A Longitudinal Study of the Temporal and Spatial Variability of Phytoplankton from 2013-2019 in Tofino Inlet, Clayoquot Sound, B.C. Canada

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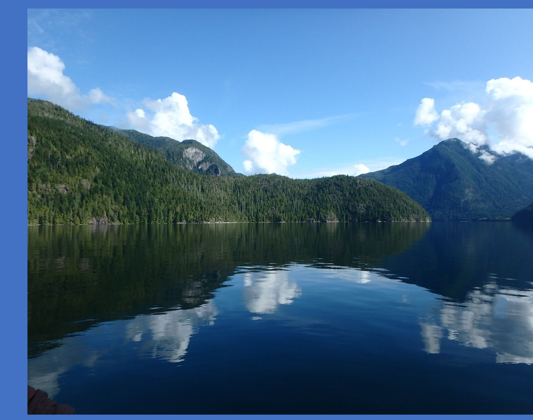

INTRODUCTION

Since 2001, the University of Washington Tacoma has been collecting water property samples in Clayoquot Sound, B.C. Canada as part of an ongoing study to examine the long-term impacts of climate change in the region. Phytoplankton samples were collected in late summer 2013-2019 at five stations from the surface and thermocline in Tofino Inlet (Fig. 2). The purpose of this project was to illuminate spatial and temporal trends of phytoplankton abundance and distribution. In addition, over the years we have carefully noted harmful algae species such as *Alexandrium spp.* which accumulate in shellfish tissue and can cause paralytic shellfish poisoning (PSP) if consumed by humans (Table 1). Continuous monitoring of harmful algae species is important for the aquaculture economics and human health impacts of this area.

In 2014 and 2019 the Eastern Pacific Ocean experienced marine heat waves also called 'the Blob', a relatively new phenomenon linked to climate change, which impacted estuaries along the Pacific Northwest coast of North America (Fig. 1). Warming waters potentially impact phytoplankton at the base of the food web, thereby affecting the whole marine ecosystem. The primary focus of this research paper is to examine the spatial and interannual variability of The phytoplankton community in Tofino Inlet in early fall 2013-2019.

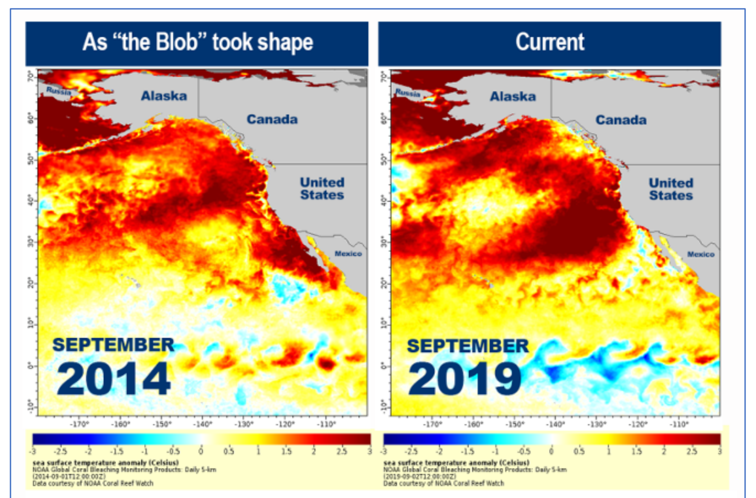

Figure 1. (NOAA, 2019)

SITE AREA

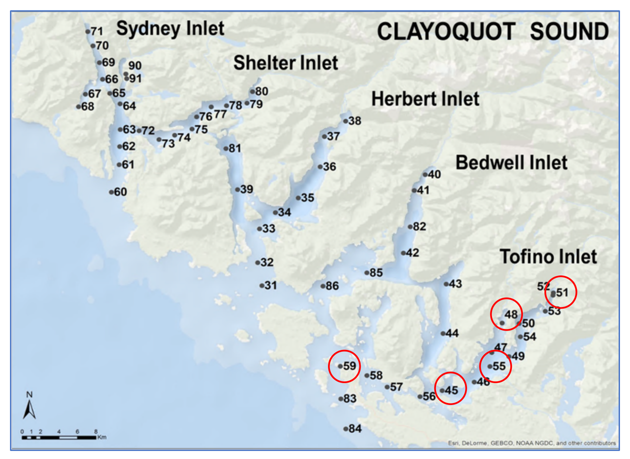

Figure 2. Map of Clayoquot Sound. Primary focus Tofino Inlet Stations 59, 45, 55, 51, and 48

