Distribution and Composition of Phytoplankton in San Juan Channel in Fall 2013

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Abstract

Phytoplankton are the base of the marine food web. They have a rapid cell growth and reproduction and can produce million of cell per liters of seawater. Phytoplankton account for 95% of primary production. In the San Juan Channel, changes in phytoplankton abundance and composition is interesting because the physical condition of the ocean give dynamics between the nutrients and the plankton. The study site is in the San Juan Channel on the weekly R/V Centennial cruise. Phytoplanktons were collected using 80μn net in 30 m deep water, then preserved in formalin. The top 5 genera for phytoplankton this year are *Ditylum, Coscinodiscus, Skeletonema* and *Asterionellopsis*. There are one instance where two out of five genera were abundant and there were some episodic bloom in two events. Overall, this yeat the phytoplankton were abundant over the beginning of fall and decline over the course of the fall quarter.

Keyword: Phytoplankton, abundances, composition, genera.

Introduction

Phytoplankton are the base of the marine food web. They have a rapid cell growth and reproduction and can produce millions of cell per liters of seawater. They account for 95% of the primary production. Phytoplankton abundances is affected by both physical and biological factors, and they vary over time. Changes in composition is observed by changes in temperature and volume of freshwater input. Biological factors such as grazing by zooplankton and competition for limited sources are also a factors in accounting their abundances. Therefore, it can lead to the variation of phytoplankton in spatial and temporal level. (Pennington, 2007)

San Juan Channel located in the San Juan Island, WA is an estuarine environment with the Strait of Georgia and Fraser River to the north and Strait Juan de Fuca entering from the south (Mason, 2001). These mixing means that most of the estuarine exchange occurs in Strait Juan de Fuca (Green, 2010). Estuarine circulation creates dynamics between the nutrients and the plankton, the question that remains is that what does it means for the phytoplankton community in San Juan Channel (Green, 2010).

In the previous studies conducted by the PEF, phytoplankton communities have a lot of different conclusions. Abundance and diversity is different in north and south stations (Pennington, 2007). Abundance was higher in the north while diversity was higher in the south (Moore, 2005).

The objective of this study is:

1. Look at the abundances and composition in both north and south stations.
2. Observed the change in abundances over the fall and decreases and increases in species in total.
3. Look at the three dominant genera in the fall 2013.

Methods

Study Site

The sampling took place in a 21.5 KM transect in San Juan Channel during the weekly cruises in R/V Centennial (September 26, October 9, 15, 22 and 29, November 5, 12 and 19). The transect runs roughly north and south with five sampling station: N, A, B, C and S (Green, 2010) but most of the phytoplankton samples were taken only in North and South station. Station North is mostly well mixed with less salinity (Siple, 2006) because of the input in Fraser River. Station South is located in the Strait Juan de Fuca at the south entrance to SJC and the water column is more saline and stratified (Siple, 2006).

Methods

On all of the surveys, phytoplankton tows were done at the North and South station, N and S respectively. At each station the plankton tow was done from 37 m to the surface. All of the surveys were done with a 80m mesh net.

All of the samples were preserved in formalin before and after the counting process. All of the 5 ml subsamples from each sample were mounted on a Palmer-Maloney counting slide, identified to the genus level and counted under an Olympus BH-2 compound light microscope (10-20x). To ensure consistency was achieved, a calculation of volume, number per aliquot and number of m^3 were conducted. In situ fluorescence was measured with a fluorometer attached to a Sea-Bird Electronics, Inc. SBE-19 CTD profiler. The CTD continuously recorded depth (m), salinity (psu), density (sigma-t, mg m^3) and chlorophyll-a (L^{-1}).

Results

Phytoplankton abundance and composition

Phytoplankton abundance and composition changes weekly in the San Juan Channel and showed decline after the bloom in October 22nd cruise. Despite the seasonal changes of abundances and variation of spring a neap tide, the top 5 genera remains the same. A total of 14 station was samples, two per transect. *Ditylum* and *Coscinodiscus* were the top 5 genera on all of the counts. *Skeletonema*, *Asterionellopsis* and *Chaetoceros* dominates on 12 Counts (Table 1). During October 22nd, there is a change on the abundances as the North station have low abundances and the South station have high abundances. The highest number of counts is the October 22nd cruise which has total numbers of 10.958 cells/L with *Coscinodiscus* being the most abundant (7111 cells/L). On October 29th, *Skeletonema* dominated the counts in North station with 3083 cells/L while in the South station is dominated by *Ditylum* with 1520 cells/L. The October 29th survey was conducted on a neap tide From the composition, *Ditylum* dominates 50%-70% of the composition in all of the cruise dates, with the exception of October 22nd Cruise where Coscinodiscus dominates 66% of the abundance (Figure 9b) in the South station and October 29th cruise where Skeletonema dominates 50% of the species composition in the North station.

Chlorophyll Variation

Chlorophyll is a proxy of phytoplankton abundances. During the weekly cruises, chlorophyll concentration vary from week to week but remain constant at the value of 0.5-1 μg/L with some value of 2.5-3 μg/L. In the North station the chlorophyll the concentration is around 0.8-4 μg/L, while the South station have a concentration of

0.3 – 10 μg/L. The highest concentration of chlorophyll is in the September 26th Cruise at North station, the value is 1.1-3.5 μg/L.

Inter-Annual Variation

Table 1 give top 5 genera variation from 2006. The last years data collection showed a variation that are consistent but the position in the top 5 changes inter-anually. *Chaetoceros, Coscinodiscus* and *Ditylum* typically present but only this year that have *Ditylum* as the dominant genera for 2013 and *Chaetoceros* is currently in the bottom 5 for this year. *Skeletonema* only appears in 2008 and this year top 5 genera. In 2009 and 2012, there are only two genera that is present which is *Coscinodiscus* and *Chaetoceros*. However, there are new species present in 2013 which is *Asterionellopsis*, where in the previous year it is never present in the past years.

Discussion

The phytoplankton are most abundant during early fall and start to decrease in number of cells. As for the October 22nd cruise, there was a massive fog in the North station which could explain the decreased phytoplankton numbers and the weather however became clearer as the sun appears in the South station. During that time, the zooplankton especially the copepods are going back and forth in terms of abundance in North and South station.

Another factors that may affect the abundances and composition are the fact that based on the data from the weather station, the Photosynthetically Active Radiation (Figure 14) are also low during the mid-October which also coincide with the October 22nd cruise where it have a thick fog. From the tidal aspect, the October 22nd cruise happened during a spring tide, however there is not much exchange going on in that day (Figure 1). Tidal mixing is common in the Strait Juan de Fuca region (Zamon, 2002). Zamon (2002) and Nagai (1995) stated that Coscinodiscus can survive as resting cells in the dark and attain a large size through vegetative growth. This may be a way to adapt in areas of great turbulence which means, that there is a possibility the South station have a lot of tidal mixing that day during the October

22nd cruise. In the South station fluctuations in temperature and salinity showed that the water is mixed in the San Juan Channel. Nutrients concentration is not yet measured in this study.

Another factor that affect the sudden bloom on October 22nd cruise was also the fact that there are presence of chlorophyll from the first cruise (September 26th) but during the rest of the cruise, the chlorophyll value might be slightly decrease but still present due to the chlorophyll being a proxy for phytoplankton presence. The value of the decrease in chlorophyll is consisten with the Photosynthetically Active Radiation. Factoring in from the chlorophyll concentration, October 22nd cruise have a lack of chlorophyll in both North and South station with the value around 0.9-3.4 μg/L in the North station and 0.5-1 μg/L for the South station. So far, there is no explanation on why the phytoplankton experience sudden bloom but it might be possible that sampling bias did happened during that day. If we take a look at the zooplankton data for the October 22nd cruise, the North station have a lot amount of copepod in which means that the zooplankton are grazing especially in the number of the copepod nauplii. This could explain the sudden decrease in the numbers of phytoplankton but only limited to North station. In the South station, the number of calanoid copepod significantly increase (Figure 14). Because of the Coscinodiscus importance and abundance and the fact that they can grow in a relatively low-light environments, this population dynamic deserve further investigation.

