REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
24 April 2016	Corrections to bottle files for events 1,3,5,8,10,26,42,48,&70. G.G.
16 July 2015	DMSP added to CHE files. G.G.
31 March 2015	Correction to header comment about salinity bottles in CHE files & loop. G.G.
8 July 2013	Corrections to Nitrate and Phosphate data; see headers for details.

PROCESSING NOTES

Cruise: 2012-13
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: August 15, 2012 – August 20, 2012

Processed by: Germaine Gatien
Date of Processing: 18 January 2012 – 2 July 2013
Number of original HEX files: 54 (2 split casts, 1 extremely shallow cast, 1 shallow upcast only)
Number of CTD files: 50
Number of bottle casts: 51
Number of original TSG files: 7

INSTRUMENT SUMMARY

Two SeaBird Model SBE 911+ CTDs (#0550 and #0506) were used for this cruise. They were both mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#1396DR), an SBE 43 DO sensor (#1119), a SeaPoint Fluorometer (#2228), a Biospherical QSP-200L4S PAR sensor (#4601) and an altimeter.

A thermosalinograph (SeaBird 21 S/N 2487) was mounted with a Wetlab/Wetstar fluorometer (WS3S-713P), remote temperature sensor #0603 and a flow meter. The fluorometer was mounted on the CTD for one cast for calibration purposes.

The data logging computer was #3.
The deck unit was a Seabird model 11, serial number 0471.
All casts were run with the LARS mid-ship station.
The oxygen kit was #2 (IOS Dosimat Model 865 and 665)
The salinometer used at IOS was a Guildline model 8400B Autosal, serial # 68572.
An IOS rosette with 24 10L bottles was used.

SUMMARY OF QUALITY AND CONCERNS

The CTD log had an equipment list, plus details about the rosette, TSG and oxygen sampling kit. The rosette logs and dissolved oxygen analysis logs were in good order. The Chief Scientist provided sampling notes with a good description of problems relevant to processing.

Salinity samples were mostly analyzed within 6 weeks of collection, but some of the samples collected at the beginning of the cruise were not analyzed until early November. Those samples showed up as having relatively higher values, confirming that storage for more than 2 months leads to evaporation of samples.

The primary salinity was found to be low by an average of 0.002 while the secondary was low by an average of 0.0005. The differences between the secondary CTD salinity and bottle salinity showed a little more pressure-dependence than for the primary, but the fit was quite flat below 500m. There were more spikes and sections of bad data in the primary channels, so the secondary were selected for archiving.

In order to create a bottle file for cast #40 it was necessary to fabricate a BL file since it was not created in acquisition. This means that the CTD values in the CHE file are based on estimates of when the bottles were fired. Another BL file required repairs to formatting to enable conversion.

The CTD crashed at the bottom of cast #84. A new file was started for the upcast but acquisition was not started until about 3 seconds before firing the first bottle. We usually select CTD data from a 10s window centred on firing time and if data are not available for the full 10s conversion fails. A shorter window was used to ensure data were available for this cast.

Cast #15 sampled only from 15db upwards. A bottle file was prepared, but not a CTD file.
Cast #29 contained only upcast data. The CTD file contains upcast data which is considered of lower quality than usual.
Cast #34 had some bad data from all sensors mounted on the primary pump which included the DO sensor. Oxygen:Dissolved:SBE data were removed from the top 50db.
Cast #71 sampled to 6db only, so only a bottle file was prepared.

The Oxygen:Dissolved:SBE data are considered, roughly, to be:

±0.1mL/L from 0 to500db
±0.06mL/L from 500 to1500db
±0.04mL/L below 1500db

As noted in other recent Tully cruises, many problems occurred in the thermosalinograph system. Filters needed frequent cleaning. The salinity was spiky. The flow rate was better than in June 2012, but there are a few sections with low flow. The intake temperature data were bad in files #1-5 reading higher than the lab temperature. A stop for repairs/cleaning after event #49 resulted in much better TSG data in files #6 and 7. The intake temperature looks good and there are fewer spikes in salinity. Throughout the cruise the TSG salinity values were close to CTD values. The only recalibration applied was to create a proxy for intake temperature for files #1-5; the proxy was named Temperature:Primary and was set equal to the Lab Temperature minus 0.18C° based on estimates of heating in the loop as observed in files #6 and 7 and comparisons with CTD temperatures..

For cast #34 the WetLabs fluorometer was moved from the thermosalinograph to the CTD to enable a comparison with the SeaPoint fluorometer. A linear fit looks reasonable, so an estimate was made of scale and offset for the TSG instrument and this was used in conversion of the TSG files. This produced TSG data that compare quite well with the CTD fluorescence throughout the cruise except at the lowest values where it reads high. Comparisons with loop samples also show that that the TSG fluorometer reads too high when chlorophyll values are low (<0.9ug/L) and too low when they are high (>5ug/L.). There were no loop samples from the intermediate range.

It would be useful to repeat this inter-calibration, but it would be better to do it in an area of large chlorophyll range, perhaps in the Strait of Georgia when the TSG is not in use on the Tully. The WetLabs fluorescence in the final TSG files include one channel with concentration units based on the test and another with raw voltage.

The SeaPoint fluorometer on the CTD also reads higher than the chlorophyll for CHL<1ug/L and is very close to rosette bottles between 1 and 22ug/L. For values above that the SeaPoint reads too low. There was high variability in CHL samples that may be due to differentiation in Niskin bottles.

PROCESSING SUMMARY

1 Seasave

This step was completed at sea; the raw data files have extension HEX.

2 Preliminary Steps

The Log Book and rosette log sheets were obtained as well as sampling notes summarizing problems and points of interest with reference to processing. There were many changes of equipment and 7 different configuration files were prepared. Several casts were interrupted and will need repairs. The TSG was apparently working better than during 2012-12.

There were 2 split casts

- for casts #41/41b, the break is in the middle of the downcast
- for casts 84/84b the break is between downcast and upcast

So there will be no need to join bottle files but a join will be needed for cast #41 profile.

Extracted chlorophyll, nutrients, dissolved oxygen, DMS and salinity data were obtained in spreadsheet format from the analysts. The file creation date was added to the names of those files to avoid confusion if changes need to be made later. The draw temperature was recorded for DO sampling so concentration can be calculated in mass units as well as mL/L.

The cruise summary sheet was completed.
The history of the pressure, conductivity and DO sensors were obtained.

The number of changes to configurations was unusually high. Usually when a sensor such as the PAR or altimeter is on intermittently, the same configuration file is used and the empty channel removed later in processing. But during this cruise there were cases where the positions of sensors changed, so a series of configuration files are required. The chief scientist provided a list of 7 configuration files, but some were essentially the same, with just a correction of some parameter or other. And there were 2 for CTD #0506 with and without the PAR channel; since it was never mounted with CTD #0506, it doesn't matter which is used – both work There were 4 basic files:

A: 2012-13-CTD0550-A – with altimeter and PAR, on CTD #550
B: 2012-13-CTD0550-B – with an extra fluorometer and PAR, no altimeter, on CTD #550
C: 2012-13-CTD0550-C –with altimeter and no PAR
D: 2012-13-CTD0506– with altimeter, no PAR on CTD #506

Here is a summary of what sensors were listed for which channels:

	Volt 0	Volt 1	Volt 2	Volt 3	Volt 4	Volt 5	Volt 6
0550CTD-A	Free	SP Fluor	Diss. Oxy.	Trans	Altimeter	Free	PAR
0550CTD-B	Free	SP Fluor	Diss. Oxy.	Trans	WetLabs FL	Free	PAR
0550CTD-C	Free	SP Fluor	Diss. Oxy.	Trans	Free	Free	Altimeter
0506CTD	Free	SP Fluor	Diss. Oxy.	Trans	Altimeter	Free	Free

For the last 3 casts the CTD was changed but only the pressure sensor is different. This requires care in choosing the right configuration file, because conversion works even if you have the wrong pressure

parameters entered. Establishing which configurations fit which file was a slow process. Conversions were first done using a single file for each CTD and seeing if conversion was satisfactory.

Test conversions were run to see which of the four choices worked properly for each cast:
A: 1-32, 35-49*, 57*, 63*, 69-72*
B: 34
C: 52, 55, 60, 61, 62, 64, 65, 66
D: 87, 89, 90
* The altimetry was bad for casts #35 to 49, 57, 63, 69-72.

File 2012-13-CTD0550-A.xmlcon produced good results for casts #1-32. For casts #35-49 the altimetry was bad with virtually no signal. This does not appear to be due to the configuration file being wrong. The change occurred after a second fluorometer had been attached for cast #34 where the altimeter had previously been mounted. The 2nd fluorometer was removed for cast #35 and the configuration file indicates that the altimeter was put back on in the same spot as for cast #32, but it is possible some other the instrument was attached for testing. If so, there is no indication of that in the log or the configuration file. Cast #41 was the only case where the CTD got close enough to the bottom to expect a good signal. The 6 different configurations for CTD 0550 were tested on cast #41 and no reasonable altimetry was achieved in the output.

Another problem that must be dealt with is cast #40 when no bl file was created. First, the full cast file was converted and plots of pressure versus scan number were used to estimate when the bottles might have been fired. This was used to create a fake BL file and the rosette file was created using that guess. After converting the ROS file to IOS format, a plot was examined to see if the results looked reasonable. There seems a fair amount of vertical movement at some stops which might suggest a poor choice of scan numbers, but the plot of the full cast did show considerable movement throughout some of the stops, so tinkering is unlikely to improve the results. A note was placed in the header of the bottle file for 2012-13-0040 to indicate the method for extracting data.

