Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 12 August 2008 **TO:** 31 August 2008

SCIENCE CRUISE NUMBER: 2008-27 **SHIP'S PATROL NUMBER:** 08-06

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Victoria Fabry (CSU-SM)	Michael Arychuk (IOS)
Karina Giesbrecht (UVic)	Michael Bentley (CWS)
Tansey Hall (CSU-SM)	Ian Beveridge (UVic)
Anissa Merzouk (UBC)	Marty Davelaar (IOS)
Marie Robert (IOS)	Tory Fitchett (OSU)
Olena (Helen) Shevchuk (UBC)	Damian Grundle (UVic)
	Jody Klymak (UVic)
	Ron Lindsay (IOS)
	Johan Schijf (U. Maryland)

AREAS OF OPERATION: North East Pacific, Rivers Inlet, Hakai Passage, Queen Charlotte Sound.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data have been collected along this line since 1956 and show evidence of the impact of climate variability on ocean productivity. It is the only Canadian long-time-series that allows scientists to monitor climate changes in the Pacific Ocean. It is also the best opportunity for other programs (e.g. Universities) to do research in the Pacific since the Line P data give them background as well as current water properties. In addition, it is the best occasion for other projects (e.g. Universities) to access offshore waters.

This cruise (2008-27) went really well. We completed all the stations along Line P even though we had to modify the order towards the end of the Line to avoid some bad weather. We looked for an eddy on the return leg using the Moving Vessel Profiler (an instrument towed behind the ship while sailing that continually records Temperature, Conductivity, Pressure, Dissolved Oxygen and Fluorescence down to about 250 m) without success. We did not sample any of the Line R stations but accomplished all our planned work in Queen Charlotte Sound (SS Line), Rivers Inlet and Fitz Hugh Sound/Hakai Passage. Vicki Fabry collected some pteropods that we delivered in Bamfield for a project led by the BBC. We also surveyed the west coast of Vancouver Island over La Perouse Bank for a short time with the MVP. Unfortunately the instrument was lost at the end of the cruise while sailing in Juan de Fuca Strait.

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CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography sections, deploy Argo float, and get CTD data using the MVP.

DAYS ALLOCATED: 20 **DAYS OF OPERATION:** 18

DAYS LOST DUE TO WEATHER: ~ 10 hours, one station cancelled.

RESULTS:

- The Line P survey was totally successful; all stations were sampled.

- Only 1 station was cancelled on the SS Line, the Rivers Inlet and Hakai Passage stations were all completed.

- No station was done on Line R.

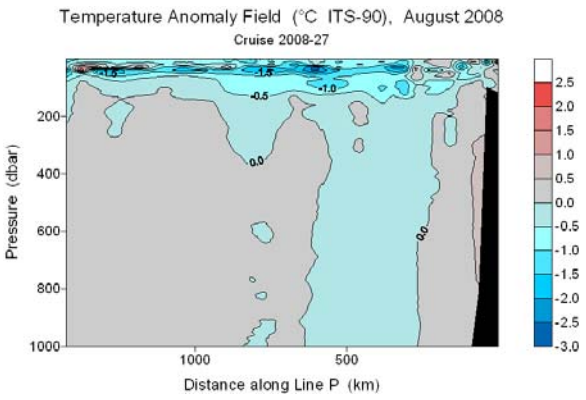
- Two Argo floats were deployed and reported successfully.

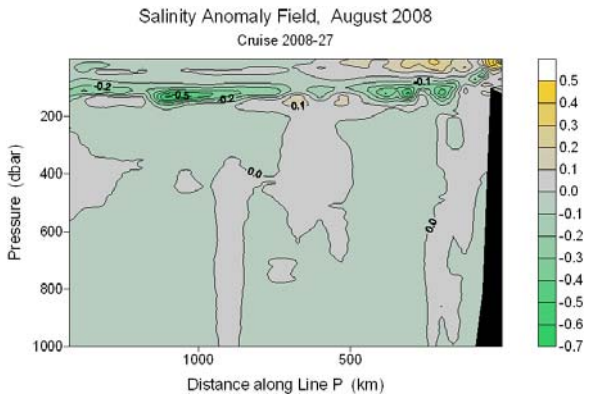
- The samples collected include:

  - Underway: T, S, fluorescence, pCO_2, acoustic sounder, pigment analysis (HPLC and fluorescence derived chlorophyll), pad absorption (to quantify functional absorbance and within-cell packaging effects) particulate carbon/nitrogen, discrete flow cytometry samples, ^{14}C productivity experiments, and continuous measurements of beam attenuation (Wetlabs ac-s), variable fluorescence (Chelsea fast repetition rate fluorometer- FRrF), and photosynthetically active radiation (Biospherical), water vapour, N_2, O_2, Ar, CO_2, DMS.
  - Discrete (casts): T, S, fluorescence, oxygen, transmissivity, irradiance.
  - Water: oxygen, salinity, nutrients, chlorophyll, HPLC, DIC, Alk, DMS, $DMSP_d$, $DMSP_t$, pH, ONAR (Oxygen, Nitrogen, ARgon), Bacterial genomic, CO_2, CH_4, N_2O, ^{14}C productivity, particulate carbon/nitrogen PCPN, Pad absorption, discrete flow cytometry samples.
  - Zooplankton using vertical and oblique net hauls.

