Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT
Line P Program – Fisheries and Oceans Canada

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 5 February 2017 **TO:** 23 February 2017

SCIENCE CRUISE NUMBER: 2017-01 **SHIP'S PATROL NUMBER:** 16-11

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Rianna Burnham (UVic)	Michael Arychuk (IOS)
Marie Robert (IOS)	Mark Belton (IOS)
Jade Shiller (UBC)	Will Burt (UBC)
Theresa Venello (UVic)	Luke Halpin (EC)
	Richard Nelson (BIO)
	Doug Yelland (IOS)

AREAS OF OPERATION: North East Pacific, Line P, Station P.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data has been collected along this line since 1956 and shows 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.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section (physics, chemistry, zooplankton), repeat cesium sampling, deploy four Argo floats for IOS, recover one glider for WHOI, one glider for IOS and one glider for UBC.

CRUISE DESCRIPTION: This cruise (2017-01) had to face many Gremlins, both on the science side as well as on the ship's side. The weather was one of the main problems we had to deal with, and the "extra" four days sure helped making this cruise the success it turned out to be. A couple of the CTD sensors failed (or were not working properly when we got on board) but both got successfully replaced. The thermosalinograph was also only half set-up, but again we managed to get some kind of data with it. The ship's broadband system failed so for one full week we had absolutely no contact with 'land'. Even the ship's email accounts could not be used. We managed to recover two gliders towards the end of the cruise, but one of them made a serious rip to the side of the work boat. Unfortunately the weather was too rough at Station P to recover the Woods Hole Glider. At least we managed to do the extra stations for the Strait of Georgia program and we could "give" one day for the calibration of the sounders.

DAYS ALLOCATED: 18 **DAYS OF OPERATION:** 17

DAYS LOST DUE TO WEATHER: ~40 hours total: ~13 hours between P35 and P26. ~27 hours between P26 and P19. Station P35 got cancelled due to weather.

SAMPLING:

- The Line P survey was 97% successful. Only one station, P35, got cancelled. All other stations were visited and all planned cast were performed with the exception of the 1200 m bongo at P20.
- 4 Argo floats were deployed for IOS. The WHOI glider could not be recovered because of very high seas while we were in the area. The two coastal gliders were recovered. 18 "Sponge-Bob" type drifters were deployed in Haro & Juan de Fuca straits for IOS.
- Trace Metal samples, pH samples, and $DMSP_d$ samples were not collected on this cruise.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder, ADCP, pCO_2 – **UBC (Burt):** Surface oxygen, total gas tension, particulate back-scatter and spectrally-resolved absorption and attenuation, Chl *a*, and size-fractioned spectrophotometry.
  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence.
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, $DMSP_t$, chlorophyll, pigments (HPLC), dissolved inorganic carbon (DIC), alkalinity, DOC – **DFO-BIO (Nelson)**: Cesium, ^{129}Iodine – **UBC (Shiller):** high-resolution bacterial DNA sequencing, number of cells per millilitre, single cell DNA analysis, virus analysis, viral counts – **UBC (Burt):** methane and nitrous oxide.
  4) From the various nets: **DFO-IOS and UVic (Yelland, Venello):** Zooplankton using vertical net hauls (Bongo to 250 m and 1200 m, and single fine-mesh net to 250 m).

RADIOISOTOPE USE:

No radioisotopes were used during this cruise. The Rad-van was not on board.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

Some ship loading was done on Sunday, February 5. The snow combined with the current state of the dock made fork lifting equipment both dangerous and nerve wracking. Hauling a heavy load is dangerous enough on a level surface but when one has to drive around splintering plywood and exposed metal it borders on impossible. Unfortunately there is no other way to get some equipment to the ship effectively and efficiently and the current state of the dock needs to be addressed and repaired before a serious incident occurs as well as before the beginning of the coming sailing season.

When we got aboard, the output bib on the 'old' fluorometer (the one connected to the system) was broken off. The 'new' fluorometer had no bibs at either end, so we had to swap one over for the input in order to connect a hose. Due to the lack of restriction, it was hard to get enough water to flow through the TSG; all the flow would go through the fluorometer since immediately after the "Y" connector that shunts water to the fluorometer, there is an "L" connector leading to the TSG. This adds to the lack of water going to the TSG by causing too much back pressure on that side of the "Y". Virtually no water was going to the TSG, all of it was going to the fluorometer. We added a hose extension to the input side of the fluorometer so that it would hang into the sink (since we couldn't attach an outflow hose; no bib), and put a hose clamp on that extension to restrict water flow. This forced some water through the TSG. We found out mid-cruise that UBC had a spare valve; after installing it to the inflow of the fluorometer it helped the issue somewhat, but not totally. The salinity is still really spiky, and the temperature seems to jump quite a bit, it's not changing smoothly.

