## REVISION NOTICE TABLE

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| DATE | DESCRIPTION OF REVISION |
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## PROCESSING NOTES

Cruise: 2024-070

Agency: IOS, Ocean Sciences Division, Sidney BC

Chief Scientist: Young K. Platform: Richardson Point

Location: Strait of Georgia Project: Strait of Georgia Plankton

Date: 12 August 2024 – 16 August 2024

Processed by: Germaine Gatien

Date of Processing: 27 November 2024 – 29 November 2024

Number of original xml files: 30 (including 3 chito casts)

Number of CTD files: 27 Number of BOT files: 14

##### INSTRUMENT SUMMARY

A SeaBird Model SBE-25 CTD (s/n 1255) was used with temperature sensor #6448, conductivity sensor #6147, Wetlabs ECO Fluorometer #8046, dissolved oxygen sensor #4378, PAR/Logarithmic Satlantic sensor #2274 and pressure sensor #1255. A 1.7 L Niskin bottle was attached approximately 1m above the CTD for deep sampling at 5 sites. The sampling rate was 16Hz.

# SUMMARY OF QUALITY AND CONCERNS

There was a digital Daily Science Log with positions and notes about sampling and a digital sampling log. Header information was entered in the raw files in a format that enabled easy conversion into IOS Header format.

Regular CTD casts were run at 27 sites. At 14 sites surface samples were collected in a bucket while the

CTD was soaking at 10m. At 3 of the sites a second CTD cast was run for Chito sampling immediately after the regular cast. There were frequent stops during the Chito downcasts to attach bottles, so the CTD data are not suitable for archiving, but they were useful for obtaining calibration samples.

Searchable bottle files were created by combining CTD data with chemistry (salinity, extracted chlorophyll and nutrients). Data from the regular casts were extracted to accompany the surface samples. Data from the Chito casts were extracted to accompany the 5m samples and samples taken 1m above the deepest level of the CTD cast. While all activities were given separate event numbers in the log, the bottle files prepared for the archive will contain only 1 BOT file per site with the event number matching the associated regular CTD cast.

There was a soak at 10m that generally lasted at least 60s, followed by a return to the surface before full casts were run. The stops at the surface after the 10m soak mostly lasted about 15s. This is a little longer than during some other recent cruises for this project, and the surface data does look more stable than in the past. That may be due to better-mixed surface waters or the longer waits. It is recommended that the CTD be kept at the surface for at least 30s before running the full cast, to enable disturbance from the upcast to dissipate.

There were 6 salinity calibration samples taken during this cruise, of which only 3 were from below 5m. CTD salinity compared well with the deep samples. Based on these samples and results of previous uses of this CTD, salinity is considered good to +/-0.005psu.

Extracted chlorophyll samples were mainly gathered at the surface using a bucket; 3 samples

came from a Niskin bottle at 5m. The near-surface CTD fluorescence data looked somewhat lower than CHL than usual for this type of sensor. However, similar results were obtained for all 2024 cruises run for this project. This may be partly due to near-surface fluorescence data being noisy and bottle samples coming from shallower water than the CTD data with which they were compared.

# PROCESSING SUMMARY

##### 1. Seasave

This step was completed at sea.

##### 2. Preliminary Steps

A digital daily log was obtained as well as sampling logs.

The cruise summary sheet was completed.

The CTD was taken down to 10m for a soak which lasted for at least 1 minute. The CTD was then brought back to the surface and after about a short wait (typically 10s-15s), the full cast was run. A longer wait before the full cast is recommended, about 30s.

The chito casts (events 12, 24 and 40) had stops during the downcast to enable mounting of Niskin bottles at a variety of depths; a CTD was also deployed on those casts. There was also a regular CTD cast at each of those sites (events #11, 23 and 39).

Surface bucket samples were gathered during the 10m-soaks of 10 regular CTD casts.