Next the calibration constants were checked for all instruments. The only problems found were that the offset for the two pressure sensors needed to be updated and the hysteresis factor E in the Dissolved Oxygen sensor parameters had been updated from 0.036 to 0.03725 based on tests run in May 2012. When the bottle comparison is done for the oxygen sensor, checks will be made to see if there is a need to revisit that setting.

The PAR sensor was not always mounted. In some cases when it is not mounted the PAR is included in the configuration file, but in other cases it is not. Based on notes from the chief scientist a cast list was prepared for casts that require removal of the PAR sensor.

3 BOTTLE FILE PREPARATION

The ROS files were converted using the various configuration files. For cast #34 Voltage 4 was also converted to enable study of the TSG fluorometer calibration.
Those files were put through CLEAN to add event numbers (*.BOT).
Conversion did not work for some casts, so they were investigated:

- For cast #25 the BL file was corrupted. The first 2 lines that usually contain file name and time were missing information, the order of firing was entered wrong and the formatting of the lines was wrong. The original BL file was saved as 2012-013-9025.BL and then a new one was prepared. Once all the errors were corrected conversion worked properly.

- For cast #40 there was no BL file. One was fabricated by first converting the full file and using plots of pressure versus scan to pick a reasonable scan range to correspond to the firing time. The scans picked were at least 30s after the CTD stopped. It was assumed that the 2 bottles fired at each stop were fired about 5s apart. A warning was added to the header of this BOT file to indicate that the CTD scans are from approximately when the bottles were fired
- For casts #41 and #84 there was an interruption during or at the end of the downcast, so new files were started with event numbers 41b and 84b. The BL files with names #41 and 84 were empty, but the correct BL files exist and had been named #41b and #84b. After conversion the ROS files were renamed as #2012-13-0041.ROS and 2012-13-0084.ROS.
- For cast #89 there was a BL file but it was empty. No ROS file was created but the logs show that no bottles were fired so that is appropriate.

Header Check was run on the BOT files and no problems were found.
Temperature and salinity were plotted for all BOT files. CTDEDIT was used to clean secondary salinity very lightly in cast #79. A few other casts had a lot of variability during the stop, but they were for shallow bottles and the variability is likely real. The edited file for cast #79 was copied to BOT.

The BOT files were then averaged to enable an ADDSAMP file to be prepared. Sample numbers were added to the ADDSAMP file based on rosette log records. A few problems were noted in this process:

- Event #29 – The rosette log indicates that 24 bottles were fired, though one had the vent open so it was not sampled. The BOT file contains only 23 bottles, and there is no bottle at 3261db, so the first bottle was never fired.
- Event #55 – The rosette file contains only 3 bottles but the rosette log indicates that 6 were fired and sampled. The BL file does not contain the 3 bottles that were to be fired at 5m. The chief scientist's notes confirm that there were no bottles fired at 5m.
- Event #58 – There were supposed to be 17 bottles fired. Niskin #13 was not fired. Niskin #15 was fired twice, with firing positions #6 and #17, at 55m and at the surface, respectively. So the bottle closed at 55m, not the surface. The log shows Niskin #17 being fired 16th, but the BL file and converted file indicate it was fired 17th. The samples planned for Niskin #13 was taken instead from Niskin #17, but the sample number was left as sample #442.
- Event #69 – The order of firing the last 3 bottles does not agree with the rosette log. In the converted file Niskins #11, 12 and 13 were fired in order, but the log shows the order as 12, 13 and 11. The data seem to come from the intended levels.
- Event #77 – The firing #s appear to be wrong in the rosette log, for all except the bottom 3 bottles. The converted file looks reasonable, but should be checked again later.

SAM files were created using the Add Sample Number routine and those files were then bin-averaged. Bin-average was then run using bottle numbers for bins to produce SAMAVG files.

The addsamp.csv file was sorted on Event_Number and Sample_Number and then converted to CST files. The CST files will form the framework for the bottle files.

Next, each of the analysis spreadsheets were examined to see what comments the analyst wanted included in the header file. These were used to create file 2012-13-bot-hdr.txt; it may need further editing to reflect problems found during processing.

Dates of creation were added to the names of spreadsheets from analysts.

<u>EXTRACTED CHLOROPHYLL</u>

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2012-13chl.xls. The file included comments and flags and an event-number column. A simplified version of the spreadsheet was prepared in which some columns were removed and the file was saved as 2012-13chl.csv which was then converted to individual CHL files. Loop data were moved to file 2012-13loops.csv.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2012-13oxy.xls which includes flags, comments and a precision study. Draw temperatures are available. The spreadsheet page with the final data was simplified by removing a few unnecessary columns and the file was then saved as 2012-13oxy.csv. That file was converted into individual *.OXY files. There were no loop data. A few flags and comments were added based on notes available after consultation with Kenny Scozzafava.

SALINITY

Salinity analysis was provided in spreadsheet QF2012-13SAL.xls. The file was simplified and saved as 2012-13sal.csv. Loop data were moved to file 2012-13loops.csv. There are some salinity samples that correspond to TMR casts, so those were not included in the CSV file. Most of the salinity data were analyzed within 1.6 months of collection, about 1 month after the end of the cruise. The following samples were analyzed 2.7 months after collection: 13, 20, 60, 69, 61, 69 (both dups), 71 (both dups), 72, 90, 93, 96, 99, 102, 103, 128, 132 (both dups), 133, 134 and the loop samples JF1, JF2, JF3 and JF4. The ones analyzed later are the ones that were collected first, so these may show up as outliers. They were flagged "2" in the working files, for now, so we can see if there is a trend. They were not flagged in the main spreadsheet. The simplified spreadsheet was converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2012-13nuts.xls which included a report on precisions. The file was simplified, reordered on sample numbers and saved as 2012-13-nuts.csv. The file was converted to individual NUT files. Loop data were moved to file 2012-13loops.csv.

DMS

The nutrient data were obtained in spreadsheet 2012-13-dms.xls which includes raw data and a precision study; details on processing were in file 2012-13 DMS report.doc. The data file was simplified and saved as 2012-13dms.csv. The file was converted to individual DMS files. One sample had been flagged 5 as a lost sample; the flag was changed to 1 and a comment entered.

The SAL, CHL, OXY, NUT and DMS files were merged with CST files in 5 steps.
After the 4th step the files were put through CLEAN to reduce the headers to File and Comment sections only.

The merged files are ordered on sample number, but the SAMAVG files are ordered on bottle number, so one or the other set needs to be reordered in order to merge them. The MRGCLN1 files were reordered on Bottle_Number, the usual method used. The output files were named MRGCLN1s.
Those files were merged with SAMAVG files choosing the Bottle_Number from the SAMAVG files.

The MRG files were exported to a spreadsheet for an initial check that all samples had been added correctly. Several errors were found and corrected and the MERGE files were derived again. Most were simple errors in spreadsheets or the ADDSAMP file, but one error could not be fixed simply.

Two bottles were fired during cast #84 and samples were taken from both. However, the ROS file contains only data from the surface bottle, not the first one near 42m. There is data available in the full file for this level, but acquisition was started just before firing so the full 10s window is not available for

that bottle and thus conversion failed for that bottle. When conversion was run with a 6s-window, data was captured for the first bottle. This file was called 2012-13-0084x.ROS. It was processed in the usual way and the data from the SAMAVG file thus created was patched into file 2012-13-0084.SAMAVG file. That was then merged with the MRGCLN1s file again to create a MRG file. CLEAN was run to update the variable limits and the final file was named 2012-13-0084.MRG.

[April 5, 2013 correction: A problem with file 2012-13-0029.CHE was discovered that required "rebuilding" the bottle file. This was a cast with no acquisition on the downcast. The CTD file was created from the upcast data. The way the bottle files are created requires a 10s-window around the firing time, but firing was started immediately after acquisition started, so that there was no data at firing – 5s. Conversion failed to catch the first bottle. The special ROS file was reconverted using a smaller window and data from the 1st bottle was then added to the original ROS file so all but the first bottle have the usual 10s-window. The new ROS file was opened in Ultraedit to realign the bottle numbers. The usual bottle preparation steps were then repeated]

The bottle steps for file #29 were repeated.

4 Compare

Dissolved Oxygen

COMPARE was run with pressure as the reference channel. Discernoble

During 2012-12 a hysteresis test was done on this DO sensor. As a result the value of E was adjusted from 0.036 to 0.03725. A preliminary run of COMPARE was used to check that this setting produces good results for this cruise. The CTD is lower relative to the bottles below 1000m than above 1000m for the same range of CTD DO values, so a further adjustment looks necessary. It looks as though the deep CTD DO values are low by about 0.03mg/L when DO is about 2mg/L, likely because the E value is too low. Tests were done on 2 deep casts, #52 and #66, adjusting the value of E and seeing how the output values varied at the 2 depths where that concentration was found. Using E=0.039 increases the deeper incidents of DO~2 by about 0.03ug/L while it has little effect on the shallow incidences. A setting of E=0.04 goes too far.

So new ROS files were created using E=0.039 and the steps described above to prepare the SAMAVG files were repeated. COMPARE was run including only values between 0 and 3.1mg/L, and dividing the data into shallow and deep. The result suggested that the E value was now too high, so a 3rd run with E=0.0385 was tried. This time the result looked better. The slopes of the fits above and below 1000 were very close:

Above 1000db DO Bottles = 1.0515*CTD DO
Below 1000db DO Bottles = 1.0510*CTD DO

The R^2 value was much higher for the shallower fit. This is likely because the measurements of very low values are noisier and there were many more of those in the deep data. It looks like the fit used does worst in the oxygen minimum, giving somewhat lower DO values than bottles. However, SeaBird suggest that the titrations are not sufficiently reliable at low DO to be used for calibration fits.