During the October 29th Cruise *Skeletonema* were abundant and only at this date the abundance were apparent. *Skeletonema* can grow and develop at salinities from 7 to 50 psu and temperatures from 8º to 32º C. However, ideal conditions are temperatures from 20º to 26º C. and salinities from 25 to 30 psu (Chunqiang, 2009). Based on the data from the CTD data taken from the centennial the salinity value is around 29 to 30 psu and the temperatures is around 10 ^{o}C and this is based on the salinity at the top 30 m (Figure 16).

Looking at that factor, it might be possible that the episodic bloom of *Skeletonema* revolves around the fact that the environment are supporting the growth of it. It generally took 3 days for a phytoplankton species to have a bloom, but given that from the October 22nd to October 29th took about a week, this episodic bloom might happen once in a while.

Inter-annually, 2009 and 2012 don't have the top 5 genera and that is because the research for those years focused more on the most abundant genera as opposed to looking for the overall phytoplankton species.

Overall, phytoplanktons were abundant at the beginning of the fall and declined over fall quarter, this is consistent with sunlight availability. Episodic bloom in some genera appears but the cause is unknown despite some data, and this year the top three genera are, *Ditylum*, *Coscinodiscus* and *Skeletonema.*

Acknowledgement

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Table

Table 1. Top 5 Genera From 2006 to 2013

2006	2007	2008	2009	2010	2011	2012	2013
Chaetoceros	Chaetoceros	Chaetoceros	Coscinodiscus	Chaetoceros	Ditylum	Coscinodiscus	Ditylum
Ditylum	Coscinodiscus	Skeletonema	Chaetoceros	Ditylum	Chaetoc-eros	Chaetocero-s	Coscinodiscus
Thalassiosira	Thalassiosira	Thalassiosira		Eucam-pia	Pseudo-Nitzchia		Skeletonema
Thalassionema	Thalassionema	Rhizosolenia		Rhizosolenia	Thalassi-onema		Asterionellopsis
Eucampia	Ditylum	Thalassionema		Coscino-discus	Coscino-discus		Chaetoceros

Table 2. Overall Calculation of Samples

Station	Flowmeter (m3)	Calculated Volume (m3)	#/Aliquot	#/Sample	#/m^3
N	570	3215.2	6051	337645.8	105.0
S	0	3215.2	1829	62186	19.3
N	285	3215.2	3230	226100	70.3
S	935	3215.2	1038	52730.4	16.4
N	245	3215.2	1143	34290	10.7
S	260	3215.2	1293	77580	24.1
N	200	3215.2	824	16809.6	5.2
S	220	3215.2	10958	657480	204.5
N	210	3215.2	5012	250600	77.9
S	200	3215.2	2573	169818	52.8
N	250	3215.2	2961	118440	36.8
S	285	3215.2	2490	134958	42.0
N	200	3215.2	1002	51102	15.9
S	210	3215.2	1232	57411.2	17.9

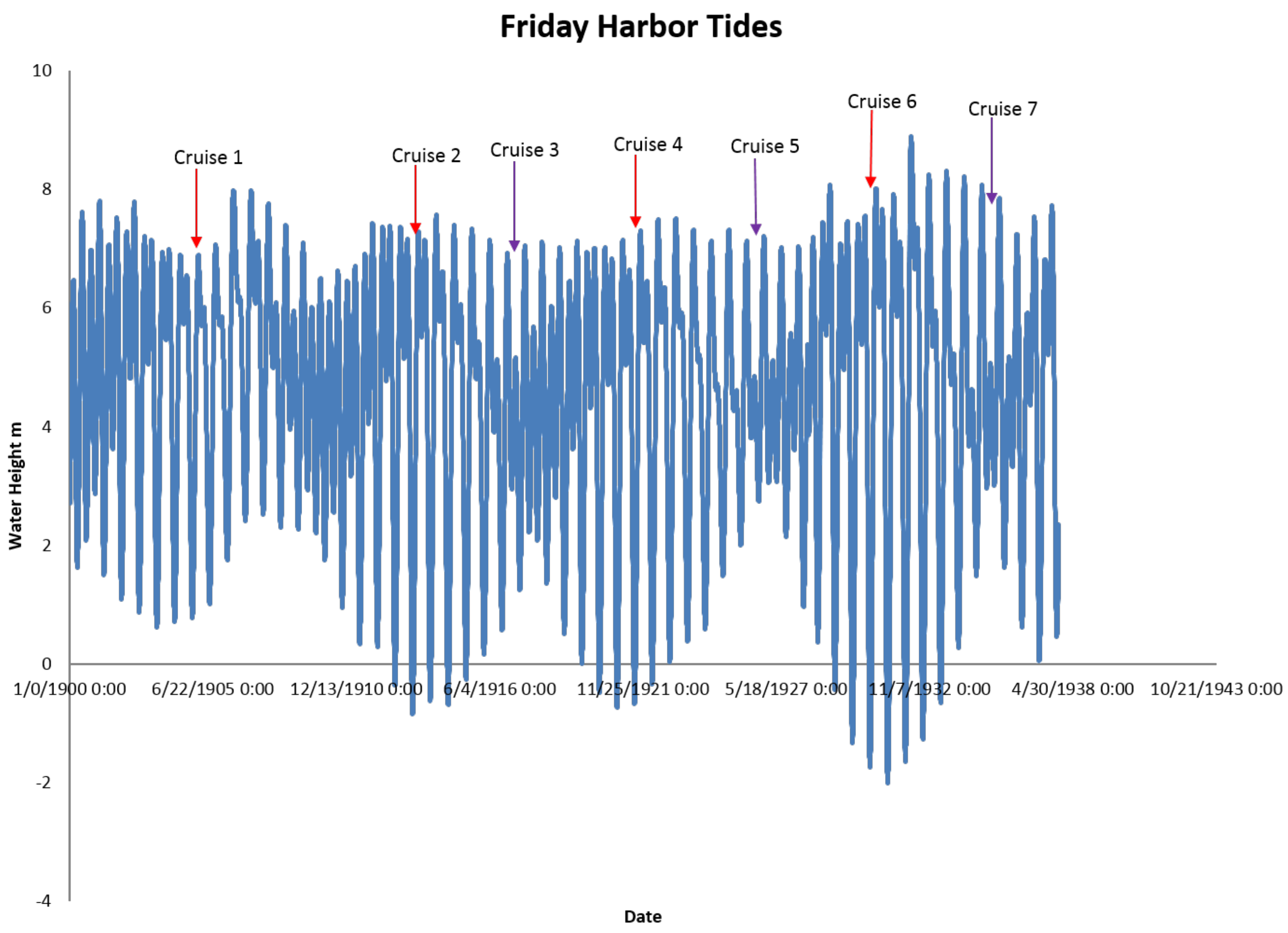

Figure 1. Tidal Data on All of the Cruises (Gould, 2013)

