

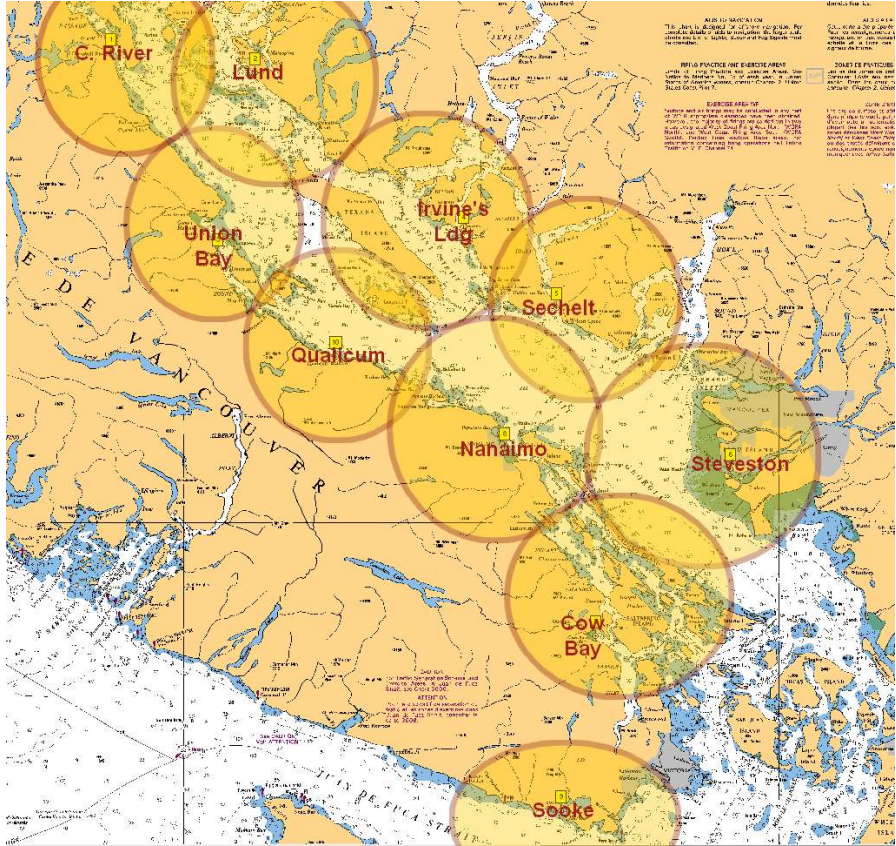


A review of unusual phytoplankton dynamics and oceanographic conditions favoring diatom growth in the Strait of Georgia, Canada 2015



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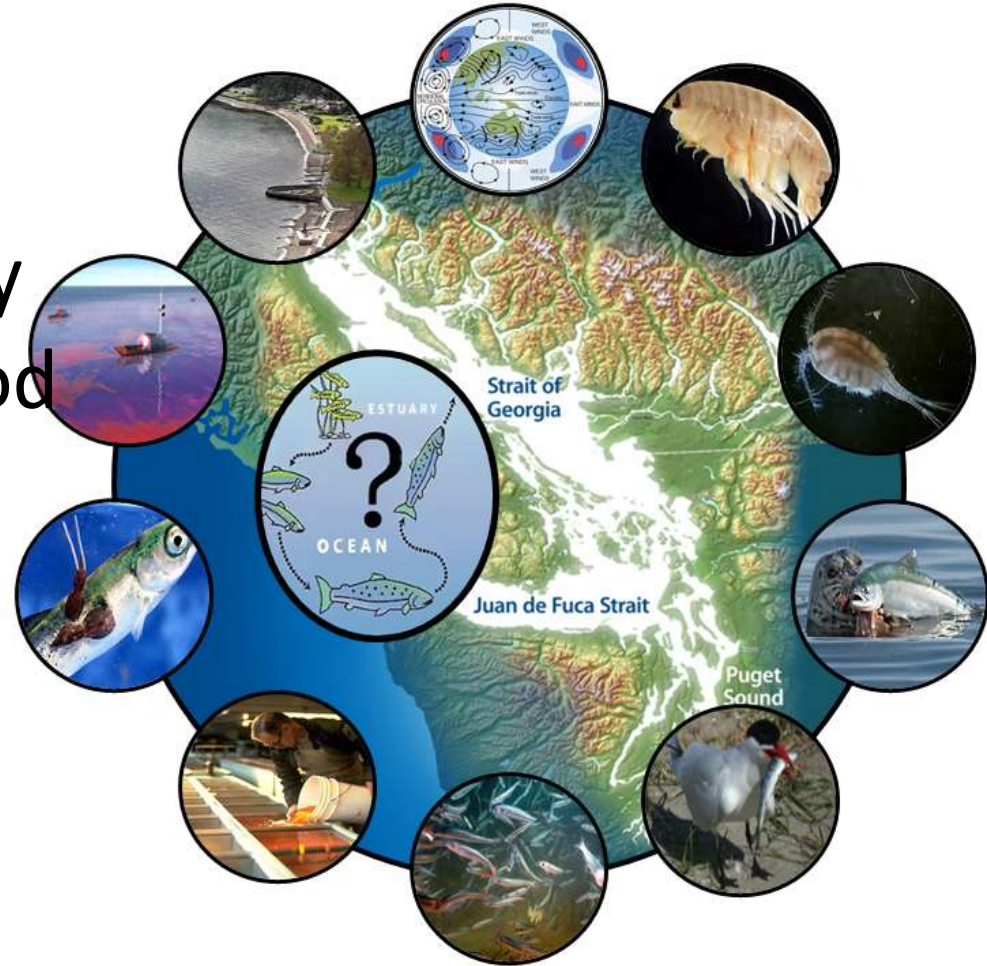
Strait of Georgia, Canada