Next, a fit was made using data from all levels but excluding bottles flagged "3" and "4". There were many flagged samples for this cruise and most do look slightly out of line in the fit. A few more outliers were identified, but they are in the presence of high DO gradients and/or reversals in DO. The only major outliers are from cast #1 with the CTD data looking bad for sample #1 at the bottom of the cast in anoxic waters, and the other two being at 50m and 10m where local DO gradients are high. There were some DO reversals between 50 and 120m complicating interpretation. Sample #8 from 50m had been flagged "2" because of a bubble; there is insufficient evidence to suggest changing that.

SeaBird recommend forcing the fit through the origin because of the unreliability of titrations below 1mL/L. Doing a fit through the origin leads to the CTD data looking too low at low DO values. If the fit is allowed a non-zero offset, the results do not vary much if data with CTD DO <1mL/L are included or excluded. So, it looks appropriate to allow that offset. The following fit is based on only cases where the CTD DO was >1mL/L:

DO Bottles = 1.0435 * CTD DO + 0.0159

For more details see 2012-13-dox-comp1.xls.

Plots of Titrated DO and CTD DO against CTD salinity were examined and no further problems were detected.

Salinity

Compare was run with pressure as reference channel.
The analyst flagged many samples, so for the first comparison all flagged samples were excluded and studied to see if the flags are justified.

Most of the samples from the first 6 casts had been flagged "2" because they were analyzed a month later than other samples. Most are outliers and show the sort of scatter that we associate with long storage, with many low by ~0.01, but a few have smaller differences and two are lower than the CTD. Of those, 2 are from the surface where the local gradient is often significant so that the 1.5m between CTD and bottle can lead to bottles being lower than the CTD. So it does look like the long storage had the effect we are coming to expect. At some point we should begin to attach a more severe flag to samples that sit too long, but for now they will be left with flag "2".

Some of the samples that were flagged "3" are minor outliers being higher than the CTD by an average of 0.005. Those flags should be left as "3".

There are no unflagged major outliers. A few bottles look slightly out of line, but the standard deviation in the CTD data is a little high for those. When flagged values and cases where the standard deviation in the CTD salinity is >0.008 are excluded, the primary salinity is found to be low by an average of 0.0019 with a standard deviation of 0.0017 while the secondary salinity is low by an average of 0.0005 with a standard deviation of 0.0019. While the secondary is closer to the bottles, there is more pressure dependence with near surface CTD values low while near the bottom they are high. The secondary salinity is much flatter with pressure if the top 500db are excluded from the fit. The standard deviation in the secondary salinity tends to be slightly higher than that of the primary.

There is some indication of salinity dependence in the fits of differences versus salinity, though the comparison is noisy. The CTD salinity for both sensors is lower relative to bottles at low salinity which could be due to incomplete flushing of bottles in high gradient zones, or some non-linearity in the Autosal. This is a question that has arisen from other recent cruises and should be investigated further.

The 22 bottles fired at 2000m during cast #65 were studied next. The standard deviations were 0.0018 for both salinity channels; the primary was low by an average of 0.0013 and a median of 0.0011 while the secondary was high by an average of 0.0006 and a median of 0.0009. This shows reasonable stability in the analysis.

For full details for the COMPARE run see file 2012-13-sal-comp1.xls.

Fluorescence

COMPARE was run using the SeaPoint fluorescence and the Extracted Chlorophyll from bottles. It was discovered that there was an error in the ADDSAMP file for cast #5. There was no oxygen or salinity sampling for that cast, so the other comparisons are not affected. The merge process was rerun for Cast #5 and then COMPARE was rerun for fluorescence.

The SeaPoint values are generally much higher than extracted chlorophyll for CHL<0.5ug/L. For the lowest values this may reflect that the ratio is not reliable for very low numbers due to the noisiness of the fluorescence and titrations. Subtracting a dark value of ~0.05ug/L from the fluorescence does not change the picture much though. There were 5 cases of very large differences, 3 from cast #87 and 1 each from casts #26 and #49. One case has extremely low CHL (0.04ug/L). Two of the samples had been flagged because of high variability and for one there was only a single sample. Two others did not have high variability. In none of these cases does the difference look like it could be explained by the vertical offset between CTD and bottles in the presence of a high gradient. There are some high fluorescence gradients but no fluorescence even remotely close to the extracted CHL values is found anywhere nearby in the profile plots. Most of the outliers are found at or just below the fluorescence maxima. It was noted during 2012-12 that the fluorescence tended to be higher than extracted CHL below the fluorescence maxima, but the differences were not as dramatic as those seen here.

The CHL analyst noted a high co-efficient of variability (CV) in samples from this cruise. The high variability is considered typical of August/September Line P cruises and there is some suspicion that there might have been differentiation in the Niskin bottles. A different technique for sample collection is being considered.

TSG Fluorometer Test

The TSG fluorometer was mounted on the CTD for cast #34. This enables a comparison with a SeaPoint fluorometer that is working reasonably well. The TSG fluorometer has not been calibrated in over 10 years and was known to read too high. Recently it was cleaned, which probably affected the calibration further, and an attempt to come up with new parameters had produced nonsense results.

Comparing the TSG voltage with the SeaPoint fluorescence leads to the fit:

SeaBird Fluorescence = 8.708 *WetLabs Voltage – 0.8233

The WetLabs Fluorescence is calculated as (Voltage – Voffset)*Scale. If we assume that the 2 types of fluorescence are equal, then it follows that the scale is 8.708 and blank output is 0.8233/8.708, or 0.094.

These parameters were then used to convert the full file and there were many negative values in the WetLabs fluorescence and higher values at the maximum. So the full file was converted to IOS Header format and put through DELETE, BIN-AVERAGE, THIN and COMPARE. The fit of differences against WetLabs fluorescence is a little noisier. When 2 outliers were excluded the fit found was

SeaBird Fluorescence = 7.2109 *WetLabs Voltage – 0.5256

That implies a scale value of 7.211 and Voffset of +0.073.

Converting the data with those values and plotting them with the SeaPoint data produces results that are very close.

All TSG files were converted using those values and a few checks were made against loop CHL samples. There is a lot of variability in the results:

Station	Extracted CHL	WetLabs Fluorescence
JF1	9.717	6.3
JF2	37.984	13.0

JF3	5.469	3.5
JF4	16.525	8.5
Loop1	0.352	0.38
Loop2	0.25	0.46
Loop3	0.189	0.46
Loop4	0.226	0.47
Loop5	0.323	0.42

The WetLabs fluorescence reads a little high at the lowest values and too low at the highest values. This may indicate that the fit is not ideal, but at least the shape is sensible.

At this point the data from the MRGCLN2 files were exported to a spreadsheet for comparison with the rosette files to ensure no data were misplaced or missing. The following problem was found:

- Cast #25 – The rosette log indicates that bottles #1 and 2 were fired at 50m and 5. The log book mentions that 2 other bottles were fired just to get bulk water with no regular sampling. There were 4 bottles fired, 2 at about 50m and 2 at 5m. The samples clearly come from different depths, so the values were assigned to Niskins #1 and #4. This does not affect the analysis spreadsheets.
- At the end of processing cast #5 was found to have an error in the assignment of sample numbers; the files were recreated. (March 28, 2013)

5 Conversion of Full Files from Raw Data

All files were converted using the 4 configuration files discussed in section 2.

A few casts were examined and all expected channels are present. The descent rate is highly variable, kept high on average, but in some cases it is so noisy that there are some complete reversals of direction during the descent and obvious shed wake corruption. During the upcasts temperature and conductivity sensors look poorly aligned, but during downcasts there is no evidence of that. This likely explains the larger differences between traces noted on upcasts. Either the fish is not vertical during upcasts, or there are differences in shed wake effects on the two sensor pairs. Spikes are not common and they occur in both sensor pairs.

Altimetry looks useful when the CTD got near the bottom.

Dissolved oxygen looks ok but for casts #15 and #37 there was a problem noted in the log about how the syringes were attached. Cast #15 is very shallow and only contains upcast data, so it is hard to judge the DO signal; it looks quite different from another cast at the same site, but salinity also looks quite different. Cast #37 is from P15 where there was only 1 CTD cast, but when the data are plotted together with casts from P14 and P16 the DO signal is intermediate between the other two at the surface and below 100db and they are similar elsewhere.

PAR looks normal. The transmissivity has an unusual step-like appearance. Fluorescence went off scale at least once.

6 WILDEDIT

Program WILDEDIT was run to remove spikes from the pressure, conductivity & temperature only.
Parameters used were: Pass 1 Std Dev = 2 Pass 2 Std Dev = 5 Points per block = 50
The parameter “Keep data within this distance of the mean” was set to 0 so all spikes would be removed.

7 ALIGN DO

Tests were done on 4 casts applying a variety of settings to make the offset between the upcast and downcast DO channel close to that for the temperature. It is very hard to judge because the temperature is so noisy on the upcast, the descent rate was noisy and only casts with few stops for bottles are appropriate. An advance of 4.5s appears to have the best effect overall though 4s and 5s look better for some features. For cruises 2012-25 and 2012-12 settings of +4.5s and +5s were used, respectively. ALIGNCTD was used to advance the DO Voltage by 4.5s relative to the pressure.

