## REVISION NOTICE TABLE

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| **DATE** | **DESCRIPTION OF REVISION** |
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## PROCESSING NOTES

Cruise: 2021-034

Agency: PBS, Ecosystem Sciences Division, Nanaimo, BC

Project Scientist: King J. Platform: Nordic Pearl

Location: WCVI / NWCVI Project: WCVI Juvenile Salmon Survey

Date: 4 October 2021 –17 October 2021

Processed by: Germaine Gatien

Date of Processing: 13 May 2022 – 18 May 2022

Number of original HEX files: 25

Number of CTD files: 25

Number of BOT files: 31

# INSTRUMENT SUMMARY

A SeaBird Model SBE-25 CTD (s/n 0456) was used with temperature sensor #5130, conductivity sensor #3500, Wetlabs ECO Fluorometer #4185, dissolved oxygen sensor #3234 and pressure sensor 0573.

# SUMMARY OF QUALITY AND CONCERNS

The cruise log was in good order.

Header information was entered in the raw files in a format that enabled easy conversion into IOS Header format. There were a few syntax errors and one typo, but those were easily fixed.

Nutrient and extracted chlorophyll samples were collected at 10m using a Niskin bottle on a wire about 2 to 3 minutes after CTD casts. There was no salinity or dissolved oxygen calibration sampling. Previous uses of the salinity sensor suggest that values may be a little high but sampling was limited and results variable. The conductivity cell was found to be damaged when it was serviced in early 2022.

Raw CTD data for casts #9 to #28 were missing due to an instrumental problem during download from the CTD. Bottle files for those casts were prepared with only sample data plus depth. For other casts, CTD data from approximately 10m were included in the bottle files.

There was a 10m soak before full casts were run, but the timing was such that the pump did not come on until the CTD was almost back at the surface. The SBE25 CTDs are usually set with a minimum wait time (usually 45s) and a minimum conductivity to be reached to ensure the CTD is in water before the pump turns on. Soaking at 10m for at least 30s after the pump turns on allows for bubbles to be cleared from the plumbing. Operating from smaller vessels limits the ability to follow standard procedures, but not following them does mean near-surface conductivity and dissolved oxygen data will be less reliable.

Casts #69 and #89 had a bigger problem as the oxygen sensor did not record a signal until about 2 minutes after launch, so there are no data above 10m for #60 and 12m for #12. The dissolved oxygen data that are clearly bad were removed from those 2 casts.

Calibration drift from dissolved oxygen sensors always tends towards low values, typically reading low by 2% to 4%. Surface saturation values ranged from 95% to 100% off the North-West coast of Vancouver Island and at most of the casts farthest from shore; there are cases with lower values that are likely due to vertical mixing, particularly those in Juan de Fuca Strait.

A comparison was done with 2 casts from another cruise that visited Juan De Fuca Strait 9 days earlier. While differences were large between the 2 sets of observations, they were not systematic. Spatial and temporal variations are generally large in this region.

# PROCESSING SUMMARY

### Preliminary Steps

The Daily Log and events table were obtained.

The cruise summary sheet was completed.

CTD Deployment method: CTD was lowered to 10m to soak and was bought back immediately to about 1m to sit very briefly before the full cast began. Typically, the pump would not have come on until the CTD was headed back to the surface, and the dissolved oxygen sensor did not register a signal until well after the pump turn-on for some casts. So the usefulness of the deep soak in clearing bubbles from the tubing and allowing sensors to equilibrate was very limited.

The SBE25 CTDs are usually set with a minimum wait time (usually 45s) and a minimum conductivity to be reached to ensure the CTD is in water before the pump turns on. Soaking at 10m for at least 30s after the pump turns on allows for bubbles to be cleared from the plumbing. Operating from smaller vessels limits the ability to follow standard procedures, but not following them does mean near-surface dissolved oxygen data will be less reliable, with values likely reading slightly high.

Sampling was done using a Niskin bottle attached to the wire and closed at 10m within 2 or 3 minutes after the end of the CTD cast.

### Conversion of Raw Data

The configuration file used at sea was correct except for the date of the fluorometer calibration. After that was fixed the file was saved as 2021-034-ctd.xmlcon and used to convert all HEX files.

All expected channels have normal profiles.

There is the usual step-like pressure which leads to unusual profiles.

### WILDEDIT

No spikes were observed except right at the surface, so this step was skipped.

### FILTER

Pressure can be filtered later in processing when running DELETE, but the poor resolution of this instrument means it is necessary to do this early to make sense of the other data which update more often than pressure. So program FILTER was used to apply a low-pass filter with a time constant of 0.5 seconds to pressure and depth. The results were excellent.

