Biophysical Coupling in the Strait of Georgia (STRATOGEM)

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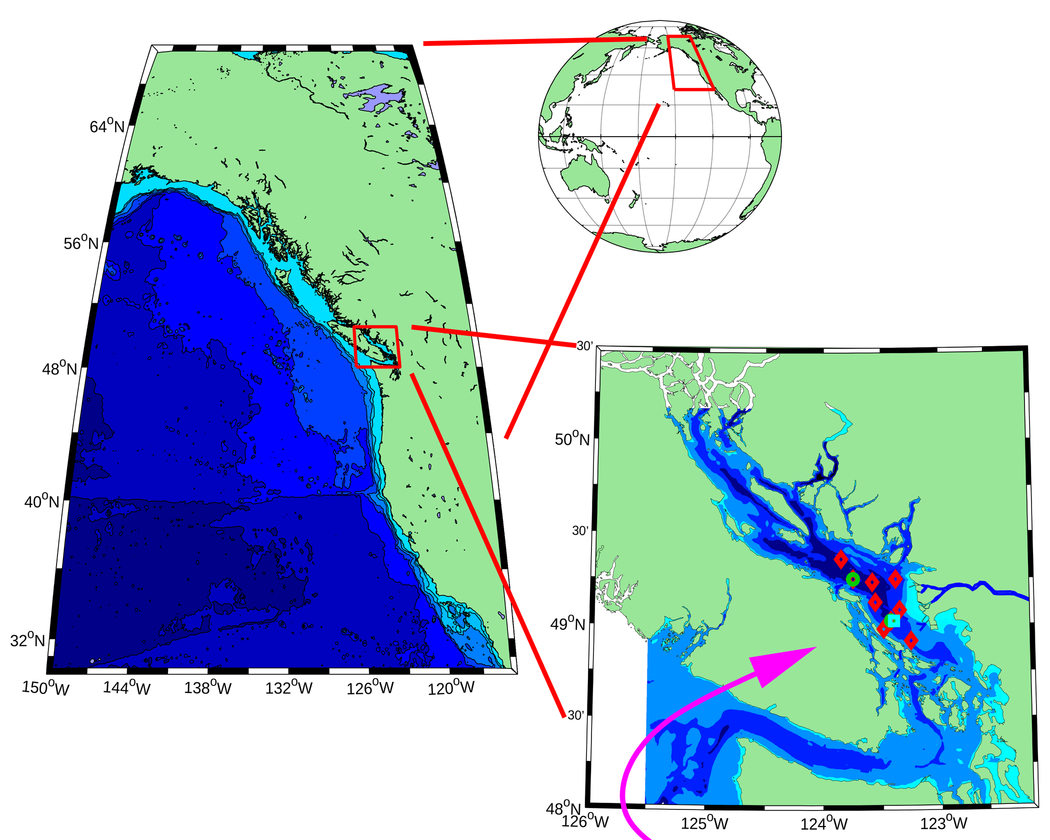
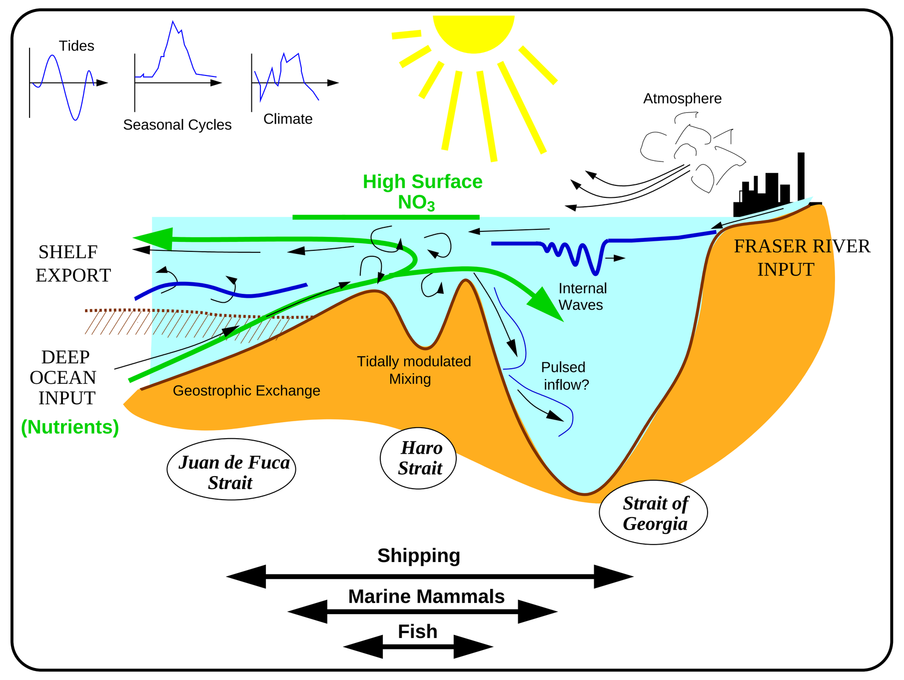
Automated nutrient analyzer clogged up with hydroids