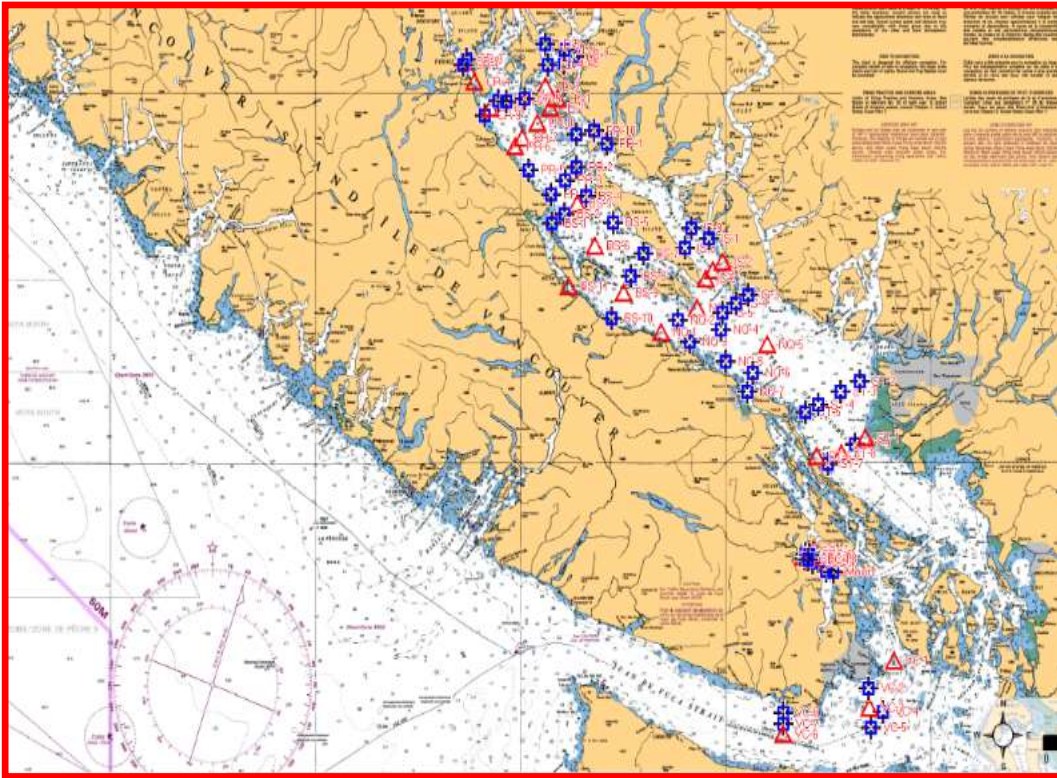
Salish Sea Marine Survival Project

Over 40 organizations are working internationally to examine the level of mortality during this early marine period and factors affecting the **survival of juvenile** Chinook and Coho **salmon**

marinesurvivalproject.com



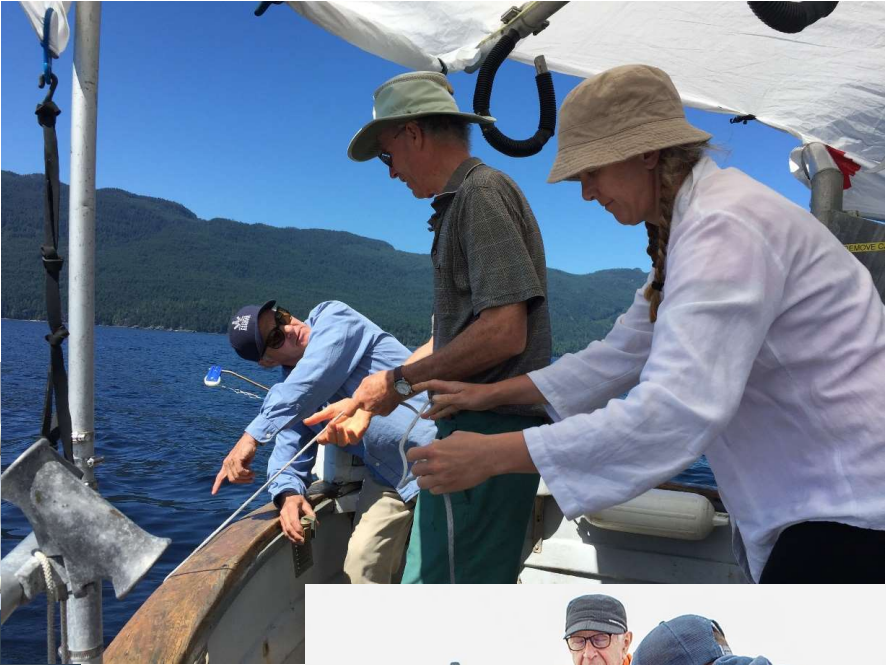
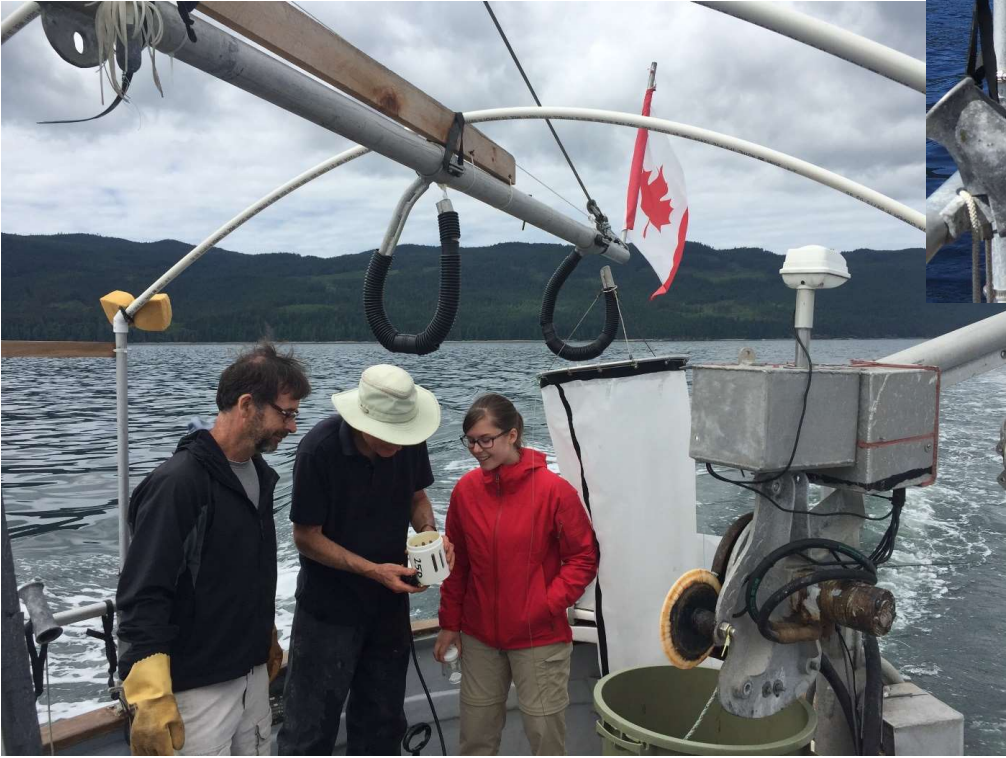
Sampling



