

EVOS Annual Progress Report

Project Number: # 10100132-E

Project Title: PWS Herring Survey: Physical Oceanographic Characteristics of Nursery Habitats of Juvenile Pacific Herring

PI Name: Shelton Gay - PWSSC

Time Period Covered by Report: March- August 2010

Date of Report: Sept. 4, 2008

Work Performed: Two oceanographic cruises were conducted in March and August 2010 respectively to deploy and retrieve moorings within Simpson Bay, Eaglek Bay, Whale Bay and Zaikof Bay (Fig. 1). During these cruises profiles of temperature (T), salinity (S), Fluorescence (F), Turbidity (Tb), and Nitrates (in August) were also collected using an SB19 plus CTD. The initial results of the March cruise were reported in May and submitted at that time to Scott Pegau of PWSSC. These same results were also included in a final report submitted recently to Peter Hagen of NOAA, closing the first herring research program entitled: *Physical Oceanographic Factors Affecting Productivity in Juvenile Pacific Herring Nursery Habitats*. In August, a calibration of the compass on the 150 kHz ADCP was also performed on the M/V Auklet in order to adjust the directions of currents measured using this vessel in 2008. The present report mainly addresses the results of the first mooring deployments in 2010 and the CTD casts performed recently in August. Some minor problems encountered in the mooring deployments are also discussed. Each of these research segments is described in greater detail below.

Mooring Cruises

The initial cruise to deploy the CT moorings was conducted from March 16th to March 21st, and the deployment parameters including locations, sensor types, depths and programming are listed in Tables 1 and 2. The second cruise was conducted from August 9th to August 12th. At this time the sensors were uploaded and moorings were redeployed at the same locations, but with some minor modifications to mitigate problems encountered in the near-surface (2m) CTs involving excessive growth of algae, mussels and barnacles, etc (Fig. 2). To counter these effects all near-surface SB16.03 sensors were replaced with SB37 microcats, which have antifouling cells recessed within the instrument housing, and the sensors were redeployed at 5m. Past experience has shown that subsurface buoys at this depth encounter significantly less marine growth in comparison to surface buoys and instruments suspended just below them. Also, since the moorings were redeployed at the end of summer the problems with fouling at this depth should be negligible. One solution to this problem may involve wrapping the entire near-surface microcats with copper tape and continuing this tape up the mooring line to prevent algal growth from hanging down over the sensors. This should allow near-surface deployments in the future.

The initial results of the near-surface and deep sensors are shown in Figures 3a,b and c,d for the shallow and deep fjords respectively. These time series reveal T/S variation in all basins at frequencies ranging from seasonal warming and freshening (i.e. fundamental) to tidal excursions and meteorological effects at frequencies close to the Nyquist interval (i.e. $2\Delta t = 1$ hr). The variation at intermediate frequencies in the near-surface sensors, however, appears to differ significantly among fjords, with periods of cooling and salinification followed by warming and freshening. The periods of these cycles appear to be ≤ 2 week (i.e. fortnightly) intervals and are possibly related to advection occurring during spring-neap tidal cycles or large scale meteorological events. The magnitude of these signals is highly suppressed in all of the deep sensors, except Eaglek Bay, which exhibits relatively large fluctuations at near fortnightly intervals. In contrast, Whale exhibits only one such event late in the deployment in early to mid July, and Simpson and Zaikof exhibit highly suppressed signals mainly only in temperature over the entire time series. The T/S conditions in both of the shallow fjords appear to reflect a semi-isolation of their inner basins due to the presence of sills and constrictions, whereas deep events at Whale and Eaglek may be related to periods of water exchange. This was most evident at Whale in which a consistent increase in T/S properties occurs late in the deployment. The variation in frequencies and amplitudes of the intermediate signals among the four fjords will become even more apparent after advanced statistical tests are performed on the de-trended data such as periodograms and integral time scale analysis.

