REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
11-Jun-2013	Added Iron profile files with cast numbers 8xxx from Keith Johnson's spreadsheet file which can be found in the cruise .DOC directory.
7 Sept. 2010	Based on reanalysis of raw data, titrated DO changed to 0 for samples #1 & 2 of cast #1. G.G.
4 July 2011	Units for extracted chlorophyll corrected. G.G.

PROCESSING NOTES

Cruise: 2008-26
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: May 28, 2008 – June 17, 2008

Processed by: Germaine Gatien
Date of Processing: 24 June 2008 – 6 November 2008

Number of original CTD casts: 61	Number of CTD casts processed: 61
Number of bottle casts: 59	Number of bottle casts processed: 59
Number of original TSG files: 3	Number of TSG files processed: 3

INSTRUMENT SUMMARY

A SeaBird Model SBE 911+ CTDs (#0443) was used during this cruise. It was mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#1005DR), an SBE 43 DO sensor (#1176), (on the primary pump), a Seapoint Fluorometer (#2228) with a 10X cable (on the secondary pump), a Biospherical QSP-400 PAR sensor (#4656) and an altimeter (#1252). The deck unit was a model 911+ (#0424) and the logging computer was an HP Compaq. Seasave v7.16 was used.

A thermosalinograph (SeaBird 21 S/N 2487) was mounted with a Wetlab/Wetstar fluorometer (WS3S-713P) and flow meter. Temperature sensor #4652 was mounted at the intake.

SUMMARY OF QUALITY AND CONCERNS

The CTD and rosette logs were in good order and notes from the chief scientist were very helpful.

The CTD file for cast #44 contains upcast data because no downcast data was available.

The secondary salinity frequently had bad values even after the secondary conductivity sensor was changed. The secondary temperature looks fine as does the fluorometer which was mounted on the secondary pump.

A different CTD deployment pattern was used for this cruise. The instrument was lowered to about 10m, soaked and then returned to the surface where pumps were turned on, acquisition begun and the CTD lowered. This is believed to produce better performance from the CTD. There was usually a short wait at the surface after acquisition began, and there may have been some wait before that, but if the lowering starts immediately after reaching the top, there is a possibility of sampling waters that might still be disturbed by the passage of the rosette. A brief wait at the surface might allow the surface waters to settle down. This is likely to be a concern only in cases where the ship doesn't drift much. There was some noisy data near the surface for this cruise, but it is not obvious that it is due to the deployment method.

Two salinometers were used for this data. The Autosal appears to have performed well without the linearity problems noted in data from other cruises in the past year. The Portasal was used at sea. Many duplicate samples were taken to compare with the Autosal. Generally the Portasal salinity was lower than the Autosal salinity by <0.002, but there are many larger differences including all the results from the first day's analysis which were consistently low by more than 0.01. During 2008-01 the Portasal was found to be lower than the Autosal by an average of 0.0018 based on samples from 1500db, which is consistent with the current results from all but the first day's analysis. However, there were analyses on days for which no duplicates are available, and there is variability on some days, so we cannot be sure that the Portasal results are all reliable after the first day.

During cast #55 23 bottles were fired at 2000db and analyzed on the Portasal. The CTD was lower than the bottles by an average of 0.0028 with a standard deviation of 0.0016. When three outliers were excluded the difference was 0.0029 which is the same result as found in the comparison of Autosal and CTD ~2000db. So the Portasal can work very well, but is subject to problems that indicate that duplicates should continue to be taken, though perhaps not as many are needed as were collected on this cruise.

Autosal data were used where available and all Portasal data are flagged "c" or "d" depending on the date of analysis. Portasal bottle salinity is likely to be reading low, but as explained above we cannot say by how much. Recalibration of CTD salinity was based on Autosal results only.

The dissolved oxygen data in the CTD files should be considered

- ±0.5ml/l from 0 – 125db
- ±0.2ml/l from 125 – 400db
- ±0.1ml/l from 400 – 1200db
- data below 1200db are considered unreliable by the manufacturer.

The fluorescence data were bad during the upcast of cast #26, so values in the CHE file are taken from downcast data found by matching pressure.

There are 3 thermosalinograph files. The differences between intake and lab temperature varied more than usual, due to noise in the intake thermistor that increased through the cruise. The intake temperature was not archived, so a proxy was created by adjusting the lab temperature to remove estimated heating in the loop. The salinity comparisons with both loop and CTD are consistent. Both loop chlorophyll samples and CTD fluorescence data show that the TSG fluorometer reads high. The comparison with extracted chlorophyll at low values is odd and may indicate some problems with the loop samples.

PROCESSING SUMMARY

1. Seasave

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

2. Preliminary Steps

The Log Book was obtained together with rosette log sheets, a cruise report and notes from the chief scientist on particular issues that would affect the processing job. A number of problems were noted including differences between downcast and upcast data and differences between sensors. The secondary conductivity sensor was replaced at one point and a cable was also replaced in an effort to fix the secondary salinity. Transmissivity was sometimes very spiky and fluorescence was a problem for one cast.

Note was made of errors in headers for casts 1-20.
The PAR sensor was used for casts 1-7, 28, 37, 45 and 62 only.

Titrated chlorophyll, nutrients, DMS and salinity data were obtained in spreadsheet format. There are a series of files with salinity data from a Portasal used at sea and a single file with Autosal analysis from IOS; that file contained results from other cruises as well. The oxygen files were provided in individual OXY files with no flags or comment channels.
The cruise summary sheet was completed.
The histories of the conductivity, DO and pressure sensors were obtained.
The calibration constants were checked for all instruments. No errors were found. There was a chance of equipment before cast #15, so copies of 2008-26-0001.con and 2008-26-0015.con were saved as 2008-26-ctd1.con and 2006-26-ctd2.con.

3. Conversion of Raw Data

The configuration files do not indicate that a surface PAR was acquired, but there is a photo of a PAR mounted on a mast in the cruise report. A test conversion was done converting the “free voltages” to ensure there was no signal there and there was none.

Data were converted using the configuration file 2008-26-ctd1.con for casts 1-12 and 2008-26-ctd2.con for casts #15 to 104. PAR was converted for all the CTD casts. It will be removed later from the casts for which it was not mounted. Headers were edited in casts 1-20 to fix errors noted by the chief scientist.

A few casts were examined and all expected channels are present.

- The two temperature channels are in reasonable agreement on the downcast, though there seems to be a little more noise than usual. The upcast data are much noisier so there are significant differences. Cast #87 looks odd near the surface.
- Conductivity is similar except that there are casts with secondary conductivity that was totally bad (10, 12, 26, 34, 38.)
- The fluorescence is sometimes spiky, but generally not too bad. For cast #26 the upcast fluorescence is near-zero throughout. Suitable values for the rosette file will be found by selecting downcast fluorescence values at the same pressure.
- Dissolved oxygen has the usual offsets and looks ok.
- PAR looks fine
- Transmissivity generally looks ok though there are some suspicious spikes.
- The altimetry looks fine for some casts, but others look very noisy.

