

Oceanographic assessment of the outer coastal region between Wrangell-St. Elias and Glacier Bay National Parks and Preserves

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Introduction

The outer coastal region between Wrangell-St. Elias National Park and Preserve (WRST) and Glacier Bay National Park and Preserve (GLBA) located in southeast Alaska consists of over 500 km of coastline. The region is home to the largest tidewater and piedmont glaciers in North America, recently deglaciated tidewater fjords, globally significant salmon runs, and marine bird and mammal populations. However, the ecosystem structure and controlling processes are not well known in this pristine region that is currently experiencing rapid ecological change. The National Park Service and UAF CFOS initiated an oceanographic monitoring program in this region during 2022.

Fjord comparison

		Watershed Area	Glacier Area	Glacier Cover	# Active Tidewater Glaciers	Glacier Status	Distance to Gulf of Alaska	Distance to Shelf Break	Water Area of Fjord	Max Depth	# Sills in Fjord	Sill Depth
Icy Bay		2145 km ²	1733 km ²	80.8%	4	Advancing	35 km	109 km	266 km ²	180 m	2	15 & 34 m
Disenchantment Bay		6641 km ²	4486 km ²	67.5%	2	Advancing	52 km	164 km	842 km ²	260 m	2	25 & 70 m
Lituya Bay		285 km ²	157 km ²	55.1%	0	Grounded	12 km	85 km	28 km ²	140 m	1	9 m

Methods

Sampling: Yakutat, Disenchantment, Icy, and Lituya bays and the outer coastal region between WRST and GLBA were surveyed from 2 – 9 June 2022 as part of the National Park Service Outer Coast monitoring program.

Water column profiles: Physical parameters were collected with a SeaBird SBE49 CTD.

Macronutrients: Water from discrete depths over the entire water column were processed on a Seal Analytical contiguous flow QuAAtro39 AutoAnalyzer for nitrogen ($\text{NO}_3 + \text{NO}_2$), silicic acid (SiO_4), phosphate (PO_4), and ammonia (NH_4).

Carbonate system: Dissolved inorganic carbon (DIC) and total alkalinity (TA) samples were processed from the surface, middle, and bottom depths on an AIRICA and VINDTA systems and analyzed using CO2SYS (ver. 2.1) to obtain calcite (Ω_{Ca}) and aragonite (Ω_{Ar}) saturation states.

Chlorophyll-a: Water from the upper 50 m was filtered for two size classes: >20 μm (diatoms) and 0.7 – 20 μm (dinoflagellates etc.).

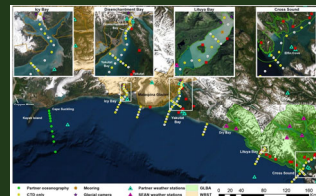
Zooplankton: communities were sampled to a max depth of 200 m with a vertical 150- μm and towed 505- μm mesh nets.

Zooplankton net tows are currently being processed for abundance, biomass, and community composition. During sampling, a substantial *Eutima indicans* (Cnidaria; left) bloom was observed in Lituya Bay.

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References: Reisdorph and Mathis (2014) doi: 10.1016/j.ecss.2014.03.018



Oceanographic stations sampled during the NPS Outer Coast program. Full oceanographic stations were sampled for chemical and biological parameters. Note, Cross Sound stations were not sampled in 2021.



Example of a single zooplankton bongo tow (505- μm mesh) tow containing *Eutima indicans*.

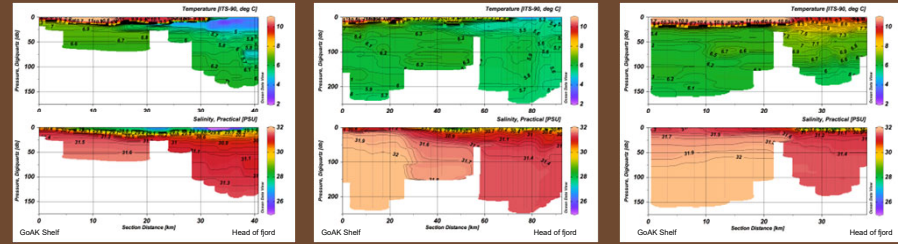
Results

Icy Bay

Yakutat and Disenchantment Bays

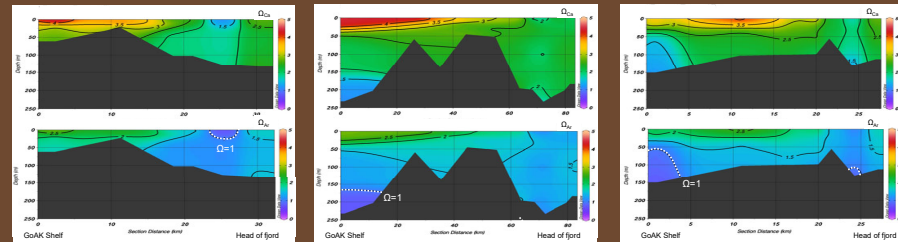
Lituya Bay

Thermohaline structure



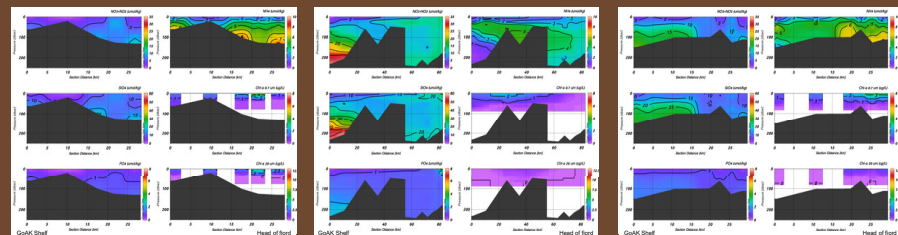
- Decreasing salinity outside of fjords from south to north
- Lituya Bay warm relative to Icy and Disenchantment bays
- Icy Bay relatively fresh at depth, meltwater plume more pronounced at surface
- Disenchantment Bay relatively cool and saline at depth

Ocean Acidification



- All four bays were saturated with respects to calcite, with pockets of water nearing undersaturated conditions ($\Omega < 1$) in Yakutat Bay, in shelf waters off Lituya Bay, and within Lituya Bay.
- In all four bays, Ω_{Ar} was low with undersaturated waters congruent with low Ω_{Ca} conditions

Nutrients and Chl-a



- Except for ammonia, nutrient levels were low in all three bays
- Nutrients were higher in shelf waters outside Lituya Bay and in Yakutat Bay
- Phytoplankton community had a larger contribution of small species (0.7 – 20 μm) in all 3 fjords
- A small diatom bloom (>20 μm) associated with the freshwater lens was observed in Icy Bay
- The lack of chl-a in the turbid meltwaters of Disenchantment Bay due to low water clarity from glacial silt (data not shown)

Conclusions

- Tidewater glaciers are highly influential in structuring the coastal and fjord marine ecosystems within SE Alaska.
- Bottom topography (i.e., sill structure) plays a pivotal role in controlling fjord dynamics and the degree of exchange between fjords and nearshore oceanic environments.
- Waters at or nearing corrosive conditions (Ω_{Ar} and Ω_{Ca}) is a results of low-TA glacial runoff. Undersaturated conditions occur seasonally in SE Alaska (Reisdorph and Mathis, 2014) and can indicate stressful environmental conditions for calcifying organisms during summer months when glacial discharge is high.
- The Aequoria* sp. bloom we observed in Lituya Bay during sampling was likely a results of warm ocean temperatures and entrapment in the bay between tidal cycles.