Hydrography in August 2010

The results of the CTD casts performed in August 2010 are shown for the shallow and deep fjords in Figures 4 and 5 respectively. These data show that the profiles of T/S properties differ significantly among the four fjords. At Zaikof Bay thermal and haline stratification is relatively low, as observed in previous years, but the variation in temperature profiles across the mouth is extreme possibly due to the convergence of ACC water within Hinchinbrook Entrance with water inside the fjord. All of these profiles show evidence of subsurface mixing, however, which is likely related to high current shear at the mouth and outer basin (Gay and Vaughan, 2001). The inner basins at both Simpson and Zaikof show evidence of semi-isolation, just as observed in the T/S time series and in previous years. In contrast to the two shallow fjords, Whale and Eaglek exhibit subsurface temperature minima and maxima indicating effects of subsurface glacial water in their outer basins and mouths. These same features of temperature are not evident at Zaikof, but at the mouth of Simpson there are minor minima and maxima possibly due to glacial water advected from the Rude River into the outer basin (Gay, 2010). Whale exhibits relatively high haline stratification throughout its basin, but the magnitude of the subsurface temperature minima within the main basin and mouth indicates that this fjord in 2010 was subjected to an unprecedented amount of glacial advection from Icy Bay (Gay and Vaughan, 2001; Gay, 2010). In contrast, the T/S properties at the mouth of Eaglek show a mixed layer within the upper 5m and a marked influence of subsurface glacial water, most likely from Uakwik Inlet (Gay and Vaughan, 2001). Unfortunately, the vertical T/S profiles within Eaglek's main and inner basin are not shown due to an oversight that resulted in a deletion of these casts before they were uploaded from the SB19 profiler.

ADCP Calibration

In addition to the above work, the direct reading 150 kHz ADCP used in 2008 aboard the M/V Auklet was calibrated using the methods of Munchow et al. (1995). The calibration was conducted by performing a series of transects forming a polygon that gradually enclosed a circle within the main basin at Whale Bay. These data will be used to adjust the flow directions of currents measured in 2008 by deriving a least squares regression between directions determined by GPS and the ADCP flux-gate compass. In addition to the calibrations, a series of regular transects were conducted during an ebb tide. Although the directions of these currents were unadjusted, the flow patterns indicated that convergence of glacial water was occurring within the lower main basin as observed in the past (Gay and Vaughan, 2001) and in the hydrography in August 2010 described above.

Future Work: Future research objectives include continued deployment of CT moorings in the four SEA fjords and the possibility of expanding this work to additional sites. The latter will depend on the results of the juvenile herring acoustic and aerial surveys (see below). Hydrographic data will also continue to be collected with a SB19 plus CTD profiler during all mooring cruises and during collaborative work described below

Coordination/Collaboration: A coordination and collaboration with other projects included T/S profiles collected during both the EVOS sponsored cruises conducted by R. Campbell and R. Thorne. Also, future coordination of collecting hydrographic profiles during aerial herring surveys is being discussed with Evelyn Brown.

Community Involvement/TEK & Resource Management Applications:

During the 2010 field season, community involvement was limited to contracting or renting vessels for use in the intensive physical surveys of the four SEA fjords. Resource management applications are not applicable at this time.

Information Transfer: No publications or presentations were scheduled during the 2010 summer field season. However, presentation of results of the first research program were given at the AGU Ocean Sciences meeting in January 2010 in Portland, OR, and a final report was submitted in early September. In addition, the new data collected in 2010 will be analyzed for inclusion in my PhD dissertation, which will be written in part over the 2010 budget year. The dissertation will serve as an additional final report for this project in 2010.

Budget: No changes to the original budget are expected for fiscal year 2011.

Signature of PI: _____

References

Gay, S.M. III and S.L. Vaughan (2001). Seasonal hydrography and tidal currents of bays and fjords in Prince William Sound, Alaska. *Fish. Oceanogr.* 10 (Suppl. 1), 159-193

Gay, S.M. III. 2010. Physical Oceanographic Factors Affecting Productivity in Juvenile Pacific Herring Nursery Habitats. *Exxon Valdez Oil Spill Restoration Project Final Report (Project 070817)*. Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574

Munchow, A., Coughran, M.C., Hendershott, M.C. and Winant, C.D. (1995) Performance and calibration of an acoustic Doppler current profiler towed below the surface. *J. Atmos. Oceanic Techn.* **12**, 2:435-444.