We started the cruise with the old TSG fluorometer (s/n 953) in use, the 'new' fluorometer (s/n 889) just sitting on the counter, but the 'new' values (for s/n 889) in the configuration file (in other words: the file had been modified but the fluorometers hadn't been swapped). Fortunately this can be fixed later. It is surprising that the calibration numbers of the "new" fluorometer are from 2004.

The oxygen sensor wasn't working properly from the first cast we did. A CTD cast at P3 confirmed our suspicion. Fortunately we had a spare on board.

Six casts had problems where we had big spikes in the data and the pumps would turn off on their own. Five of the spikes happened between ~300 and ~1000 dbar, whereas one occurrence was at the end of P1 (shallow cast), near the surface.

The altimeter wasn't kicking in. We used the altimeter from the spare rosette for most of the cruise.

The water system gave good water the entire cruise but seemed to be working very hard to do so. Upon start-up it would give a "filter change" error message and the pump would appear to strain to start the flow of water. Once water started to flow the error symbol would disappear and the system would operate normally. When the flow was stopped the system would continue to dispense water for several seconds after the pump was off. Both symptoms seemed to be an indication of an air lock within the system. No corrective action was taken as the system continued to give good water despite the problem.

pCO2 – Michael Arychuk
The pCO2 system was not fully operational this cruise due to a software update that could not be installed in time. The contractor responsible for the update was unable to make it to IOS prior to the cruise due to personal conflicts, family obligations and weather related delays. The updates were supposed to correct calculation and location mapping (latitude and longitude) issues which ultimately affected the quality of data collected on this cruise. Updates aside, the system did run without incident and was functionally operational. Once updates are installed there is still the issue of getting a secondary RTD temperature probe installed in order to get the temperature of the Inlet. This will require the co-operation of the Chief Engineer and the Chief Scientist to either find a multi-strand wire not in use or get one strung into the Main Lab.

Cages – Michael Arychuk
Having been the one to be responsible for the cages this cruise I feel it is important to point out several flaws in the process of using cages to load gear:

- The forklift cannot fully enter the cruise staging area at IOS. This means any cages packed require a hand truck to move them out onto a flat road surface. Manoeuvring a hand truck down the incline of the loading area is precarious at best and dangerous at worst.
- The cages cannot be moved to the road ahead of time because they are not protected from the elements and gear could get damaged when wet. Thus each cage must be transported one at a time.
- There is no time saved by loading the cages onto a flatbed truck. It is faster to just forklift them directly to the jetty but still time consuming when one has many cages (six for this cruise).

Essentially the only benefit of using cages is that people can load their gear ahead of time and then not have to concern themselves with loading it into a van. Unfortunately the saving of time for some adds to the time of others! In my opinion, this is not an effective manner to load the ship and should be abandoned. It is time consuming (for the person who has to deal with it) and time would be better served just loading the gear directly into the cube van.

Cages – Marie Robert
I agree with what Mike wrote above. If we are going to use cages to load the gear it would be best to have weatherproof cages that can be left outside. But it is hard to see the true advantage of the cage system as it is used at the moment. Let's go back to using the cube van in the future unless improvements to the current cage system can be made.

Two UBC students did not receive their security clearance in time to sail, despite starting with the paperwork at the end of November 2016 (in one case).

One IOS participant could not sail because of last minute sickness.

SUCCESSES [SCIENTIFIC]:

The loading worked really well (despite the cages and the snow) with loading the science gear on Sunday and loading the rest of the heavy gear and ship gear on Monday. This way we had plenty of time to set-up on both Sunday and Monday.

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

There were a few technical problems with the main Hawboldt CTD winch: it was losing power after stopping to close a Niskin. As usual the engineers did a great job dealing with the problem.

The communication system allowing the transfer of emails while out of Internet-at-Sea range wasn't working, so we had no contact whatsoever with land for over a week.

The work boat (753) got ripped while recovering one of the gliders.

SUCCESSES [SHIP]:

Despite the problem with email transfer we could still get weather forecasts every day.

This cruise showed the importance of getting the extra four days for the February cruise. We lost almost two full days due to bad weather, and managed to do as much work as we did because we sailed with both engines quite often during the cruise. Of course there are some years when the weather days won't be necessary; during those years we can do more of the Strait of Georgia work that used to be done in the winter and has now been cancelled because of the winter decommissioning of the Vector.

DELAYS [OTHER THAN WEATHER]:

A VLE meeting was scheduled on the Tully on the last day of the cruise so we had to be back.

SAFETY CONCERNS:

The weather doors between the aft-deck and the main lab could only be opened from the outside, and only with the help of a crow-bar. Since the aft-deck is our muster station this is a safety concern. It is also an issue when someone working in the aft-deck container has to walk in the breezeway to come back inside the ship since those doors are usually closed when the weather is really bad and the breezeway is then a dangerous place to be walking.