temperature, salinity,
density, nutrients
fluorescence, oxygen,
turbidity,
nutrients (nitrate+nitrite, silicate, phosphorus),
zooplankton,
phytoplankton

- ~ 80 locations are sampled every ~2 weeks
- From February to October

Citizen Scientists



Phytoplankton sampling

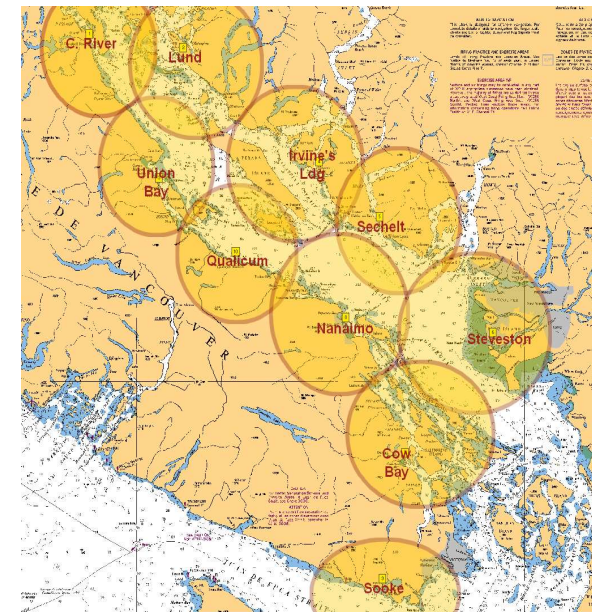
- Most of the station sampling at the surface, 1 station at 0, 5, 10, 20 m
- Samples preserved with Lugol's Iodine, processed under light microscope
- Samples:
 - 1300 in 2015
 - 2000 in 2016



Observing non skeletal Dictyocha in the field
Cowichan Bay, summer 2016

Summary grid with the average biomass per area for the year 2015

	February 18	March 12	March 20	March 27	April 4	April 11	April 18	May 11	May 18	May 25	June 9	June 16	June 24	July 1	July 15	August 6	August 14	September 14	October 5
Victoria	1.5			1.7			1.9	1.4	1.8	1.9	1.6			2.3	2.1	2.4	1.9	2.1	
Cowichan	1.5	3.3	2.2	2.0	2.2		1.5	2.1	2.1	2.0	1.8			2.5	2.9	2.7		2.4	
Nanaimo	1.5	3.6	3.0				2.2	1.8	1.8	2.0	1.6	1.8	1.5	1.5	1.6		1.6	1.5	1.6
Baynes			2.6		1.7	3.4	2.6		1.7	2.2		1.9			1.6	2.1	2.2	1.9	
Campbell	1.8	2.2	2.3	1.5	1.5	1.5	2.4	1.6	1.6	2.5	1.5	2.9	2.1	1.5	1.5	2.4			1.9
Lund	1.5	3.4	2.1	1.5	1.5	1.6	1.6	1.8	1.6	1.9	1.6			1.6	1.5	1.7	1.8	1.5	2.1
Powell	1.5	3.6	2.6	1.8	1.5	2.7	1.8	1.5	1.5	1.9	1.5			1.6	1.7	1.8	1.6	1.7	1.9
Irvine's		3.8	2.6		2.4	4.0	1.9	1.9	2.4	2.2	2.0	2.3	1.8	1.8	1.9	2.2	1.8		1.9
Steveston										2.3			2.0			2.1		1.9	1.6



the spring bloom was recorded extremely **early** with the dominant species being a diatom - *Skeletonema costatum*

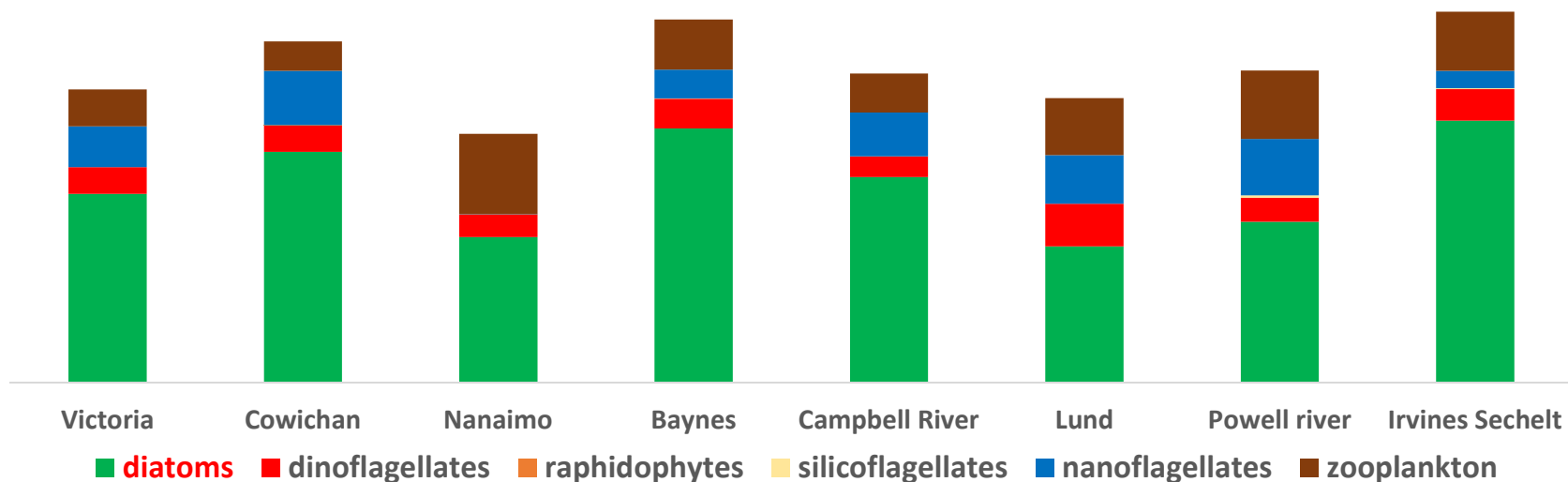
Phytoplankton biomass and composition 2015, Strait of Georgia