Table 1. March 2010 Herring Survey: CTD Mooring Deployment Parameters

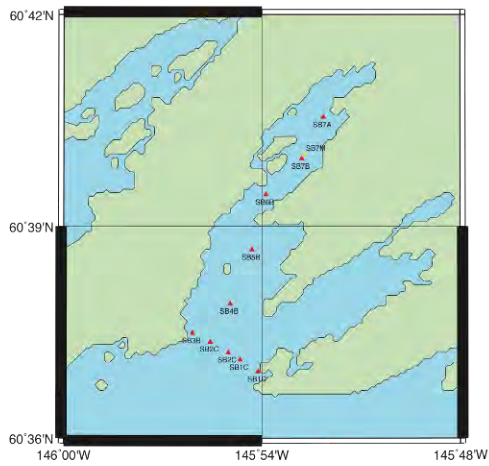
<u>Location</u>	<u>Mooring</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m)</u>	<u>Date</u>	<u>Time</u>	<u>Tide Stage</u>	<u>Max Mooring Length (m)</u>
Simpson	SB7m	60 40.300	145 52.753	56.9	16-Mar	17:00	Ebb (+2.25hr)	70
Eaglek	EGB16m	60 55.455	147 44.332	63.5	19-Mar	20:10	Ebb (+3.6hr)	75
Whale	WB13m	60 9.802	148 11.922	86.5	20-Mar	18:35	Ebb (+1.5hr)	92
Zaikof	ZB13m	60 16.438	147 4.564	42.7	21-Mar	7:00	Ebb (+2.25hr)	54

Table 2. March 2010 Herring Survey: CTD Mooring Instrument List

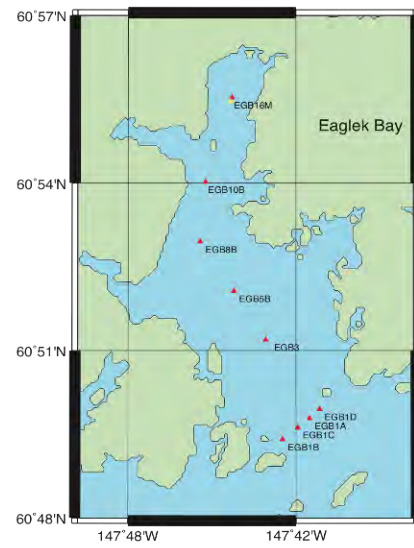
<u>Mooring</u>	<u>Station</u>	<u>Instruments:</u>							
		<u>Type</u>	<u>Serial No.</u>	<u>Approx. * Depths (m)</u>	<u>Start Time</u>	<u>Sample Interval (s)</u>	<u>Press. Sensor (Y/N)</u>	<u>Ref. Press (db)</u>	<u>Salinity Output (Y/N)</u>
Simpson	SB7m	SB16.03	#513	2.3	15:00:00	1800	N	n/a	n/a
		HoBo TB		10-15	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		20-25	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		30-35	12:00:00	1800	n/a	n/a	n/a
		SB37	#5360	40-45	14:00:00	1800	Y	n/a	Y
Eaglek	EGB16m	SB16.03	#531	2.3	12:00:00	1800	N	n/a	n/a
		HoBo TB		10-15	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		20-25	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		30-35	12:00:00	1800	n/a	n/a	n/a
		SB37	#4148	50-55	14:00:00	1800	N	50.0	Y
Whale	WB13m	SB16.03	#528	2.3	13:00:00	1800	N	n/a	n/a
		HoBo TB		10-15	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		20-25	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		30-35	12:00:00	1800	n/a	n/a	n/a
		HoBo TB		50-55	12:00:00	1800	n/a	n/a	n/a
Zaikof	ZB13m	SB37	#4149	2.3	5:30:00	1800	n/a	2.0	n/a
		HoBo TB		10-15	5:00:00	1800	n/a		n/a
		HoBo TB		20-25	5:00:00	1800	n/a		n/a
		SB37	#3079	30-35	-03:43:00	1800	N	30.0	Y