Next the temperature and conductivity were examined and the usual approach of applying a cosine filter size 9 in routine WFILTER did a good job of removing small reversals. Derive was run on a few casts to calculate salinity and plots showed great improvement in stability in T-S space after running WFILTER.

### ALIGNCTD

For other recent cruises in this project using the same DO sensor, an advance of 2.5s was generally applied to the dissolved oxygen. ALIGNCTD was run on all casts to advance the DO channel by +2.5s. Plots were examined after this step and the results were good.

### CELLTM

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

### DERIVE

Program DERIVE was run to calculate salinity and dissolved oxygen concentration (tau correction included). Plots were examined and confirmed that steps 5, 6 and 7 had improved the data.

### 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.

A preliminary header check was run and indicated there were some negative fluorescence values at the beginning of the casts. Checks will be made after DELETE is run to see if negative values remain.

Some bad positions were found. Simple syntax errors were found in the SeaBird headers. When those were fixed, the conversion and CLEAN steps were repeated and the results look good.

Plots were made to find the minimum pressure from the ends of casts and they varied from -0.1db to +0.2db. The pressure sensor has a 2800db range so the resolution is only 0.5db; these results look excellent.

Plots were examined to see how many records needed to be removed corresponding to the 10m soak; they were saved in file 2021-034-clip.csv.

CLIP was run on the CLN files. Plots were examined after this step to ensure that the proper # of points were removed; a little fine tuning was done until all looked fine.

### Checking Headers

A cross-reference list was produced and compared with the log book entries. No errors were found.

Track plots looked ok but since bottle casts without CTD data are not included, they were not added to the end of the report. After the BOT files are ready, plots will be made.

HEADER CHECK was run. No problems were found except some negative values that may be removed when DELETE is run..

The surface check shows an average of 0.2db before CLIP was run with a range of -0.12db to +0.25db.

### SHIFT

Conductivity

When this CTD was used on other recent cruises shifts of between +0.3s and 0.45s worked best at removing unstable features in T-S space.

Tests were run on a few casts; for most there was little difference, but a few cases showed an improvement with a setting of +0.5s.

SHIFT was applied to all casts advancing conductivity by +0.05s.

Fluorescence

The fluorometer was not pumped, so a shift in alignment is usually unnecessary. Profile plots of temperature and fluorescence were examined. As noted during 2021-024 and 2021-025 a shift of +5 records leads to a vertical offset between upcast and downcast profiles that is closer to that in temperature. Shift was applied to all casts using +5 records.

Dissolved Oxygen

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

### 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.

COMMENTS ON WARNINGS: There were no warnings.

### DETAILED EDITING

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

CTDEDIT was used to remove records corrupted by shed wakes and to clean salinity where unstable features looked likely to be caused by misalignment of T and C. All casts required editing except for #41; most editing was near the surface and bottom of casts.

Notes of editing details were made in the headers.

T-S plots were examined after this step. Small unstable features are found near the surface of some casts; these may be real, so no further editing was applied.

### Data selection for bottle files and Dissolved Oxygen surface saturation study

The edited files were then bin-averaged (0.5m bins) and put through Change Units to add dissolved oxygen in mass units. These data will be used in the creation of bottle files. Surface saturation of DO was derived and plotted and turned up some problems. Casts #69 and #89 did not record a signal until about 2 minutes after launch, so there are no data above 10m for #60 and 12m for #12. After the pumps came on the values may be slightly high, but there is no obvious problem when compared to upcasts.

The dissolved oxygen data that are clearly bad were removed from those 2 casts using CTDEDIT.

Spikes in fluorescence were discovered in casts #41 and #89 as well, so those were padded in the EDT files.

Calibration drift from dissolved oxygen sensors always tends towards low values, typically reading low by 2% to 4%. Surface saturation values ranged from 95% to 100% off the North-West coast of Vancouver Island and at most of the casts farthest from shore; there are cases with lower values that are likely due to the pump turning on late and, as usual, values were low in Juan de Fuca Strait due to mixing.

### Other calibration checks

Sensor History – The pressure, conductivity and dissolved oxygen sensors were used on 7 other cruises since last serviced. Salinity appeared to be slightly high but incomplete flushing could explain that. For this program there are only a few bottles from near the bottom so they are considered only a guide, not the basis for recalibration. On the first 4 of the cruises the CTD salinity was close to bottles with estimates that salinity was within 0.003 to 0.0045psu. For 2021-024 the scatter was too large to make an estimate. For 2021-025 salinity appeared to be high by ~0.007 but Niskin flushing was likely weak. For 2021-045 there was no calibration sampling. No problems have been noted with pressure calibration.

There was no calibration sampling for the dissolved oxygen sensor during any of the cruises.