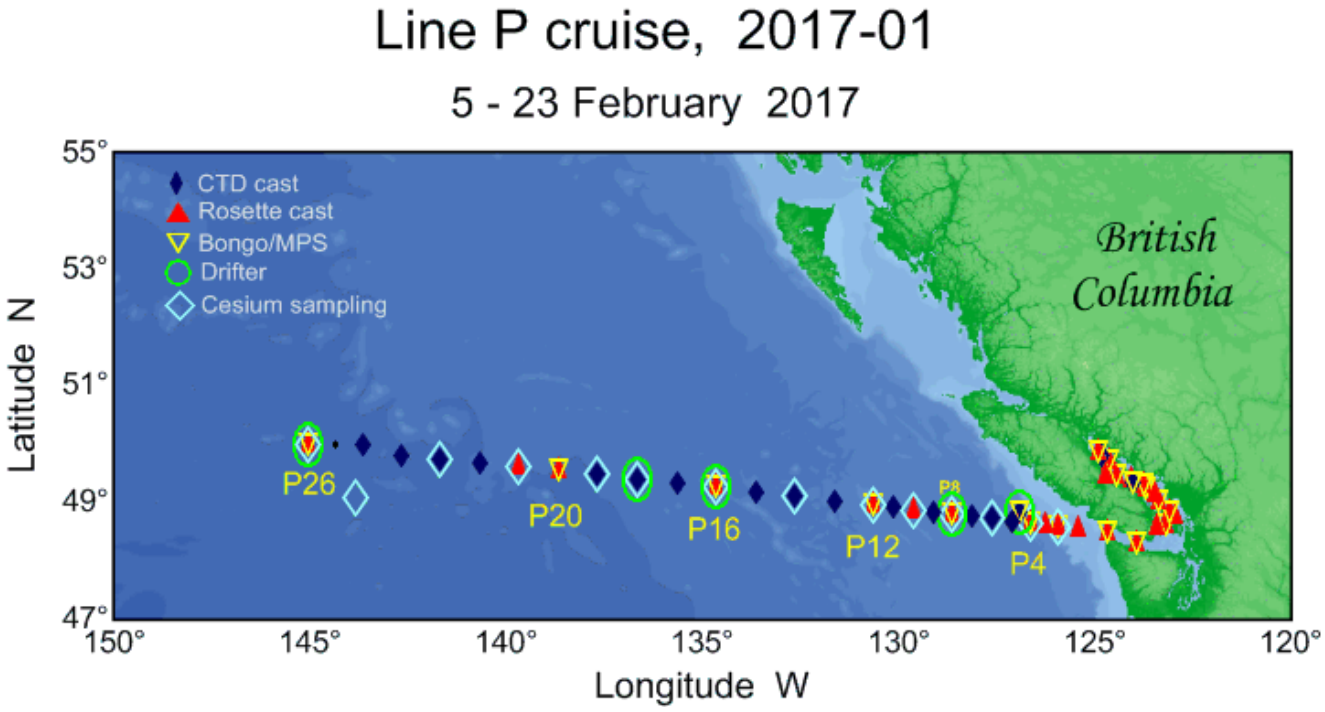
HAZARDOUS OCCURRENCES:

A cold was being propagated on board the ship during the cruise, affecting many crew members and some of the science staff.

EVENT LOG:

Sunday 5 February:	Start loading scientific equipment around 1230.
Monday 6 February:	Safety meeting 1000. Science meeting 1230. Leave Pat Bay 1500. Go straight to P3.
Tuesday 7 February:	Stations P3 and P4.
Wed 8 February:	Sail west
Thursday 9 February:	Stations P20 and P21.
Friday 10 February:	Stations P22, P23, P24.
Saturday 11 February:	Station P25. Sail to Papa, weather course. Start Papa ~ 2200.
Sunday 12 February:	Complete Papa at ~1000. Deploy Argo float. Too rough to recover WHOI glider. Start heading SE, weather course.
Monday 13 February:	Stay on weather course until 1815, then start heading towards P19.
Tuesday 14 February:	Station P19
Wed 15 February:	Stations P18 to P16. Deploy Argo at P18 and P16.
Thursday 16 February:	Stations P15 to P12.
Friday 17 February:	Stations P12 to P7. Deploy Argo at P8.
Saturday 18 February:	Stations P6 to 102. Recover two gliders between P5 and P4.
Sunday 19 February:	Stations JF2 to 27. Swap 753 for a new one.
Monday 20 February:	Stations 2 to CPF1. Sail back to IOS.
Tuesday 21 February:	Saanich Inlet cast. Offload.
Wed 22 February:	Sounder calibrations.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Kenny, Nina, Kelly, Moira, Tamara, Kyle … your help is always greatly appreciated! Thanks for the extra hand (and backs!) while offloading ... and Glenn: we missed you.

- Thanks to Doug Yelland for spending so much time dealing with network issues, and to Mark Belton for looking after the rosette before and during the cruise.

- Thanks to the "DIC samplers, picklers and tapers", and to Luke for sampling all the nutrients rosette after rosette after rosette.