* The approximate depths are based only the tidal prism. The actual ranges will be slightly higher due to depression caused by currents

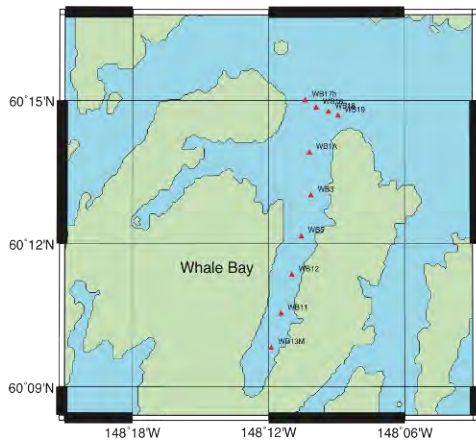
a) CTD Stations Simpson Bay August 2010



b) CTD Stations Eagle Bay August 2010



c) CTD Stations for Whale Bay August 2010



d) Zaikof Bay CTD Stations August 2010

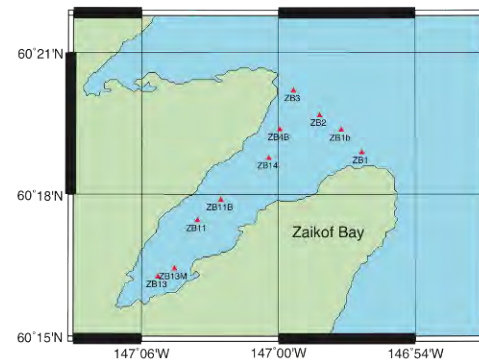


Fig. 1. Locations of oceanographic stations and CT moorings within the four SEA herring nurseries in August 2010

A



B



C



D



Fig. 2. Photos from the mooring cruise conducted in August 2010. a) near-surface CT (2m depth) showing fouling accumulated over the summer; b) vessel-mounted 150 kHz ADCP being calibrated during the cruise within Whale Bay; c) mooring preparation for re-deployment; SB37 microcat replacing the near-surface SB16 and placed at 5m depth.