##### 3. Conversion of Raw Data

The configuration file used at sea was correct. It was saved as 2024-070-ctd.xmlcon and used to convert all HEX files.

Plots were made of a few casts and all expected channels have data that looks reasonable.

There were a few small spikes in conductivity.

Fluorescence dark value is the same as for cruise 2024-043, 2024-029, 2024-030 and 2024-031 at ~0.035ug/L, but noise in the signal occasionally went very slightly negative. Negative values should disappear in bin-averaging.

Salinity and Descent rate derivations were left until step 8.

##### 4. WILDEDIT

WILDEDIT was run and removed the conductivity spikes noted before the run.

##### 5. FILTER

The pressure looks very smooth, so FILTER was not run.

Next the temperature and conductivity were examined and the usual approach of applying a cosine filter, size 16, in routine Windows Filter was used.

##### 6. ALIGNCTD

ALIGNCTD was run on all casts using an advance of 2.5s, based on previous results with this type of DO sensor.

##### 7. CELLTM

CELLTM was run on all casts using the SeaBird recommended parameters, (α, 1/β) = (0.04, 8).

##### 8. DERIVE

Program DERIVE was run to calculate salinity and dissolved oxygen concentration (tau correction included) and descent rate.

Checks were made that each step worked properly:

* The temperature and conductivity were smoothed by the WFILTER step. This produced much smoother salinity traces after DERIVE.
* The alignment of DO and temperature is hard to judge due to a lot of small-scale variation in the dissolved oxygen, but downcast features are in better correspondence after ALIGN was run.
* The descent rate is noisy with a lot of fine-scale variability. In the past descent rate was derived at the convert stage, which likely explains some of this increased variability and low DO gradients at depth are another factor. This makes the profiles of dissolved oxygen data very noisy, and so alignment is hard to judge. For casts with steadier descent rate the alignment is definitely improved and downcast features are in good agreement, so ALIGNCTD appears to have worked well.
* CELLTM worked as expected, lowering salinity where temperature is decreasing (cell warms water raising conductivity, but temperature sensor reading is correct, so salinity is overestimated). Conversely, it raises salinity where temperature is increasing (conductivity too low). This brings downcast and upcast traces closer together, so T-S downcast and upcast plots are in better agreement after this step.

At this point the 3 CHITO files were renamed with a leading 9 in the event number to make them easier to treat them separately in IOS SHELL routines.

##### 9. Conversion to IOS Headers

The IOSSHELL routine was used to convert the CNV files to IOS Headers.

CLEAN was run to add event numbers and replace pad values in the pressure channel with interpolated values..

##### 10. Checking Headers

Cross-reference listing was run.

Times in the files are within a minute of those in the log. This confirms that the clock is well.

Surface Check was run on the IOS files; the average was +0.32db with a range of +0.27 to +0.40db. Files were reversed and Surface Check was run again and the average was +0.33 with a range of 0.28-0.39db.

These results are very close to those during 4 other uses of this CTD in 2024.

No recalibration will be applied.

Track plots were added to the end of this report, one with event #s and one with station names.

##### 11. CLIP

The next step is to remove the data collected during soaks at 10m. Plots were examined to see how many records should be removed from each cast. File clip.csv was prepared with 2 columns containing event # and # of records to removed. CLIP was run and output plots examined; adjustments were made to the clip file until all plots looked appropriate.

##### 12. SHIFT

Conductivity

For 3 previous 2024 cruises using this CTD shifts of +2s proved most effective for aligning conductivity but for 2024-030 +1.8s looked best. For all cruises there is some variability from feature to feature, so no choice works everywhere.

A few tests were run using a variety of settings, and +2s was found to work a little better than 1.8s and significantly better than 1.6 or 2.2s. As usual no choice worked best for all features examined. There appears to be a lot of variability in alignment, which may be due to small-scale temperature variability or possibly some variability in flow to the conductivity sensor. Some jitter in descent rate is seen at most casts, but not in pressure, so it must have something to do with how descent rate is calculated.