M. Robert: water masses.

As they were during June 2008, the water masses along Line P are still slightly colder than the 1956-1991 average, as well as fresher between ~100 and ~200 dbar. The colder anomalies are situated between 50 and 100 dbar.





V. Fabry, J. Schijf, T. Hall: Dissolution kinectics of aragonitic pteropod shells

Using information that resulted from our work on the Line P in August 2007, we re-designed a temperature-controlled, pressurized experimental cell for calcium carbonate dissolution experiments. The new system worked very well. We collected aragonitic pteropod shells from a series of plankton tows, and subjected these freshly collected shells to seawater that was undersaturated with respect to aragonite. Using a high-precision,

spectrophotometric method to measure pH, we were able to detect very small amounts of dissolution. We also took water samples from station P26 (Station Papa) for dissolved inorganic carbon and total alkalinity analyses. We took additional seawater samples and collected pteropod shells from plankton tows and will ship these samples so that we can conduct additional dissolution experiments in the shore laboratory. In plankton tows, we primarily collected two species of euthecosomatous pteropods, *Limacina helicina* and *Clio pyramidata*. The Line P stations are of critical importance to our project because of the shallow depth of the aragonite saturation horizon and because of the ancillary measurements made by IOS scientists. We will complete additional experiments and data analysis back onshore. Near the end of this research cruise, we collected live pteropods and transported them to the Bamfield Station as requested by the BBC. The BBC will film these organisms and use them in a film on the Pacific. We greatly appreciate the opportunity to participate in this cruise. The crew, officers and scientists onboard were outstanding. Owing to their efforts, this cruise was very successful for us.

Damian Grundle (PhD Student, University of Victoria, Canada)

Data collected during this cruise was part of an ongoing 3-year study of nitrification along Line P in the NE Pacific Ocean. The primary objective of this study is to measure the rate of both ammonium and nitrite oxidation (collectively referred to as nitrification hereinafter) at each of the major sampling stations (i.e. P4, P12, P16, P20 and P26) along Line P, and to assess how varying chemical, physical and biological factors affect these rates. While nitrification rates were measured throughout the upper 300 metres of the water column, particular attention was paid to the euphotic zone as we have recently shown that nitrification can occur in this portion of the water column, thus indicating that previously calculated *f*-ratios based on measurements of new and regenerated primary productivity may have been overestimated. A secondary objective is to assess the relative importance of nitrite to the overall nitrogen budget in NE Pacific Waters.

At P4, P12, P16, P20 and P26 samples were collected from 20, 40, 75, 150, and 300 metres for the purpose of onboard incubation experiments to estimate daily rates of nitrification at each station. Water samples were also collected from each of these depths and stations to measure dissolved ammonium, nitrite, nitrate, phosphate and silicic acid concentrations, total bacterial biomass (through the use of DAPI staining) and nitrifying bacterial biomass using FISH (fluorescent *in situ* hybridization). In addition, vertical profiles of temperature, salinity, PAR (photosynthetically active radiation), fluorescence (chlorophyll *a* + phaeopigments), and oxygen were obtained from CTD casts conducted at each station.

A cursory overview of results pertaining to the nitrification rate estimates indicate that ammonium oxidation rates were typically higher than nitrite oxidation rates, and nitrification rates were typically highest between 40 and 75 metres and lowest at 150 and 200 metres. Furthermore, depth-integrated nitrification rates appeared to be highest at P4 and showed a gradual decrease with increasing distance along Line P. These results combined with data to be collected during subsequent Line P cruises will significantly increase our understanding of nitrogen cycling in NE Pacific waters, and will enable us to re-evaluate estimates of new and recycled primary production and the carbon sequestration models which have relied upon these estimates.

I am extremely grateful to Marie Robert and the rest of the IOS science party for enabling me to participate in this cruise, and for providing a very organized and efficient sampling schedule. Thanks also to Janet Barwell-Clarke for allowing me to use the IOS TD-700 Fluorometer to measure ammonium concentrations. I would also like to thank the Captain and Crew of the CCGS John P. Tully for all their help in the collection of samples and for ensuring that the needs of the scientists onboard were met.

Cruise report for *John P. Tully* mission 2008-27 (08/12/08 – 08/31/08)

Educational outreach: Johan Schijf, assistant professor, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science

While on the team of Dr. Victoria Fabry, who is funded by NSF to study the effects of ocean acidification on pteropod aragonite, I conducted a small educational outreach project. This project was conceived by myself and presented as the educational outreach component of a recent proposal to NSF. A majority of the actual work was conducted by CBL Regional Marine Specialist Dr. Jacqueline Takacs, who is a tenured member of our faculty and coordinates educational

outreach with the help of a dedicated staff assistant. CBL has an extensive record of comprehensive educational outreach to local schools and the general public. The flagship of this effort is our Visitor Center in Solomons, MD, which highlights current CBL research with revolving displays and weekly guided tours of our laboratories and facilities. The Center welcomes thousands of visitors each year from all over the USA and is operated entirely by volunteers (mostly local retirees and students) who receive regular refreshers on the latest scientific developments.