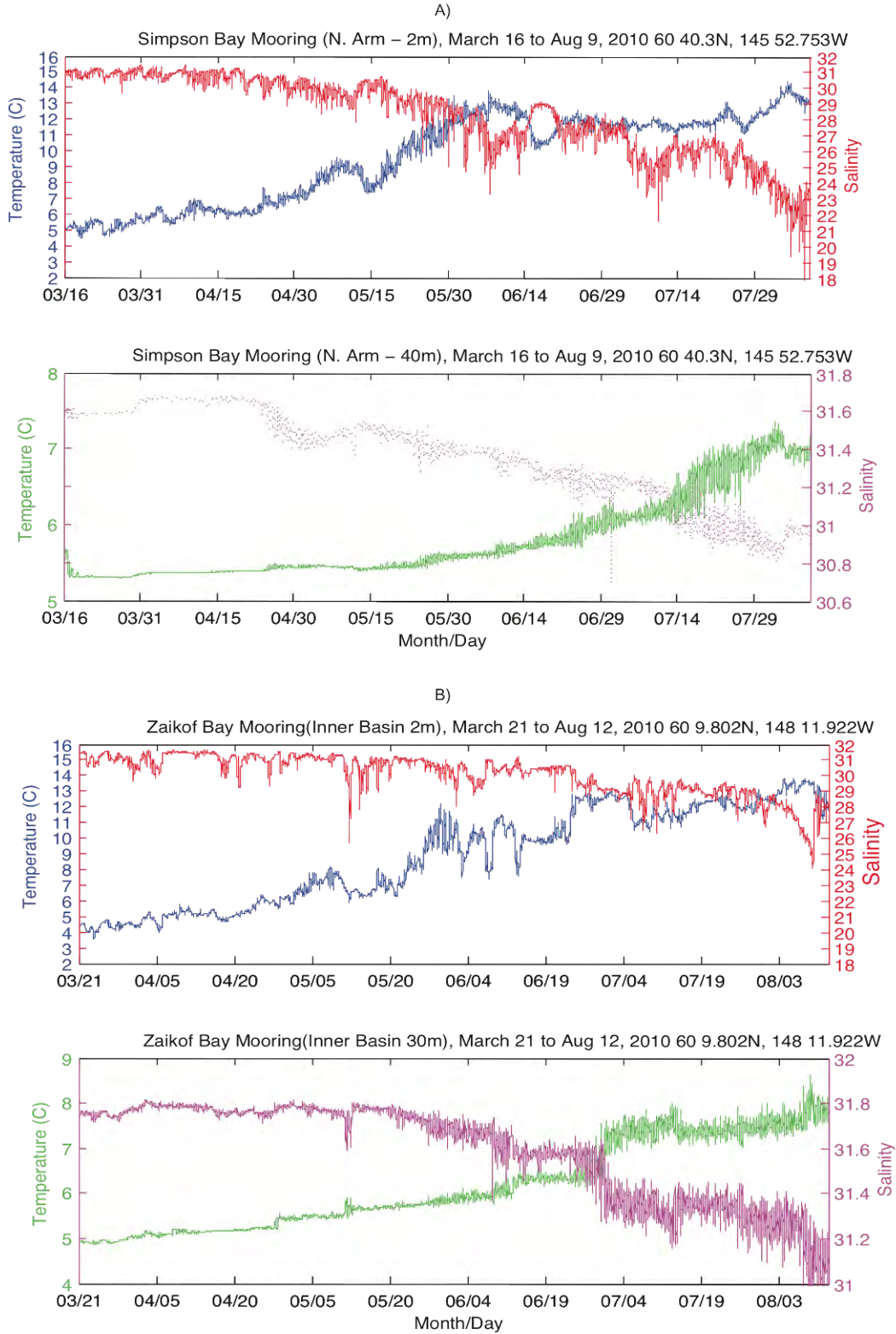


Fig. 3. Time series of temperature and salinity from March to August 2010. A) Simpson Bay, B) Zaikof Bay,