Introduction:

The Strait of Georgia is a highly productive, semi−enclosed, marine ecosystem located between Vancouver Island and mainland British Columbia. In recent years the Strait has undergone considerable changes, many of which are tied to the rapid population growth. These changes have included increased usage of the Strait for both commercial and recreational purposes, reduced air−quality, and increases in sewage and other effluent. There have also been significant changes in the marine ecosystem. Surface water temperatures have warmed by about 1C since the 1960's. Certain fish species have been fished virtually to local extinction. There are increased occurrences of red tides. Key zooplankton species are now arriving about a month earlier than they did historically. The public's attention was caught by the highly visible collapse of salmon stocks in the late 1990s.



This schematic illustrates the basic physical mechanisms at work in the Strait of Georgia − further details available on request.

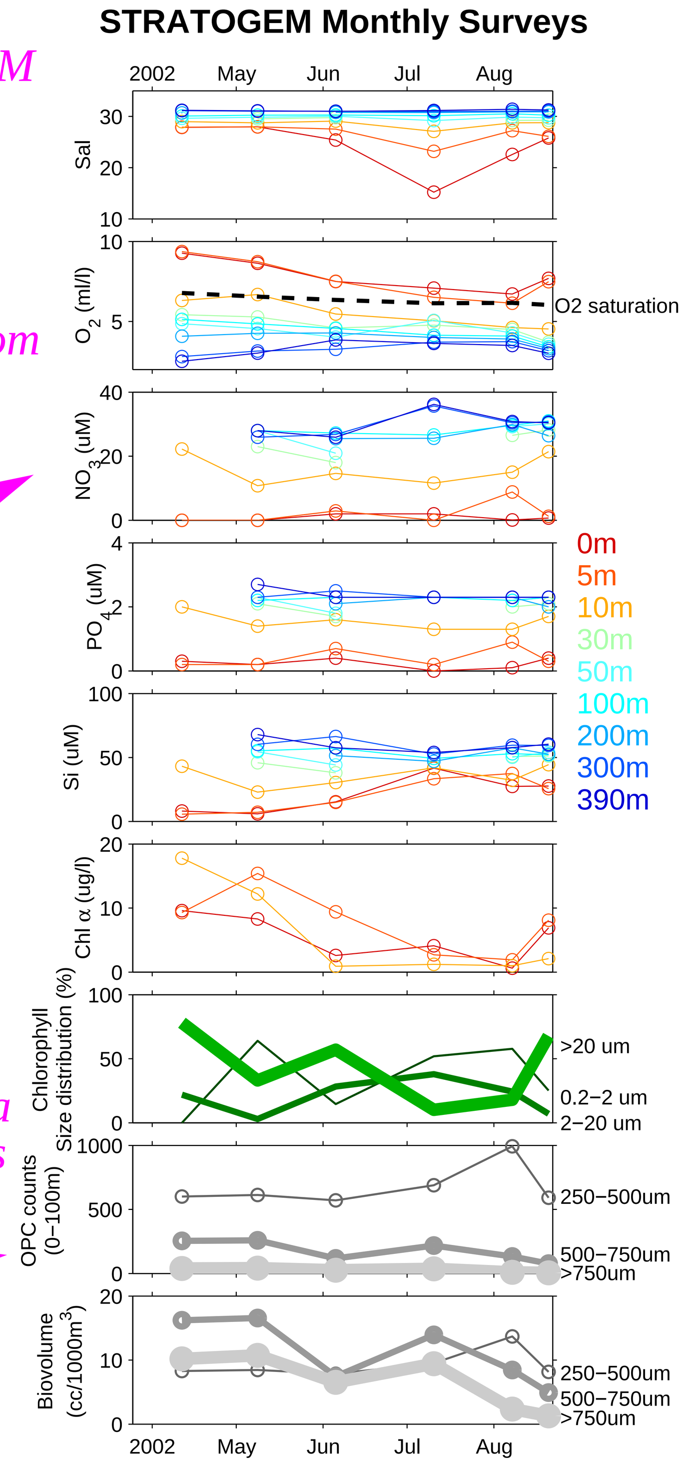
To date there has been little recognition of the role played by natural physical variability in regulating biological production in the Strait. However, a growing body of evidence suggests that changes in the productivity and structure of this and other marine ecosystems are likely due to interannual variability in the linkages between physical and biological processes. Our research project STRATOGEM is an attempt to understand the links between the lowest levels of biological productivity and the physical dynamics of the system. The project will tie together a 3 year monitoring program with computer models of the circulation and biological dynamics. Monitoring began in April 2002.