To provide a window on ocean acidification research and what working on a scientific vessel at sea is like, I maintained a web log ('blog') using the newly installed internet system on the *John P. Tully*. Daily bulletins of our activities were posted by Dr. Takacs on a special website linked to the UMCES Environmental Science Education Partnership page (www.esep.umces.edu/index.php?area_id=611) and enlivened with digital pictures taken by me during this mission and a similar one last year (2007-15). In addition, the site contains a brief summary of the importance of, and principles behind, ocean acidification, as well as a link where the public can submit questions, which were also posted along with my answers. Only a handful of questions were submitted during the cruise, but since the site will continue to be available and regularly updated and improved, we anticipate that more may come in. The blog was initially meant to focus on middle and high school students, but due to the timing of the mission Maryland schools were not yet in session. We therefore targeted teachers in the hope that they can convey some of their experiences in their science curricula. A special workshop "Climate Change and the Aquatic Environment", funded by the Eileen Setzler-Hamilton Foundation, was organized to coincide with the start of the mission and involved presentations by CBL faculty on related Arctic research, a visit to my laboratory narrated by graduate student Katherine Davis, and a day trip to Chesapeake Bay aboard CBL research vessel *Aquarius*.

This successful project would not have been feasible without the new internet capabilities of the *John P. Tully*, which enable rapid transmission of both text and pictures during any time of the day or night. When the vessel was temporarily out of internet range (beyond station P-20) daily bulletins continued to be submitted through the old satellite e-mail system, however this is only uplinked a few times per day and does not easily accommodate large attachments such as picture files. Educational outreach efforts like this are ever more highly valued by federal funding agencies and have become an integral component of grant proposals and an important criterion in award decisions. The continued financial and technical support of the internet system on the *John P. Tully* and other DFO vessels therefore deserves the Department's full dedication and attention.

Anissa Merzouk and Helen Shevchuk, UBC, Line P – August 2008

Objectives:
Establish underway surface and depth distributions of the climate active gases nitrous oxide (N_2O), methane (CH_4), carbon dioxide (CO_2) and dimethylsulfide (DMS), measure underway surface O_2/Ar gas distributions to infer Net Community Production, and describe the taxonomic and metabolic diversity of the bacterial communities involved in the cycling of these gases along Line P.

Sampling plan:
Measure dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar) and DMS continuously at the surface using a membrane inlet mass spectrometer (MIMS).

At 11 surface stations along Line P, filter large volumes (20 L) of seawater at the surface to create DNA and RNA genomic libraries of the bacterial communities and identify bacterial genes involved in sulfur and DMS cycling.

At the 5 major stations, 1) measure the bacterial abundance and the concentration of greenhouse gases (CO_2, CH_4 and N_2O) along a 12 depth-vertical profile, 2) filter 1 L samples at 12 depths for high resolution bacterial DNA and RNA extraction and sequencing; and 3) filter large volumes (up to 120 L) of seawater at 4 depths across the oxygen minimum zone (OMZ) to create genomic libraries of the bacterial communities.

At Station Papa, viral proteins were precipitated from 0.2 μm filtered seawater and will be examined to see if this may be a useful and interesting protocol to add to our regular Line P agenda.

Comments:

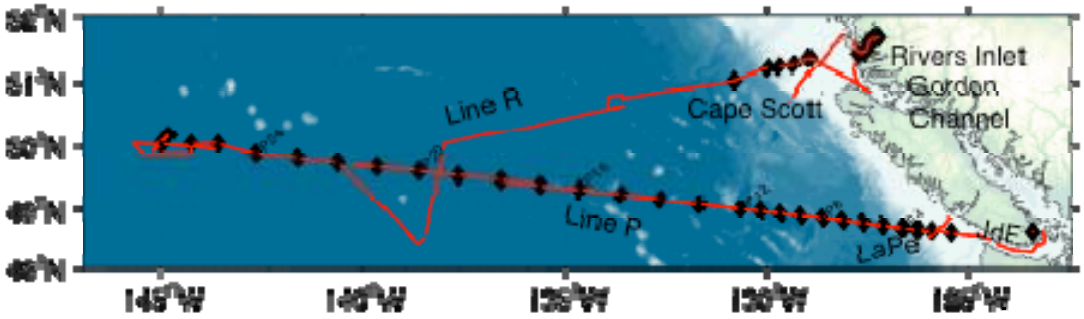
The sampling and filtering for all the bacterial genomics work went smoothly. This is the first time we have taken such large volumes at depth (120L) and we hope this will provide enough DNA for our purposes.–Salinity samples were taken from all Niskins for our of large volume samples which will help to identify any rosette mis-firings.