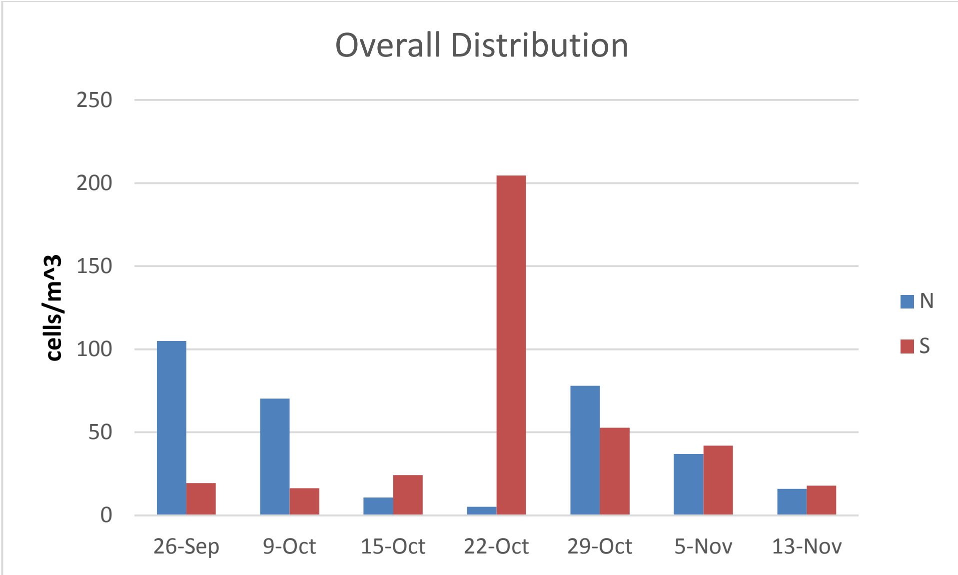

Figure 2. Overall Distribution Over the Week

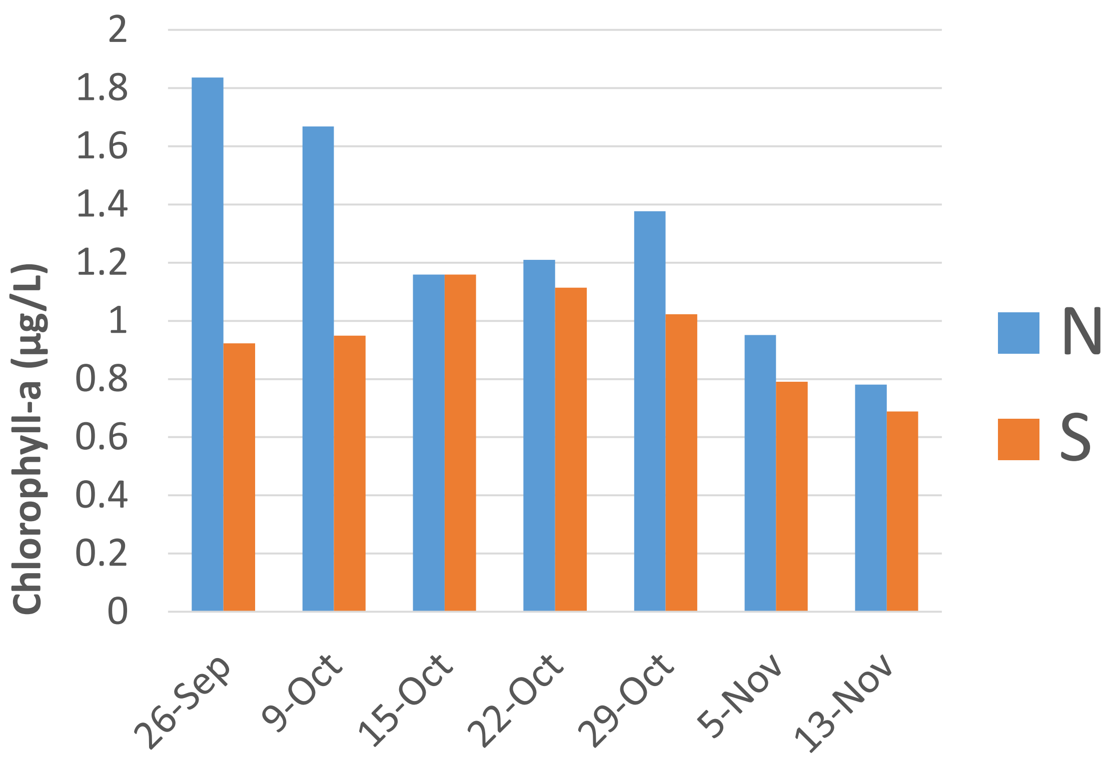

Figure 3. Chlorophyll-a Concentration

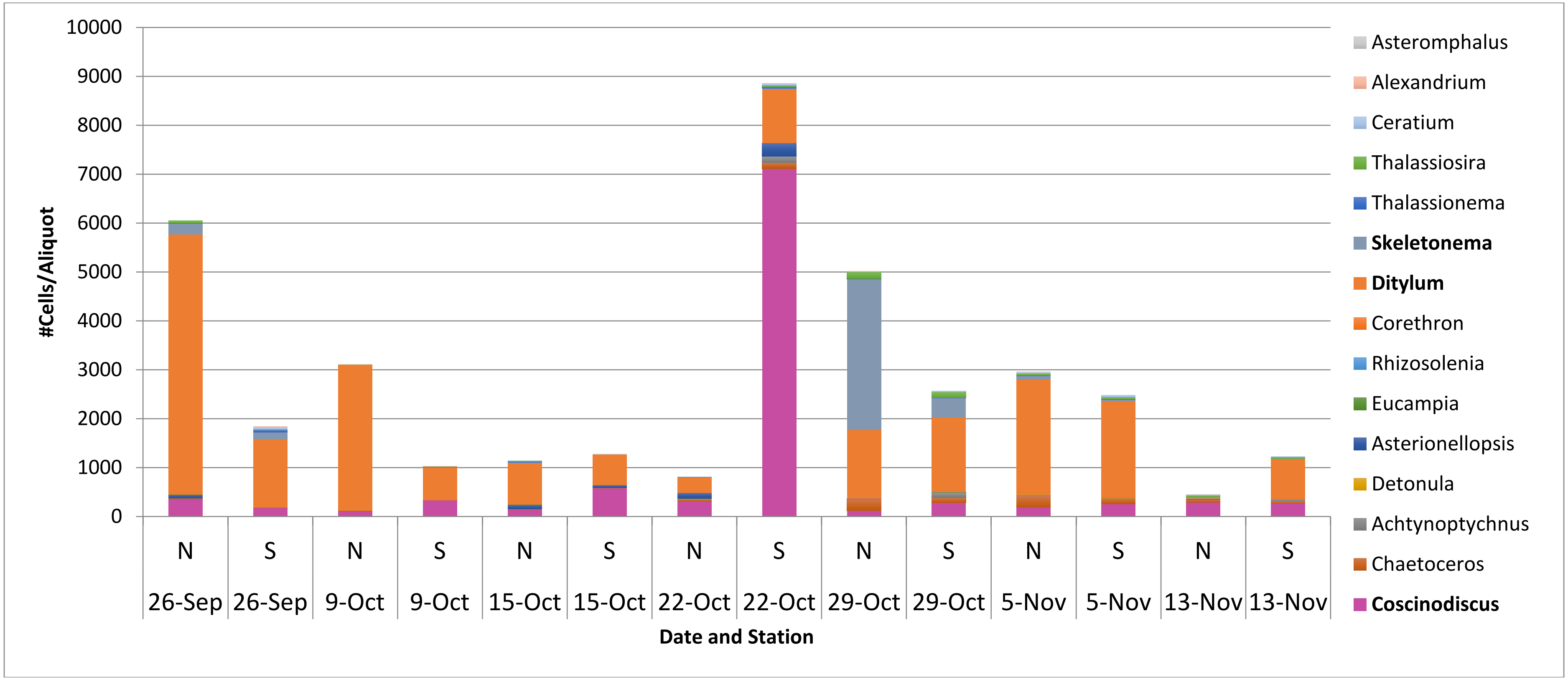

Figure 5. Overall Genera Abundances

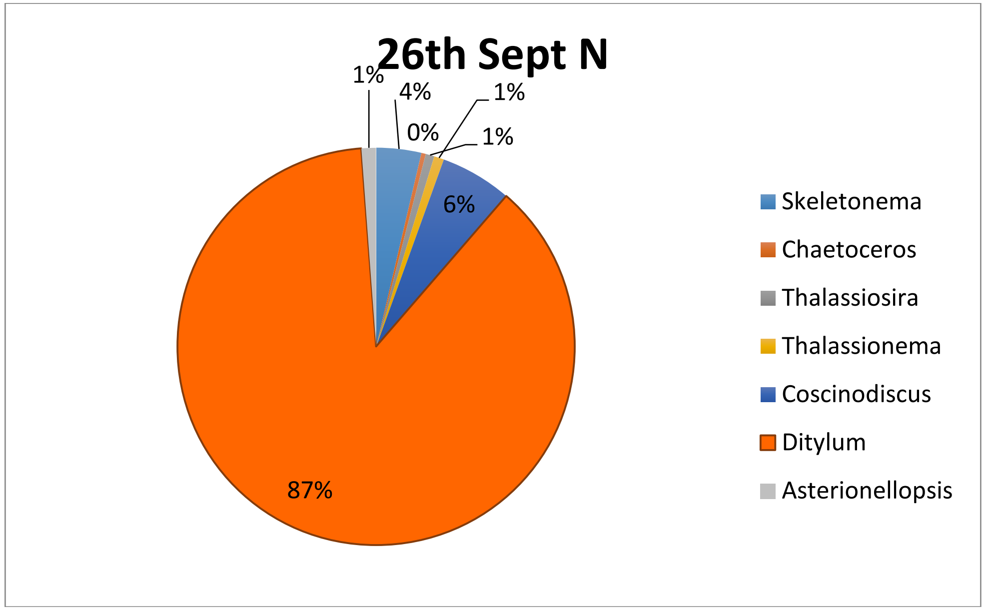

Figure 6a. Phytoplankton Composition of Sept 26 Cruise North