The majority of the phytoplankton biomass throughout the sampling season was comprised of diatoms, while the dinoflagellate contribution was unusually low and silicoflagellates and raphidophytes were almost absent

No *Heterosigma* blooms were recorded throughout sampling period (February 18 – October 5)

high

low



Average plankton biomass and its composition for each area from February to October 2015.

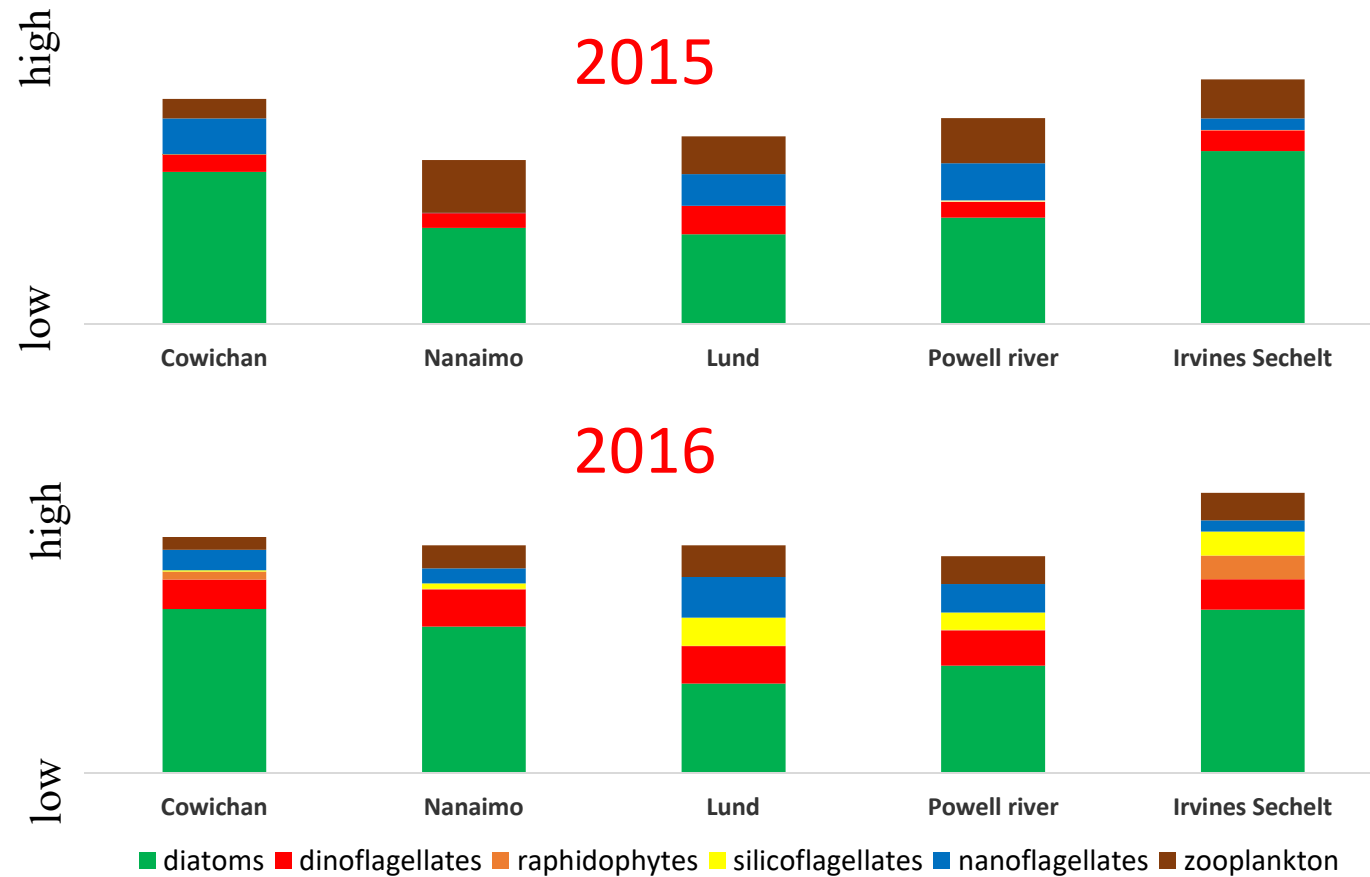
2015 vs 2016 biomass (2016 preliminary data)

2015	2015-02-18	2015-03-12	2015-03-20	2015-03-27	2015-04-04	2015-04-11	2015-04-18	2015-05-11	2015-05-18	2015-05-25	2015-06-09	2015-06-16	2015-07-01	2015-07-15	2015-08-06	2015-08-14	2015-09-14	2015-10-05
Cowichan	1.5	3.3	2.2	2.0	2.2		1.5	2.1	2.1	2.0	1.8		2.5	2.9	2.7		2.4	
Nanaimo	1.5	3.6	3.0				2.2	1.8	1.8	2.0	1.6	1.8	1.5	1.6		1.6	1.5	1.6
Lund	1.5	3.4	2.1	1.5	1.5	1.6	1.6	1.8	1.6	1.9	1.6		1.6	1.5	1.7	1.8	1.5	2.1
Powell River																		
Irvin's Sechelt		3.8	2.6			4.0	1.9	1.9	2.4	2.2	2.0	2.3	1.8	1.9	2.2	1.8		1.9