The operation of the new MIMS instrument went smoothly for most of the trip despite problems with the ship's intake pump, which was shutdown and replaced with a second pump making a lot more bubbles in the loop. These bubbles created more noisy signals for some gases during the 2 days when this second pump was in operation. The new instrument was fitted with a thin membrane that allowed a low detection limit for DMS (1.0-1.5 nM). This cruise was also very exciting in terms of surface DMS concentrations, where concentrations of 20 to 35 nM were recorded for a long section of the transect (P7 to P14).

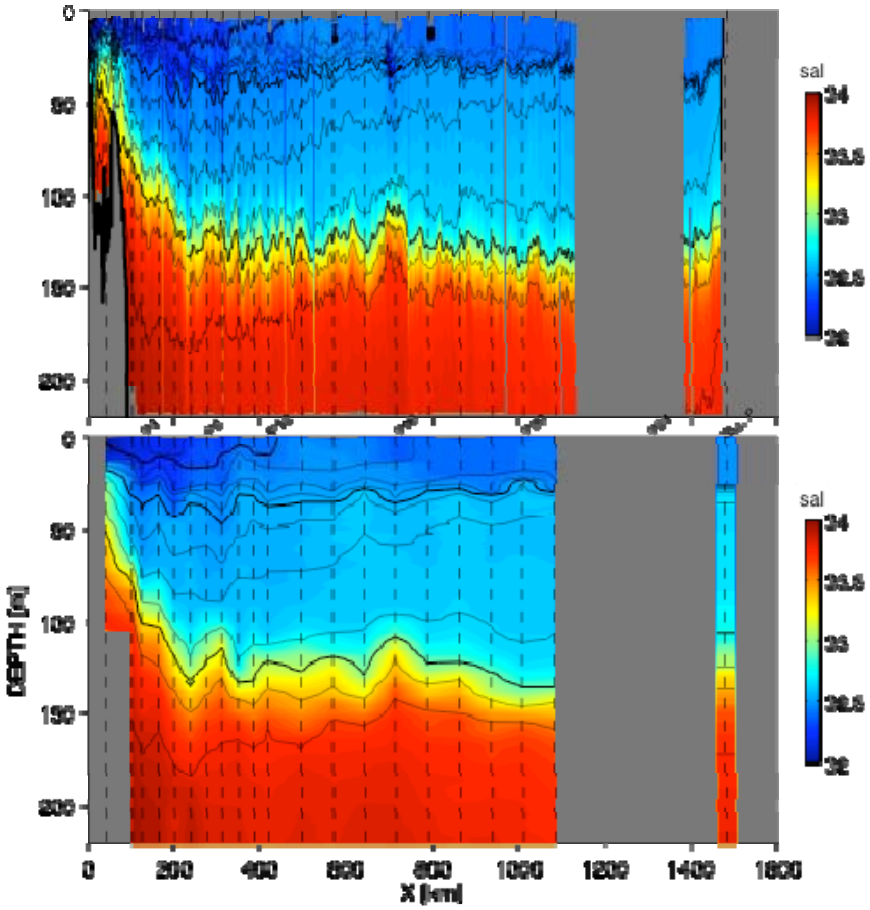
We wish to thank the Tully crew for their assistance and excellent work throughout the cruise. Special thanks to the engineers for repairing the ship's pump in a timely manner. Thanks to the chief scientist Marie Robert and the scientists onboard for their help on deck and in the lab.

J. Klymak and I. Beveridge (UVic) Moving Vessel Profiler

Our objective was to perform high resolution sampling of the upper ocean on the way out to Papa and during the return trip. We also hoped to perform some tidal sampling of the banks near Vancouver Island if time had permitted. Our sampling consisted of a Brooke Ocean Moving Vessel Profiler, a winched system deployed while the ship is steaming between hydrographic stations, and able to perform repeated profiles to 200 m.



Comparison of MVP (top) and hydrographic CTDs (bottom) for Line P. Contours are isopycnals. Vertical dashed lines are ship's CTD locations. The gap in the data was for 1.5 days of weather. The MVP casts are about 1.2 km apart (0.8 nm).