A shift of +2 records was applied to all casts.

Fluorescence

The fluorometer was not pumped, so a shift in alignment is expected to be small or unnecessary. Profile plots of temperature and fluorescence were examined. They are usually fairly close, though there are some areas where the fluorescence offsets are larger. Those are in areas of high gradients and the downcast features line up quite well with temperature features. Since the upcast alignment is of no significance in preparing downcast files, no adjustment appears necessary.

Dissolved Oxygen

This channel was aligned earlier, but checks were made by examining plots of temperature and dissolved oxygen. No further adjustment was made.

##### 13. DELETE

DELETE was run on all casts using the following parameters:

Surface Record Removal: Last Press Min. Surface Swell Pressure Tolerance: 1.0

Swells deleted. Warning message if pressure difference of 2.00

Drop rates < 0.3m/s (calculated over 9 points) was deleted from 10db to 10db above the maximum pressure.

Pressure was filtered over 7 records. (Tests were done and, as expected, filtering had no noticeable effect since pressure was very smooth.)

COMMENTS ON WARNINGS: There were no warnings.

##### 14. DETAILED EDITING

All DEL files were copied to \*.EDT so there will be a complete set of files even if some need no editing.

The DEL files were zipped and submitted to the CTD-QC File processor. DELPRED files were returned.

CTDEDIT was used to edit 21 DELPRED files, which mostly involved the removal of records near the top and/or bottom of the cast and some cleaning of salinity.

No editing was applied to files from events #35, 36, 39, 42, 43, 47.

Notes of editing details were made in the headers.

During 2024-029, 2024-030 and 2024-031 there were some slightly unstable features in the presence of temperature gradients. These were not noted during 2024-043. Some such features were found during this cruise, but not many. Tests were done during 2024-029 to see this might be due to a poor choice in the conductivity alignment correction, but no improvement was noticed when the shift setting was varied. Further tests were run to see if the CELLTM step had created these features, but dropping that step made no difference. Skipping the Windows Filter step made reversals much larger and more frequent. This was thought to possibly be due to a vessel change, but for 2024-070 the vessel is the same as for 2024-043. So the winch is likely not an issue. The frequency of sharp temperature gradients is likely the variable factor. These instabilities are 2-sided, so in many cases bin-averaging would have the same effect as cleaning salinity, so editing was generally not applied or kept light.

T-S plots were examined after this step. No significant unstable features were noted.

##### 15. Initial Bottle Data Steps

There was no rosette available for this cruise.

There was salinity, chlorophyll and nutrient sampling.

Each of the analysis spreadsheets were examined to see what comments the analysts wanted included in the header file. These were used to create file 2024-070-bot-hdr.txt which will be updated as needed during processing.

For the chito casts (events 12, 24 and 40) multiple rosette bottles were attached and all fired when the bottom was reached. Most of the bottles during those casts were for chito sampling only, so are not included in the bottle files. A CTD was used during the chito casts. There were regular CTD casts at each site, run before the Chito casts (#11, 23 and 39). Surface samples were taken while the CTD was soaking at 10m during the regular casts. The samples from 5m and near bottom were taken during the chito casts.

File 2024-070-bottles\_plus\_CTD\_6linehdr csv was created and a 6-line header was added based on such files from previous cruises from this program. Analysis data from the QF worksheets were added. Space was left for the addition of appropriate CTD data. Data were sorted on sample # order.

The next step was to select CTD data from as close to the depth of sampling as possible during the cast when they were gathered – regular (bucket) or chito (Niskin).

The edited CTD files associated with sampling were averaged over 0.5db and thinned to the levels of bottle samples including the 3 different deep water depths; data were selected over a ±0.5db range in case some levels were not present in the files. Those data were exported to a spreadsheet and lines removed for which there was no sampling. A second run was made for the chito casts.