2016	2016-02-18	2016-03-03	2016-03-18	2016-03-29	2016-04-10	2016-04-19	2016-04-26	2016-05-10	2016-05-17	2016-05-22	2016-06-05	2016-06-15	2016-07-05	2016-07-12	2016-08-02	2016-08-22	2016-09-07	2016-09-21
Cowichan		1.5		1.7		2.8				2.3			2.4					2.0
Nanaimo	1.7		2.2	2.1		2.7				2.6			2.3	2.1		1.8	2.0	
Lund	1.5		1.5	3.2	3.2		1.6			1.6			2.8	2.0	2.0	1.9	1.5	1.5
Powell River	1.5		1.6	2.9	2.5		2.6			1.7	1.8		2.5	1.8	2.4	2.7	1.7	1.5
Irvin's Sechelt	1.7		1.7	2.8	2.6			3.7	3.5	2.9	2.6	2.0	2.8		3.5	3.4	2.2	2.1

Different dynamics: 2016 later start of the spring bloom, higher biomass throughout summer

2015 vs 2016 biomass composition (2016 preliminary data)



Average plankton biomass and its composition from February to October.

Trends:

- 2015 was less productive than 2016
- 2015 had noticeably less dinoflagellates, silicoflagellates, and raphidophytes

Deductive logic – West vs East



Pseudo-nitzschia spp. bloom 2015 on the west coast, but not on the east.

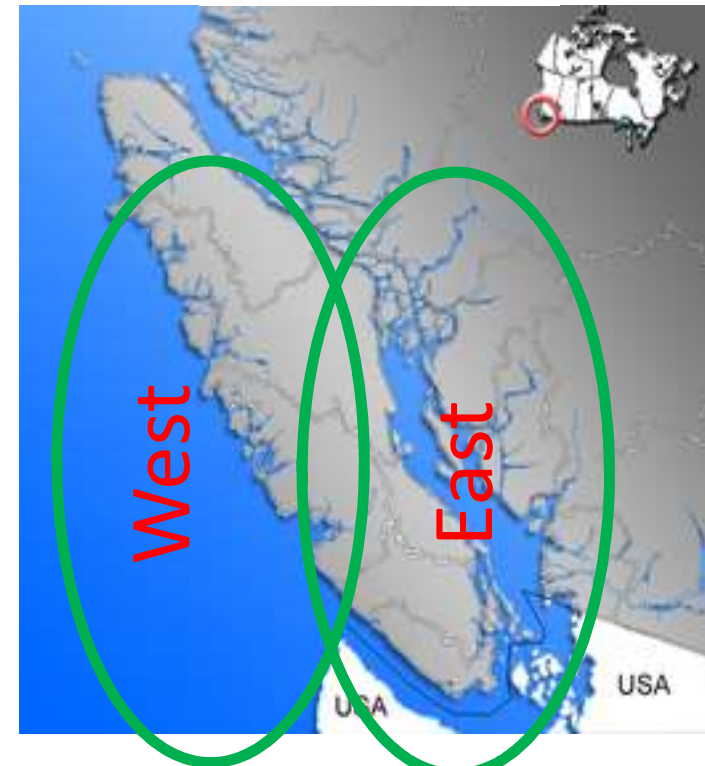
What critical factors were different?