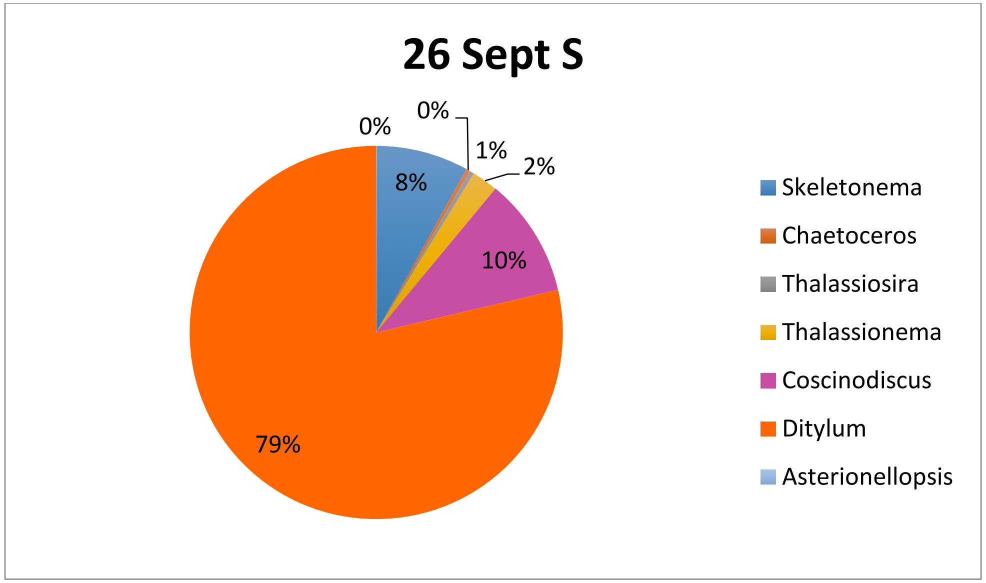

Figure 6b. Phytoplankton Composition of Sept 26 Cruise South

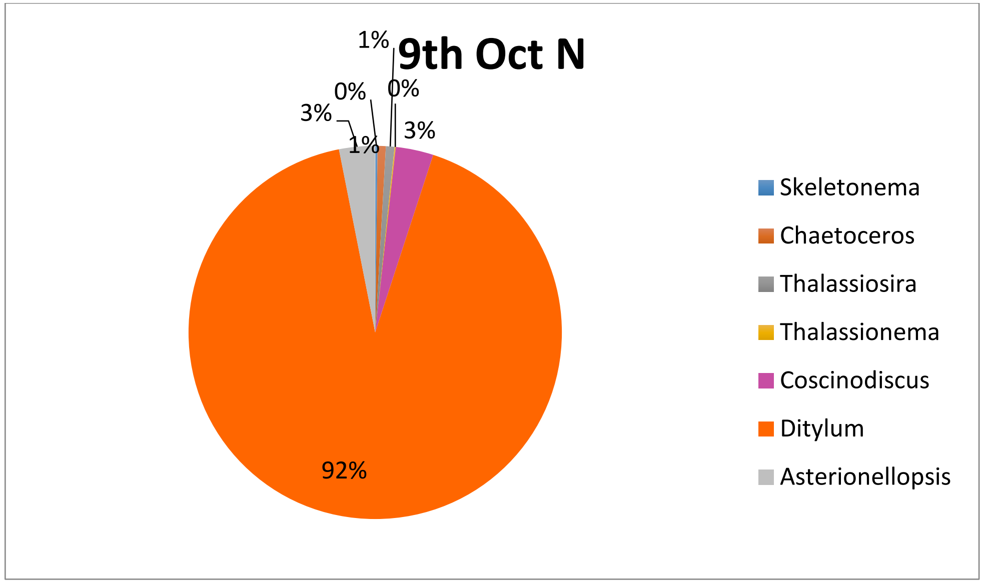

Figure 7a Phytoplankton Composition of October 9 Cruise North

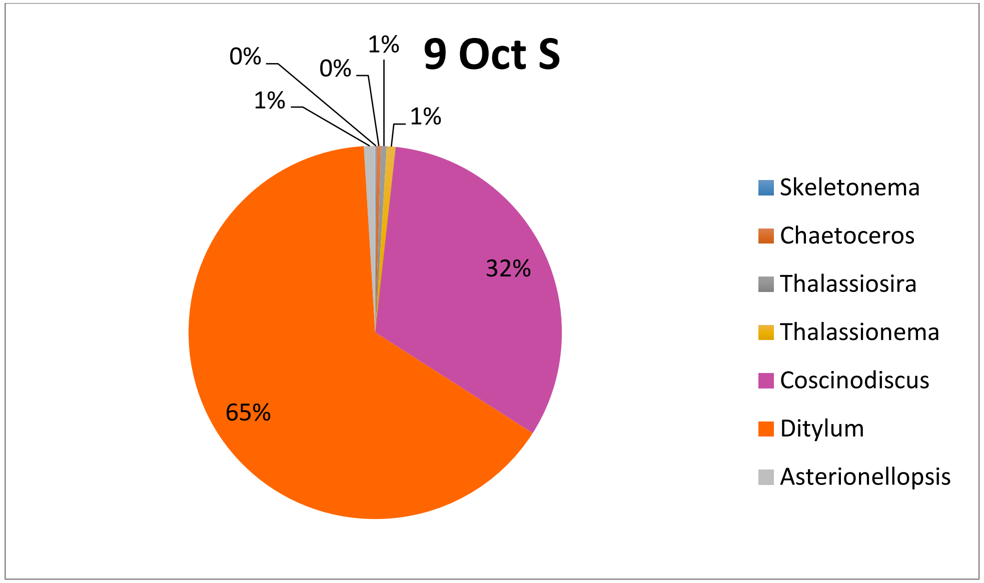

Figure 7b Phytoplankton Composition of October 9 Cruise South

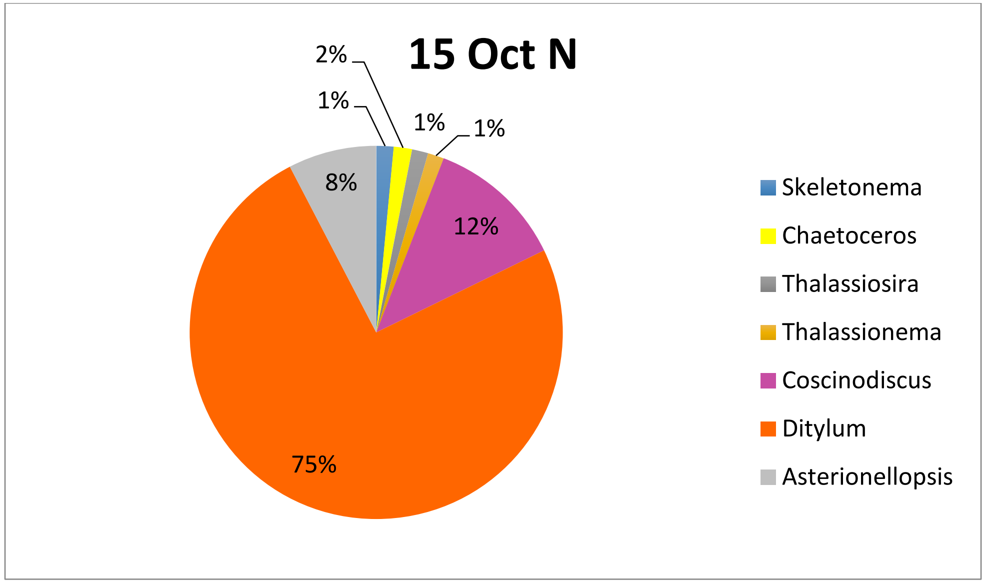