The CTD data were sorted on event # and pressure and added to the 6-line header file. Care was taken to ensure the sample numbers matched. (The problem of separating date and time was solved by entering the combined data in 2 columns in a CSV file. When opened from within EXCEL take advantage of the controls over how columns are treated.)

The spreadsheet was sorted on pressure for each event.

The spreadsheet was then converted to separate files in IOS Header format.

##### 16. Compare

Workbook 2024-070-CTD-bottle-comp.xlsx was prepared (using data from the 6-line header file) to do a comparison of CTD and bottle data for salinity and fluorescence.

Salinity Comparison

There were 6 bottle samples, 3 from 5m and 3 from near the bottom.

The surface CTD salinity was higher than the bottle sample by an average of 0.157psu but the 3 differences varied greatly (+1.46psu, -0.51 and -0.01psu) which is due to high variability at the surface.

The 3 deep samples that came from a CTD on the chito cast have a tighter range with 2 showing the CTD salinity to be low by 0.0008psu and 0.0022psu and 1 showing it to be high by 0.0005psu, with an average of low by 0.0008psu.
The deep bottle results are in line with previous cruises using this equipment and offer further evidence that the sensor calibrations are good.

Fluorescence

The only extracted chlorophyll sampling was at the surface (10 samples) or 5m (3 samples).

The CTD Fluorescence is an average of 55% of extracted CHL with highest values when CHL is low.

That is lower than usually seen from this type of sensor, especially at the low end of the CHL range, but is close to observations from other cruises using this equipment in 2024.

As during those other cruises, many of the samples come from higher in the water column than the CTD data with which they were compared and CTD fluorescence data this close to the surface are noisy. The results are similar to other 2024 cruises using this CTD.

The FL/CHL ratio is a little flatter than usual when plotted against CHL pattern though it does decrease somewhat as CHL rises, as is normal.

See 2024-070-CTD\_Bottle\_comp.xlsx for more detail on both salinity and fluorescence comparisons.

##### 17. Other calibration checks

Sensor History –

* 2023-023 July 2023. The pressure sensor had surface values from 0 to +0.4db. Salinity was high by a median of 0.003psu based on 5 bottles from roughly 300db. There was no dissolved oxygen sampling. The fluorometer may have read low, but with only surface sampling this was not clear.
* 2023-043 March 2024 Pressure was high by about 0.25db. Salinity appeared good to ~0.005psu. Fluorescence looked low but all samples from surface with CTD values from deeper. There was no DO sampling.
* 2023-029 April 2024. Pressure high by about 0.25db. Salinity appeared good to ~0.005psu. Fluorescence mostly low but one sample from 5db looked normal compared to extracted CHL. No DO sampling.
* 2023-030 May/June 2024. Pressure high by about 0325db. Salinity appeared good to ~0.005psu. Fluorescence low compared to extracted CHL. No DO sampling.
* 2023-031 July 2024. Pressure high by about 034db. Salinity appeared good to ~0.005psu. Fluorescence low compared to extracted CHL. No DO sampling.

Historic Ranges – All salinity fell within the climatology except during the cast at Station 56, which as often is seen, fell within the Gulf Islands range but not that for the southern Gulf of Georgia.

Temperatures were frequently above the historic range with a different character in different parts of strait. To the north it was typically high between 100 and 150m while in the central section there were many reversals in temperature gradients at those depths, though mostly within the climatology. There would appear to be incursions of warm water from the north. These excursions are likely due to real variability in this very active region rather than calibration problems.

Post-cruise calibrations – None were available.

##### 18 CALIBRATE

No recalibration was applied. Surface pressure is within expectations. The salinity bottle comparison is very limited, but suggests the calibration is good.