Phytoplankton drivers

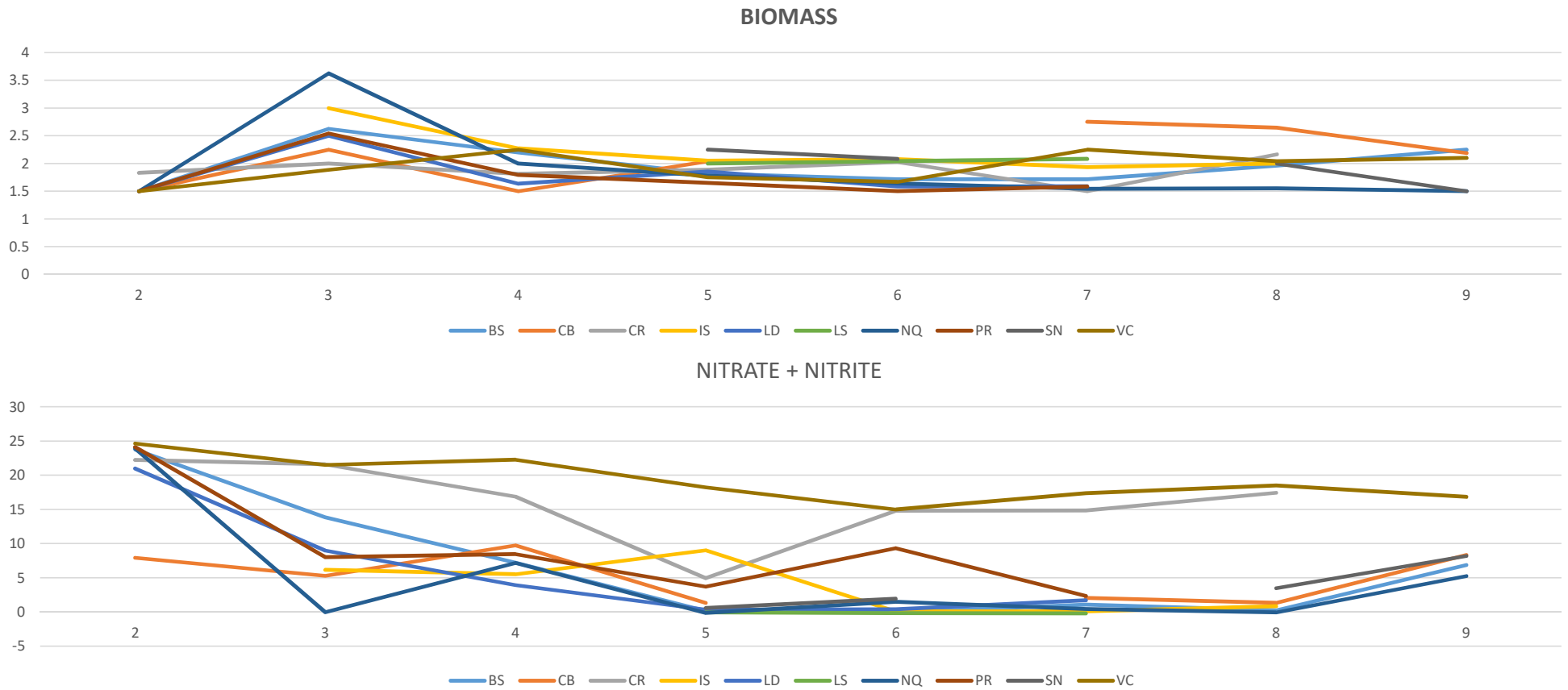
Temperature, sun light

nutrients, stratification

