Bedwell Inlet Clayoquot Sound Phytoplankton and Water Properties 2014-2024 Comparison

Sawyer Townsend and Vernon Reed
Mentored by Cheryl Greengrove

TESC 499

Introduction

Phytoplankton are microscopic algae which are responsible for almost all primary production in the ocean. They form the base of the marine food web and produce the majority of the oxygen in the atmosphere. There are over 20,000 known species of phytoplankton, about 200 of which can be harmful to humans and marine mammals. One such species, *Alexandrium catenella* (Fig. 4), found in PNW waters, produces a neurotoxin which can accumulate in filter-feeding shellfish and can be lethal to marine mammals and humans if ingested by causing Paralytic Shellfish Poisoning (PSP).

University of Washington Tacoma researchers have been studying the marine ecosystem in Clayoquot Sound (Fig. 2) on the west coast of Vancouver Island, BC, Canada annually in the fall since 2001. In 2014, the Northeast Pacific Ocean, including the Pacific Northwest coast, experienced the first of a series of marine heatwaves (MHW). This study will examine the phytoplankton populations and estuarine conditions in Herbert Inlet, one of five inlets in Clayoquot Sound, in 2024 and compare water properties and phytoplankton abundance and diversity in this inlet with data collected in 2014. Water properties and phytoplankton will also be compared with nearby Bedwell Inlet for 2024.

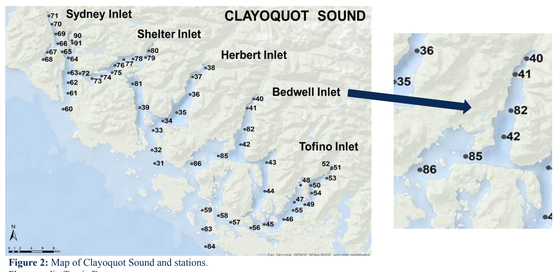


Figure 2: Map of Clayoquot Sound and stations.
Photo credit: Tracie Barry.

Methods

Study Area & Sampling Design: Sampling was conducted in multiple inlets throughout Clayoquot Sound, BC. (Fig. 1) September 5-7, 2024, as part of an ongoing, 20-year water-property and phytoplankton monitoring project. Fifty CTD stations were sampled, with phytoplankton collected at 19 stations.

Field Sampling: Six water properties (temperature, salinity, density, oxygen, fluorescence, and transmissivity) recorded in continuous profiles with a Seabird 19 CTD at each station. Discrete water samples were taken at the surface and 10-m depths (thermocline) at each station with a Niskin bottle (Fig. 9). Concentrated phytoplankton samples taken were with 0-10-meter vertical net tow (Fig. 8). All samples were preserved with formalin.

Laboratory & Species Analysis: Phytoplankton identification and enumeration of water samples from bottles and nets were done using a 0.1 mL Palmer-Maloney slide with compound microscope at 400X magnification. Monitoring primarily for *A. catenella*, a toxic dinoflagellate linked to PSP, but recorded all species found. All species counts were compared across sites to identify spatial distribution patterns in abundance and diversity. The Simpson Index was used to calculate phytoplankton diversity.

Data Integration & Use: The MHW year, 2014, was compared with 2024 data and Bedwell Inlet was compared with nearby Herbert Inlet. Environmental water property data were paired with species counts to investigate ecological drivers of harm algae blooms (HABs). Results contribute to datasets informing on shellfish contamination risk and support management and of and public advisory on HABs.

Figure 8: Phytoplankton net.
Photo credit: UW Tacoma.

Figure 4: *Alexandrium catenella.*
Photo credit: Sound Water Stewards.

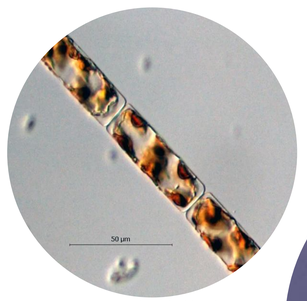


Figure 6: *Guinardia delicatula.*
Photo credit: Lars Edler.