8 CELLTM

The upcast data are extremely noisy making the usual tests for CELLTM settings hard to interpret, especially for the secondary sensors. For the primary sensors the best choice was clearly ($\alpha = 0.02$, $\beta=7$) For the secondary it is harder to judge, but ($\alpha = 0.03$, $\beta=7$) look best overall. The recent history of these sensors shows great variability in the best choice of settings for other cruises.
CELLTM was run using ($\alpha = 0.02$, $\beta=7$) for the primary and ($\alpha = 0.03$, $\beta=7$) for the secondary conductivity channels.

9 DERIVE

Program DERIVE was run twice:

on all casts to calculate primary and secondary salinity and dissolved oxygen concentration.

on a few casts to calculate the differences between primary and secondary channels for temperature, conductivity and salinity. These were placed in a test directory and will not be archived.

10 Test Plots and Channel Check

A sample of casts was plotted to check for agreement between the pairs of T and C sensors. The differences are very noisy so these are very rough estimates; if there was a spike at the given depth, nearby values were chosen. For comparison, values are listed from 3 recent cruises which used the same equipment, but none of those cruises sampled below 350db.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate
2012-05-0032	250	+0.0001	+0.00015	+0.0018	Steady, high
2012-05-0039	350	+0.0002	+0.00014	+0.0013	Steady, high
2012-57-0013	270	-0.0002	+0.00025	+0.0027	Steady, high
2012-58-0081	240	+0.0001	+0.00006	+0.0006	V.Steady, high
2012-13-0035	350	+0.0008	+0.00018	+0.0013	Noisy, high
“	500	+0.0004	+0.0002	+0.0011	“
“	1000	-0.0002	+0.0001	+0.0012	“
“	1800	-0.0006	+0.00008	+0.0016	“
2012-13-0041	350	+0.0005	+0.00013	+0.0012	Noisy, high
“	500	+0.0003	~0 XN	+0.0007	“
“	1000	-0.0002	+0.00008	+0.0011	
“	1800	-0.0005	+0.00006	+0.0013	“
	3500	-0.0012	+0.00007	+0.0021	“
2012-13-0052	500	+0.0002	+0.0001	+0.001	Noisy, high
“	1000	-0.0004 VN	+0.00009	+0.0014	“
“	1800	-0.0006	+0.0001	+0.0018	“
“	3500	-0.0012	+0.00008	+0.0023	“
2012-13-0066	<1800	Too Noisy	Too Noisy	Too Noisy	X Noisy, high
“	1800	-0.0006	+0.0001	+0.002	V Noisy, high

“	3500	-0.0012	+0.00012	+0.0027	“
“	4000	-0.0013	+0.00012	+0.0028	“

It is unusual to see so much pressure dependence in the deep temperature differences Taken together with the pressure-dependence found in the comparison of secondary salinity with bottles, this may indicate a problem with the secondary temperature sensor. The conductivity does not show much variation with depth. However, none of the differences are particularly large. The salinity differences are consistent with the average difference of 0.0014 found in the bottle comparison.

11 Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers.
At this stage files 2012-13-0041 and 2012-13-0041b were renamed as 2012-13-0041.iosa and 2012-13-0041iosb.
JOIN was run to combine those two files with output named 2012-13-0041.ios.
There is no need to merge the Event #84 files because the first file contains all the downcast data, so #84b will not be needed. Note that the Rosette file for that event was renamed #84 to match the downcast file.

CLEAN was run to add event numbers and to replace pad values in the pressure channel with interpolated values based on record number. Florescence values >49.1 were also replaced with pad values because for at least Cast #90 the data are clearly off-scale with values just above 49.1ug/L during the downcast.

12 Checking Headers

The header check was run. There are some off-scale values in the SeaPoint fluorescence. There are no negative pressure or dissolved oxygen values. Speeds look reasonable.

Surface Check was run and shows an average surface pressure for the cruise was 2.7db which looks reasonable for the Tully. The minimum was 1.35db at cast #69 with what look like “in water” values. The stop for a bottle during cast #55 at an average of 1.5db so that the Niskin bottle would have barely been in the water. So it is unlikely that the pressure is reading too high, but it could be low.

Deck readings of pressure were -0.3db at the beginning of the cruise and +0.5db at P20. At cast #58 there were records at the end for which the pressure went negative while the pumps were running. The transmissivity soon reached 0 values and salinity moved to very low values. The surface appears to be at roughly -0.1db. No further recalibration of pressure looks necessary at this point.

The cross-reference check was compared with the log book and the only possible problem was inconsistencies in times of casts between the log and the headers. The differences varied from 0 to 15s with smaller differences towards the end of the cruise. Either there was a delay in writing up the log or some clocks were fast. No change was made to the headers.

The cruise track was plotted and added to the end of this report. No problems were found.

The altimeter readings from the headers of the CLN and SAMAVG files were exported to a spreadsheet. Most casts did not get within 15m of the bottom so there are no header entries. Problems were found for casts #35 to 49. The altimeter had been removed for cast #34 but for casts #35 to 49 the configuration file indicated that it was mounted. The data suggest otherwise. All voltages were plotted for a test cast and the traces are in agreement with what is expected from all but voltage 4 which supposedly had an

altimeter mounted. It seems likely that the altimeter had not been put back on, but just left in the configuration file. The header entries were removed for those casts.

Water depths were checked and while there were differences from the log book entries, they were all close to those entries or made more sense in light of the bottom altimetry except for:

- Casts #63 and #64 at P24 have the same header entry as the previous cast at P23. The headers were likely not updated. The log entry makes more sense and will be used.
- Cast #70 is hard to judge, but in the absence of other evidence the log entry will be used.
- Cast #89 which is clearly not 1328m deep given a cast to 310db and altimetry reading ~9m at the bottom of the cast. The log entry of 316 looks likely and that was put into the header.

The usual protocol was not followed for cast #63. Acquisition started before the soak period including the initial drop to 13db and return to the surface. The CLN file was edited to remove the initial drop so that DELETE would select the full cast after the soak period.

13 Shift

Fluorescence

Tests were run on two casts to see what SHIFT value should be used to make the offset between the downcast and upcast fluorescence trace look like that of the temperature trace. This task was complicated by noisy upcast temperature data but the usual value of +24 records looks appropriate.
SHIFT was run on all casts to advance the SeaPoint fluorescence by +24 records.
After this step a few plots were made to see if the results are satisfactory and they were.

Conductivity

Tests were run on 4 casts with CTD #0550 and 1 with CTD #0506 to determine how to align the conductivity channels relative to temperature, so as to minimize noise in the salinity channels.
A shift to the primary conductivity of -0.9 to -1.1 records looked best overall and for the secondary values a shift between +0.3 and +0.5 looked best. The traces are noisy with no one setting producing very satisfactory results.
SHIFT was run on all casts using -1.0 records for the primary conductivity and +0.4 records for the secondary conductivity.
T-S plots were examined after this step and while some noise remains the results look ok overall. The secondary traces look slightly less noisy.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier. A few casts were checked to see if further alignment is needed for the DO concentration channel, but this does not appear necessary.

14 DELETE

REVERSE was used for casts #29 since the downcasts were not archived.
Cast #15 will not be processed further since it contained upcast only from 16db with several stops. No CTD file will be prepared. (A separate file was processed for the chief scientist to distribute as needed, but it will not go in the archive.)
Cast #71 had pressure <10db. This was a surface cast only to get samples. No CTD file will be prepared. (A file was prepared for the chief scientist to distribute as needed, but it will not go in the archive.)

DELETE was then run on all files and then on the reversed file for cast #29.
The following DELETE parameters were used:

Surface Record Removal: Last Press Min

Maximum Surface Pressure (relative): 10.00
Surface Pressure Tolerance: 1.0 Pressure filtered over 15 points
Swells deleted. Warning message if pressure difference of 2.00
Drop rates < 0.30m/s (calculated over 11 points) will be deleted.
Drop rate applies in the range: 10db to 10db less than the maximum pressure
Sample interval = 0.042 seconds. (taken from header)

COMMENTS ON WARNINGS: There were a few warnings:

- Cast #29 – pressure <10db because no downcast data were archived. When the reversed files were processed there were no warnings. Cast #29 was deep, so a CTD file will be prepared from the upcast data.
- Casts #58 and 63 had warnings that pertained to the upcast only, so are not relevant to CTD files.

15 Other Comparisons

Previous experience with these sensors –

1. Salinity:

   The conductivity sensors were both recalibrated in late March 2011 and were used for many cruises since then. There have not been many good comparisons with bottles; the best available was from 2012-05 and indicated that primary salinity was low by about 0.001 and the secondary was high by about 0.0004.

2. Dissolved Oxygen

   The DO sensor was recalibrated in April.2011 and has been used for 8 cruises since then. None of those comparisons used the bottle comparison method now recommended by SeaBird.

3. Pressure

   The sensor on CTD #0550 has been used many times since it was recalibrated in April 2011. The offset was increased in June 2012 from +0.24 to +0.74. The sensor on CTD #0506 has been used 6 times in 2012 and the offset was increased from -1.4 to -0.1 in April 2012.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. The only excursions in salinity were some low values in both salinity channels in the top 10m of cast #2. There was also a large excursion in the primary salinity in the top 40m of cast #34, but the secondary salinity looks fine. There was an obvious problem in the primary conductivity, but that cleared by the time the CTD was at 40db. The dissolved oxygen also looks bad with low surface values, so this is assumed to be a case of the primary flow being interrupted. There were many cases of temperatures being slightly below the climatology around 100m and at 250m between P15 and P21. Similar data from P18 and P22 fall within the climatology, so this is assumed to be an incursion of waters from nearby and not due to instrumental problems.