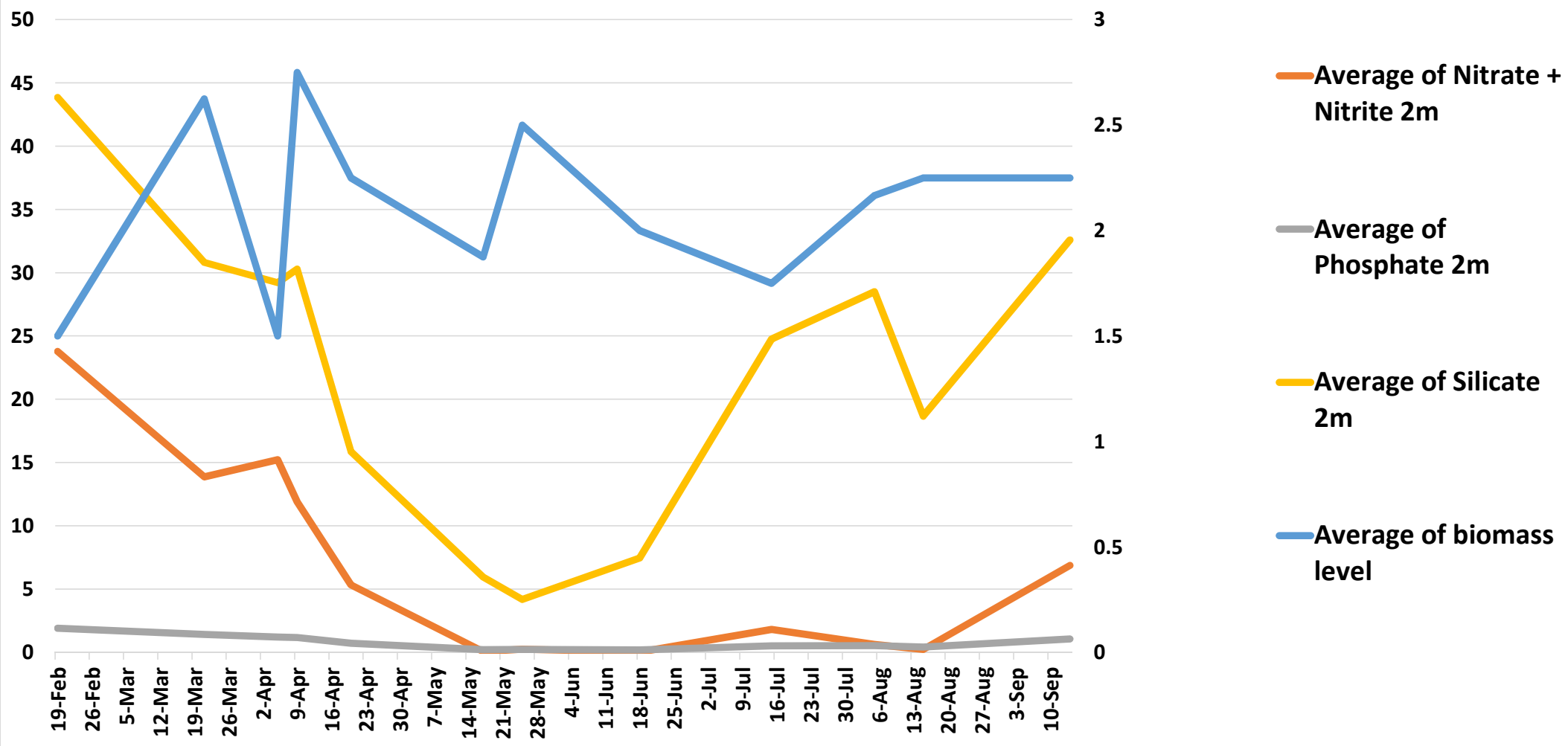
Early bloom



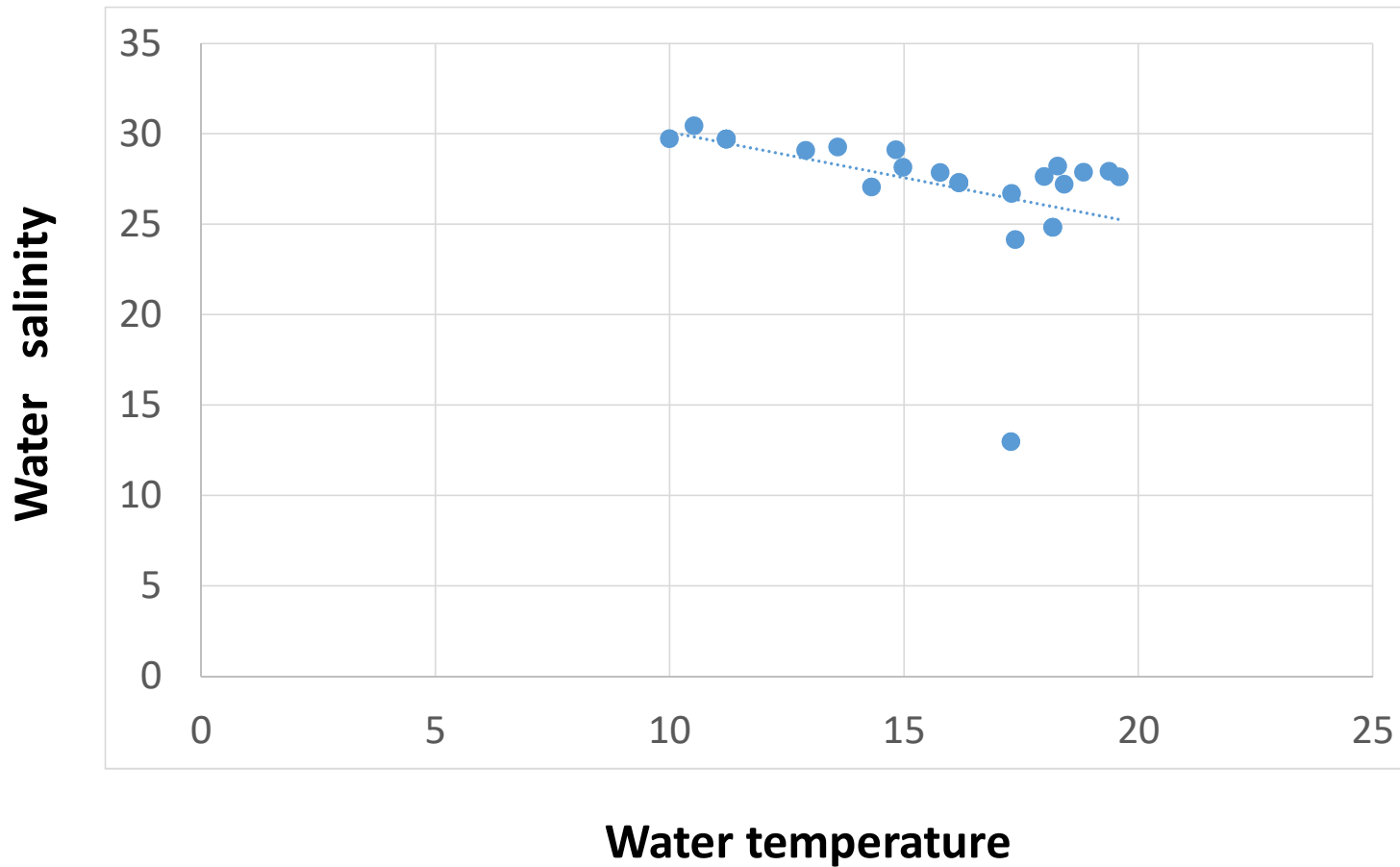
Phytoplankton biomass and nutrients 2015