Alexandrium spp. Table						
Sample Type	Year	Station				
		59	45	55	51	48
Surface	2013			■		
Net	2013				■	
Surface	2014					■
Surface	2016	■				■
Net	2016	■		■		■
Surface	2017		■			
Thermocline	2017					
Net	2017	■	■	■		
Surface	2018					
Thermocline	2018					
Net	2018	■				
Surface	2019					
Thermocline	2019					
Net	2019	■	■			

Table 1. *Alexandrium spp*. table, red shading indicates species found in samples.

OBJECTIVES

This study was undertaken to address three main questions:

- Are there similarities in phytoplankton abundance, diversity, or group composition in years of the marine heat wave (2014 and 2019)?
- Do the years without the marine heatwave look different from heatwave years?
- What does the longitudinal distribution of phytoplankton look like spatially up Tofino Inlet?

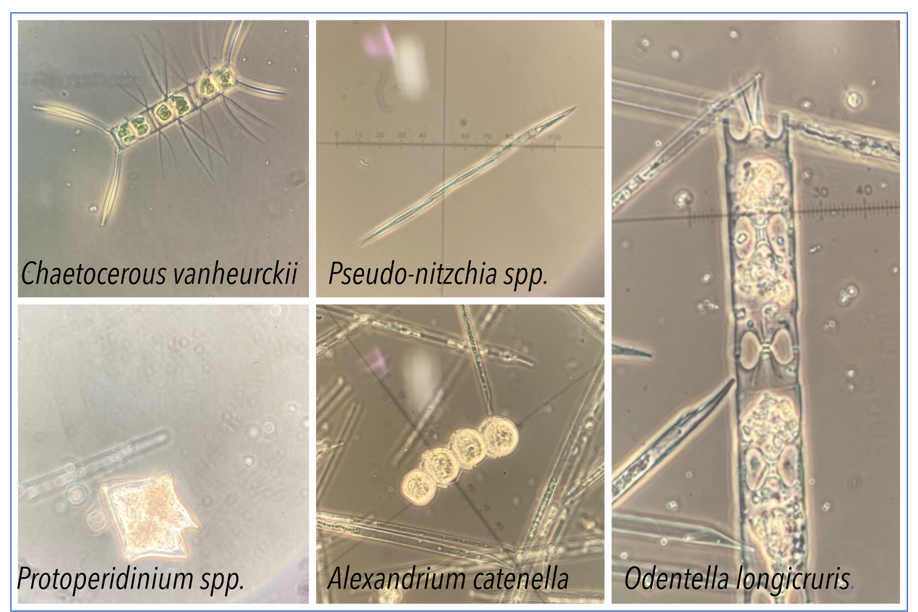

Figure 3. Collage of phytoplankton species identified in various samples throughout Tofino inlet.