Repeat Casts –

There were many repeat casts. At P26 there were 3 casts within 11 hours of each other and the differences were ~0.002°C and <0.001psu. When casts over 28 hours were included the differences were ~0.006°C and ~0.001psu at about 900db. This is below the area of greatest variations.

Post-Cruise Calibration

There were no post-cruise calibrations available.

16 DETAILED EDITING

The bottle comparison shows that the secondary salinity is closest to the bottles but there was a little more pressure dependence in the secondary. Since the temperature differences show some odd pressure dependence, it is possible that there is a problem with the secondary temperature sensor. There has been

little change in calibration since these sensors were used in June 2012. The sensors chosen for archiving have varied among recent uses. While the primary might look like the better choice, it has many more spikes and some sections of clearly bad data. Overall the secondary T/S looks like the better choice for archiving.

CTDEDIT was used to remove large spikes, smaller spikes that appear to be due to instrumental problems (chiefly mis-alignment of T and C) and likely to affect the bin-averaged values and records corrupted by shed wakes including some surface records. The data tend to be noisy between 10 and 50db where salinity varies little and temperature gradients are large; small variations in alignment lead to very noisy salinity.

Editing was required for all casts but was fairly light, for most. Late in the cruise the descent rate was very noisy with many complete reversals of direction; for casts #64 to 84 heavy editing was required to remove records corrupted by shed wakes.
Cast #29 is from the upcast and also required heavier editing.

For cast #34 only, another run of CTDEDIT was applied to remove SBE Dissolved Oxygen data from the top 50m due to a problem with all sensors on the primary pump. (Note this affects the downcast only.)

The first attempt at processing the profile files contained an error. The step CELLTM was skipped inadvertently so that the salinity values are slightly high in areas of high temperature gradients. To correct this involves editing all the files again. To minimize the editing effort steps were taken so that the records that had been removed in the first run, were removed from the DEL records from the second run. The steps were:

1. The EDT files from the first run were stripped of all channels except Scan Number. (REMEDT)
2. The REMEDT files were cleaned to remove SeaBird headers and comments and all headers except the HISTORY file which contains the correct information for both runs as all settings listed remain the same. (REMCLN)
3. The new DEL files were merged with the REMCLN files with Scan Number as the reference channel, and DELMRG files as output.
4. There are now two "scan number" channels, one from the new DELETE files and a second one from the previously edited files. The 2nd scan number channels has pad values, -99, where records were removed. So the files were put through SORT ordering by the 2nd scan numbers. This brings the bad records to the top of each file and leaves the rest in the proper order. (DELMRG1)
5. CLIP was run to remove all records with scan number <0. (Output: DELMRG2)
6. Cast #29 needed special treatment because it was from the upcast and had been reversed. The Merge process rearranged the data in reverse, so it was put through REVERSE to once again produce a file with increasing pressure. DELMRG3 was edited for this cast only.
7. Cast #41 was also a problem because it was the join of 2 files. It cannot be merged on scan number so it will be re-edited in full.

CTDEDIT was then applied to the DELMRG2 files except for cast #29 (DELMRG3) and for cast #41 (DEL). This editing was mostly cleaning of salinity as the corrupted records removed in the first run are not present (except for cast #41), but a few more records were removed. All subsequent steps were then applied again.

17 Initial Recalibration
No recalibration was considered necessary for pressure and salinity.

Dissolved oxygen was recalibrated using the results of the comparison described in section 4.

DO Corrected = 1.0435 * CTD DO (original) + 0.0159

CALIBRATE was run using file 2012-13-recal1.ccf to apply that correction to the dissolved oxygen channel. This was applied to the SAM and MRGCLN2 files. COMPARE was rerun to check that the salinity was recalibrated appropriately and it was. The calibration was then applied to the EDT files. (See file 2012-13-dox-comp2.xls.)

18 Final Calibration of DO

The initial recalibration of dissolved oxygen corrects for sensor calibration drift. Alignctd corrects for transit time errors. Those 2 steps may partly correct for response time errors, but a further correction is sometimes found appropriate to correct for errors found by comparing downcast CTD data to bottle data from the same pressure.

Downcast files were bin-averaged to 0.5m bins for the casts with DO bottle samples. Those files were then thinned to the usual levels for bottles and compared to the bottle values in the MRG files. COMPARE was used to study the differences between the downcast CTD DO data and the upcast bottles.

COMPARE was run again. When the differences were plotted against DO concentration and pressure there is a lot of scatter, but no systematic slope or offset. There is no need for further recalibration.

Based on the final comparison a very rough estimate was made of the accuracy of the Oxygen:Dissolved:SBE data:

±0.1 mL/L from 0 to 500db
±0.06 mL/L from 500 to 1500db
±0.04 mL/L below 1500db (See 2012-13-dox-comp3.xls.)

19 Special Fluorometer Processing

There were no off-scale fluorescence data.

Special files were prepared for Dr. Peña by clipping the COR1 files to 150db. The clipped files were bin-averaged (0.25db bins), put through REMOVE and HEADEDIT and named as *.FCTD1 and saved. A second set, *.FCTD2, were created by filtering before bin-averaging. The SAM files were put through REMOVE and named *.BOF and saved. A readme.doc file was prepared with some notes on the preparation of those files.

A median filter, fixed size=11, was applied to the fluorescence channels in the COR1 files to reduce spikiness. Before and after plots of a few casts showed that the filter was effective.

20 BIN AVERAGE of CTD files

The following Bin Average values were applied to the FIL files (output AVG):
Bin channel = pressure Averaging interval = 1.000 Minimum bin value = .000
Average value will be used. Interpolated values are NOT used for empty bins.
After averaging, page plots were examined on screen and no further editing appeared to be necessary.

21 Final CTD File Steps (REMOVE and HEADEDIT)

REMOVE was run on all casts with a PAR sensor mounted to remove the following channels:

Scan_Number, Scan_Number:2, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag

REMOVE was on casts with no PAR sensor to remove the following channels:

Scan_Number, Scan_Number:2, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, PAR, Descent_Rate and Flag

The channel Fluorescence:URU:Wetlabs was also removed from cast #34. This data was only collected to help calibrate the TSG fluorometer.

A second SBE DO channel (with umol/kg units) was added.
REORDER was run to get the two DO channels together.

HEADER EDIT was used to fix formats and channel names, to add "Mid-ship" to the instrument location section and to add the following comments:

Data Processing Notes:

Transmissivity, PAR and Fluorescence data are nominal and unedited except that some records were removed in editing temperature and salinity.

For details on how the transmissivity calibration parameters were calculated see the document in folder "\cruise_data\documents\transmissivity".

Based on the recommendation from SeaBird, the method for calibration of Dissolved Oxygen concentration was changed from that used for 2011 and some 2012 cruises. SBE DO calibration was done using the method described in the SeaBird Application NOte #64-2 with a modification allowing a small offset.

The Oxygen:Dissolved:SBE data are considered, very roughly, to be:
±0.1 mL/L from 0 to 500db
±0.06 mL/L from 500 to 1500db
±0.04 mL/L below 1500db

For details on the processing see processing report: 2012-13-proc.doc.

The cross-reference list was produced and one typo in a station name was fixed.
The Standards Check routine was run and no problems were found.
The Header Check was run and no problems were found.
The final files were named CTD.

Profile plots were made and look ok.
The track plot looks ok.
The sensor history files were updated.

22 Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. The near-surface values westward of station P5 were all about 105%. In Saanich Inlet values ~150% were found and at P1 to P5 values ranged from 110% to 150%. When the ship returned to P4 at the end of the cruise the saturation was down to about 110%.

23 Final Bottle Files
The MRGCOR1 files were put through SORT to order on increasing pressure.

REMOVE was run on casts with a PAR sensor mounted to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag
REMOVE was run on casts with no PAR sensor to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, PAR, Descent_Rate and Flag

A second SBE DO channel was added with different units and REORDER to get the 2 SBE DO channels together.

HEADER EDIT was run to fix formats and units, fix a few headers, change the channel name Bottle_Number to Bottle:Firing_Sequence and the name Bottle:Position to Bottle_Number and to add a comment about quality flags and analysis methods and a few notes about the CTD data.
Cast #34 also has the TSG fluorometer mounted on the CTD. For that cast only both the concentration and raw voltage channels were kept.

A header check was run on the final files and problems were found in the draw temperature for cases of duplicates – sometimes there was only 1 draw temperature available and it had accidentally gotten averaged with a pad value producing negative temperatures. These cases were fixed in the oxygen spreadsheet and in the CHE files as well as some intermediate files.

For a final check the CHE bottle data were exported to a spreadsheet and compared with the rosette log sheets and no errors were found.

Plots were made of CTD Salinity versus SBE Dissolved Oxygen and bottle DO and no further outliers were identified.

Standards check was run on all files and no problems were.
A cross-reference list turned up no further errors.
The track plot was produced on screen and no further errors were found.

24 Thermosalinograph Data –
Data were provided in 7 hex files. The final file was misnamed as 2012-12-0012.hex.
There are many notes in the log about difficulties with the loop system, spikes in the TSG salinity and clogged filters.