- Thanks to everyone on board for such a successful cruise despite the February weather! Very special "thank you" to all the galley crew for keeping us so well fed; it must have been like performing acrobatics for you guys, yet you never missed a beat.

- Thanks to Captain Gronmyr for keeping an eye on the weather forecasts, especially at Station P where we just had time to do all the work during a very short weather window. If we hadn't started two hours earlier as we did we could not have done all the work. Thank you too for the extra speed; that was definitely a factor in the success of this cruise.

- Finally thanks for those who dealt with all the various gremlins we had on board, so that we could keep getting weather forecasts even when all systems were down, or that we kept having power to the winch…

  See you all in June! ☺

  Marie Robert

- We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating our sampling needs.

  Theresa Venello

- I'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and willingness to work through winter storms. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for staying calm in the face of the inevitable tribulations of fieldwork.

  Jade Shiller

- We'd like to thank Marie Robert and the IOS science crew for having us on board to do this work and accommodating the recovery and data collection that will complement that of the gliders. Also thanks to the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise, but particularly those directly involved with the glider retrieval and setting the time aside to make it possible.

  Rianna Burnham

- Thanks to the officers and crew of the CCGS John P. Tully for the work to make this a successful cruise. Special thanks to Marie Robert for all of the wire time and all those who helped carry the 24 ℓ carboys.

  Rick Nelson

- Personally, this was my first Line P trip, and despite some foul weather it was a real pleasure sailing with this science team. A major thank you to Marie Robert, whose thorough, flexible, and personable style makes her an ideal Chief Scientist. Our lab greatly appreciates all of help we consistently receive on these trips – particularly in accommodating our objectives and instrument setups, as well as the additional efforts to measure our Winkler O_2 calibration samples. An extra special thank you to Jade Shiller for helping to collect gas samples at all major stations.

  Thank you to the entire crew of the Tully for their assistance. The engineering staff were especially helpful when working with Miss Piggy in the transducer room. The help we have received from this crew throughout the various cruises have been 'instrumental' as we work to optimize our setup.

  It is important to note that our continued opportunities aboard Line P and La Perouse trips, combined with an additional trip aboard the R/V Oceanus, have facilitated a sea-going dataset with very impressive spatial and temporal coverage throughout the Subarctic Pacific. For example, in regions like Barkley Canyon, we have underway and discrete samples covering 5 months of the year, including the majority of the summer (February, May, June, July, August). As stated earlier, this particular trip will provide an important 'winter-time' dataset to compliment the wealth of spring/summer data we have already collected. Furthermore, the tests we are able to run on these trips allow us to improve our setup consistently.

  Will Burt

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The weather during this cruise has been quite stormy. We managed to do the work at Station P during a very short weather window, then had to hove-to for 1.5 day before finally sailing back towards Line P (see ship track in Figure 1). Because of these storms the mixed later depth was quite deep, ~90 m; a 'normal' value for February. Finally it seems that there is still some residual warm water left behind by the "Blob", but after the surface mixing caused by the windy weather the maximum anomaly is now well below the surface. Figure 2 shows the temperature anomaly field with respect to the 1956-1991 averages in February 2015, 2016 and 2017.

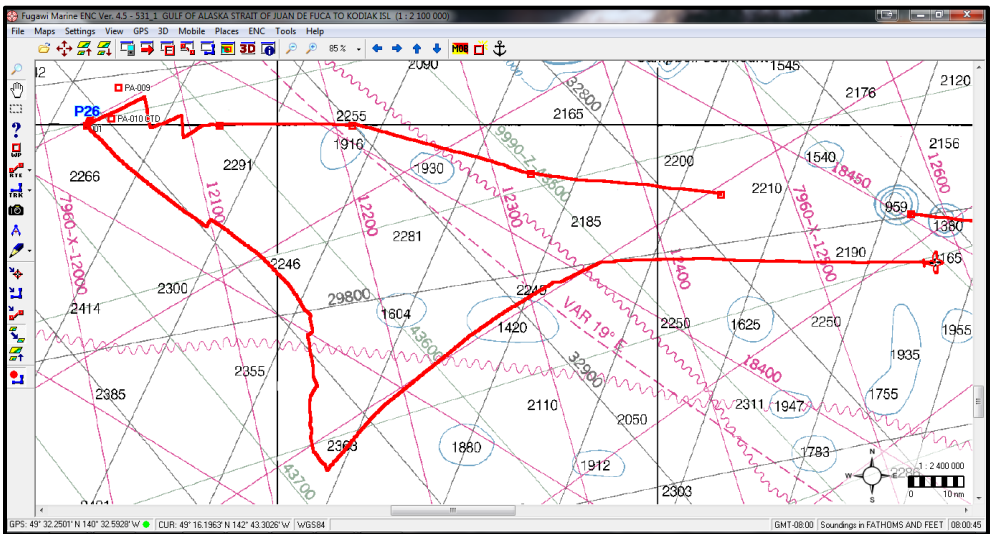


Figure 1: Ship track during 2017-01 Papa cruise, from early on 10 February to late on 14 February 2017.