Rosette files were converted using a start time of -2s and duration of 5s and header station names and bottom depths were corrected as needed. Headers were edited in casts 1-20 to fix errors noted by the chief scientist. The rosette files were then converted to IOS SHELL files. CLEAN was run to add event numbers and the output files were named *.BOT.

All BOT files were plotted. In general there is good correspondence between the two pairs of sensors, but as noted in the log and chief scientist’s notes, there were problems with the secondary conductivity with bad data throughout casts #10, 12, 26, 34 and 38. Editing was applied to minor noise in the primary salinity for casts #28 and 37; editing details were noted in the headers. The output editing files were copied to *.BOT. No rosette file was created for casts #101 and 104 and this agrees with the log book which notes there was no sampling from those casts.

4. WILDEDIT

Program WILDEDIT was run to remove spikes from the pressure, conductivity and temperature channels only. Parameters used were: Pass 1 Std Dev = 2 Pass 2 Std Dev = 5 Points per block = 50

5. CELLTM

Tests were run on three casts using settings (α = 0.01, β=7), (0.02, 7), (0.03, 7), (0.02, 9), (0.03, 9) and (0.0245, 9.5) to see what settings looked best for this cruise. The best choice overall was (0.02, 7) for the primary channel and (0.03, 9) for the secondary; the latter worked well for both conductivity sensors used on the secondary. CELLTM was run on all casts using those values.

6. DERIVE

Program DERIVE was run twice:

on all casts to calculate primary and secondary salinity.

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.

7. Test Plots and Channel Check

A sample of casts using was plotted to check for agreement between the pairs of T and C sensors. The differences are noisy so these are very rough averages.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate
9**	500	-0.0008 N	+0.0001	+0.0013	Mod, OK
	1000	~0 N	+0.00005	+0.0008	Mod, OK
15	500	~0 N	+0.00014	+0.0021 N	High, OK
	1000	-0.0001	+0.00011	+0.0013 N	
	1500	-0.0002	+0.0001 N	+0.0012	
	1950	+0.0001 N	+0.00009	+0.0011	
34	500	-0.0008 VN	+0.00017 XN	+0.0023	High, noisy
	1000	-0.0001	+0.00012 XN	+0.0015	Very high, noisy
	1500	+0.00020	+0.00013	+0.0013	Very high, ok
	1950	+0.00025	+0.00012 XN	+0.0012	Very high, ok
	2000	+0.00065	+0.00012 XN	+0.0009	High, noisy
53	500	-0.001 XN	+0.0001	+0.002	High, X noisy
	1000	-0.002 VN	+0.00012	+0.0016	High, X noisy
	1500	+0.0002	+0.00012	+0.0012	High, X noisy
	1950	+0.0003 XN	+0.00012	+0.0011	High, X noisy

** - The secondary sensor did not work properly after this cast. For cast #10 and 12 the primary will have to be used and for casts #15 onwards a different sensor was mounted on the secondary pump.

There is pressure dependence in the temperature differences which is unusual. The conductivity does not show such pressure-dependence. The salinity differences are quite small and show some slight pressure dependence. There is no obvious time-dependence in the salinity differences. The temperature differences increase somewhat with time, but that may just reflect noisier descent rates further offshore.

8. Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers.
CLEAN was run to add event numbers and to replace pad values in the Pressure channel using linear interpolation based on scan number.

9. Checking Headers

The header check was run; the speed to cast #84 stands out as higher than others, but this was a long steam from station P26 to M6 with no stops, so that is reasonable.

A cross-reference listing was checked. The time in the header for cast #1 is different from the log book, but the start time in the log is obviously in local time not UTC. That was corrected in the log entries for bottom and end times. The station names for casts 18 and 20 were corrected. The station name for cast #80 differs between the header and log book, but the header looks correct.
The cruise track was plotted and no problems found.
The average surface pressure is 2.7db with a range of 1.5 to 4db; this is reasonable for the Tully.

The altimeter readings from the headers of the CLN and BOT files were exported to spreadsheets and all casts were checked. There is a lot of noise in the data for many casts, and the algorithm did not work well for the downcasts of #5, 16, 18-22, 32-33, 38, 62-63 and 69. For these casts the altimeter reading was removed from the header of the CLN files. For the bottle files, there were more problems especially with the very shallow casts. The altimetry headers were removed from the SAMAVG bottle files for casts #5, 16-18, 21, 24, 31, 38, 42, 44, 50, 56-57, 69 and 85.

10. BOTTLE FILE PREPARATION

The BOT files were averaged to enable an addsamp file to be created. This file was edited to add sample numbers taken from the rosette sheets.
The ADDSAMP file was converted to CST files to be used as a framework for the bottle files. It was also used to add sample numbers to the BOT files. The BOT files were then bin-averaged (SAMAVG).

<u>SALINITY</u>

Salinity was analyzed at sea on a Portasal and at IOS on an Autosal. There were many duplicates, sometimes both were run on the same instrument, but in other cases they were used to compare the two salinometers.

The Portasal files were arranged by individual casts. Bernard Minkley incorporated that data into a single spreadsheet (2006-26-bottle salinity.csv). That spreadsheet was simplified and saved as 2008-26-bottle-salinity-portasal.csv. There were some flags, but no comments to explain them. For some there were comments on the salinity sheets so those were entered in the spreadsheet. Comments about a “loose liner” and “only 1 reading” were found for two samples that had not been flagged; “c” flags and comments were added to those samples. Duplicates were saved to a separate spreadsheet “2008-26-SAL-duplicates.xls”. Then the duplicates in the spreadsheet were replaced with a single, averaged value which was flagged “f”. A few problems were encountered:

- There were two samples entered as being #24 from cast #3. The values differ markedly and only the first value could be found on the Portasal Analysis log sheet; the 2nd value was not in the Portasal file created at sea for that station. According to the Rosette Log there were two samples taken from that bottle, but a second sample was analyzed on the Autosal and has a value close to the first reported on the Portasal sheet. The 2nd value was removed.
- A sample #23 was found but the value makes no sense nor is there any entry for salinity sampling for cast #3, sample #23, so this was deleted. There were a few other samples like this with repeated sample numbers; they are probably from separate sampling for Fe studies.

The Autosal analysis data were delivered in file “LineP 2008-26_july29-Aug5.xls”. This spreadsheet included data from another cruise. It was simplified and saved as 2008-26-bottle-salinity-autosal.csv. (Note: another file was later provided named “2008-26_Line P salinity values_Final.xls” which was similar but appeared to have comments out of line with sample numbers in one place.) The sample numbers were not all in the normal format, so that had to be fixed. Duplicates were added to the duplicate file (2008-26-SAL-duplicates.xls), then the values were averaged in the spreadsheet and flag "f" was entered except where the two did not agree well. Problems found included:

- Cast 3, at 75db two bottles were fired and both had duplicate samples. The results are given in the table below:

Sample #	Salinometer	Bottle Salinity	CTD Salinity	Bottle #	
15	Autosal	33.2600	33.2589	3	0.0011
15D	Autosal	33.2656	33.2589	3	0.0079
16	Autosal	33.2603	33.2711	4	-0.0108
15	Portasal	33.2596	33.2589	3	0.0011

Sample #15 from the Portasal and Autosal compare well with each other and with the CTD. But sample #16 looks like it is from 15 and sample #15D is probably supposed to be #16, though it is not really close to the CTD it is closer than the others. So samples 15D and 16 will be relabelled but flagged "c" with an explanation in the header.