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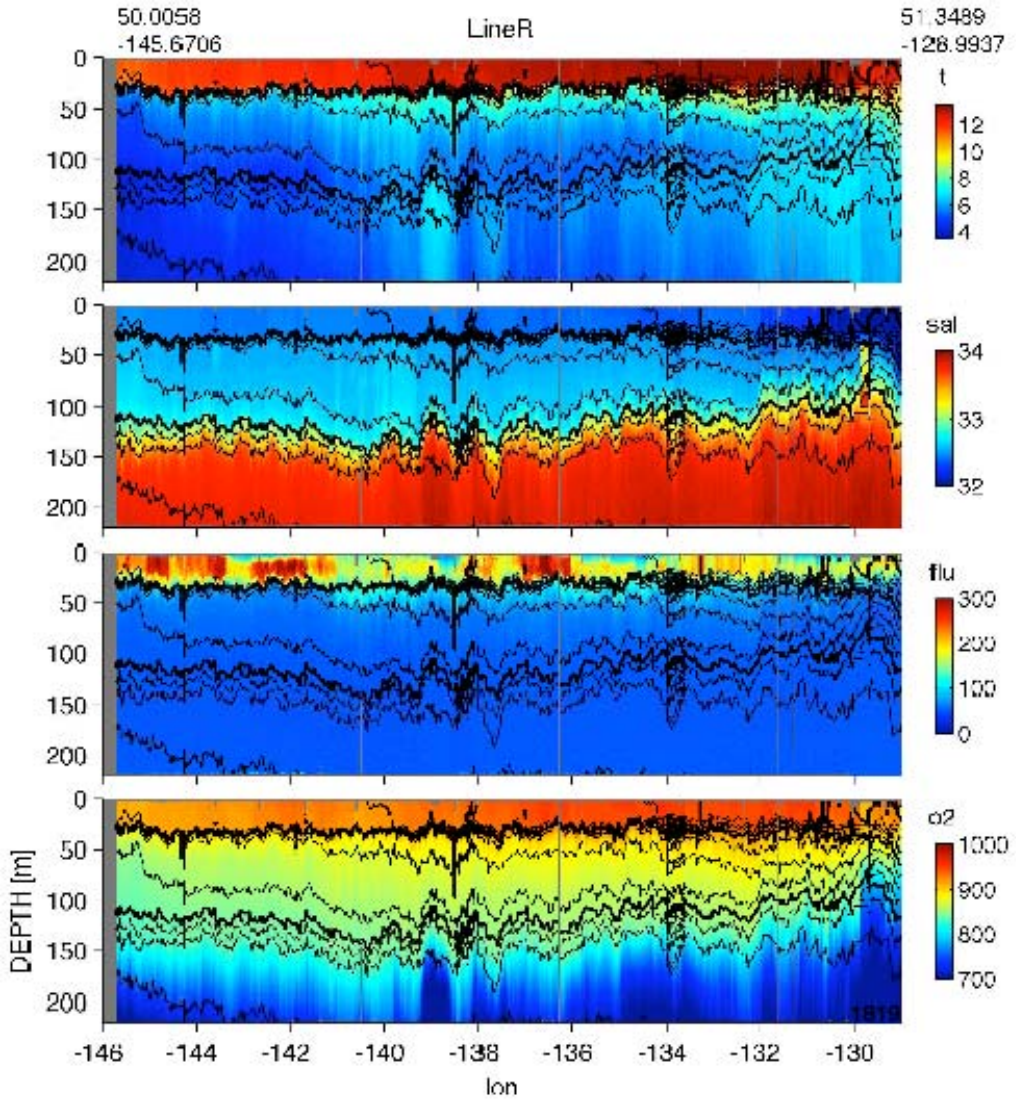
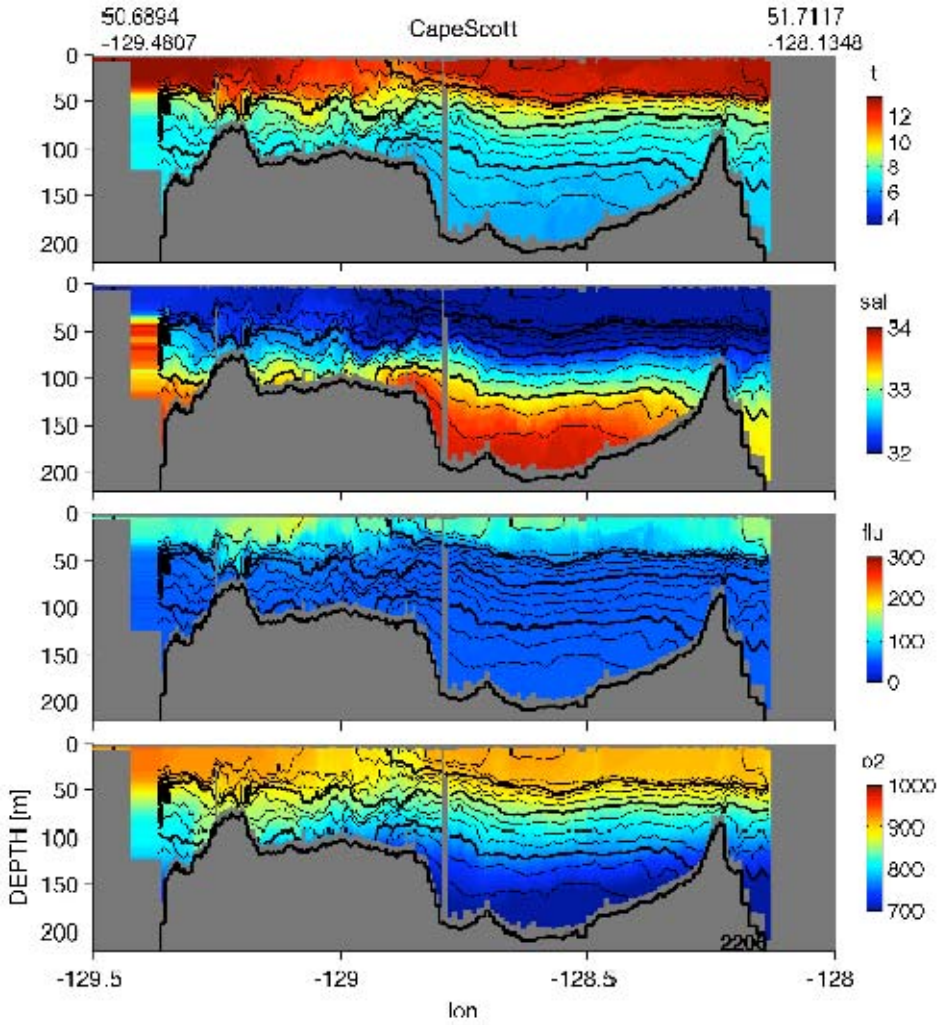
A comparison of the data collected along Line P from the MVP to the ship's CTD is shown below. The gross features in salinity are apparent in each, including the influence of Juan de Fuca water near the start of the line, the upwelling of deep water, and the general decrease in salinity in the permanent thermocline as the influence of California current water is reduced. What the MVP reveals are the scales of the mesoscale features. For instance, the rise in isopycnals at station P16 appears to be a well-defined mesoscale feature of approximately 50 km width. Most strikingly, there is a sudden uplift of isopycnals at Line P that we would not have known the scale of from the routine sampling.