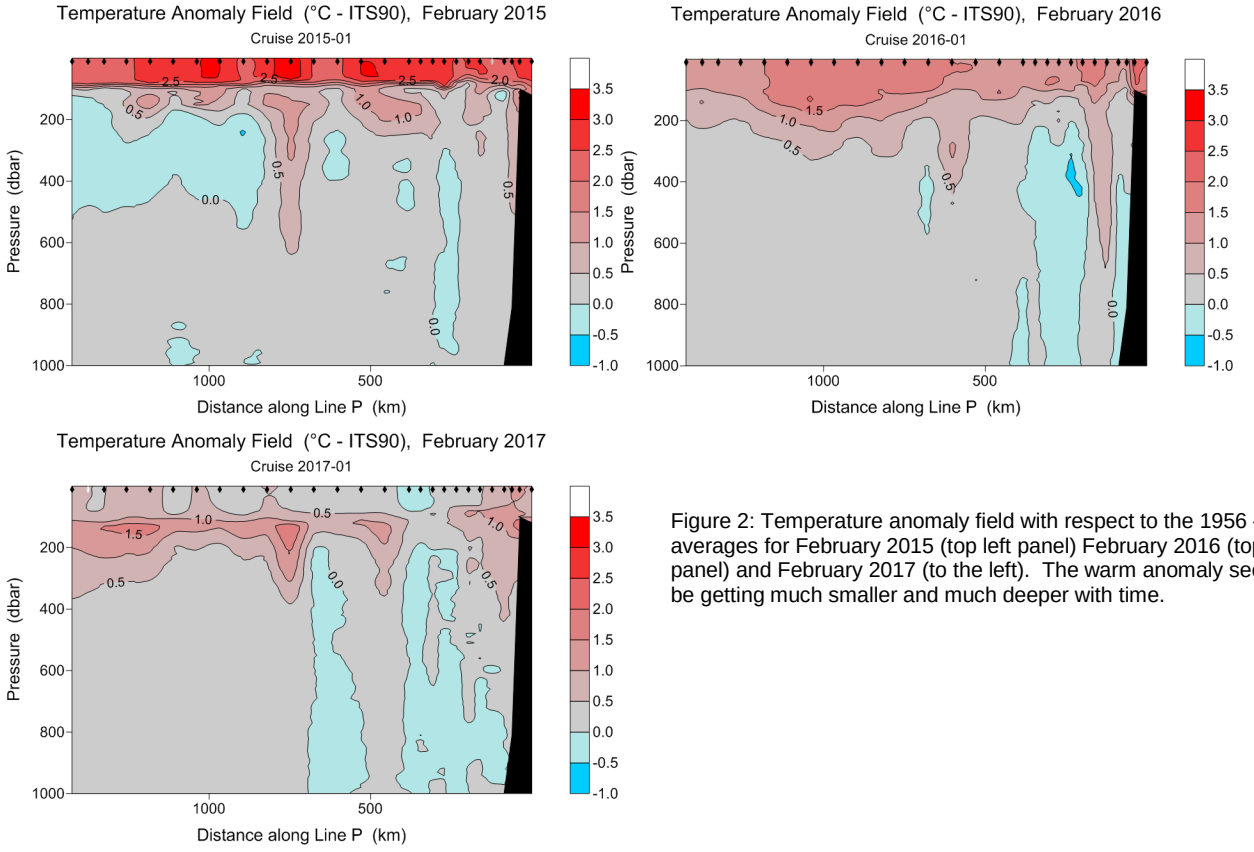


Figure 2: Temperature anomaly field with respect to the 1956 – 1991 averages for February 2015 (top left panel) February 2016 (top right panel) and February 2017 (to the left). The warm anomaly seems to be getting much smaller and much deeper with time.

Line P – February 2017: Theresa Venello, Rianna Burnham-UVIC (Dower Lab)

Objectives: Quantifying crustacean zooplankton productivity along Line P using the chitobiase-method. Comparing production rates from the *Tully's* seawater loop system and 5 m rosette niskin bottle. Linking zooplankton community composition to crustacean zooplankton productivity.

Sampling:
500mL of seawater was taken from 6 depths (5, 10, 20, 50, 150, 250 m) at all 7 major stations that have a bongo net cast (P2, P4, P8, P12, P16, P20, P26). Samples from station P4, P20 and P26 were taken on the way out to OSP, all other station samples were taken on the way back. Loop seawater samples (500 mL) were also taken at each of these stations.

In addition, loop seawater samples were taken at P6, P10, P14, P19, P22, P24 to increase the spatial resolution of our production rate estimates. Loop samples for P22 and P24 were collected on the way out to OSP, the rest were taken on the way back in.