- Cast 9, Sample 60 has an unbelievably high value, so was deleted.
- There is a sample labelled "Masaya" which is not associated with any cast. It was deleted.

A column was added to each of the spreadsheets to indicate which type of salinometer was used (A or P). Then the two spreadsheets were combined and rearranged on sample number. All cases without a sample from both salinometers were removed to produce file 2008-26-bottle-salinity-port-auto-dups.xls. The duplicates were then analyzed.

Duplicate Studies

(i) There were 7 pairs of duplicates that were analyzed on the Portasal. For those Sp=0.0012 where Sp is defined as:

Sp = Square Root (sum of squares of differences / 2*number of pairs)

All differences were <0.001 except for one pair which differed by 0.004. When that pair was excluded Sp=0.0005. (See 2008-26-sal-duplicates.xls)

(ii) For the Autosal there were 5 duplicate analyses. Three of the differences were <0.001, one was 0.001 and one was 0.005 which included a 2nd reading with a fairly high standard deviation in the readings. If all pairs are included Sp=0.0017 and 0.0005 if the one pair is excluded with the largest difference and noisy 2nd reading. (See 2008-26-sal-duplicates.xls)

(iii) Next cases with 1 sample from each of the Portasal and Autosal were considered. When differences >0.01 were highlighted samples #199-266 stand out. All of those samples were run on the Portasal on June 5th, 2008. All the June 5 Portasal data with duplicates fall into this range. There were many cases of 3 and 4 runs, and once 5 runs. A plot of differences against date of analysis made June 5th stand out clearly, but June 11th also has many with larger differences. When the differences >0.01 were excluded the Portasal data are lower than the Autosal by 0.0019 with a standard deviation of 0.0029. (During 2008-01 when 24 samples from 1500db were run on the two salinometers, the Portasal was found to be lower than the Autosal by ~ 0.0018 with the Portasal showing a slightly higher standard deviation.) For June 5 the Portasal is low by an average of 0.0136 with a standard deviation of 0.0019. For casts #26 and #34 run on the Portasal on June 5, there are also Autosal data, but not for cast #23. There were a few outliers in the comparison that are not explained by the June 5 problem, nor had flags been attached by analysts. Those were all from cast #47: samples #357, 362, 367 and 371. The values were checked and agree with the main spreadsheets. No flags had been assigned, nor are there any notes in the rosette log or daily log. One thing noted is that there were usually 3 Portasal readings and the 1st was usually very different from the 2nd and 3rd. Perhaps a 4th reading would have been advisable. (See 2008-26-bottle-salinity-port-auto-dups.xls.)

When differences >0.005 were excluded the Autosal was found to be higher than the Portasal by an average of 0.0007, 0.0006 and 0.0011 on June 9, 10 and 11. June 11^{th} showed a lot of variability. Thus it appears that the Portasal was often very close to the Autosal, but when it was not, there appeared to be a lot of instability in the Portasal analysis results. A general note of explanation will be put in the CHE headers for any cast with Portasal values included.

The Portasal and Autosal spreadsheets were converted to SAL files in separate folders, Portasal and Autosal, so that COMPARE could be run separately.

The comparison of Autosal bottles with CTD turned up many severe outliers, all from between 4.5 and 10db, except for one at 99db. The standard deviations in the CTD salinity were extremely high for some of the outliers, high for most and only low for 2 of them. The differences between the CTD and bottles for 8 of the outliers were between 3.7 and 3.9. Careful checks were made of the surface sample from cast #84 for which the bottle value is given as 26.5440 and the two CTD salinity channels have average values of 30.3783 and 30.3799. Keeping in mind that the Niskin bottles are 1m above the CTD sensors, it is not surprising to see a large difference near shore. Yet, there is no CTD salinity <30.27 in the original full downcast and upcast files and we have sampling up to 2.4db. There was a second bottle fired near the surface, but it has similar CTD salinity values, so this can't be explained as sampling from the wrong bottle. In all of the cases of severe outliers in the primary salinity there were no Portasal samples. Where could such low-salinity water have come from?

Discussions with the chief scientist provided a possible explanation. The surface waters of the near-shore stations were probably very fresh due to intense rain. This might not be seen in the downcast data because of the CTD deployment method used for this cruise. The CTD was lowered to 10m, soaked, then returned to about 2m where the pumps were turned on, acquisition started and the CTD lowered. The lowest salinity water might not be sampled since the CTD package would carry higher salinity water with it. It might take a longer stop at the top to equilibrate to ambient conditions. Cast #88 shows salinity at almost 30psu. After about 200 scans with pressure near constant, the salinity begins to go down, getting to values <27 just before the CTD started down again. This suggests that there should be a wait at the surface of at least 250 scans (10s) before the full cast is run. The large difference between rosette bottle and CTD data is probably due to the large gradient and the bottles being 1m higher. If this is true, then it does indicate that the bottles flushed well.

There were more outliers for the secondary sensors and investigation showed that the conductivity values were 99 or close to 99 for some of those bottles in both the CTD and bottle files.

When the outliers were removed the primary/secondary sensors were low by 0.0026/0.0020 below 200db and by 0.0036/0.0027 below 3000db, and by 0.0031 for the 3 bottles below 4000db. There is not much data below 3000db, so this difference is probably not due to pressure-dependence in the cell, but rather to noise in the comparison. Looking at individual casts confirms there is no obvious pressure-dependence and the fact that primary and secondary respond in approximately the same way makes it even less likely. Assuming the CTD is low by about 0.003 looks like a reasonable estimate.

When COMPARE was run with Portasal results the only extreme outliers for the primary salinity were very close to the surface and the standard deviation in the CTD salinity was high. There were more outliers in the secondary comparison, but this is expected based on the observations of bad CTD salinity in many. When outliers were excluded the primary was found to be high by 0.0009 and the secondary by 0.0021. The differences between primary and secondary are slightly higher than from the Autosal data, but the problems in the Portasal analysis and in the secondary CTD data make this a questionable conclusion. The following outliers were flagged “c” in the Portasal spreadsheet:

- Cast 10, Sample 87, 599db, Difference 0.06
- Cast 47, Sample 357, 2998db, Difference 0.02
- Cast 67, Sample 532, 1998db, Difference 0.03

A run of COMPARE was done using Portasal results and sample number as reference channel. This showed that the June 5th data were lower than the CTD by ~0.009 and from other days higher by ~0.0017. The difference between the two groups is ~0.0107, which is roughly consistent with the results of the duplicate study in which they differed by about 0.0126. The different choices of outliers to be excluded in each study would readily explain the different results.