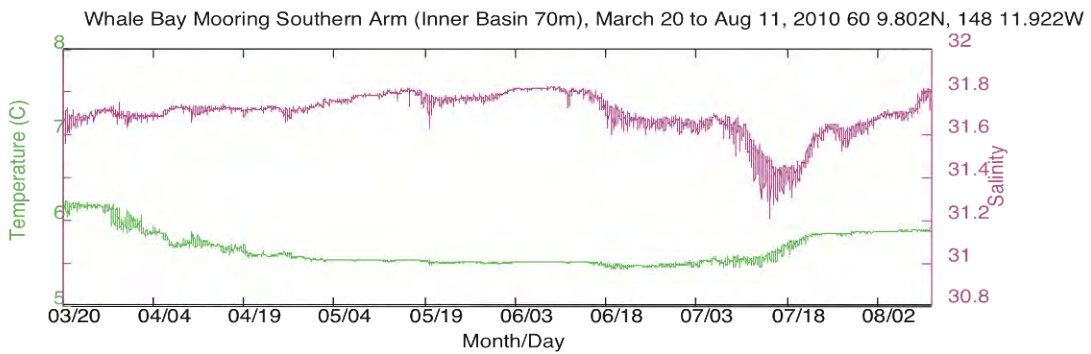
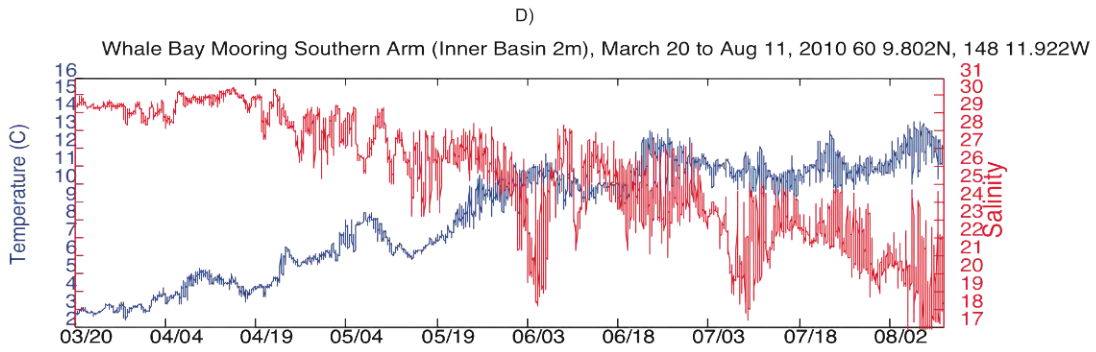
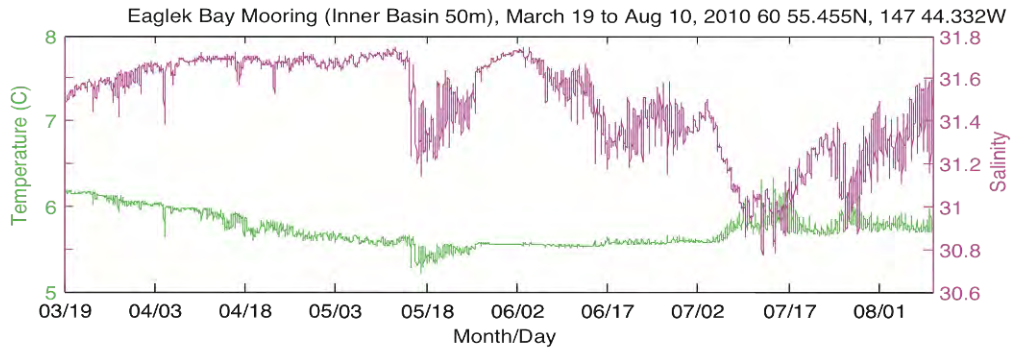
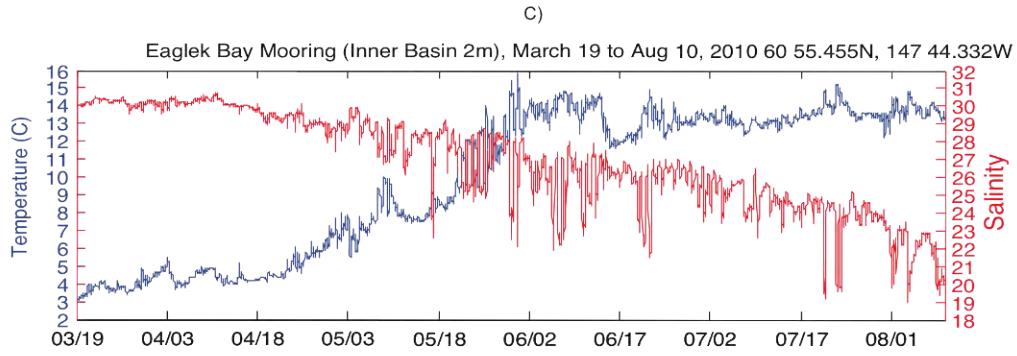


Fig. 3 (cont.). Time series of temperature and salinity from March to August 2010. C) Eaglek Bay, B) Whale Bay.