Historic Ranges – The only climatology available for the inlets is one that covers very large blocks, so it inappropriate. Even where local climatology is available it is not well-suited to near-shore casts. Nevertheless, temperatures all fell within the local climatology except for 1 small excursion towards higher values at the bottom of 1 near-shore cast. Similarly, salinity values were all within the climatology except for a few excursions towards low near-surface salinity at a few near-shore casts. None of these excursions suggests a problem with calibration.

Post-cruise calibrations – There was a factory check in February 2022 that found a damaged conductivity cell. This was the last know use before that check.

Repeat casts – There were no repeat casts.

### Final Steps in CTD file preparation

CLEAN was rerun to pad some very small negative values in fluorescence data. (\*.cln2)

Calibration was not run:

* There was no calibration sampling for salinity and dissolved oxygen
* The surface DO saturation is highly variable. See section 19 for details.
* Pressure looked good.

The fluorescence did not need filtering.

The files were bin averaged using 1db bins.

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

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

REORDER was used to get the 2 dissolved oxygen channels together.  
Header Edit was used to fix headers, fix formats and to add comments about processing.

A header check and standards check were run on the CTD files. A few problems were found and resolved.

A cross-reference listing was produced.

The sensor history was updated.

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

### Initial Bottle Data Steps

Niskin bottles fired at 10m at 31 sites; no CTD data are available for 6 of those sites.

BOT files were prepared with the sample data plus bin-averaged CTD gathered at the same site.

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 2021-034-bot-hdr.txt and some comments about CTD processing were added.

Spreadsheet 2021-034-bottles\_plus\_CTD\_6linehdr.csv was created. Cast times, station names, sample numbers times and positions were obtained from the CTD file headers.

Data from 10m were extracted from the edited files that were averaged using 0.5m bins. (See section 13.)

Data from the QF worksheets were added.

The file was then converted to \*.IOS files.

REMOVE was run to the Date and Time channels.

CLEAN was run to reset channel limits and to add ”0” to empty quality flag entries.

Header Edit was run to fix formats and channel names and to add comments.

The data from that spreadsheet were transferred to file 2021-034-FLvsCHL-comp.xlsx.

The standards check was run and no errors were found.

A cross-reference list was produced and no errors were found.

A header check were run on the BOT files and no problems were found.

Track Plots were produced. No problems were found so they were added to the end of this report.

### Compare

Fluorescence

There was chlorophyll sampling at 10m for all casts. CTD fluorescence from 10m does not match the time of the samples exactly, but the errors due to the mismatch are expected to be random, so the overall pattern is likely reliable. The pattern shows that the fluorometer reads close to extracted chlorophyll for low CHL values but then starts to fall towards 0.5 as CHL rises. This is a pattern normally seen with these fluorometers.

For more details see file 2021-034-FLvsCHL-comp.xlsx.

Comparison with 2021-022

There was another cruise that sampled in western Juan de Fuca Strait in October 2021. While this is an area of rapid change, and there was a gap of 9 days between them, there is a possibility of learning something by comparing results at 2 casts that were fairly close. The closest found were casts 2021-022-0011 and 2021-034-0105. They are in similar depth waters but the earlier cruise (2021-022) is closer to the mouth of Juan de Fuca. The earlier cruise has higher gradients in temperature, salinity and dissolved oxygen. Water above 50m is warmer and fresher in the earlier cruise, while dissolved oxygen values are similar to the later cruise near the surface. Close to the bottom the earlier cruise is cooler, saltier and has lower DO. The later profiles are better mixed. This study is not very helpful, but at least it shows no evidence of large, systematic sensor errors.

##### PARTICULARS

8,13,18,21,25,28. Data lost in download from CTD due to instrumental problem.

60 & 89. Problem with DO data near surface.

74. Obvious error in Longitude in file header– changed to match log.

**CRUISE SUMMARY**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cruise ID#: 2021-034 | | | | | |
| Dates: Start: 23 July 2021 End: 27 July 2021 | | | | | |
| Location: WCVI Juvenile Salmon Survey | | | | | |
| Chief Scientist: King J. | | | | | |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** | |
| 1 | SEABIRD | 25 | 456 | No | Yes | |

**CTD CALIBRATION INFORMATION**

**Make/Model/Serial#: SEABIRD/SBE25/0334 Cruise ID#: 2021-034**

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| --- | --- | --- | --- | --- | --- |
| **Calibration Information** | | | | | |
| **Sensor** | | **Pre-Cruise** | | **Post Cruise** | |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **5130** | **12Dec2019** | **Factory** |  |  |
| **Conductivity** | **3500** | **17Dec2019** | **Factory** |  |  |
| **ECO Fluorometer** | **4185** | **11Dec2019** | **Factory** |  |  |
| **SBE43 Oxygen** | **3234** | **6Dec2019** | **Factory** |  |  |
| **Pressure** | **0573** | **1Feb2019** | **Factory** |  |  |