Figure 8a Phytoplankton Composition of October 15 Cruise North

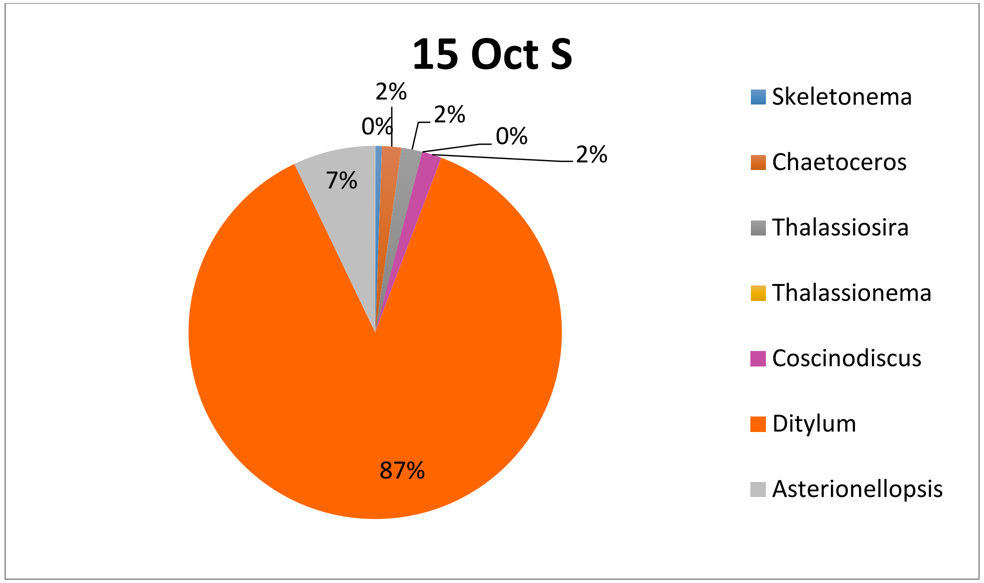

Figure 8b Phytoplankton Composition October 15 Cruise South

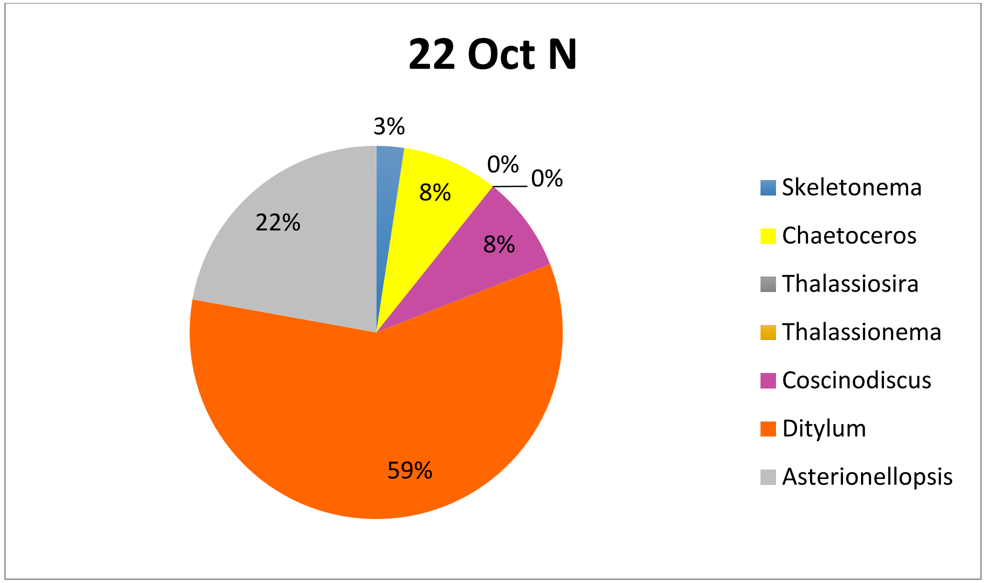

Figure 9a Phytoplankton Composition October 22 Cruise North

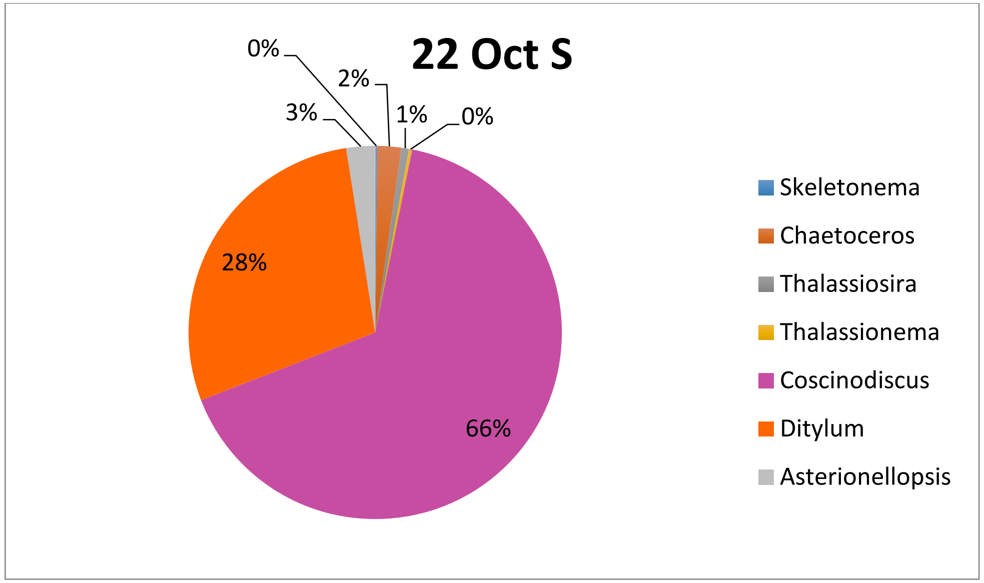