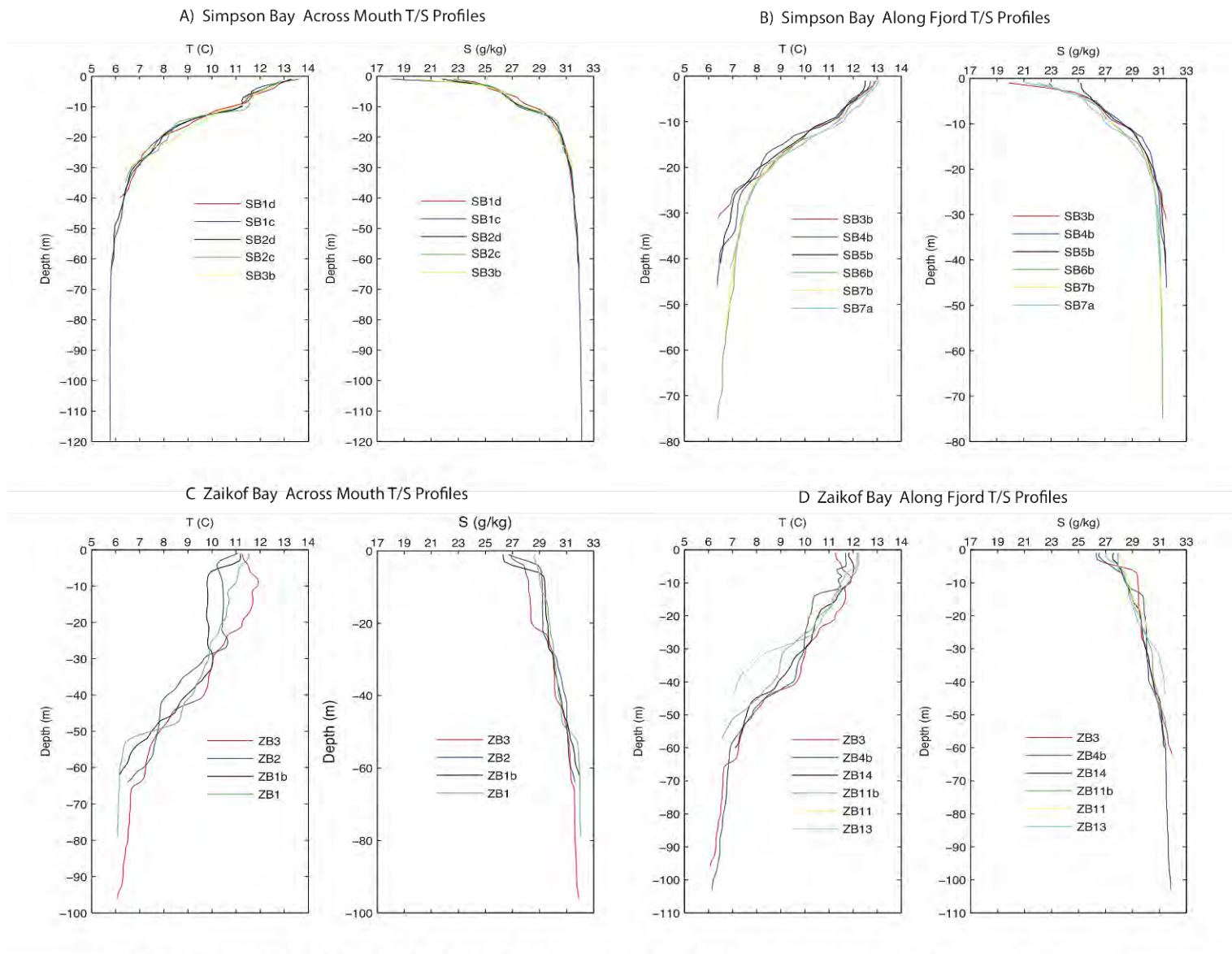
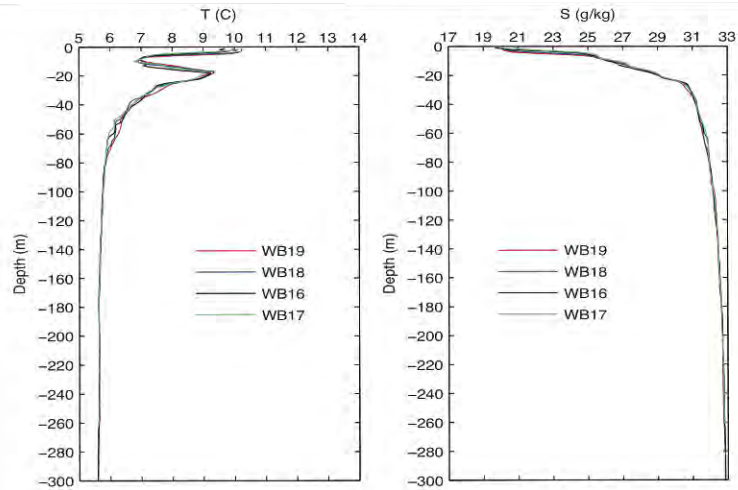
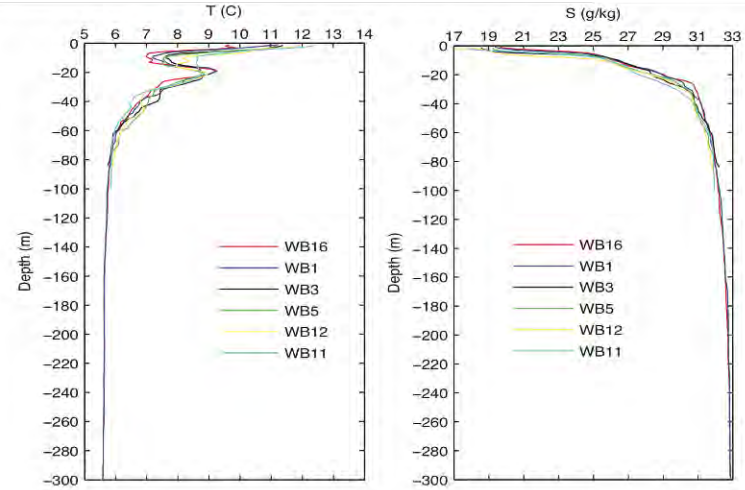