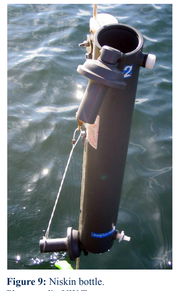


Figure 9: Niskin bottle.
Photo credit: UW Tacoma.

Figure 7: *Ditylum brightwelli.*
Photo credit: EOS.

Results

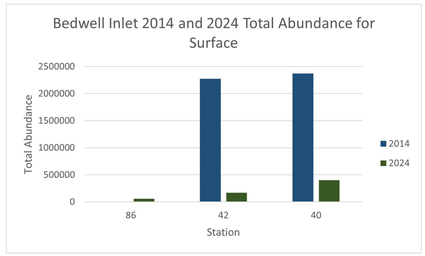


Figure 3a: Simpson index values for surface 2014 and 2024.

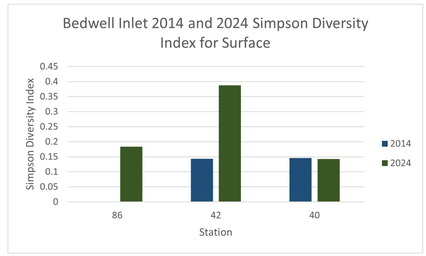


Figure 3b: Total abundance for 2014 and 2024.

	Station	Depth	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Bedwell	40	srfc	33,600		10,236	0	0	0	0	3,077	0				0	0			0	0	0
	40	thrm													0	3,279			0	0	0
	40	net		19,048	116,667	4,545	8,000	0	0	0	0				0	210,000			0	0	0
	42	srfc	8,800		0		0	806	0	7,826	935				0	0			0	0	0
	42	thrm													0	0			0	0	0
	42	net		0	18,987	23,585	53,906	0	0	0	0				10,000	0			20,000	120,000	0
	86	srfc	0												0	0			0	0	0
	86	thrm													0	0			0	0	0
	86	net													0	20,000			70,000	50,000	100,000

Figure 5: *A. catenella* concentrations (cells/L) by depth from 2014 to 2024 in Bedwell Inlet.

Most Prevalent Species

- *D. brightwelli*
- *P. micans*
- *A. senarius*
- *G. delicatula*
- *R. setigera*
- *P. gracile*
- *Chaetoceros spp.*

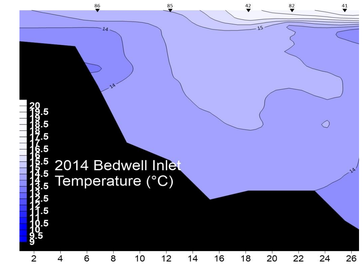
- Phytoplankton abundance was greatest at station 40 at the head of the Bedwell Inlet in 2014 and 2024, and total abundance of phytoplankton was much higher in 2014 (Fig. 3b).
- High phytoplankton diversity was found in the inlet at stations 42 and 40 in 2014 and across all stations in 2024, with diversity being greater in 2024 across all stations (Fig 3a).
- Less *A. catenella* was found in 2014 than in 2024 in Bedwell Inlet (Fig. 5).
- The water properties in 2024 and 2014 were similar except that dissolved oxygen was lower throughout the water column and fluorescence was significantly higher in 2024. Highest fluorescence occurred near the head of the inlet in both years (Fig 1a and 1b).