Loop data were combined in file 2012-13-loops.csv. There were 9 salinity, nutrient and extracted chlorophyll samples. One of the chlorophyll samples was flagged and 4 of the salinity samples were stored about 3 months so the values are not trusted. Time and date were added to the file to enable addition of the TSG data later.

None of the loop samples coincide with rosette casts.

a.) <u>Checking calibrations</u>
The calibrations were checked and the only problem concerns the fluorometry. Based on the comparison reported in section 4, new values were entered for the scale and blank value and the data was entered as

August 2012 since the data on which the calibration was based was collected during 2012-12. The configuration data from February 2012 were found to be inappropriate.

The CON file was saved as 2012-13-tsg.xmlcon.

b.) The files were converted to CNV files using the configuration files mentioned above.
Given the continuing doubts about the fluorometer calibration, both concentration and voltage were converted for the fluorometer.
After conversion to CNV, file 2012-12-0012 was renamed as 2012-13-0007.cnv.
The files were then converted to IOS HEADER format.

CLEAN was run to add End times and Longitude and Latitude minima and maxima to the headers.
ADD TIME CHANNEL was used to add Time and Date channels based on the Julian time.

Time-series plots were produced:

- Flow rate has some significant drops both early and late in the cruise. The system was turned off to clean the filters frequently.
- The intake temperature traces look odd, too smooth, and having values higher than the lab temperature for files #1-5. There were many comments in the log about grease in the filters. After event #49 the system was shut down and cleaned, the intake temperature looks normal in files #6 and #7.

c.) Checking Time Channel
The CTD data were thinned to reduce the files to a single point from the downcast at or within 0.5db of 4db and exported to a spreadsheet which was saved as 2012-13-ctd-tsg-comp.xls.

All ATC files were opened in EXCEL, median and standard deviations (over 5 records) were calculated for intake temperature, lab temperature, salinity and fluorescence, and the files were reduced to the times of CTD files. Those data were added to 2012-13-ctd-tsg-comp.xls. There were 48 matches.

To check for problems in the TSG clock or bad matches of TSG and CTD data, the differences between latitudes and longitudes were found. The differences in latitude were $\leq 0.0007°$ and in longitude were $\leq 0.0018°$ and the median differences were 0° for both, so there is no systematic error. This shows both the times and positions are reliable for both systems.

TSG values were also found for times of underway loop sampling and added to the loop file which was then saved as 2012-13loops-tsg-comp.xls. The nutrient data were removed from the latter file.

These spreadsheets will be used in step (d) to compare temperature, salinity and fluorescence.

d.) Comparison of T, S and Fl from Loop and Rosette samples and TSG and CTD data

- T1 vs T2 The intake thermistor was connected throughout the cruise. The temperature difference (intake temperature minus the lab temperature) varied greatly, with the intake temperature being higher than the lab temperature for most of the first 5 files. When there was a significant change in the difference it was associated with changes in the intake temperature with little change in the lab temperature. For files #6 and 7 there differences are of the normal sign with the lab temperature higher than the intake temperatures.

Plots were prepared using the data in spreadsheet 2012-13-ctd-tsg-comp.xls When plotted against TSG flow rate the worst outliers among the differences were cases with low flow rate, but there were many outliers that are associated with normal flow rates. So flow rate does not explain the problem. When plotted against event # a clear pattern emerges with an abrupt change after CTD event #49. While stopped for CTD casts #2 to 49 the intake temperature was higher than the lab temperature by a median value of 0.47C° and standard deviation of 0.160C°. But for casts #52-87 the difference dropped to the expected negative values; the lab temperature was higher than the intake by a median value of 0.17C° and standard deviation of 0.017C°. The final two casts had values that were more negative, with more apparent heating in the loop, but the flow rate was low for one of them and ~0 for the other, so likely there really was more heating in the loop.

- TSG vs CTD The spreadsheets comparing CTD and TSG files were then examined to find the differences between the salinity, fluorescence and temperature channels for the CTD and the TSG. The following table summarizes the results which show a clear difference between early and late casts. Casts #89 and 90 are excluded as they were outliers and had low or zero flow in the loop.

		T:Intake - T:CTD	T:LAB-T:CTD	T:LAB-T:Intake	Sal TSG - Sal CTD	TSG FL/CTD FL
All casts	Average	0.4450	0.3022	-0.1428	0.0009	1.121613
	Median	0.4757	0.1826	-0.1987	0.0000	1.022589
	Std dev	0.5117	0.2641	0.3734	0.0085	0.561275
Events #2-49	Average	0.8475	0.3806	-0.4669	0.0012	1.1378
	Median	0.6716	0.1992	-0.4495	0.0000	1.0525
	Std dev	0.3960	0.3243	0.1595	0.0116	0.3906
Events #52-87	Average	0.0033	0.1733	0.1700	0.0004	1.2192
	Median	0.0050	0.1687	0.1715	0.0000	1.0083
	Std dev	0.0069	0.0180	0.0163	0.0025	0.6463

The earlier casts show TSG salinity to be in good agreement with the CTD salinity, but the standard deviation is high. The largest differences are associated with high standard deviations in the TSG salinity. The TSG intake temperature is in very poor agreement with the CTD temperature. The lab temperature shows a lot of variability during that early period, but the mean values are higher than the CTD by ~0.20C° which is about right for the amount of heating expected in the loop. The TSG fluorescence is close to the CTD fluorescence.

For the later casts the TSG salinity continues to be in good agreement with the CTD, and the standard deviation in the differences is notably smaller. The intake temperature is slightly higher than the CTD temperature. That may reflect an error in either the CTD or TSG intake temperature sensor calibration, or may indicate that the TSG system draws water from a little higher in the water column than 4m. The CTD data are noisy around 4m due to ship noise and the matching of time for when water sampled by the CTD at around 4m would reach the TSG is uncertain. So while errors should be reduced by averaging, it is unwise to over-interpret these results. Fluorescence from the TSG continued to agree well with the CTD fluorescence for these later casts though the standard deviation was higher. For CTD fluorescence <1ug/L the TSG fluorometer tended to read higher than the CTD fluorometer, but for 0.9ug/L<CTD<5ug/L the two fluorometers were close. Above 5ug/L the TSG fluorometer read lower than the CTD.

When the data were reduced to CTD casts which were considered well-mixed as judged by having the salinity vary by <0.005 between 4m and 10m, the results are as seen below:

		T:Intake - T:CTD	T:LAB-T:CTD	T:LAB-T:Intake	Sal TSG - Sal CTD	TSG FL/CTD FL
All casts	Average	0.2902	0.1851	-0.1051	0.0004	1.2233
	Median	0.0107	0.1768	0.1573	0.0000	0.9923
	Std dev	0.3299	0.0311	0.3235	0.0025	0.5912
Events #2-49	Average	0.6457	0.1903	-0.4554	-0.0001	1.1844
	Median	0.6364	0.1759	-0.4606	0.0000	0.9817
	Std dev	0.0666	0.0431	0.0369	0.0021	0.3986
Events #52-87	Average	0.0059	0.1810	0.1751	0.0008	1.2545
	Median	0.0064	0.1800	0.1736	0.0000	0.9923
	Std dev	0.0043	0.0184	0.0165	0.0028	0.7309

The intake temperature still looks bad for the early part of the cruise. The lab temperature is higher than the CTD temperature by about 0.18 C°. The salinity now looks extremely close to the CTD salinity. The TSG fluorescence is close to the CTD fluorescence judging by the median value but the standard deviation is high.
(See 2012-13-ctd-tsg-comp.xls.)

- Loop Bottle - TSG Comparisons The spreadsheet described in section (c) contains all loop sample data with TSG salinity and TSG fluorescence (median values over 2 minutes). The salinity samples were analyzed in 2 groups; 4 were analyzed about 3 months after collection and 5 within 2 months. Those analyzed faster show the salinity to be low by 0.065 and those analyzed later indicate it is low by 0.346. A wait of 3 months has been found to lead to bottle values that are too high, probably due to evaporation, which easily explains the difference in these results. There are 2 bottles that were collected at a time when the Standard Deviation in the TSG salinity was very low and they show the TSG being high by 0.002 and 0.005. The comparison of fluorometer and chlorophyll is limited because of the absence of intermediate CHL values – all are either <0.4 or >5ug/L. The TSG fluorometer reads about 85% times the CHL, on average, for the high CHL though the scatter in the results is so large that the results do not look meaningful. For low CHL values the TSG reads consistently too high by a factor of from 1.8 to 3.4. (See 2012-13loops-tsg-comp.xls.)

- Calibration History

The TSG primary temperature and conductivity were recalibrated in March 2011 and have been used during 2012-01, 2012-14, 2012-25, 2012-12 and 2012-31. There was no intake temperature available on the first 2 of those cruises and no calibration sampling on the last. During 2012-25 and 2012-12 there were similar problems to this cruise with flow problems, bad intake temperature and apparent shifts in relationship of CTD and TSG salinity. Looking further back to see how much heating is expected in the loop in late summer in this region, values found were 0.14 and 0.17C°.

Conclusions

1. The TSG clock appears to have worked well.

2. The flow rate was fairly steady and high though there were some sections where it drifted lower. The flow was shut off a few times to enable cleaning.

3. The temperature in the loop increases by about 0.18C° based on comparisons with CTD temperature and for files #6 and 7 comparisons with the intake temperature.

4. The TSG intake temperature looks reliable for files 6 and 7 and should be archived. For files 1-5 the intake temperature will be removed. The lab temperature will be recalibrated by subtracting 0.19C° to produce a proxy for intake temperature.