Figure 9b Phytoplankton Composition October 22 Cruise South

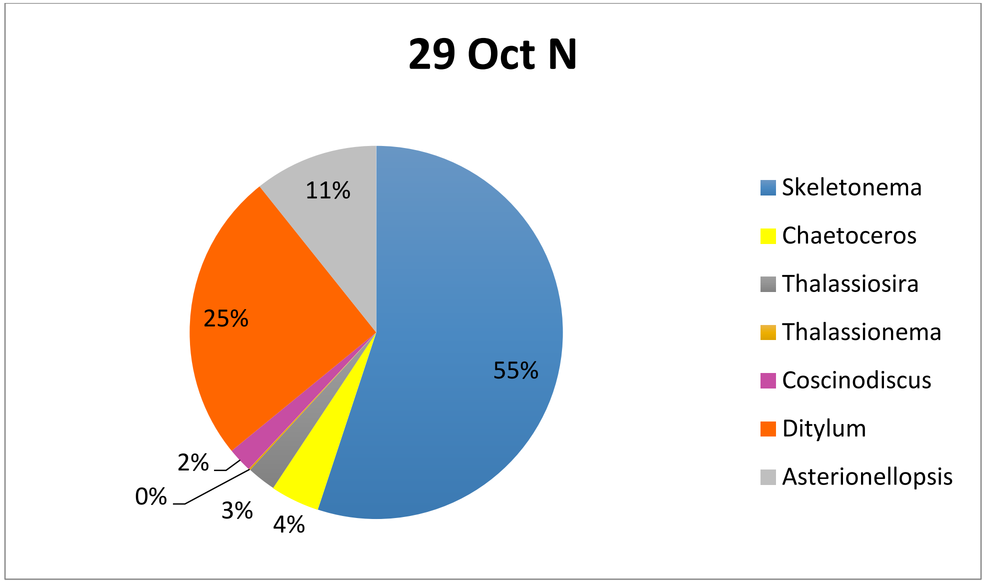

Figure 10a Phytoplankton Composition October 29 Cruise North

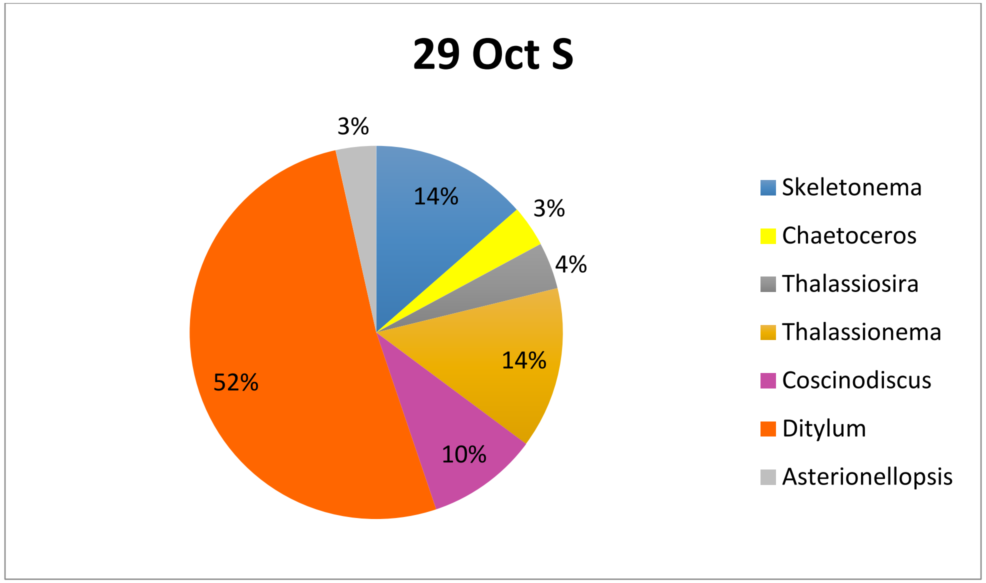

Figure 10b Phytoplankton Composition October 29 Cruise South

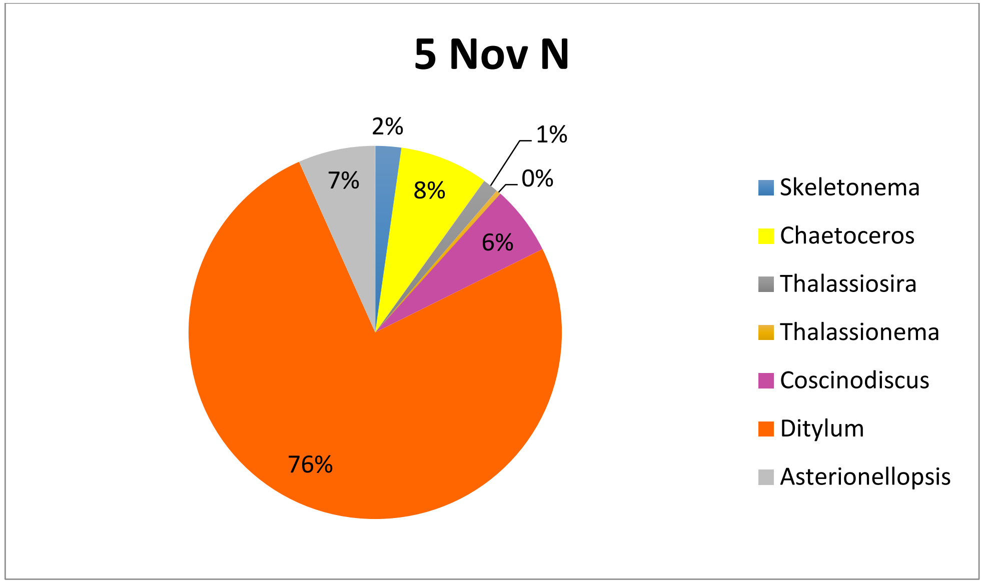

Figure 11a Phytoplankton Composition November 5 Cruise North