MVP data along line R. Note the high degree of variability in fluorescence along the line, not all of it necessarily in the upper few meters. The warm salty anomaly around -139 Lon was partly because the ship steamed south.

There was no shipboard sampling along line R, but the MVP completed the sectioan (albeit only to 220 m!). A quick excursion to the South in search of a putatative eddy succeeded in finding domed isopycnals, and warmer saltier permanent thermocline water, but no hard evidence of an eddy.
Soon after (138 W and 134 W) there were two small dips in the thermocline centered on somewhat warmer deep water. These dips were about 50 m in amplitude, and approximately 40 km wide. We were not sure if these were mesoscale features, or waves, so we doubled back on the second feature at 134 W. Resampling found the depression in the same spot, and sampling to the north of the line idnicated that it was at least semi-circular (we had no time to sample the south half). An initial guess would be that this is a small sub-mesoscale eddy, likely far too small to show up on satelites, but if common perhaps still important to the mixing of coastal water with gyre water.
Sampling in Gordon Channel and over the Banks near Cape Scott revealed the mixing structures in these coastal waters. This is really the kind of sampling I am excited about for this instrumentation, and I hope to do more of it in upcoming cruises. Making sense of this sort of data requires repeated tidal sampling, which time did not allow.



MVP data along line R. Note the high degree of variability in fluorescence along the line, not all of it necessarily in the upper few meters. The warm salty anomaly around -139 Lon was partly because the ship steamed south.

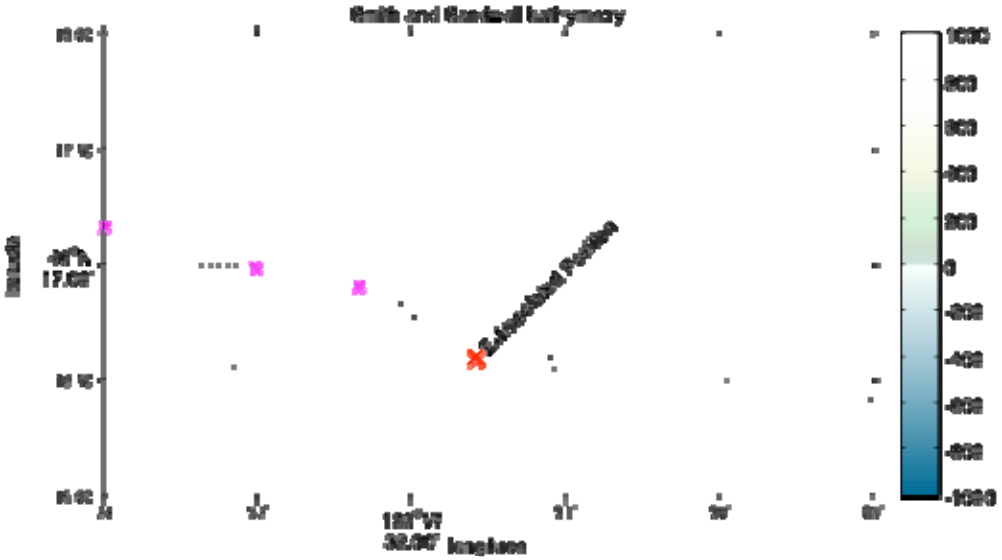
PROBLEMS [OPERATIONS]

The in-water fish part of the MVP was lost in the Strait of Juan de Fuca. The location as near as we can determine is:
123.526359 W = 123 31.5815 W
48.278994 N = 48 16.59462 N
which is between Race Rocks and Beachy Head. This was an $85k piece of equipment.

Full time towing of an undulating profiler was a new experience for the ship, and a learning process for everyone. The routine nature of the deployment possibly contributed to a couple of lapses where the ship made sharp turns. This is very hard on the cable. Three-quarters of the way through the cruise we had to reterminate because the jacket and conductors on the cable had been stripped, consistent with running the cable in under strong side loads. Hopefully sharp turns will be avoided on future deployments, or if they can't be avoided, they will as quickly as possible be relayed to the MVP group so we can stop profiling and not drag the line through the sheave when there is a strong side load.