All Portasal values from days other than June 5 were flagged “c” and those from June 5 were flagged “d”; comments were added to indicate that the analysis was done on the Portasal. The Portasal and Autosal spreadsheets were then combined, ordered on sample number and where there were values from both Autosal and Portasal, the Portasal data were removed. The spreadsheet was saved as 2008-26-bottle-salinity-combo.csv. It was then converted into SAL files that were saved in the main HYDRO folder.

In summary:

- From the COMPARE run on Autosal data: CTD – Autosal ~-0.003
- From the COMPARE run on Portasal data: CTD – Portasal ~+0.009 (June 5); ~-0.0017 (other)
- Combining the two COMPARE results implies Autosal – Portasal ~+0.012 (June 5); +0.0013 (other)

This is reasonably consistent with the results of the duplicate studies from which we have: Autosal – Portasal ~+0.014 on June 5 and ~+0.001 for other days. The methods of choosing outliers differ, so complete agreement is unlikely.

After all other processing was completed 3 more Portasal salinity values were found. The values for samples #12, 38 and 123 were added to the CHE files.

DISSOLVED OXGYEN

Dissolved oxygen files (*.oxy) were provided. These lacked a flag channel and comments.
Bernard Minkley found an error in the calculation of DO, so prepared new files named *.DOXX which also lacked a flag channel and comments. They included two DO channels with the same name. The first was the original value and the second was the corrected value. Edit Headers was used to change the name of the original DO channel and REMOVE was then run to remove the original channel. Finally ADD CHANNEL was used to add a flag channel.

There were duplicate samples from the same bottles for 12 casts. Those were averaged and flag “f” added. For one case where the two samples had values different by >10%, the two values were entered in the comments and a flag “c” was added. The duplicate values were entered in spreadsheet 2008-26-duplicate-DO.xls. The pooled standard deviation of pairs of samples (Sp) was calculated by:

$$Sp = SQRT\{sum (d*d)/2k\}$$

where k = no. of pairs and d = difference between pairs.
Sp was found to be 0.090 when all data were included. The duplicates differed by from 0.1 to 10.3%, with all but 1 value differing by <6%. When the single pair with a large difference is excluded, Sp=0.086.

There were also some samples from different Niskin bottles at the same depth. These were not studied as the results of the duplicate study looked sufficient.

NUTRIENTS
The nutrient data were obtained in spreadsheet QF2008-26nuts.xls which was simplified and saved as 2008-26nuts.csv. Extraneous columns were removed, header names were changed to standard format and -99 was entered for blank values. Data were sorted on sample number. File 2008-26nuts.csv was then converted to individual NUT files.

EXTRACTED CHLOROPHYLL
Extracted chlorophyll data were obtained in file QF 2008-26CHL.xls. The file was edited to remove extraneous lines and columns, header names were changed to standard format, and the file was saved as 2008-26CHL.csv. That file was converted to individual CHL files. SORT was used to reorder on sample number in files called CHL2.

DMS
DMS data were obtained in file DMS 2008-26 summary.xls. It was saved as 2008-26-dms.csv and edited. Where there were duplicates they were averaged to get a single value for each bottle and an f flag was added. Headers were changed to standard format and unnecessary columns were removed. The file was then converted to individual DMS files.

The SAL, CHL2, ADD, NUT and DMS files were merged with CST files in four steps. (Output: MRG1, MRG2, MRG3, MRG4 and MRG5), MRG5 was put through CLEAN to reduce the headers to File and Comment sections only. That file was then merged with SAMAVG files (Output:MRG). Data were exported to a spreadsheet 2008-26-bottles.xls and compared to the rosette sheets to ensure all expected data are present. A number of problems were found and fixed.

11) Compare

Salinity
COMPARE was run using both the combined files with mostly Autosal but some Portasal results. The average difference after severe outliers are excluded shows the primary salinity to be low by 0.001. When COMPARE was run using the sample number as reference channel, it was possible to separate the Autosal from Portasal data. The Autosal data show the CTD to be low by about 0.002 to 0.006 depending on how many outliers are excluded. The Portasal data mostly look similar to the Autosal, but there is a large group of values that make the CTD look high, thus producing the average difference noted above. This fits the observations of the comparisons done earlier on the two sets of data. The secondary salinity was not studied as both sensors performed badly.

Dissolved Oxygen
COMPARE was run using pressure as the reference channel. There was only 1 extreme outlier and that was found to be due to an error in the cast to which sample #334 belonged. The ADD file was fixed and COMPARE was rerun. When points with pressure>1200db were removed as well as outliers identified by residuals, the fit was:

CTD-BOT = 1.0645 DOX-CTD +0.0196

In recent cruises it has been found that forcing an offset so that the CTD has a positive reading when the Bottle DO = 0, is more realistic. There is not usually enough sampling at low values to get a good fit near 0 especially because SeaBird do not recommend using values from below 1000db. But when there is near-zero sampling it is clear the SBE DO does not reach 0. When the offset of the trendline is set so that CTD values are +0.01 when bottle values are 0, the resulting fit is:

CTD-BOT = 1.0708 DOX-CTD -0.01

There were no severe outliers. (See 2008-26-dox-comp1.xls.)

Fluorescence

COMPARE was run using the CTD Fluorescence and the Titrated Chlorophyll from bottles. For CHL<1 there is a lot of scatter with the fit showing that the CTD Fluorescence is ~130% of CHL; the zero crossing matches the dark value fairly well. For CHL>4 FL is ~60% of CHL. The only outliers are not so severe as to suggest there was a problem with a titration. (See 2008-26-chl-fluor-comp.xls.)

13. Shift

Fluorescence

To find what shift is needed for the fluorescence, upcast and downcast profiles were examined to determine the vertical offset of the temperature and fluorescence traces. The differences between these two offsets are treated as a measure of how much the fluorescence needs to be shifted. The “excess” offset for the fluorescence was divided by the averaged descent/ascent rate and divided by 2(since the shift will be applied to both up and downcast) to find the shift (in seconds) to remove that offset. The usual shift of +24 records (1s) was found to be appropriate. This is the shift that has been used in most other cruises. (Output: SHFFL)

Conductivity

Tests were run on 5 casts using shifts between -1s and +1s and T-S plots were prepared to compare the results. A setting of -0.3s worked best overall for the primary sensor; -0.2s for the secondary sensor used for casts 1 to 12 and +0.25s was best for the secondary sensor used for casts #15 to the end of the cruise. All casts were put through two runs of SHIFT using those settings. (Output *.SHFC0 and SHFC1).

Dissolved Oxygen

Tests were run on a few casts to determine the best SHIFT value to apply to the Dissolved Oxygen channel. This was judged by how the vertical offset between downcast and upcast traces compares with that of the temperature. Because there is an offset in values between upcast and downcast due to the time response, alignment will not produce traces that overlie each other exactly. There were few distinctive features to aid this judgment. Values of +110 and +120 seemed best.
SHIFT was run using +110 records for all casts.