RESULTS

TOTAL ABUNDANCE

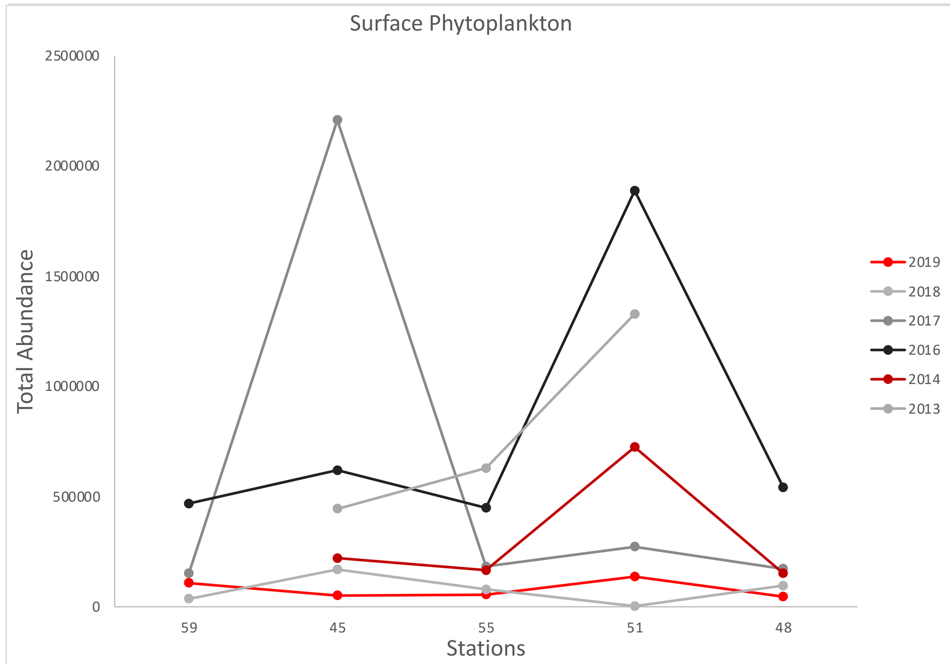

Figure 4. Total abundance by station for each year for Surface phytoplankton. 2019 and 2014 illustrating lower total abundance than 2013, 2016, and 2017.

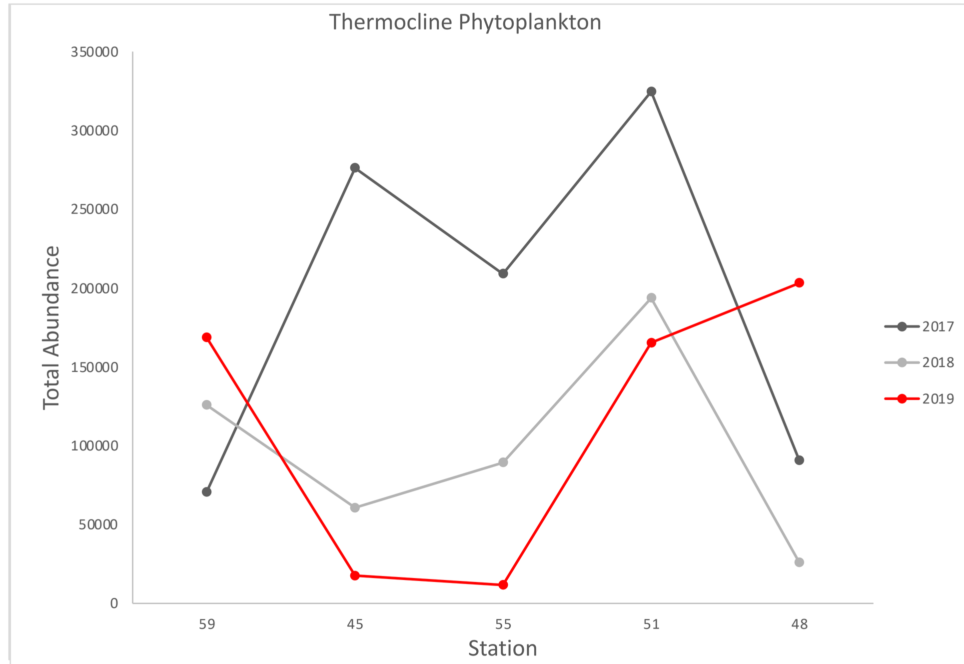

Figure 5. Total abundance by station for years 2017-2019 for Thermocline phytoplankton. 2018 and 2019 follow similar spatial trends up the inlet.