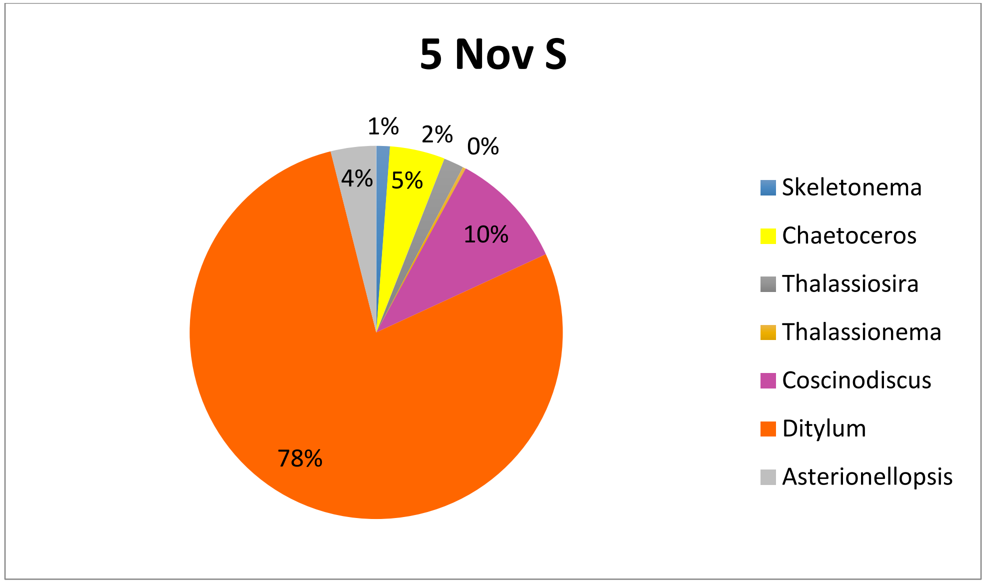

Figure 11b Phytoplankton Composition November 5 Cruise South

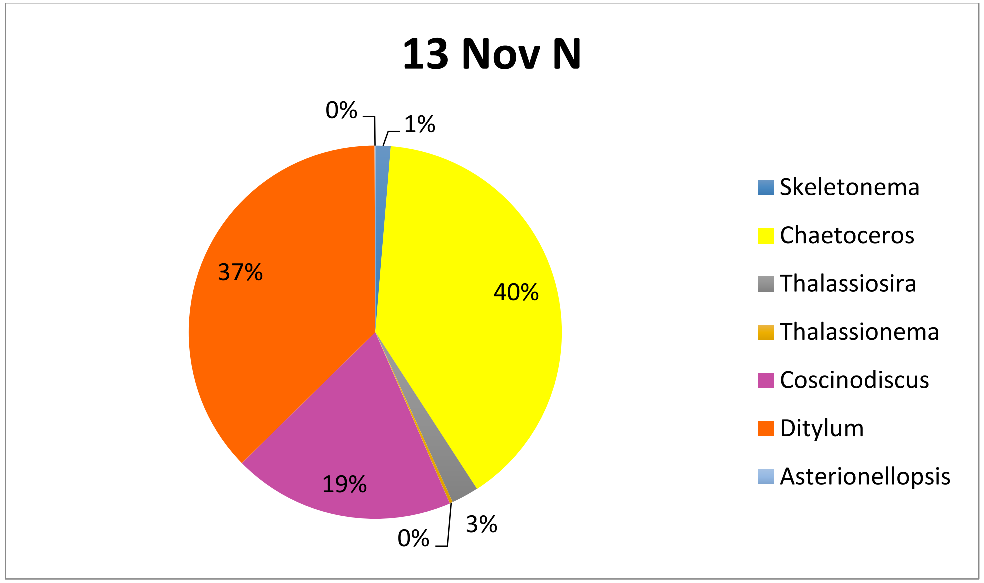

Figure 12a Phytoplankton Composition November 13 Cruise North

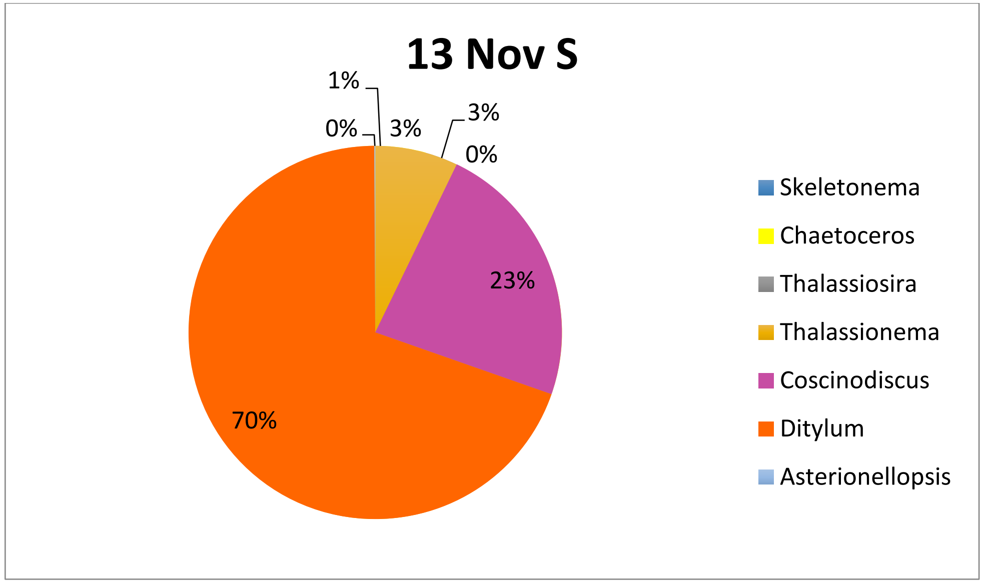

Figure 12b Phytoplankton Composition November 13 Cruise South

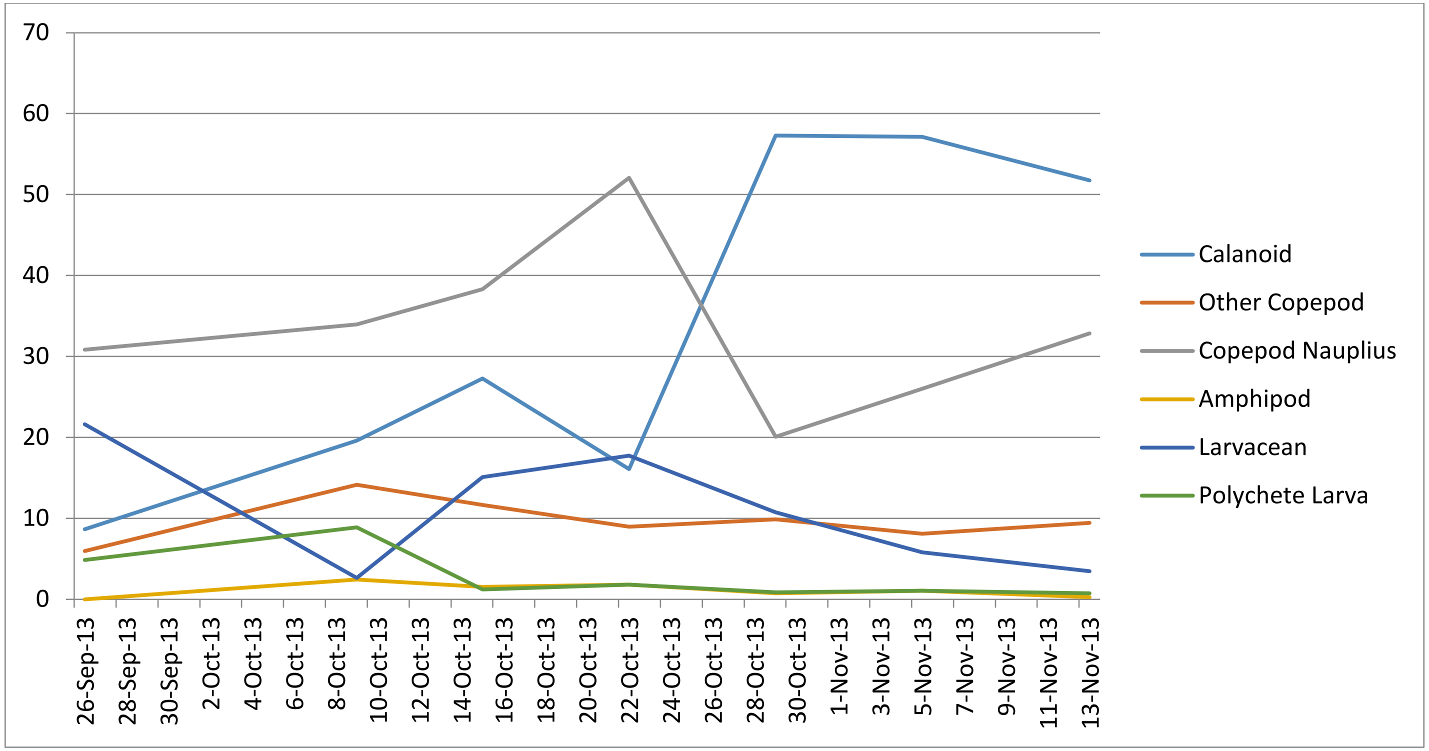