Water was taken from the rosette, filtered through 54µm mesh and into 500 mL Nalgene bottles. Water samples were then 'spiked' with a homogenate made from ground krill and/or copepods (depending on what was in the bongo sample); filtered every three hours over a 12 hr period to create a decay of the moulting enzyme chitobiase. Samples were assayed and read using a fluorometer while on board.

Zooplankton samples were also collected from the rosette at P2, P4 and P26 by filtering whole niskin bottles at three depths (5, 50, 100) through a 40 µm mesh sieve. The white net (60 µm) was also used at P2, P4, P8, P12, P16, P20 and P26 to collect an additional zooplankton taxonomy sample. Again work at P4, P20 and P26 were done on the way out, all other station samples were collected on the way back in. This work was conducted for Evgeny Pakhomov and Lian Wong at UBC.

Comments:
All of our sampling goals for this cruise were met.

We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating our sampling needs.

Line P – February 2017: Rianna Burnham-UVIC (Whale Research Lab, IOS/ONC), Theresa Venello- UVIC (Dower Lab)

Objectives: To retrieve ocean gliders that have been surveying the offshore and continental shelf region.

Retrieval:
Location and progress in mission of the ocean gliders was kept, when possible, throughout the cruise. Nearer to retrieval (morning of Feb 18) more frequent locations were obtained and a waypoint chosen that the two gliders would convene at to be retrieved. A detour from Line P was made after sampling at P5 ~0515 with gliders located soon thereafter through frequent communication with land-based glider pilots and the bridge. They were visually located by using the strobe light just forward of the tail fin. Gliders were recovered by using the zodiac 'Tully 1'. The Tully was back on route to P4 by ~ 0830

Comments:
The gliders were successfully retrieved – with data download to commence after docking. Unfortunately, the port pontoon of the zodiac 'Tully 1' was torn during the retrieval of the second glider, with repair/replacement of central pontoon tube needed.

We'd like to thank Marie Robert and the IOS science crew for having us on board to do this work and accommodating the recovery and data collection that will complement that of the gliders. Also thanks to the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise, but particularly those directly involved with the glider retrieval and setting the time aside to make it possible.

Jade Shiller UBC Line P – February 2017

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial and viral communities in the cycling of major nutrients along Line P, focusing on the communities in the oxygen minimum zone.

Sampling summary:
At 5 stations (P4, P12, P16, P20, and P26),

1) 2 L seawater samples (at 16 depths) for high-resolution (HR) bacterial DNA sequencing were filtered.
2) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Additionally, at 3 major stations (P4, P12, and P26), the following were sampled at four depths: 10, 500, 1000, and 2000 (bottom+10 at P4) across the oxygen minimum zone:

1) Large volumes (20 L; LV) at each depth were filtered to create genomic libraries of the bacterial communities.
2) After adding iron chloride to the filtered water, the samples were filtered again for later virus analysis.
3) For viral counts, samples were taken and preserved using glutaraldehyde and betaine.
4) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Comments:

All my sampling objectives for this cruise were successfully fulfilled. I had also hoped to train two of my colleagues on this cruise. Unfortunately, their security clearances were not processed in time for them to sail with us.

The work area distribution was convenient for my sampling needs. In addition to the two benches I was originally assigned, I used a third bench (closest to the -80 freezer) so that my gear did not block the large computer monitor.

I'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and willingness to work through winter storms. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for staying calm in the face of the inevitable tribulations of fieldwork.

Cs-137 – Richard Nelson, DFO/BIO.

An earthquake triggered tsunami on March 11, 2011 caused extensive damage to the nuclear generating station at Fukushima Japan resulting in the discharge of large amounts of Cs-137 and other radionuclides directly to the Western North Pacific ocean during the months following the accident. The radioactive plume was transported northeastward under the influence of the Kuroshio current and was expected to approach the Canadian coastline several years after the accident. A Canadian monitoring program was established to detect the arrival of Fukashima radioactivity in the water columns of the eastern North Pacific and the Arctic oceans.

Water samples were collected at stations occupied on the "Line P" missions on the CCGS J P Tully in June of 2011, 2012 and 2013. The program was expanded in 2014 to include both the Feb and Aug Line P missions and has continued until 2017.
Future participation is planned for the February and August line P missions for 2018.

Sampling 2017-01:

Five depth profiles were collected at stations P-4, P-10, P-16, P-21 and P-26. Samples were collected at 500, 400, 300, 200, 150, 100, 50 and 5 meters. As the signal from Fukushima moves towards the coast and begins to slowly sink all 5 stations were sampled to 500 meters. Sixty liter samples were collected at all depths.

In addition 60 liter surface samples were collected from the underway loop system after the ship was on station at P-1, P-6, P-8, P-12, P-14, P-18, P-19, P-23 and P-25.
A total of 48 samples were collected.
The samples for Cs were extracted onto KCFC (potassium cobalt ferrocyanide) ion exchange resin at flow rates of approximately 300 ml's per minute, and then sealed for return to the Bedford Institute of Oceanography.