The following information was sent to J. Bedard for sensor history:

*CTD 1255*

*Pressure high by about 0.33db.*

*Conductivity 6147 (Temp 6448) –only 3 deep samples;sal low by <0.001psu.*

*Oxygen Dissolved: No dissolved oxygen sampling.*

*Fluorometer: ECO 8046 –fluorescence about 50% of bucket CHL samples, but most CTD FL data are from a little deeper.*

##### 19. Fluorescence Filter

The fluorescence data did not require filtering.

**20. Bin Average, Remove, Derive DO in mass units, Reorder**

The files were bin averaged using 1db bins.

REMOVE was run to remove Scan\_Number, Oxygen:Voltage, Descent Rate, Flag and Prediction\_Flag channels.

Oxygen:Dissolved:SBE values cannot be confirmed as there was no calibration sampling

for dissolved oxygen.

Dissolved Oxygen was derived in mass units and that was used to calculate DO saturation.

Surface saturation values were all between 100% and 135% except for station 56 where it was 65%. That is a site of active mixing.

It is likely that SBE dissolved oxygen values are slightly low with typical errors for these sensors being from 1% to 3%.

REORDER was used to get the 2 dissolved oxygen channels together.

##### 21. HEADER EDIT and final checks of CTD files.

Header Edit was used to fix headers, fix formats and to add comments about processing.

A cross-reference listing was produced.

A header check and standards check were run on the CTD files and no errors were found.

Plots of CTD casts were examined and no problems were found.

##### 2. Final BOT file preparation

Workbook 2024-070-bottles\_plus\_CTD\_6linehdr. csv was converted to IOS Header files. (\*.ios)

The time and date are present as channels as these could not be converted directly into header entries.

CLEAN was run to add START and END time to the headers. The END TIME is identical so the START time so it will be removed later.

CLEAN was also used to enter 0 flags where the flag channels are empty.

There are salinity values <25, so CALIBRATE was run using 2024-070-recal-SIL.ccf to correct silicate.

Change Units was run to add mass units to channel Oxygen:Dissolved:SBE.

There was no DO calibration sampling so a second run of Change Units was not needed.

REORDER was run to get the 2 DO channels are together.

REMOVE was run to remove Date and Time channels.

Header Edit was run to add comments and to remove END TIME since it is the same as START TIME and TIME ZERO.

The final files have extensions BOT.

The standards check was run and no errors were found.

A header check was run on the BOT files.

Plots were made of all BOT casts. With just 1 to 3 levels these were not very useful.

Finally all data from BOT files were extracted to a spreadsheet and compared to the 6line header file and sampling logs; no problems were found. It was found that one CHL sample had been missed from event #4. That file was recreated and the comparison with CHL rerun.

PARTICULARS – notes from log

12. Chito cast – Bottle data included in BOT file for cast #11.

24. Chito cast - 250m bottle top lid did not close properly. Bottle data included in BOT file for cast #23

39. Chito cast – Bottle data included in BOT file for cast #40.

**CRUISE SUMMARY**

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| --- |
| Cruise ID#: 2024-070 |
| Dates: Start: 11 August 2024 End: 16 August 2024 |
| Location: Strait of Georgia Plankton |
| Chief Scientist: Young K. |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** |
| 1 | SEABIRD | 25+ | 1255 | No | Yes |

**CTD CALIBRATION INFORMATION**

**Make/Model/Serial#: SEABIRD/SBE25/0456 Cruise ID#: 2024-070**

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| --- |
| **Calibration Information** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **6448** | **4Feb2023** | **Factory** |  |  |
| **Conductivity** | **6147** | **18Jan2023** | **Factory** |  |  |
| **ECO Fluorometer** | **8046** | **21Apr2023** | **Factory** |  |  |
| **SBE43 Oxygen** | **4378** | **28Mar2023** | **Factory** |  |  |
| **PAR/Satlantic** | **2274** | **25Jan2023** | **Factory** |  |  |
| **Pressure****D:\Te****lewo****rk\2022-0** **28\Process****ing\ios\** | **1255** | **13Feb2023** | **Factory** |  |  |