Figure 13. Comparison with Zooplankton North station

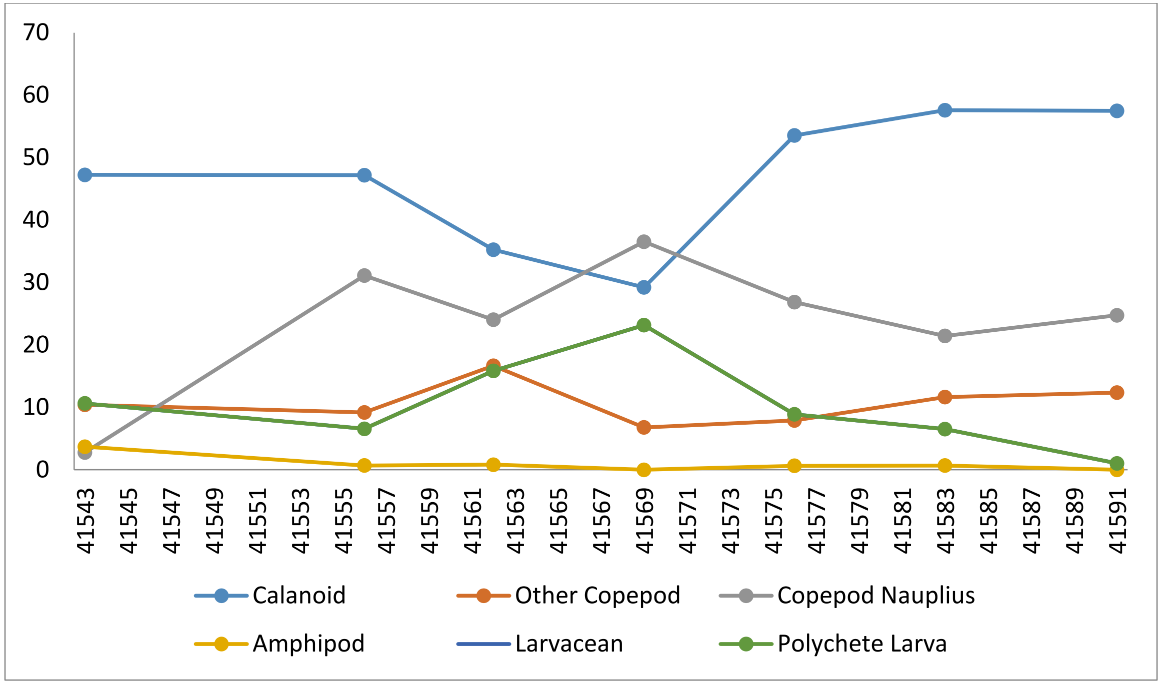

Figure 14. Comparison with Zooplankton South station

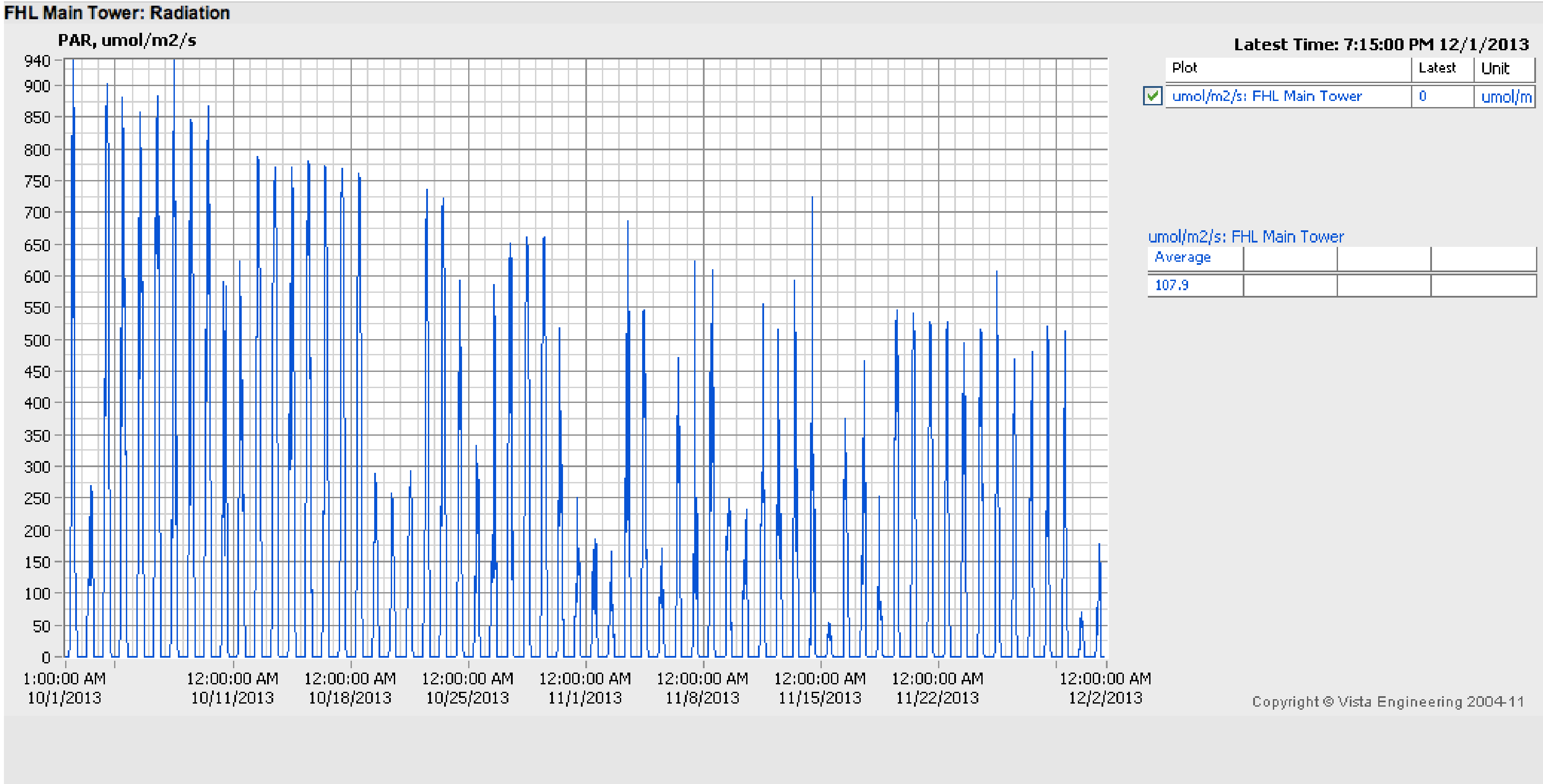

Figure 15. Photosynthetically Active Radiation

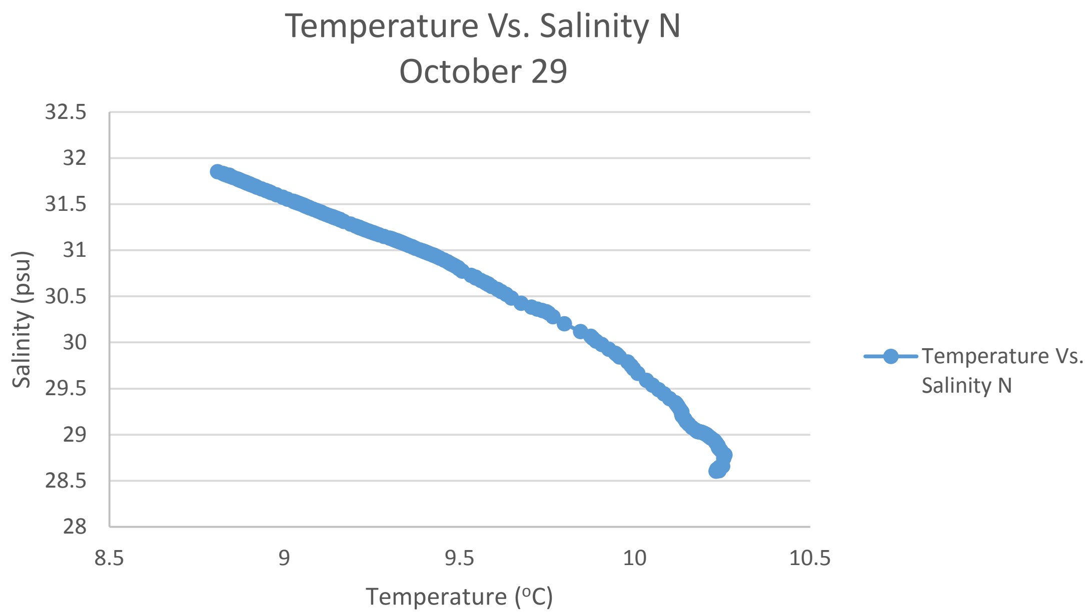

Figure 16. Temperature and Salinity plot for October 29th Cruise