The resin samples were then dried placed in appropriate counting geometries and the Cs-137 and Cs-134 radionuclides were determined by Gamma ray Spectroscopy using HPGE (high purity Germanium) detectors.

Thanks to the officers and crew of the CCGS John P. Tully for the work to make this a successful cruise. Special thanks to Marie Robert for all of the wire time and all those who helped carry the 24 ℓ carboys.

Bird observations – Luke Halpin, EC/CWS

I conducted pelagic seabird transect surveys along the Line P route and made several observations of seldom seen pterodroma petrels. Mottled petrels (*Pterodroma inexpectata*) were observed outside of the Canadian Exclusive Economic Zone, and Murphy's petrels (*Pterodroma ultima)* were observed both within and outside of the Exclusive Economic Zone. I also saw several sperm whales. Surveys were conducted whilst the ship was in transit between sampling stations. Weather conditions were mostly good, but there were several days with high wind and large swell conditions causing poor sightability during which it was not possible to survey.

Cruise Report – Will Burt (Tortell Lab; UBC, Earth, Ocean & Atmospheric Sciences)

Objectives:

Our participation in this cruise was focused on measuring the distribution of biogenic gases, as well as indices of phytoplankton biomass, along the Line P transect. We deployed a number of automated instruments for real-time analysis, and collected discrete depth profiles for subsequent laboratory analysis. A key aim of these efforts was to quantify net community production and various components of phytoplankton productivity at high spatiotemporal resolution along the Line P transect. The cruise also provided an opportunity to test and troubleshoot new instrument setups and methods.

Gas Measurements and Quantification of Net Community Production:

At the major stations (P4, P8, P12, P16, P20, and P26) we collected discrete profile samples for analysis of methane and nitrous oxide (N_2O), contributing to an almost-ten year time-series of these gases along the Line P transect.

Continuous measurements of surface O_2 and total gas tension were made by pumping seawater through an oxygen optode and two independent gas tension devices (GTD) using a SBE pump, with all 4 instruments housed in a water-tight PVC tube. Two GTDs were used to test their parallel performance. This trip marked the third design strategy for this complete instrument package (named “Miss Piggy”). In this new design, residence time of water in the housing was decreased by making the overall housing volume considerably smaller, and adding a small impellor pump (“Water Puppy”) after the housing to pull water through the entire system. As in previous trips, the instrument was setup in the ship’s transducer space (see Fig. 1). Overall, the instrument required very little maintenance, with issues limited to minor electrical shutdowns. The instrument remained water tight and had a consistent flow rate of 10-15L/min, lowering the residence time to less than 1 minute for the whole system. Overall, the data quality appears good, but in particularly rough seas, may have been impacted by bubble intrusions through the seawater intake. The two independent GTDs showed very good agreement, suggesting that a single, smaller GTD could be used in future, facilitating an even smaller housing.

As in previous cruises, discrete O_2 samples were taken from the seawater loop at various stations to calibrate the optode. Samples were not taken from the transducer room, as the previous cruise had shown no significant offset between samples collected in the transducer room, and those collected in the main lab.