SIMPSON DIVERSITY INDEX

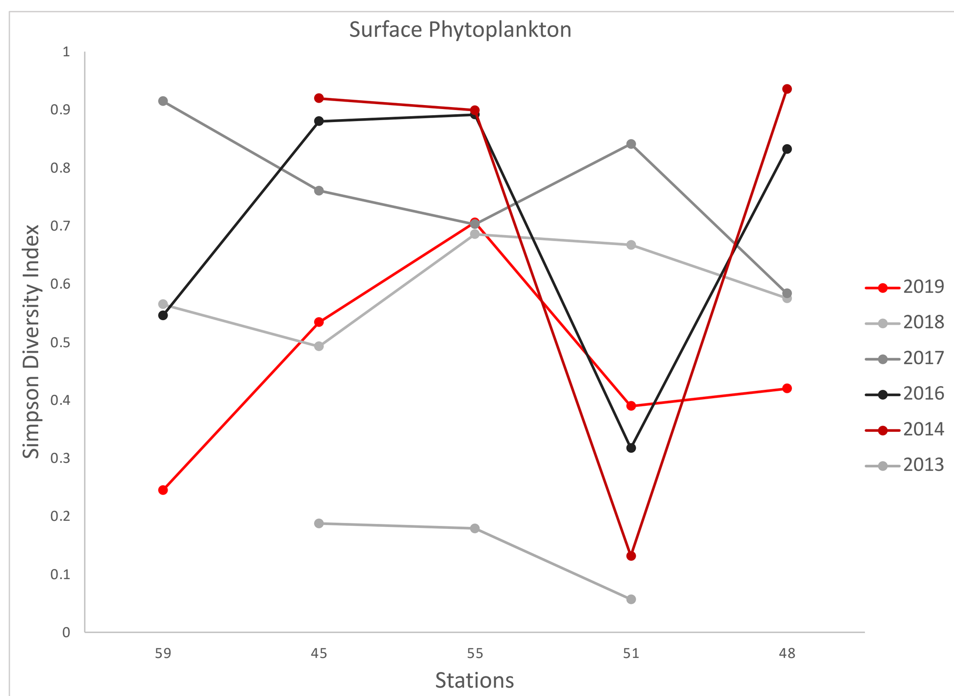

Figure 6. Simpson Diversity Index by station for each year for Surface phytoplankton. Station 51, at the head of the inlet, illustrated lower levels of biodiversity.

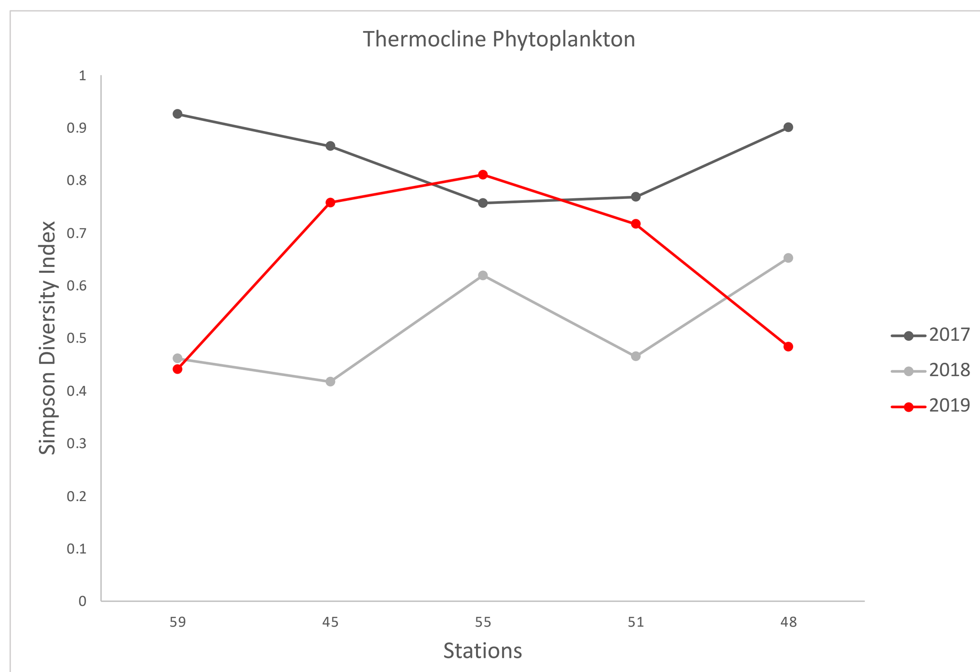

Figure 7. Simpson Diversity Index by station for years 2017-2019 for Thermocline phytoplankton. Biodiversity increased at station 48 for 2017 & 2018. Biodiversity peaked at station 55 for 2019.