14. DELETE

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 warnings casts #5, 44 and 69 because there as <20m of data The log confirms that was deliberate for 2 of the casts, and archiving did not start for cast #44 until partway through the upcast. Cast #44 will not be processed further. A decision on #5 and 69 will be left until later.

To create a file for cast #44, the SHFC1 file was put through REVERSE and then DELETE.

15. DETAILED EDITING

The primary channels were selected for editing because the secondary salinity was bad at times, even after the conductivity sensor was changed.

Graphical editing was done using program CTDEDIT. On-screen plots of descent rate and pump status were also used.

There was a lot of small-scale noise in the salinity in the top 100db for all off-shore casts. This did not appear to be a problem in Rivers Inlet, so it is likely related to noisy descent rate for the CTD. The pump appears to be affected by acceleration as well as descent rate. Some attempt was made to edit this noise, but it is impossible to get rid of all unstable features without losing data that are probably useful.

In the top 5 to 10db there were frequent unstable features which could be caused by the ship, or it might be due to the CTD being lowered to 10db and then returned to the surface just before acquisition began. The salinity at the surface is higher (and temperature lower) than that at 5m, which might be due to the rosette pulling higher-salinity water up with it during the initial soak. However, there often was a long enough wait at the surface so that subsurface waters should have equilibrated.

Only light editing was needed for casts #1-17 and 38-39 and 63-104. For other casts the descent rate was very noisy; many records corrupted by shed wakes were removed and salinity was cleaned.

16. Initial Recalibration

File 2008-26-ctd.ccf was prepared to add 0.003 to the primary salinity and to apply the following equation to the CTD Dissolved Oxygen channel:

CTD-BOT = 1.0708 DOX-CTD -0.01

This was applied to SAM and MRGCLN2 bottle files for both the Autosal alone and the combined Autosal and Portasal data.

COMPARE was then rerun. The CTD salinity looks high compared to bottles for the combined results, but when only the Autosal analyses are included the average difference is 0.0001. The CTD dissolved oxygen data are closer to the bottles after recalibration; when the same bottles are included as in the first fit, the average difference is 0.008ml/l. (See 2008-26-sal-comp2, 2008-26-sal-auto-comp2 and 2008-26-dox-comp2.xls.)

The same DO and salinity calibration was applied to the edited files.

17. Special Fluorometer Processing

The COR1 files were clipped to 150db and processed separately for A. Peña. (Output: CLIP)

A median filter, fixed size=11, was applied to the fluorescence channel in the COR files to reduce spikiness. One cast was examined before and after this step and showed that the filter was effective.

18. 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. There were some slightly unstable features near the surface, but with noisy salinity this is hard to avoid without removing data that may be useful. No further editing was applied.

19. Other Comparisons

Previous experience with these sensors –

1. Salinity: All sensors have been recalibrated since last use.
2. Dissolved Oxygen – Since the sensor was recalibrated in Feb. 2007 it has been used for 4 other cruises of which 1 has not yet been processed, 1 had very short bottle stops, 1 was in a shallow inland area with a limited DO range and another gave very confusing results.
3. Pressure – This sensor is older and prone to drift, but has been fairly stable recently.

Historic ranges – Profile plots were made with historic ranges of T and S superimposed. The only excursions from those ranges found for casts for which local climatology was available were small excursions of temperatures beyond the range limits. For P3 temperatures were slightly high around 650-800db and for P4 from 700-1350 and P5 from 1700db to the bottom. For P15 to P17 the temperatures were slightly low around 800-900db. These do not look like systematic errors, so are presumed to represent real variations.

Repeat Casts – There were a number of repeat casts. Examining 3 casts at P26 along lines of constant σ_t, temperature and salinity varied by <0.005Cº and <0.0005 at 930db and 2700db which included some of the largest variations seen in the profile below 150db.

20. Final Calibration of DO

At this stage in the processing it was realized that the new dissolved algorithm in the SeaBird Processing package produces much better data below 1500db. The first run of COMPARE was re-examined and the deep data fell close to the upper ocean data; there does not appear to be a need to redo the first recalibration, but deep bottles will be included in the comparison for doing the 2nd recalibration.

The first recalibration of dissolved oxygen corrects for calibration drift. Shift corrects for transit time errors. A further correction will be applied to at least partly correct for response time. To do this we compare downcast data to bottle data from the same pressure.

Files were bin-averaged to 0.25m 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. When data from below 1200m are excluded plus a few outliers, the differences against CTD DO provided the simplest fit. Forcing an intercept of 0 the fit is:

DOX_BOT = 0.9758 * DOX_CTD

(See 2008-26-dox-comp3.xls.)

The thinned files were recalibrated by multiplying all values by 0.9758 and the comparison was rerun. That showed that the results were good. (See 2008-26-comp4.xls.)
Recalibration using file 2008-26-recal2.ccf was applied to the downcast files only. (AVG and CLIP) (Output: COR2 and CLIPCOR2)

The clipped, recalibrated files were then bin-averaged (0.25db bins), put through REMOVE and HEADEDIT and named as *.FCTD1 and saved for Angelica Peña. A second set, *.FCTD2, were created by filtering before bin-averaging. The SAMCOR1 files were put through REMOVE and named *.BOF and saved for the use of Angelica Peña. A readme.doc file was prepared with some notes on the preparation of those files.

21. FINAL CTD files steps (REMOVE and HEADEDIT)

The following channels were removed from all casts: Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag.
The PAR channel was removed from casts #9-26, 31-34, 38-44, 47-59 and 63-104 because the instrument was not mounted on the CTD for those casts.

A second SBE DO channel was added; REORDER was run to put the two SBE DO channels together.

HEADER EDIT was used to fix formats and channel names and to add the following comments:

Transmissivity and fluorescence are nominal and unedited except that some records were removed in editing temperature and salinity.

The salinity was recalibrated based on a comparison with samples analyzed at IOS on an Autosal. Other samples run at sea on a Portasal appear unreliable based on a study of duplicates run on the two salinometers.

The dissolved oxygen data in the CTD files should be considered

- *±0.5ml/l from 0 – 125db*
- *±0.2ml/l from 125 – 400db*
- *±0.1ml/l from 400 – 1200db*
- *data below 1200db are considered unreliable by the manufacturer.*

The Standards Check routine was run and HEADEDIT adjusted until no further problems were found. The final files were named CTD.

A header check turned up a few problems which were resolved.
Profile plots were made and no problems were found.
The track plot looks ok. The cross-reference lists turned up no problems.

As a final check of dissolved oxygen data, % saturation was calculated and plotted. The near-surface values for offshore casts (P6 – P26 and M4) were ~105%. Values were slightly higher between P2 and P5 and at CS09 and CS10, and up to ~130% in Saanich Inlet and at P1. There were some lower values in Rivers Inlet (85-105%). These values look reasonable.

23. Final Bottle Files

Checks done at the end of bottle file preparation showed that the dissolved oxygen file that should have been identified as from cast #26 had actually been named as from #30. So all steps from DO Merge onwards had to be repeated for that one file. A quick check of COMPARE showed that adding that file did not have a significant effect on the result.