The fish loss itself was apparently from snagging kelp, or perhaps driftwood. The fish was recovering normally, and broke off the line just as it was coming to the surface. There are unavoidable incidents at sea, and this was likely one of them. However, when we came on deck after being informed of the loss, there was a lot of kelp and driftwood in the water. If

noted in time, the protocol discussed with the bridge was to inform the MVP group that there were significant hazards in the water so we could stop profiling and make a by-hand recovery, preferably while the ship slows. Presumably the debris in the water was not noted in time, and this was not possible.



Location where MVP was lost, 30 Aug 2008, 16:49:38 UTC

Karina Giesbrecht, ONAr sampling (Oxygen, Nitrogen, Argon), University of Victoria

Biological productivity is an important process controlling the export of carbon into the deep ocean. The two main objectives of this project are 1) Measure the dissolved gases O_2, N_2 and Ar (ONAr) and use the O_2/Ar ratio to estimate net biological production and 2) Use other productivity measurements such as Nitrogen and Carbon uptake rates to generate a better-constrained estimate of biological carbon export in this region of the subarctic North Pacific. Recent ONAr sampling for this project started along Line P in February 2007 in collaboration with Steve Emerson's group at the University of Washington. On this cruise, we also began measuring the Nitrogen and Carbon uptake rates in the euphotic zone using dual, stable isotope tracer $^{15}N/^{13}C$ incubations. Surface (5m) samples of ONAr and dissolved O_2 along Line P were collected at stations P4, P12 and P20 along with a depth profile to 1000 m at Station P. Water samples for the $^{15}N/^{13}C$ incubations were collected at 100, 55, 30, 10 and 1% light levels at Station P as determined from the PAR sensor. Samples were placed in the appropriate number of screen bags relative to their light levels and incubated at sea surface temperature on deck for 24 hours. In addition to the incubation samples, Nutrient, DIC, Chlorophyll a and Ammonia samples were also collected at these depths.

RADIOISOTOPE USE:

Some work was done with radioisotopes (^{14}C) by the OSU personnel. The lab was cleaned and decommissioned as soon as their work was completed. Copies of the decommission lab report and other related paperwork were handed to the first officer on board the Tully as well as to the IOS RSO.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

The science server was working for the first few hours of the cruise then was constantly rebooting on its own. It was suspected that this was due to an over-heating problem, so we tried to let it run without the lid on, but it would still shut down on its own, so we had to do the rest of the cruise without our server. Because of this, there was no distribution of GPS signal to various computers on the ship, no SCS (weather) data were recorded, and our usual means of sharing files and data was not available. We need to have a new system, as well as a distribution box for the science GPS' signal. At

least this way if the server gets shut down we can still get the distribution of GPS, and the software usually ran on the server can then be run on different computers.

We lost the last few days of acoustic sounder data, EK60, because both hard drives were full. People collect data on the sounder and leave all their data on the drives, constantly creating that problem.

We also lost the Moving Vessel Profiler. Despite the cable being checked every few hours, and shortly before the incident happened, the tension created by the instrument being caught in some kelp was apparently too strong. Hopefully it can be recovered or else replaced. Hopefully too the new version will have a tension meter device on it, as well as a pinger.

All sea-going computers should have proper (computer) names, no passwords, shared hard drives, and they should all be connected to the LAN. The transfer of data from one computer to another would then be much easier. With the LAN on board the Tully, there should be no need anymore to have to carry flash drives and/or diskettes.

SUCCESSES [SCIENTIFIC]:

Just prior to the February Line P cruise (19 January – 19 February 2008) a -80 freezer was set up in the main lab. Although really useful, it was very loud. During the May La Perouse cruise (20 – 28 May 2008) it seemed to stop working. Some representative from Fosters (the Fisher service representative) came to look at the freezer and determined the problem, but the parts could not be delivered on time. So during the June Line P cruise (28 May – 17 June 2008) the freezer stopped working. The Fosters representative came again at the end of the June Line P cruise, and during this cruise the -80 freezer worked like a charm. Not only did it keep its temperature without any problem, but it is really quiet and it is barely noticeable when the compressors are working.

We had some regular mis-firing of some Niskin on the Rosette early during the cruise. Thanks to Ron Lindsay for looking into the problem and fixing them as soon as possible.

We managed to time the long stations so that most of the work happened during day time. This worked pretty well Thanks to Anissa Merzouk and Olena (Helen) Shevchuk from UBC to be so adaptable as to when their water was being collected.

PROBLEMS [SHIP'S EQUIPMENT/OPERATIONS/PLATFORM SUITABILITY]:

The pump providing water to the loop system in the lab (Monyo pump) lost most of its pressure during the first week of the cruise. The engineers switched to the other pump (Roper), but this one was creating lots of bubbles in the system. The engineers managed to get the Monyo pump going again and switched back, which made every one really happy. Thanks guys!

SUCCESSES [SHIP]:

The Internet access worked really well for most of the cruise. Of course there is no access west of ~ 138°W, but while we were in reach it was quite reliable. Please see report by Johan Schijf.