Averaged nutrients – Strait of Georgia 2015



Pennate diatom – *Rhizosolenia setigera* occurrence



Occurrence of cells
More than 50 cells

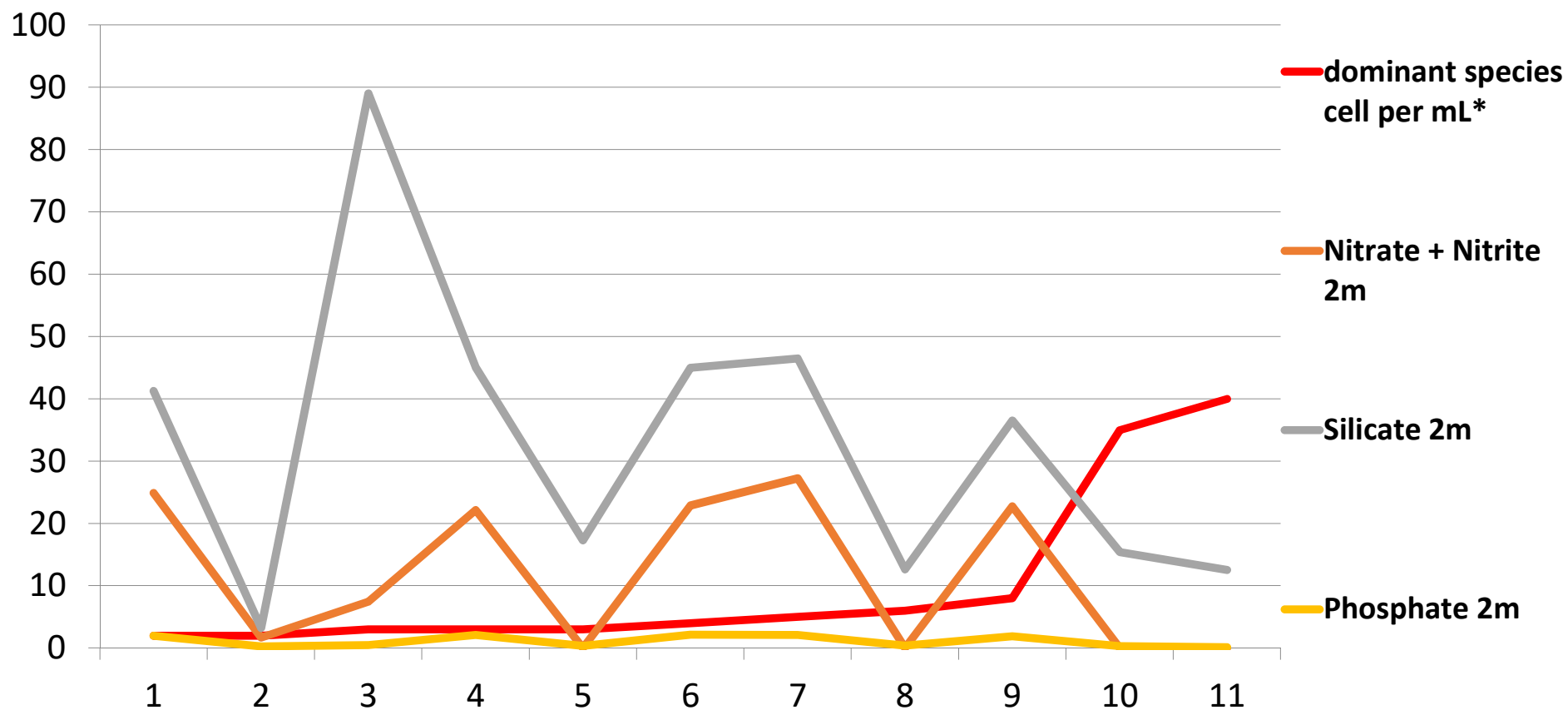
Temperature 18-19.5
Salinity 27-28

All occurrences of *Pseudo-nitzschia* in SoG 2015

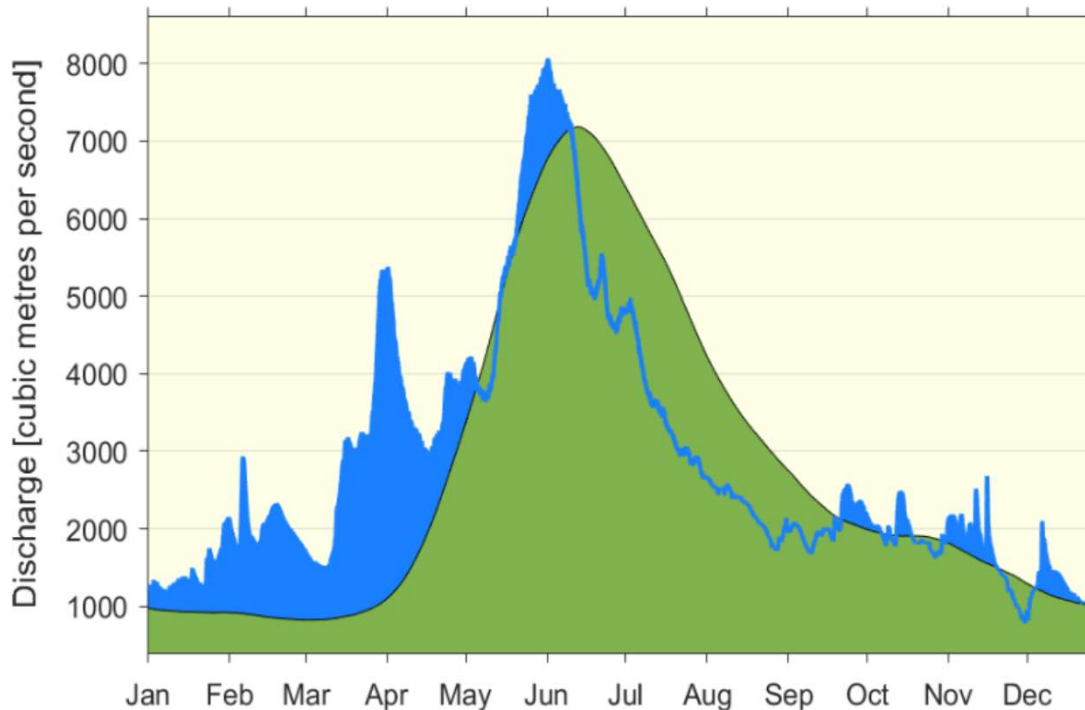
(15 samples out of 1300)

station ID	Date	depth (m)	cell per mL	Nitrate + Nitrite 2m	Silicate 2m	Phosphate 2m	Nitrate + Nitrite 20 m	Silicate 20 m	Phosphate 20 m
Victoria	26 Jan	0	5	27,23395	46,4724	2,0975	25,69586	42,57878	2,042
Victoria2	26 Jan	0	2	24,88155	41,28038	1,984	24,6258	41,56822	1,952
Cowichan	26 Jan	0	3	7,472	89,01808	0,488	25,6855	51,65296	1,993
Victoria	20 March	0	8	22,77376	36,53601	1,88	23,0051	37,00443	1,864
Campbell River	27 March	0	4	22,87762	44,98274	2,1685	22,8725	44,56519	2,131
Campbell River	2 Apr	0	3	22,17029	45,09494	2,111258	22,32975	45,80283	2,113221
Lund	18 Apr	0	2	1,698	3,204011	0,264305	34,692	42,4156	2,002994
Lund	18 May	20	5	0,704	8,504697	0,241683	20,062	40,49692	1,820448
Cowichan	25 May	10	6	0,09	8,019764	0,034	6,358	10,78244	0,535
Ladysmith	17 Jun	0	35	0	15,42149	0,3098	9,3947	26,30706	1,42525
Ladysmith	17 Jun	0	40	0	12,55979	0,144	12,58223	32,07395	1,598
Ladysmith	17 Jun	20	6	0	12,55979	0,144	12,58223	32,07395	1,598
Irvines	1 Jul	0	3	0	17,28751	0,367	25,28497	51,78577	2,265041
Ladysmith	2 Jul	0	6	0	12,61918	0,41525	17,36225	37,53542	2,01315
Campbell River	5 Oct	5	7	24,085	50,87249	2,335977	24,726	50,52655	2,293789

Pseudo-nitzschia spp. at 0m (11 occurrences, in order of ascending from 2 to 40 cell L-1)



Conditions SoG 2015



Fraser River flow at Hope in 2015 (blue) and the average flow based over the past 103 years (data source: Water Survey of Canada)

Snow accumulation was extremely low in southwest BC

A rapid and early snowmelt

River discharge rates at Hope were five times higher than normal in April

Lack of snowmelt later in the summer, and lower than average rainfall (low rivers flow conditions)



“Boom and bust”

Summary

- Unusually early spring phytoplankton bloom was associated with higher than normal water temperatures in the Strait of Georgia and early snowmelt
- Lower summer biomass and dominance of diatoms (low dinoflagellates contribution, silicoflagellates, and raphidophytes) were associated with lower than usual river discharges and rainfall in summer

Stay in touch



- Facebook page “**Phytoplankton - Citizen Science Program**” was created for informal communication between citizen scientists on the topics concerning phytoplankton in the Strait of Georgia

Thank you

- Environmental data – Ocean Networks Canada
<http://www.oceannetworks.ca/>
- Phytoplankton data – Strait of Georgia data Center
<http://sogdatacentre.ca/>
- Contacts:
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