The MRGCOR1 files were put through SORT to order on increasing pressure. REMOVE was run to remove Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Status:Pump, Descent_Rate, Altimeter and Flag.
The PAR channel was removed from casts #9-26, 31-34, 38-44, 47-59 and 63-100 because the instrument was not mounted on the CTD for those casts.
A second SBE DO channel was added with different units. Then the files were reordered to put the two SBE DO channels together.

HEADER EDIT was run to fix formats and units and to add a comment about quality flags and analysis methods. The following extra comments were entered:

WARNING: The salinity analyses done on a Portasal salinometer at sea are considered unreliable. Many duplicate samples were run using an Autosal at IOS and the Portasal. The results showed that the Portasal read much lower than the Autosal for those samples analyzed on the Portasal on June 5th.
For other days the Portasal was low by an average of 0.0016 but there was a lot of noise in the comparison with many values within 0.001 of the Autosal, while others looked unstable.
(For more detail see file 2008-26-bottle-salinity-port-auto-dups.xls.)
Autosal values have been selected for Salinity:Bottle where possible.

Where there are no Autosal values, the Portasal values were used, but were all flagged "c", except for those from June 5th which have been flagged "d".

Standards check was run on all files and HEADEDIT adjusted until all format problems were resolved. Fluorescence values in the CHE file for cast #26 were replaced with values from the downcast because the upcast data were bad. (Output: CHE)

24. Thermosalinograph Data

a.) Checking calibrations

There were 3 identical files containing TSG data. All parameters were entered correctly, except that the date of calibration was missing. That was added and the file was saved as 2008-26-TSG.con.
The history of the T/S sensors was obtained. They had been used for 3 cruises since last calibration, but one was on the Vector and the salinity was bad for another, so only 2008-01 is likely to be useful though that cruise also had some problems with the TSG.

b.) Converting to IOS Headers, adding position headers and time channels, preliminary checks

The data were converted to CNV files using a SeaSoft routine. The channels converted were: Scan_Number, Temperature:Primary, Temperature:Secondary, Temperature:Difference, Conductivity:Primary, Fluorescence:URU:Wetlabs, UPloy0, Salinity:T0:C0 and Time Julian and 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 in IOS SHELL format and the output files were named *.ATC.

Time-series plots were produced. There are a few spikes in salinity and the secondary temperature has small-scale noise in patches. The flow rate was unusually high at the beginning (~1.7) and was then reduced to ~1.1 which is about usual. The fluorescence and primary temperature looked ok. There was one spike in latitude and longitude in the first file; the values were replaced with an average of the values before and after the spike. After that step the track plot looks fine.

c.) Checking Time Channel

The CTD data, after editing and metre-averaging, were thinned to reduce the files to a single point at or within .3db of 4db and exported to a spreadsheet which was saved as 2008-26-ctd-tsg-comp.xls. The TSG files were opened in EXCEL, median and standard deviations (over 2minutes) were calculated for temperature and salinity, and the file was then reduced to the times when CTDs were run. Those files were added to the CTD data in file 2008-26-ctd-tsg-comp.xls. The positions were compared and were very close, with average differences for both latitude and longitude of <0.0001º and no difference greater than 0.0003º so the clock appears to have worked well.
This spreadsheet will also be used in step (e) to compare temperature, salinity and fluorescence.

d.) Alignment check

This equipment has showed no alignment problems in the past. There are variations in alignment, but they are not systematic. This step was skipped.

e.) Comparison of T, S and Fl from TSG and CTD data

- T1 vs T2 The average difference over the whole record shows the lab temperature to be high by 0.1498 Cº for the first file and by 0.0029 Cº for the second file and 0.0637 Cº for the third file (which is very short). The secondary temperature is noisy in patches, so the variability would appear to be with the intake thermistor. The second file becomes much noisier around 8:50 on June 6, 2008, but even before that there are some hints of trouble even in the first file. Analyzing the ship's heating effect can only be attempted in parts of the first file which do not show such noise. When only data with the standard deviation in the secondary temperature <0.004 were included the average difference was 0.15C°. However, even that data had considerable variability.

- 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. There were 59 casts that could be used.

  If all data are included the TSG lab temperature is found to be high by 0.23 C° and the intake temperature by 0.091 C°. A group of 22 casts were identified with low standard deviation in the TSG temperature channels. The average of those show the lab temperature to be high by 0.17 C° and the intake temperature by 0.029 C°.

  Using a similar approach for salinity the TSG salinity is low by 0.22 using all data and by 0.127 using 13 casts with low standard deviation.

  The ratio of TSG fluorescence to CTD fluorescence ranges from 1.5 to 8 with an average of 3.4. When one outlier is excluded and the fit of TSG versus CTD FL is forced through the origin, the slope is ~2.5. This is the same slope as found during 2007-01. During 2008-01 that slope was ~1.6 but it was noted that the TSG fluorometer was quite unresponsive, possibly due to a film build-up. During 2007-01 the ratio was ~2.3.
  (See 2008-26CTD-tsg-comp.xls)

- Loop Bottle Comparisons There were 17 loop bottles. Some were analyzed on the Portasal and it was hard to find some of this data. Some were in a loop file prepared by the chief scientist, but the numbers did not agree exactly with what was written on the log sheets. Some were in one of the many small Portasal CSV files. Others were listed on the Log sheets but were not found in any of the Portasal files. The values were taken from the Salinity Log sheets where no file could be found. None of the loop analyses were run on the Portasal on June 5th. The times and positions were found in the loop file. The corresponding TSG fluorescence and salinity values (using a median over a 2-minute window) were found in the TSG files.

  The TSG salinity was low by an average of 0.126 if all samples are used. If only those analyzed on the Autosal are included it is low by 0.124.

  When loop CHL is plotted against TSG fluorescence the trendline is:
  TSG = ~1.10 * Loop CHL + 2.29
  When one outlier and 1 flagged sample are excluded the fit is
  TSG = ~1.07 * Loop CHL + 1.92
  The slope is similar to the results of 2008-01 but the offset is much larger. For loop CHL values from 0.3 to 0.5mg/l, the TSG fluorescence values varied from 1 to 4. The average ratio of TSG FL/ Loop CHL is 4.3, or 4.7 if 1 flagged sample and another with a high standard deviation in the TSG data are excluded. At higher CHL values the correspondence is fairly close, but it looks like the TSG fluorometer is not resolving low values well. It is not unusual to see TSG FL failing to get much below 1, but the large offset in the fits are unusual. (See 2008-26-loop-TSG-comp.xls.)

- Calibration History

The TSG primary temperature and conductivity were recalibrated in December 2007. They have been on 2 other cruises that had calibration sampling. During 2008-01 there was no intake thermistor and the lab temperature was estimated to be high by 0.19C°.

The salinity data were thought to be low by 0.055. During 2008-32 the lab temperature was believed to be high by 0.228 C° and the salinity data were bad.

