmon growth and survival as prey resources decline and salmon species and stocks from around the North Pacific interact, potentially increasing competition for food and reducing growth among species and stocks. However, winter is a time when traditional research surveys are not conducted and less is known about salmon distributions, feeding activity, and interactions.

With funding and logistic support from the NOAA Office of Marine & Aviation Operations (OMAO) UxS Operation Center, scientists from the NOAA Fisheries, University of Alaska Fairbanks, and the University of Washington are expanding the sampling capability of a Slocum autonomous underwater glider (Figure 1) to provide *in situ* ecosystem monitoring in support of NOAA's International Year of the Salmon (IYS) winter Gulf of Alaska (GOA) field survey during 2022 (Figure 2). Sampling from instruments housed in the glider will concurrently occur with ship-based measurements and net collections of fishes and zooplankton. The glider sensors measure physical, chemical, and biological parameters to characterize water properties, its structure, bio-optical measures of water quality, and acoustic density of aquatic organisms (i.e. backscatter). To enable near-real-time transmission of high-bandwidth acoustic data from the glider, on-board processing of acoustic backscatter data enables transmission of summary metrics that characterizes fish biomass and their distribution throughout the water column.

These metrics are relevant to NOAA Fisheries ecosystem-based fishery management (EBFM) for sustainable fisheries. EBFM requires an understanding of both commercial, marine mammal, and non-commercial fishes and invertebrate species' life histories, distributions, population abundances, and interactions with the environment. For the GOA, this requires improved field observations utilizing new technologies, including uncrewed vehicles, innovative instrumentation, and expansion of traditional sampling on ships.

Through the project we will be able to provide automated data collection, processing, and near-real-time internet availability of results in a custom web-based *Ecometrics Dashboard* interface hosted by the Alaska Ocean Observing System (Figure 3). Resource managers and other stakeholders will be able to easily access real-time information on the state of the ecosystem. Using a glider rated for deployment depths of up to 1000m, our observations will complement and expand the upper ocean measurements made by the Argo profiling float array from the open ocean to coastal waters. The emerging capacity to conduct high resolution, largely automated, and rapid habitat assessments will greatly improve scientists' ability to understand and address pressing management issues in this rapidly changing northern ecosystem.

The goal is to demonstrate that an ecosystem monitoring underwater glider can supplement and/or replace many components of vessel-based surveys; be deployed when staffed vessel platforms may have limited availability; and be used operationally for long-term monitoring of high latitude environments.

This project is a partnership between NOAA Fisheries (Edward Farley), University of Alaska Fairbanks (Seth Danielson & Hank Statscewich), University of Washington (John Horne), the Alaska Ocean Observing System (Molly McMammon) and Axiom Data Science (Stacey Buckelew & Kyle Wilcox). The Slocum autonomous underwater vehicle (AUV) used for remote sensing of the Gulf of Alaska ecosystem metrics includes a SeaBird CTD, Wetlabs optic sensors, Rinko quick response dissolved oxygen sensor, Simrad WBTmini echosounder, and an ES200-7CDK splitbeam transducer (Figure 4).