Victoria Fabry was contacted by the BBC (British Broadcasting Corporation) over a year ago to provide pteropods for one of their episodes of a new series on the Pacific Ocean. I was contacted myself in June of this year to coordinate the delivery of the pteropods so that they would be as healthy as possible without impacting the cruise too much. Thanks to the crew of the Tully, we brought the animals to the Bamfield Marine Station using the 733 and they were still swimming in their jars when we got to the Station. (Please see report by Vicki Fabry).

DELAYS [OTHER THAN WEATHER]:

~ 20 hours to go to Port Hardy to drop off science personnel needed at IOS as well as fixing the ship's GPS.

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SAFETY CONCERNS:

One person had to be moved from her cabin because of a flood of grey water soaking her carpet.

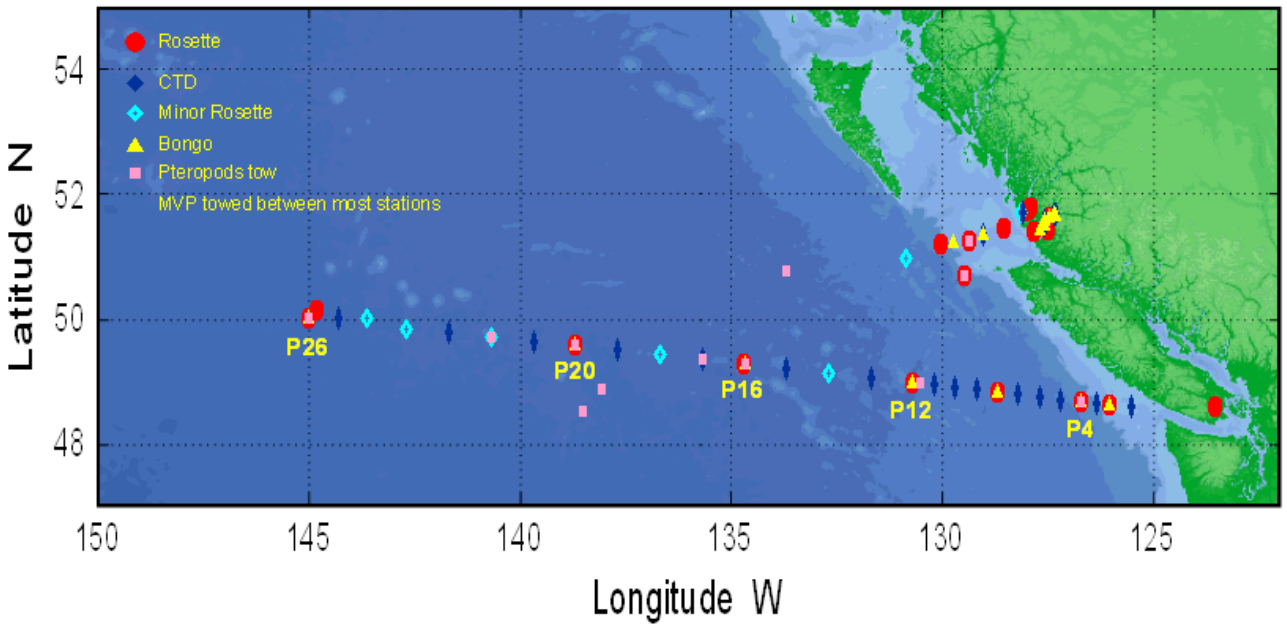
HAZARDOUS OCCURRENCES:

We lost the University of Victoria's Moving Vessel Profiler.

EVENT LOG:

DATE	OPERATIONS
Tuesday 12 Aug:	**Start loading the ship at IOS.**
Wednesday 13 Aug:	**Leave Pat Bat. Saanich Inlet cast.**
Thursday 14 Aug:	**Start Line P.**
Tuesday 19 Aug:	**Go straight from P21 to P26 because of bad weather.**
Wednesday 20 Aug:	**Arrive at Station P.**
Saturday 23 Aug:	**Complete all Line P stations with P22. Try to find the eddy.**
Monday 25 Aug:	**Start the SS Line.**
Tuesday 26 Aug:	**Anchor off Port Hardy.**
Wednesday 27 Aug:	**Sample Koeye River/Hakai Passage and Rivers Inlet.**
Friday 29 Aug:	**Drop off pteropods at Bamfield Marine Station.**
Saturday 30 Aug:	**Lose MVP. Arrive at IOS.**
Sunday 31 Aug:	**Offload.**

CRUISE TRACK:



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SUMMARY/FINAL COMMENTS:

- Many thanks to the whole crew of the Tully for all their help in making this cruise such a success
- Very huge ‘thanks’ to the cooks, and the whole galley crew, for keeping all of us so well fed, as well as for your enthusiasm. You guys were truly awesome!
- Congratulations Matt for 10 years in the fleet!
- Finally, thanks to Captain McGregor for great communications. Every thing was always clear and communicated to us; plans, weather, problems, etc. It makes the planning of stations and the whole cruise in general much easier!