Fig. 4. Temperature and salinity profiles across the mouth and along fjord at Simpson Bay and Zaikof Bay, August 2010

A) Whale Bay Across Mouth T/S Profiles



B) Whale Bay Along Fjord T/S Profiles



C) Eaglek Bay Across Mouth T/S Profiles

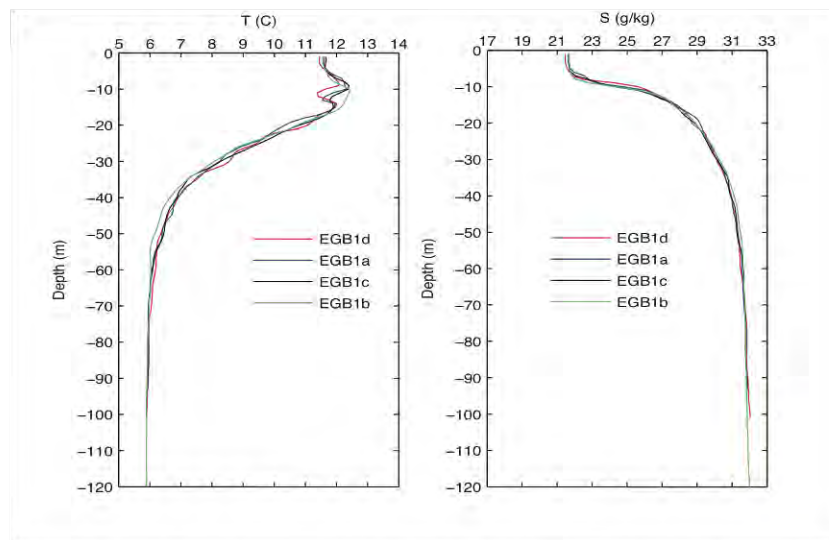


Fig. 5. Temperature and salinity profiles across the mouth and along fjord at Whale Bay and Eaglek Bay, August 2010