Field Program:

STRATOGEM stations

Bottle data from station S4−1

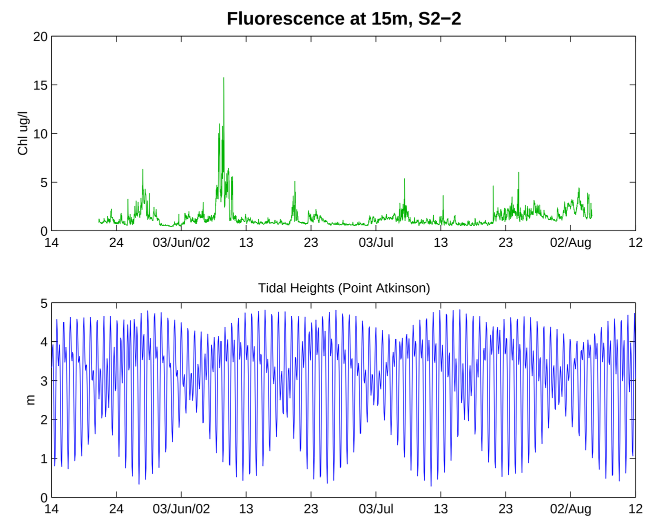
Zooplankton data for all stations



Monthly monitoring

Using the high−speed capability of the CCG hovercraft SIYAY, we sample a suite of physical and biological parameters at 9 stations in the southern Strait of Georgia (a track of 180km) as a day trip once a month to form a baseline for other studies.

This monthly sampling will continue for 3 years, with weekly sampling during the spring bloom and freshet periods.



Fluorescence record in mid−Strait

Moorings

A fluorometer and an automated nutrient analyzer (see photo upper right) have been added to current meter moorings in the Strait (collaboration with R. Thomson, IOS).

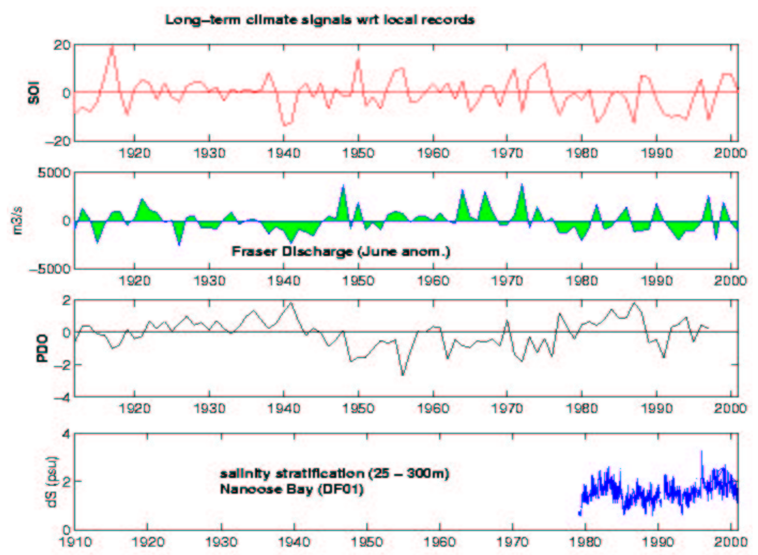
Ferry data

In cooperation with J. Gower (IOS), we are instrumenting several ferries that traverse the Strait of Georgia many times each day to provide a near−continuous record of surface properties.