DIATOM TO DINOFLAGELLATE RATIO

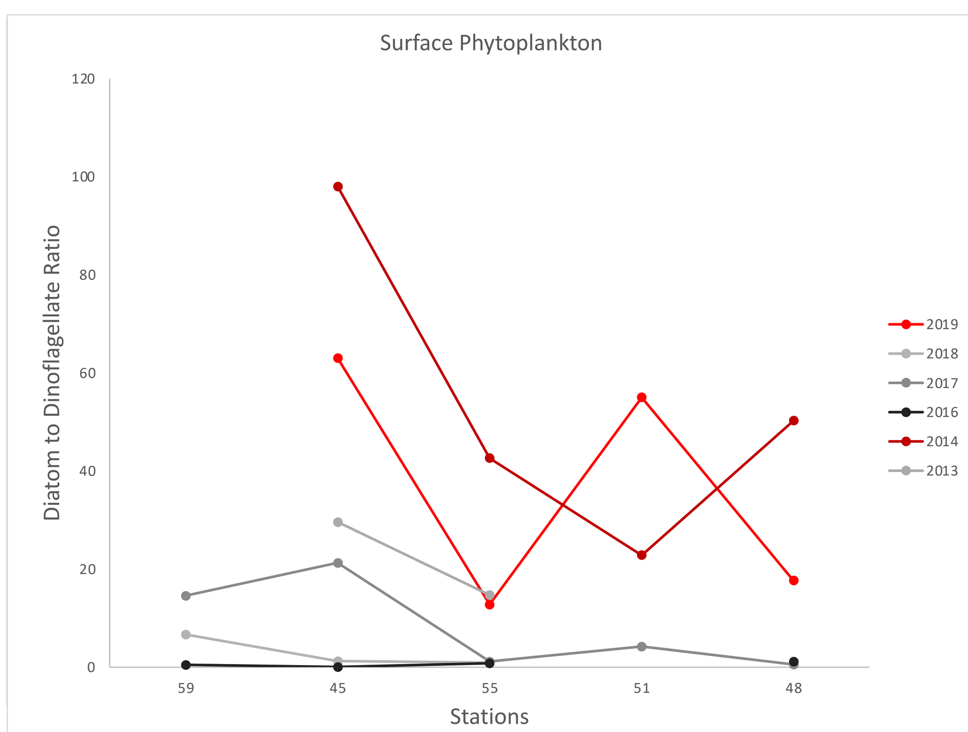

Figure 8. Diatom to Dinoflagellate ratio by station for each year. 2019 & 2014 illustrated higher ratios than comparing years. 2013 and 2016 did not have all stations sampled.