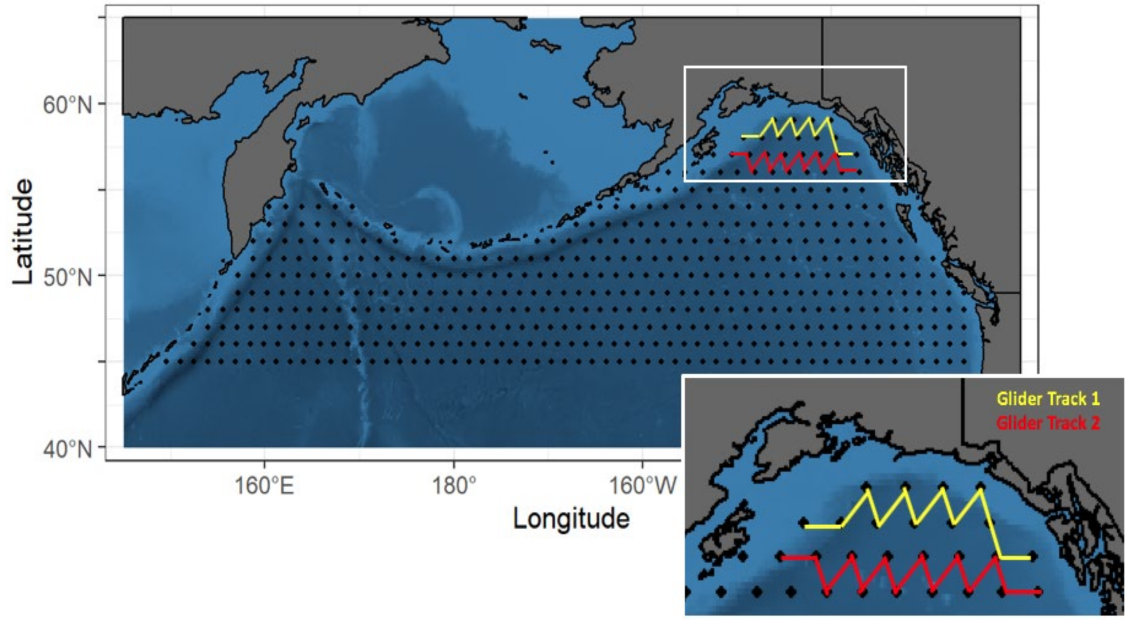

Figure 2: The International Year of the Salmon (IYS) 4-vessel winter survey grid (black dots) planned for winter 2022. Two proposed Gulf of Alaska AUV surveys are shown in yellow and red, with 1400 and 1600 km track lines, respectively. Field operations are proposed to take place in February to April 2022.

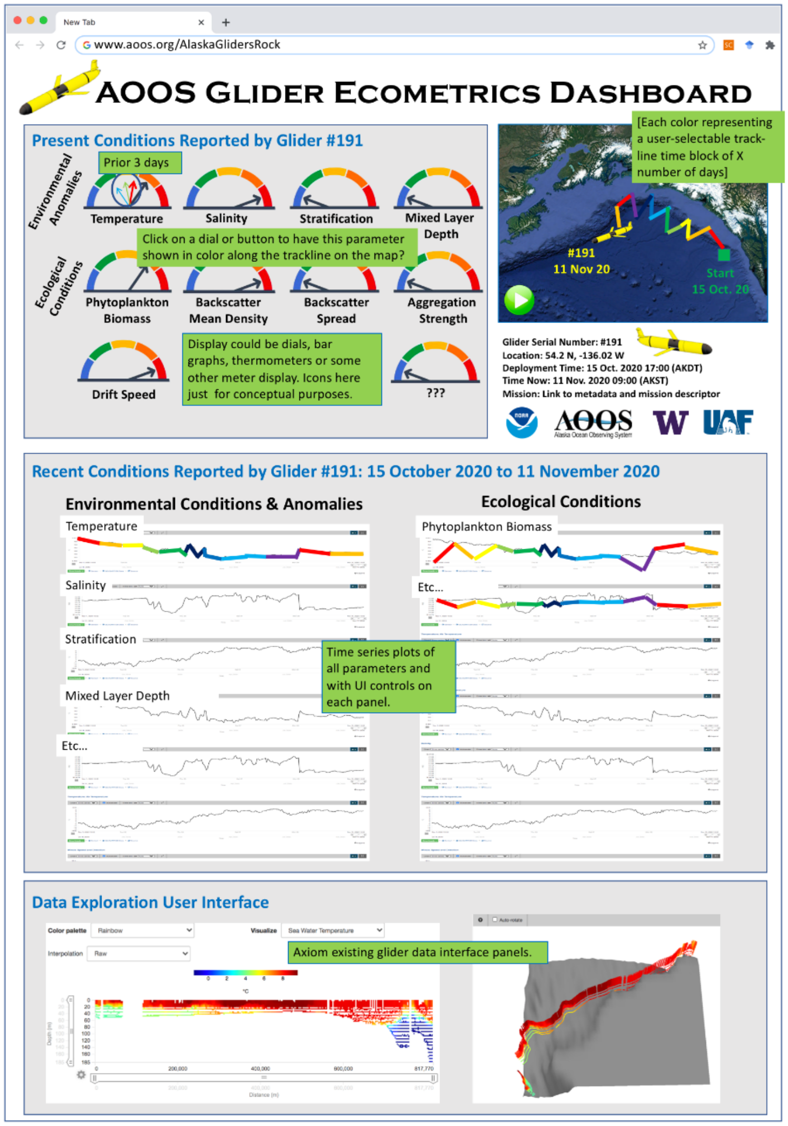

Figure 3: Example Ecometrics Dashboard that would display near-real-time oceanographic metrics with user interface (UI) and other controls to compare with historic information.

Figure 4: Hank Statscewich (University of Alaska Fairbanks), describes the Slocum glider to an audience gathered on the Auke Bay dock in Juneau, Alaska.