5. The TSG Salinity has some spikes that will need editing. Temperature, salinity and fluorescence values should be replaced with pad values where flow was turned off or very low.

6. The TSG salinity is very close to the CTD salinity during stops, with the difference averaging 0 for the casts that were well-mixed in the top 10m. No salinity correction is required.

7. The fluorescence data were converted using the results of a comparison with the CTD fluorometer when both were mounted together for one CTD cast. The results look good but based on comparisons with loop and with CTD fluorescence, the TSG fluorometer tends to read too high for low CHL values (<0.9ug/L) and too low for high values (>5ug/L).

f.) Editing

The ATC files were copied to *.EDT.
The ATC files were opened in CTDEDIT. Single-point spikes in salinity that are not associated with temperature spikes were removed from all files. In files #1, 5 and 7 there were small sections where flow was near-zero; for those, lab temperature, salinity and fluorescence values were removed. A group of bad salinity points were removed in file #1.

The edited files were copied to *.EDT.
Plots were examined and no further editing was deemed necessary.

g.) Recalibration -

For files 1-5 ADD CHANNEL was run to add channel Temperature:Lab which was set equal to Temperature:Primary.

The salinity looks close to the CTD salinity and no recalibration will be applied. Temperature will need adjustment for some files.

- Files 1-5: The intake temperature is not usable, so a proxy will be created by subtracting 0.18C° from Temperature:Primary.
- For files 6-7: The intake temperature is fine, so no temperature adjustment is required.

CALIBRATE was used to subtract 0.18C° from Temperature:Primary for files #1-5 using equation 2012-13-tsg-recal1.ccf.

h.) Preparing Final Files

REMOVE was used to remove the following channels from casts #1-5: Scan Number, Temperature:Secondary, Temperature:Difference, Conductivity:Primary, Flag and Position:New.

REMOVE was used to remove the following channels from casts #6-7: Scan Number, Temperature:Difference, Conductivity:Primary, Flag and Position:New.
REMOVE was run a second time on all files to remove a second instance of Scan Number which was accidentally converted twice.

The flow rate channel was not removed since there were a few flow problems and users may need the information.
The fluorescence voltage channel was also left in case updated calibration information becomes available later.

HEADER EDIT was used to add a comment, change file names UPLOY0 to Flow_Rate and rename Temperature:Secondary as Temperature:Intake for files 6-7, change the DATA TYPE to THERMOSALINOGRAPH and add the depth of sampling to the header. Those files were saved as TOB files.

The TSG sensor history was updated.
As a final check plots were made of the cruise track and it looks fine.
The cruise plot was added to the end of this report.
Header Check was run to ensure calibrations were applied correctly and they were.

25 Producing final files
A cross-reference listing was produced for CTD and CHE files.
The sensor history was updated.

An initial loop file, 2012-13-loop-surface.csv, was prepared with rosette samples above 10db and all loop samples.
The CHE files were put through DERIVE to calculate sigma-t. They were then exported to a spreadsheet and sorted on pressure. All bottles below 10db were removed. The loop sample data prepared for the TSG processing was then added to the file and lined up appropriately with the CHE data. The data were then ordered on time.

Next, the 6-line header was added which involved some reordering of columns.
The sampling method column was added entered ROS or UWS for rosette data and true loop data, respectively.
The original header line was removed leaving just the 6-line header.
The file break column was filled with value 1 so all data will be in a single file when converted later.
The file was then saved as 2012-13-che-surface-loops-6linehdr.csv.
CONVERT was run but, as usual, there was a problem that was finally resolved by removing a semicolon from a comment.
CLEAN was run to get start and stop times and positions.

A header file was prepared using comments from the CHE files.
HEADEDIT was used add comments.
The final file was named 2012-13-surface.loop. A track plot looks reasonable and a plot of salinity versus date looks right.

File 2012-13-0015 and 2012-13-0071.ctdspec were prepared for the use of the chief scientist for the shallow cast s (6db and 15db, respectively). These are not intended for the archive but to help with calibration of other instruments. The data were put through DELETE, recalibrated and edited but only dissolved oxygen was aligned. Unnecessary channels were removed.

Particulars

1. PAR on. C-STAR transmissometer mounted but deliberately not included in configuration file. He only wants raw voltage.
3. Transmissivity corrected in CON file.
13. UBC cast
15. Syringes put on incorrectly. DO was full of water for about 10 hours. No downcast data archived. Upcast useful for bottle, but not for profile. No CTD cast prepared.
16. PAR left on accidentally.
25. Bottles 3 and 4 fired just for bulk water.
29. Did not archive on way down. Problem converting data from 1st bottle – could not use usual 10s window.
34. Stopped at 200m for 7 min to get depth figured out. The fluorometer from the TSG was mounted on the rosette to try to get better calibration.
35. Syringes on wrong side of DO sensor – stored full of water for 3.5 hours.
41. Cast down to 400db – restart after that.
41b. Rest of downcast plus upcast.
46a. MetOcean Drifter.S/N 300234011241370 deployed 21Aug2012 0605.
62. Transmissometer sprayed but not wiped.
65. Calibration cast.
77. Altimeter and Jim Bishop's sensor plugged in for this cast.
83. MetOcean Drifter.S/N 300234011246370 deployed at 0122 on 26Aug2012 0605
84. Program crashed at 3000db.
85. Continuation of 84.
87. changed to CTD #0506
90. very lightly touched the bottom.

TSG: Aug 18 ~2140 TSG emptied and flooded immediately at scan 551 in file 2012-13-0003.
TSG flow stopped ~1920, Aug.17 to clean filter and adjust flow meter and pumping system.
TSG: 1600, Aug 20 – TSG stopped ~1623 for cleaning to try to stop salinity spiking.
TSG - ~1900 Aug. 21 TSG filter clogged with plankton and grease. Turned off flow to clean.
TSG -0030 Aug. 22 TSG loop pump turned off. Grease in filters.
TSG -0125 Aug 22 TSG on.
TSG: ~1450 Aug. 25 stopped flow to clean the filter as flow rate had dropped off ~scan 6819* file 2012-13-0012.

CRUISE SUMMARY

CTDs

CTD#	Make	Model	Serial#	Used with Rosette?	CTD Calibration Sheet Competed?
1	SEABIRD	911+	0550	Yes	Yes
2	SEABIRD	911+	0506	Yes	Yes

Calibration Information CTD #550

Sensor		Pre-Cruise		Post Cruise	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**2374**	**1Apr2011**	**Factory**		
Conductivity	**3396**	**29Mar2011**	**Factory**		
Secondary Temp.	**2668**	**1Apr2011**	**Factory**		
Secondary Cond.	**2754**	**29Mar2011**	**Factory**		
Transmissometer	**1396DR**	**26Jan2012**	**IOS**		
SBE 43 DO sensor	**1119**	**29Mar2011**	**Factory**		
SeaPoint Fluorometer	**2228**				
PAR	**4601**	**16Mar2011**	**IOS**		
Pressure Sensor	**75636**	**13Apr2011**	**Factory**		
Altimeter	**43281**				

Calibration Information CTD #506

Note: All sensors were moved from #550 to #506 late in the cruise. Only the pressure sensor is different.

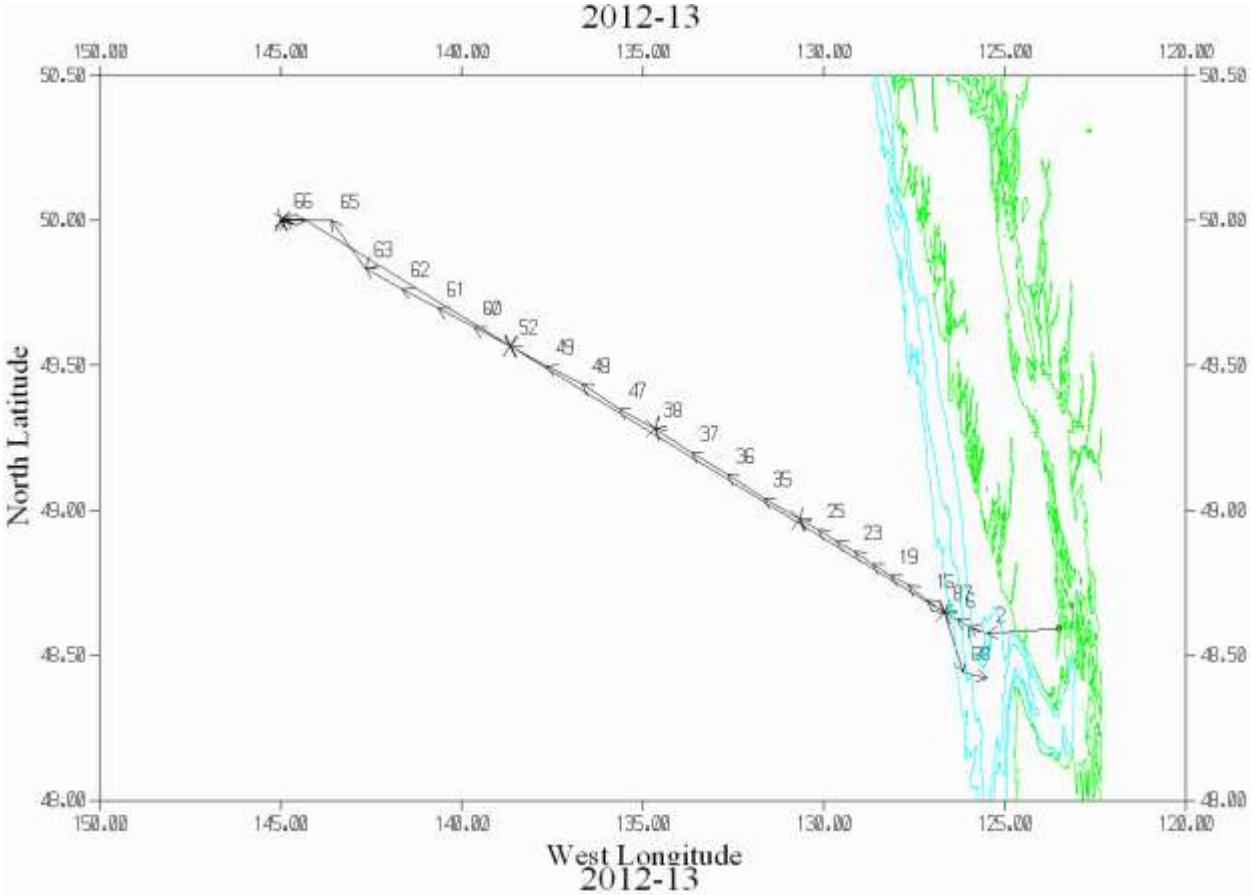
Sensor		Pre-Cruise		Post Cruise	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Pressure Sensor	**69698**	**15Apr2011**	**Factory**		