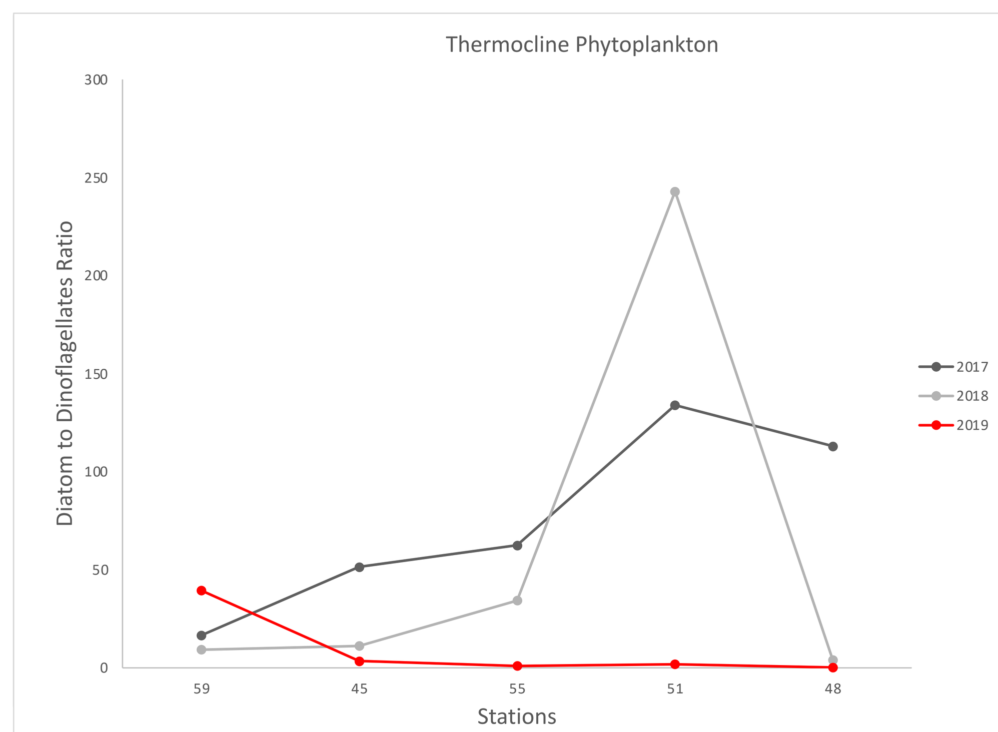

Figure 9. Diatom to Dinoflagellate ratio by station for years 2017-2019 for Thermocline phytoplankton. 2018 & 2019 illustrates that the ratio increases as you move up the inlet, while 2019 illustrated the opposite trend.

METHODS

- Using a Niskin bottle, surface samples were taken at a depth of 1 meter, and thermocline samples taken at 10 meters (Fig. 10)
- Concentrated net samples were obtained using a 20 μm mesh net by vertically towing 10 meters up the water column (Fig. 11)
- Phytoplankton was fixed using 1 mL of formalin (37%) within 10 hours of collection
- Samples were morphologically identified and counted on a 0.1 mL Palmer-Maloney counting slide using a microscope at 400x magnification
- Total phytoplankton counts were then calculated using a concentration factor for (cells/L)
- Phytoplankton species were sorted into diatoms and dinoflagellates to calculate a diatom to dinoflagellate ratio.
- Phytoplankton diversity was calculated using the Simpson Diversity Index (SDI):

$$D = 1 - \left(\frac{\sum n(n-1)}{N\,(N-1)}\right)$$

Figure 10. Image of Niskin bottle while collecting sample

Figure 11. Image of 20 μm mesh phytoplankton net after sample collection

Figure 12. Image of Niskin bottle in the field

RESULTS

- 2014 & 2019 illustrated lower total abundance than 2013, 2016, & 2017 (Fig. 4)
- Total abundance tends to increase at the head of the inlet (STA 51) but decreases in biodiversity indicating the abundance of dominant species (Fig. 4 & 6)
- 2014 & 2019 had the highest diatom to dinoflagellate ratios indicating that the warming water caused diatoms to dominate (Fig. 8)
- Diatom to dinoflagellate ratio in surface data tends to decreases up the inlet toward the head, particularly during marine heatwave years (Fig. 8)
- Diatom to dinoflagellate ratio in thermocline data increases toward the head in non-marine heat wave years, illustrating a reverse trend to surface data (Fig. 9)
- *Alexandrium spp.* was found in all years of sampling (Table 1)

FUTURE WORK

- With limited sampling done in Clayoquot Sound it is important to continue to research the physical and chemical properties, as well as biological productivity in these inlets
- While the pacific marine heatwaves are a new phenomenon, it is crucial to study and understand the impacts of warming temperatures on all parts of the marine ecosystem
- Studying and analyzing years that experienced the pacific marine heatwave might foreshadow future trends in phytoplankton abundance, diversity, and distribution due to climate change
- It is important to continue monitoring HAB species, since they can impact human health and aquaculture

REFERENCES & ACKNOWEDGEMENTS

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