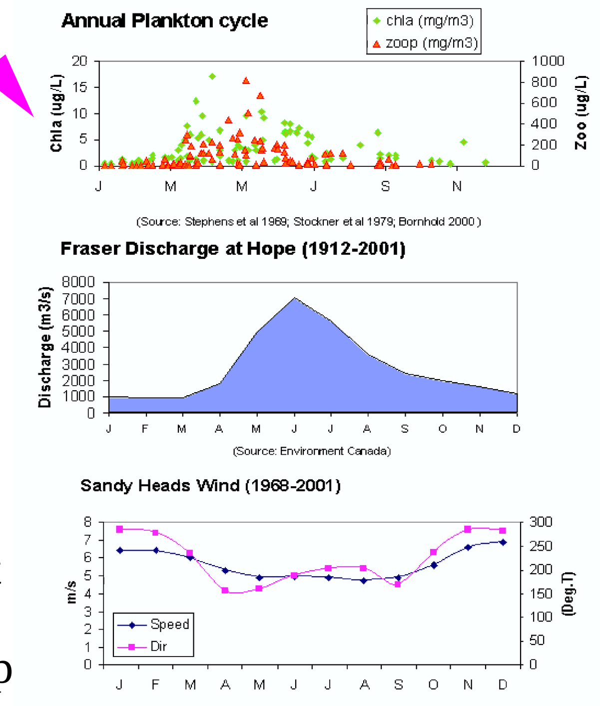
BC ferry steaming past an internal wave packet in the southern Strait of Georgia (pretend it's collecting data).

Historical Data:

Historical chl and zooplankton data with forcing variables.



Climate signals.

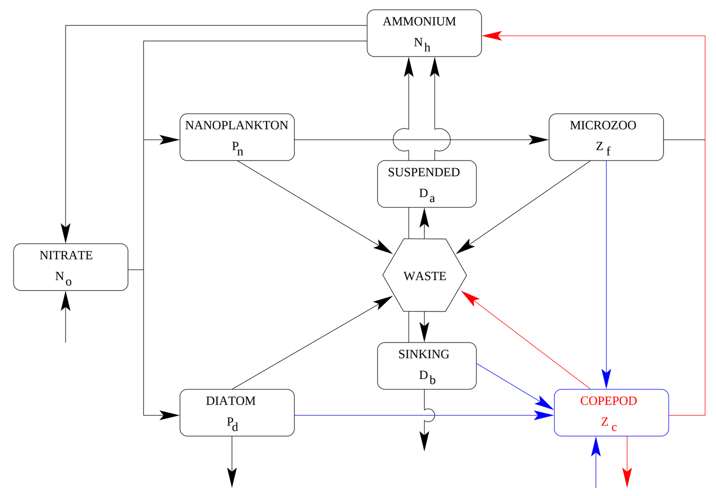


Long−term climate signals (SOI and PDO) are evident in local records. June discharge anomaly correlates well with +ve SOI and −ve PDO variations, while deep salinities also exhibit decadal patterns.

The seasonal cycle shows that in winter, strong southerlies and a weak Fraser flow give the Strait a weak stratification. In summer, greatly increased discharge and weaker winds result in a stratification that may determine the biological productivity.

Modelling:

We plan to couple a complicated NPZ model (see figure) with a 1−D vertical and a 2−D slice physical model. The physical model is based on the mixed layer KPP model. The biological model was initially developed for the open Pacific. It includes a life−history model for *Neocalanus plumchrus*, the dominant copepod in the Strait. The model will be used to investigate the timing of the spring bloom, summer productivity and the role of *Neocalanus plumchrus*, in controlling the phytoplankton abundances. Modelled and observed interannual variations will be compared to an ECOSIM model of the Strait.