Conclusions

The lab temperature is higher than that of the CTD by about 0.17Cº if we use data from before June 6 at 8:50 or use the median of all the data. The intake temperature is higher than the CTD by about 0.074 Cº if we use the data from before June 6 at 8:30 or by 0.022Cº if we use the median of all the data. Using the early data would suggest that the heating in the loop is ~0.1Cº Using the medians is consistent with the results that the lab temperature is higher than the intake temperature by ~0.15Cº before June 6. So that looks like the best guess and is in the range of heating seen in other cruises at that time of year. So to get an estimate of the intake temperature an offset of -0.15 will be applied to the primary temperature.

For salinity the TSG is lower than the loop salinity by 0.124 and lower than the CTD by 0.127 when casts with low standard deviations are used. The last time we had a good comparison for this data, the salinity was found to be low by 0.055. To recalibrate the salinity will be increased by 0.125.

The TSG fluorescence is much higher than the extracted chlorophyll at low CHL values and about 2.5 times the CTD fluorescence, on average. The plot of loop CHL against TSG fluorescence looks odd at low CHL values, something that does not show up in the comparison with the CTD fluorescence, or between the CTD fluorescence and Niskin bottle CHL samples. Could this be an indication of problems in sampling CHL from the loop? No recalibration will be applied.

f.) Editing

The time-series plots were examined and a few spikes in salinity were cleaned in the first two files.

g.) Recalibration

Because the intake temperature is not reliable it will be removed. A new channel Temperature:Lab was added using the ADD CHANNEL routine.
CALIBRATE was run using file 2008-26-tsg-recal1.ccf to set Temperature:Lab = Temperature:Primary.
CALIBRATE was then run a second time using file 2008-26-tsg-recal2.ccf to apply offsets of -0.15 to the Temperature:Primary +0.125 to Salinity:T0:C0 for all files.

Thus we have:

- Temperature:Lab as the uncorrected temperature recorded in the lab.
- Temperature:Primary as the lab temperature adjusted to remove the effects of ship heating; this is a proxy for the intake temperature.

h.) Preparing Final Files

REMOVE was used to remove channels Scan_Number, Temperature:Secondary, Temperature:Difference, Conductivity:Primary, Flag and UPloy0 (flow rate) from all files.

HEADER EDIT was used to add a comment, change the DATA TYPE to THERMOSALINOGRAPH and add the depth of sampling to the header. The comment includes a note to indicate that the Temperature:Primary was recalibrated to correct for heating in the loop based on the historic observations and comparison with CTD data.

The TSG sensor history was updated.
As a final check plots were made of the cruise track and data; no problems were noted.

25. Producing final files

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

TO BE DONE LATER: The final loop file (2008-26 loop.xls) will be prepared by the chief scientist including data from the final CTD files and salinity and chlorophyll samples from the loop or from 5m bottles. That spreadsheet will be checked to ensure all information is present and in the right format. It will then be converted to IOS format, put through CLEAN and HEADEDIT to get start and stop times and positions, and to add general comments. The final file will be named 2008-26-surface.loop.

Particulars:
1. No flow to TSG fluorometer until JF1.
1. 24 Niskins closed, but only 11 samples. Others closed to check for misfiring.
10. Secondary salinity found to be bad.
15. Secondary sensor changed on CTD.
42 problem with secondary salinity
43 problems with secondary salinity and trans noisy.
44. CTD problems returned to surface and changed cables. Reran cast but problems with trans cable, archiving not started until 1700 on upcast. Processed upcast.
54. Note that fluorometer might need new cable. Program crash noted in rosette log.

Institute of Ocean Sciences

CRUISE SUMMARY

CTD

CTD#	Make	Model	Serial#	Used with Rosette?	CTD Calibration Sheet Competed?
1	SEABIRD	911+	0	Yes	Yes

Calibration Information					
Sensor		Pre-Cruise		Post Cruise	
Name	S/N	Date	Location	Date	Location
Temperature	4054	16Jan08	Factory “		
Conductivity	1766	07May08	“		
Secondary Temp.	4700	16Jan08	“		
Secondary Cond.	2173	07May08	“		
Secondary Cond. replacement	2128	07May08			
Transmissometer	1005DR	5Mar08	IOS		
SBE 43 DO sensor	1176	14Feb2007	Factory		
PAR	4656	11Feb2003	IOS		
Fluorometer	2228	?	IOS		
Pressure Sensor	63507	25/Oct/2004	Factory		
Altimeter	1252	?	?		

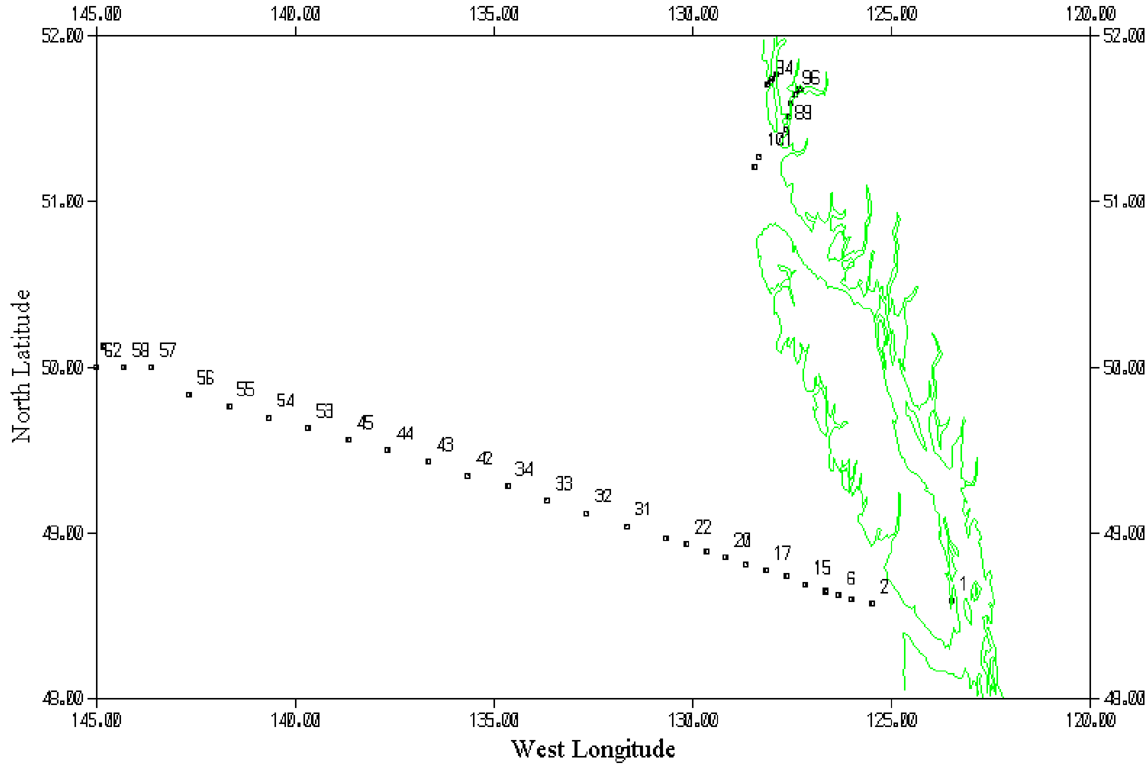
TSG

Make/Model/Serial#:__SEABIRD/21/2487__ Cruise ID#:______2008-26

Calibration Information					
Sensor		Pre-Cruise		Post Cruise	
Name	S/N	Date	Location	Date	Location
Temperature	2487	01/12/07	Factory		
Conductivity	2487	01/12/07	“		
Wetlab/Wetstar	WS3S-713P	8/01/01	“		
Temperature 2	4652	22/Dec/06			
Flow Meter	?	?			