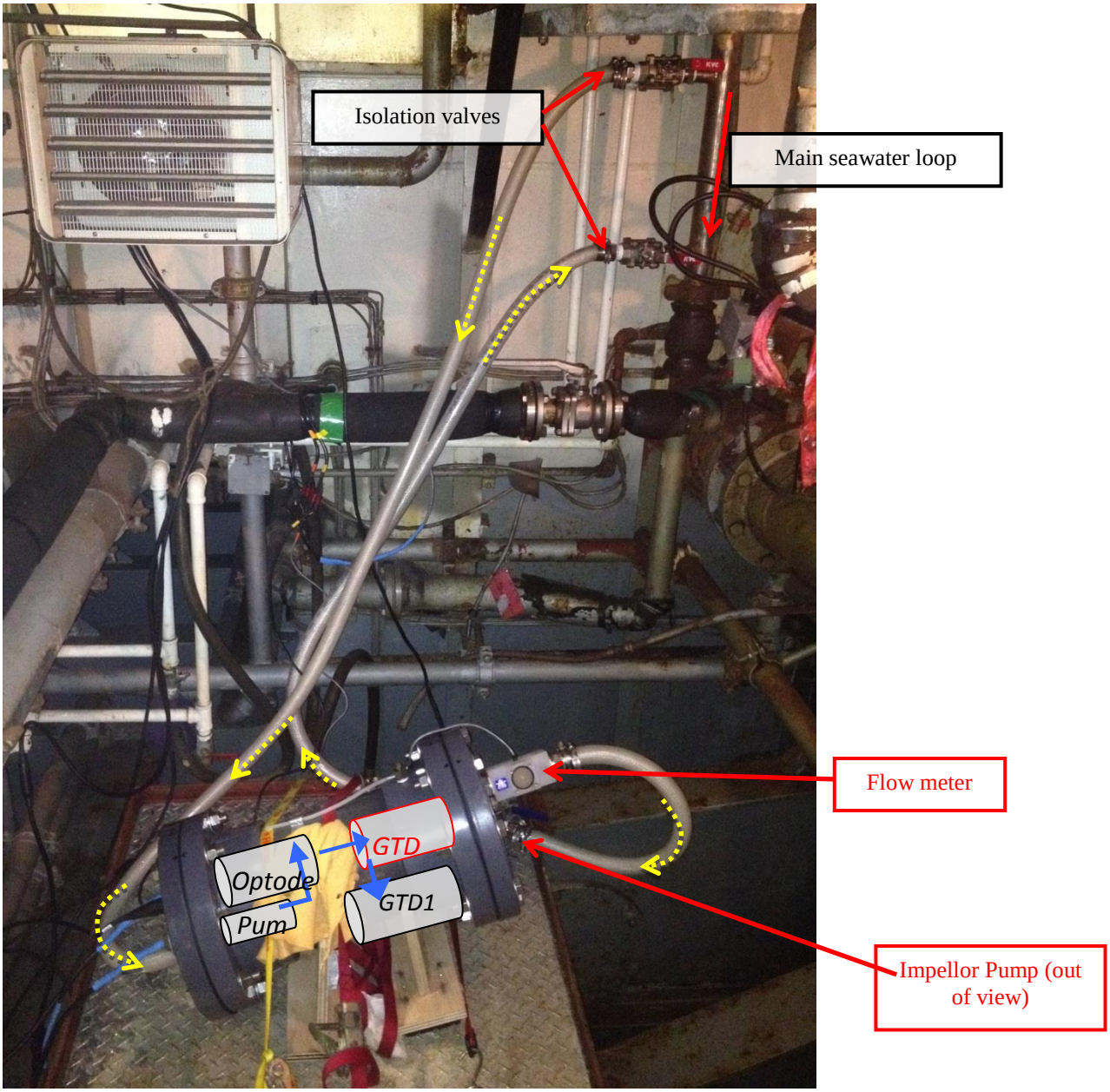


Figure 1. The setup of the new GTD-optode system ("Miss Piggy", vol. 3) in the ship's transducer space. The smaller design of the housing, the mini-GTD (GTD2), the external paddle-wheel flow meter, and the "water puppy" impellor pump (all shown in red) highlight the new additions to the system. Yellow arrows show direction of flow in the system.

Optical Instrumentation:

We continued our measurement of optical properties from the seawater loop, including particulate back-scatter and spectrally-resolved absorption and attenuation. These measurements will be used to derive estimates of chlorophyll a (Chla), phytoplankton carbon, as well as the relative abundance of different pigment classes (which can be used to indicate phytoplankton taxonomic abundances) in surface waters. As was the case last summer, the wall-mounted setup was ideal, and the addition of the outward-facing grating facilitated an even more compact, more easily-adjusted setup. Similar to Miss Piggy, the optics suffered from bubble contamination during particularly rough parts of the cruise, but overall, we were able to get good measurements along the entire length of the transect, and were consistently able to take measurements on-station, when the ships roll was less violent. The data obtained here will provide a useful seasonal comparison to existing and

future summer datasets. Also, calibration against discrete Chl measurements in very low-productivity waters will prove useful.

Samples for both Chla, and size-fractioned spectrophotometry were taken from the seawater loop on numerous stations (collected when rosette was near 5m). Spectrophotometry samples will be used to calibrate the high-resolution absorption/attenuation spectral data from the optical system, and for comparison between our in-situ data and satellite algorithms.

Comments:

Personally, this was my first Line P trip, and despite some foul weather it was a real pleasure sailing with this science team. A major thank you to Marie Robert, whose thorough, flexible, and personable style makes her an ideal Chief Scientist. Our lab greatly appreciates all of help we consistently receive on these trips – particularly in accommodating our objectives and instrument setups, as well as the additional efforts to measure our Winkler O_2 calibration samples. An extra special thank you to Jade Shiller for helping to collect gas samples at all major stations.

Thank you to the entire crew of the Tully for their assistance. The engineering staff were especially helpful when working with Miss Piggy in the transducer room. The help we have received from this crew throughout the various cruises have been 'instrumental' as we work to optimize our setup.

It is important to note that our continued opportunities aboard Line P and La Perouse trips, combined with an additional trip aboard the R/V Oceanus, have facilitated a sea-going dataset with very impressive spatial and temporal coverage throughout the Subarctic Pacific. For example, in regions like Barkley Canyon, we have underway and discrete samples covering 5 months of the year, including the majority of the summer (February, May, June, July, August). As stated earlier, this particular trip will provide an important 'winter-time' dataset to compliment the wealth of spring/summer data we have already collected. Furthermore, the tests we are able to run on these trips allow us to improve our setup consistently.