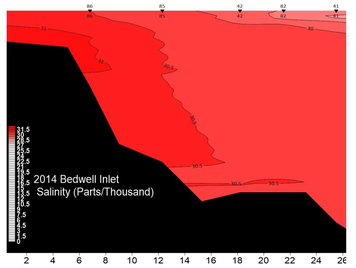
Figure 10: *References cited.*

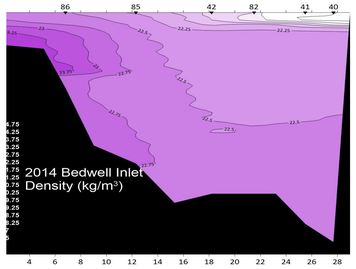
Conclusions and Future Work

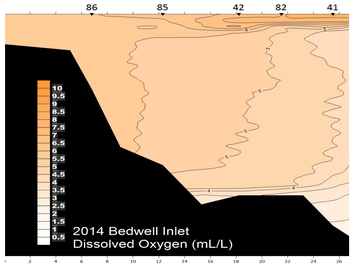
- It appears that the MHW affected phytoplankton in Bedwell Inlet by increasing abundance and decreasing diversity in 2014.
- *A. catenella* concentration increased significantly in 2024 compared with 2014 in Bedwell Inlet.
- Phytoplankton abundance was greater in Bedwell inlet overall compared with Herbert Inlet.
- Relative to Herbert Inlet, Bedwell Inlet is warmer, fresher, less dense, less stratified, and has more oxygen, indicating more mixing and flushing across the sill (which is deeper than the Herbert sill).
- Fluorescence, a measure of higher biological productivity, occurred at the head of Bedwell Inlet in both years, near where there is resort. We hypothesize that this increase in biological productivity may be due to an increased nutrient load from the resort.
- Future research is needed to continue monitoring phytoplankton, and especially the harmful algae *A. catenella*. We propose sampling for nutrients as well to determine if the nutrients are higher at the head of Bedwell Inlet which will inform marine resource managers.

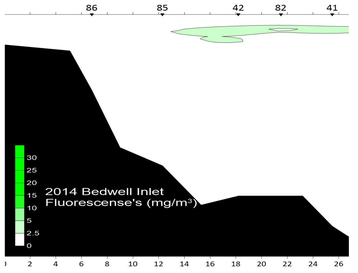
2014 Water Properties











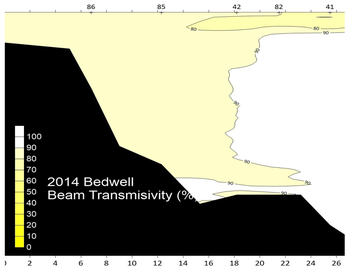
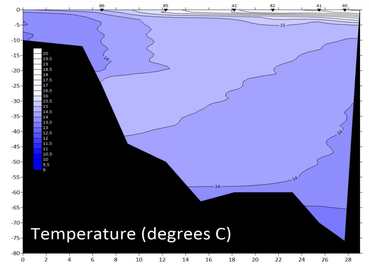
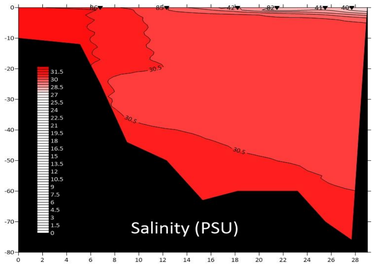
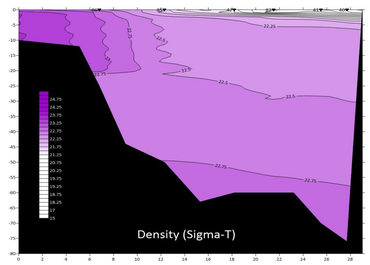


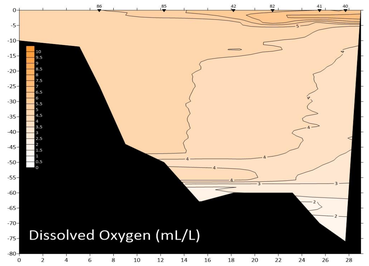
Figure 1b: CTD longitudinal transects of Bedwell Inlet water properties in 2014.

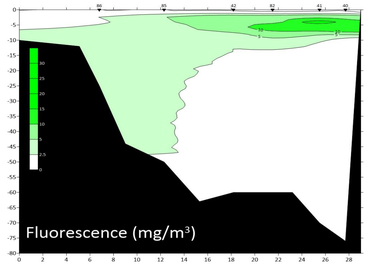
2024 Water Properties











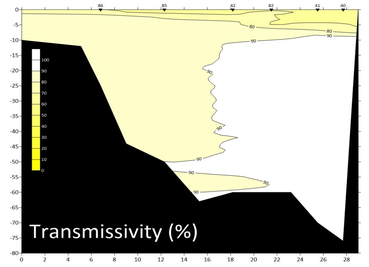


Figure 1a: CTD longitudinal transects of Bedwell Inlet water properties in 2024.