PLOTTED: 2008/07/03 09:22:47

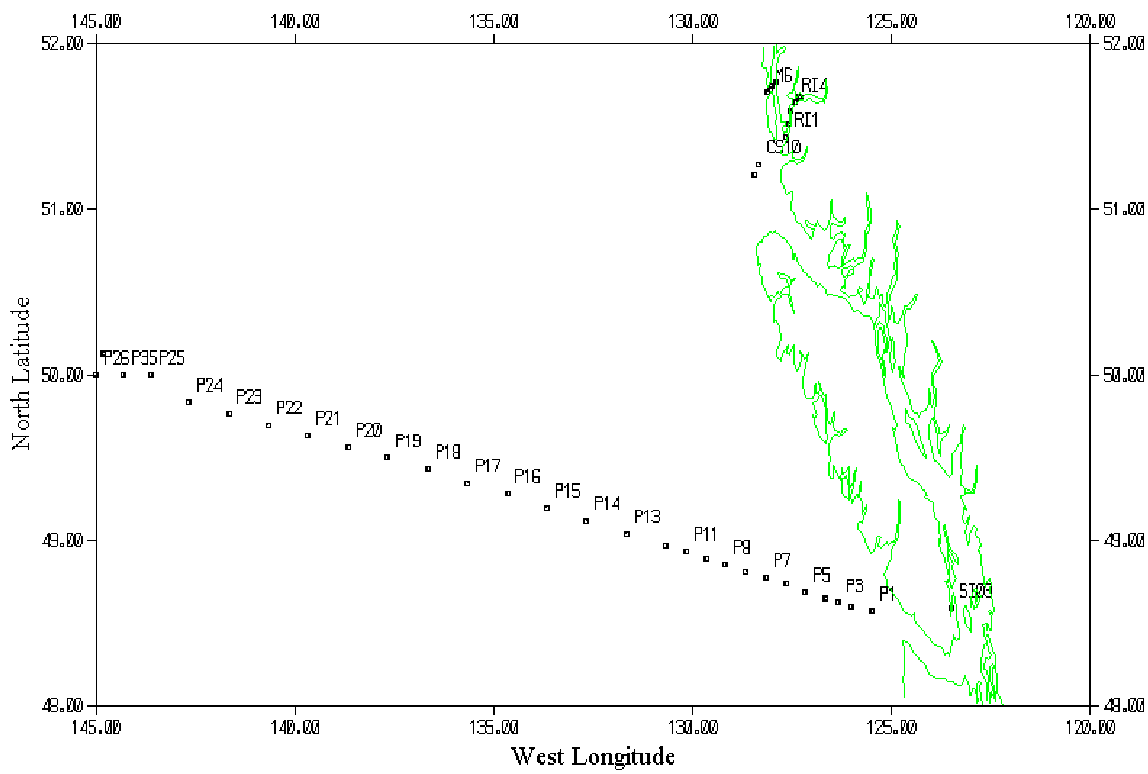
2008-26



START TIME: UTC 2008/06/01 02:07:05 END TIME: o

PLOTTED: 2008/07/03 09:48:36

2008-26 STN NAME



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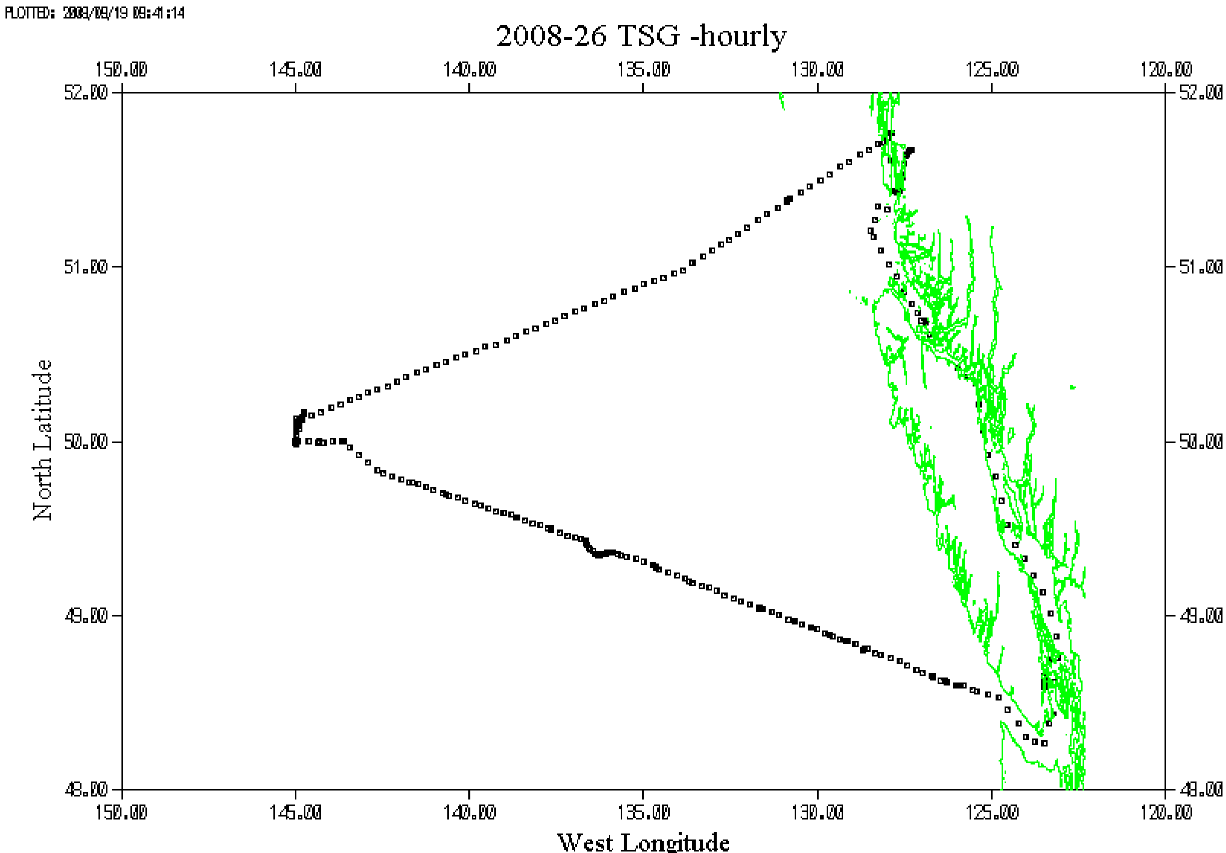

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