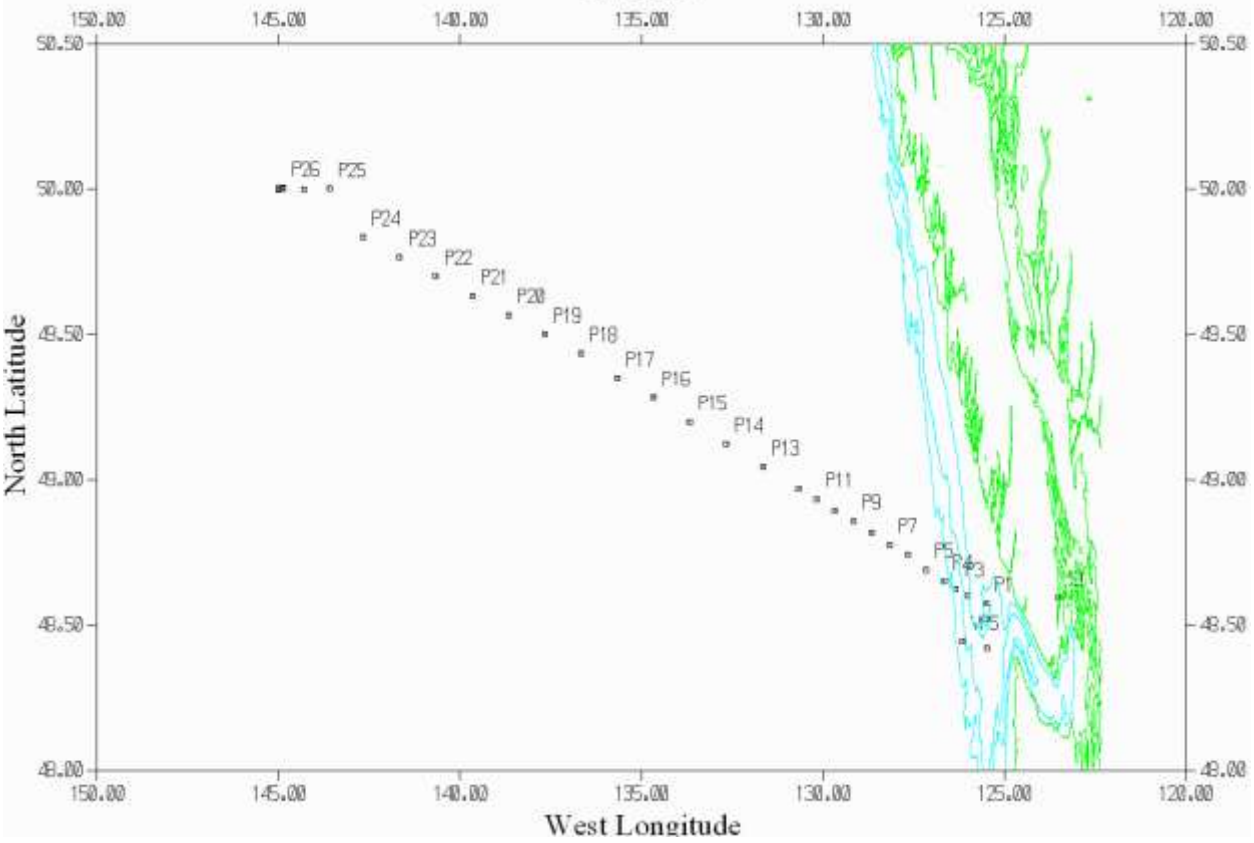
TSG

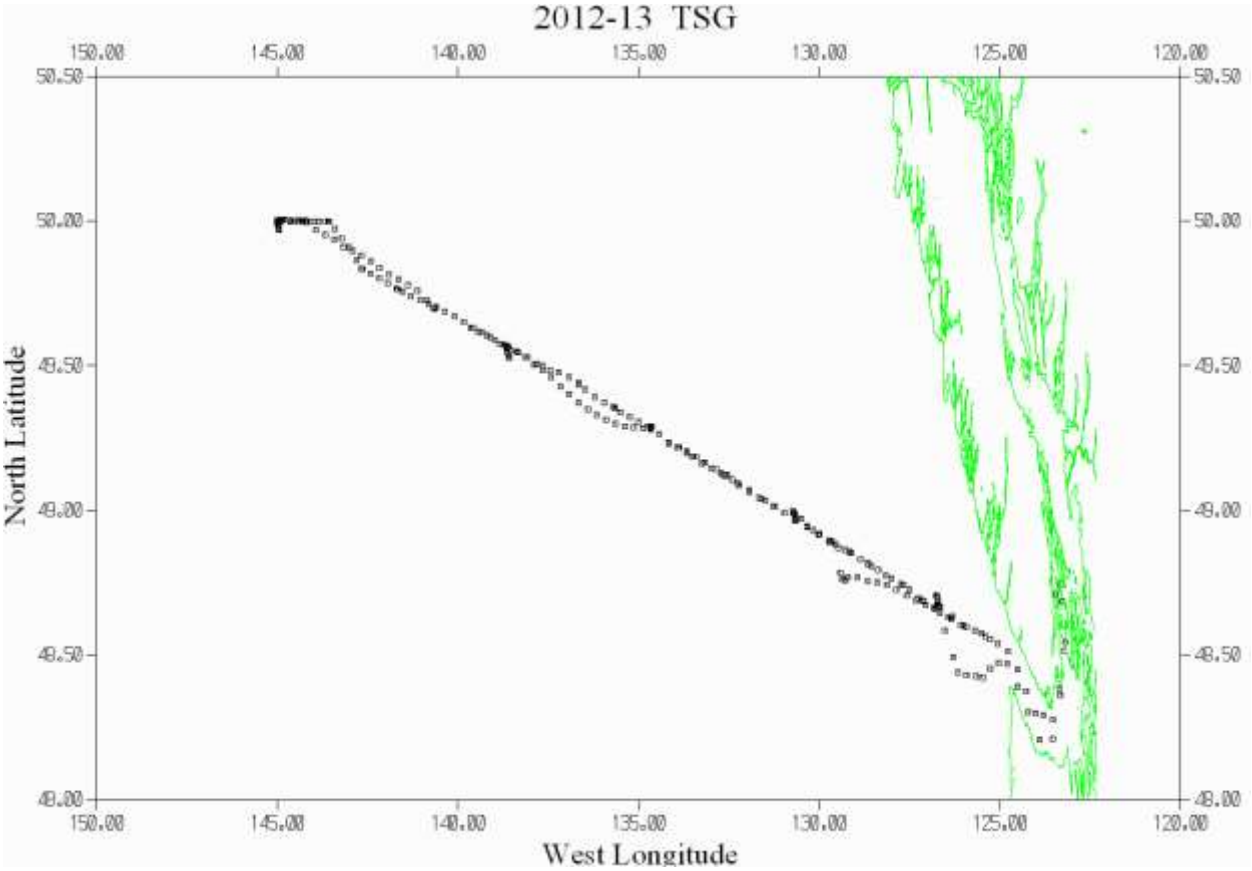
Make/Model/Serial#: SEABIRD/21/2487 Cruise ID#: 2012-13

Calibration Information

Sensor		Pre-Cruise		Post Cruise	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**2487**	**26Mar11**	**Factory**		
Conductivity	**2487**	**26Mar11**	**“**		
Wetlab/Wetstar FL	**WS3S-713P**	**1Feb12**	**IOS**		
Temperature:Secondary	**0603**	**03Mar11**	**“**		


2012-13
150.00
145.00
140.00
135.00
130.00
125.00
120.00
50.50
50.00
49.50
49.00
48.50
48.00
North Latitude
West Longitude
66
65
63
62
61
60
52
49
48
47
38
37
36
35
25
23
19


2012-13
150.00
145.00
140.00
135.00
130.00
125.00
120.00
50.50
50.00
49.50
49.00
48.50
48.00
North Latitude
West Longitude
P26
P25
P24
P23
P22
P21
P20
P19
P18
P17
P16
P15
P14
P13
P11
P9
P7
P5
P1


2012-13 TSG
150.00
145.00
140.00
135.00
130.00
125.00
120.00
50.50
50.00
49.50
49.00
48.50
48.00
North Latitude
West Longitude