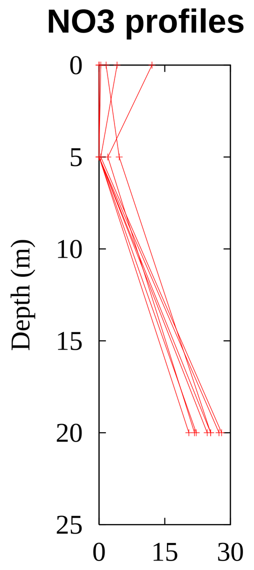


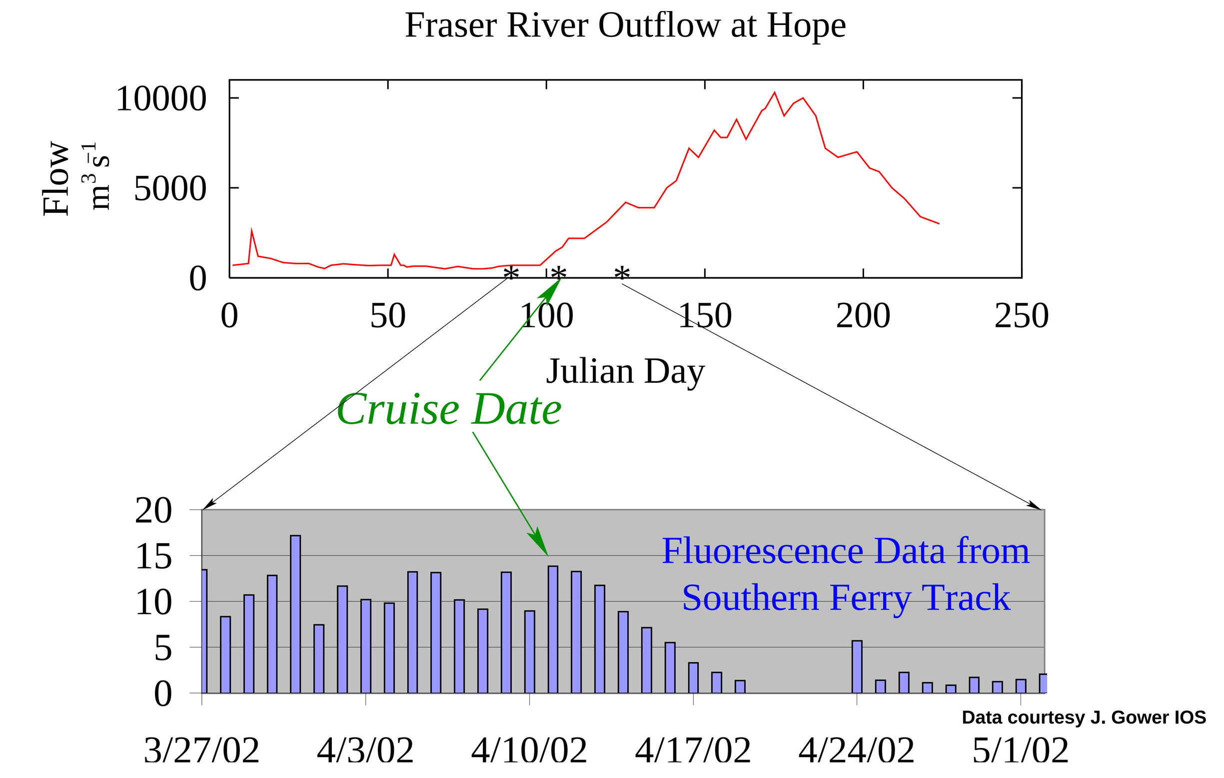
Jeffery 2002, Modelling a phytoplankton dichotomy. Phd thesis, UBC.

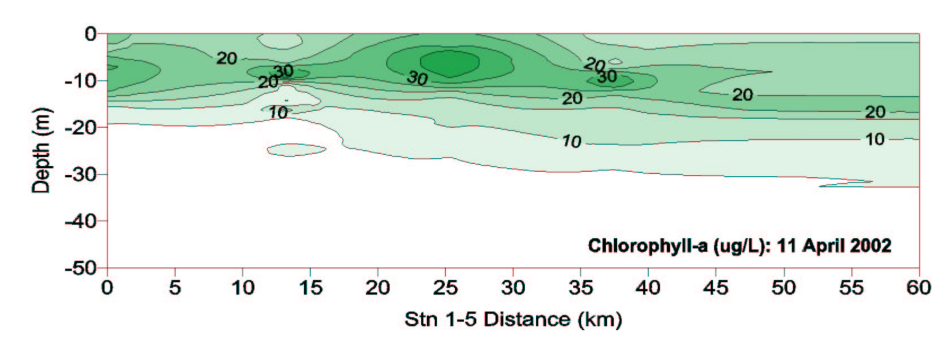
Large et al 1994, Oceanic vertical mixing Rev. Geophys. 32: 363−403.

Walters et al 1997, Structuring dynamic models from trophic mass−balance. Rev. Fish. Biol. Fisher. 7: 139−172.

Preliminary Results: 2002 Spring Bloom







In 2002 the Fraser River freshet started at Hope on about April 10. Our Hovercraft survey took place one day later.

The theory of Yin et al. (1992) for the timing of the Spring Bloom predicts that the bloom occurs after the freshet starts. The increase in fresh water flow is needed to stratify the water column. However, in April 2002 we observed the bloom to be well underway at the start of the freshet.

Evidence from the ferry fluorometer shows that our sampling day occurred at the peak of the bloom at the depth recorded by the ferry. The upper water column was stratified throughout the Strait, nitrate was exhausted at the surface at 6 of 9 stations and maximum fluoroscence and Chla occurred sub−surface.