HLY-03-03 Service Group Bottle Data

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Barrow, Alaska to Nome, Alaska

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General:

Overall, the bottle data from this cruise appear to be of acceptable quality, but insufficient bottle flushing caused bottle salts to be generally higher than CTD salinities except for the first (deepest) bottle tripped where the bottle salts tended to be lower than the CTD salinities. This condition arises because salinities increased with depth with strong gradients in the upper ~250 m. Therefore, the first (deepest) bottle tripped could contain remnants of lower salinity waters from above, and the remaining bottles could contain remnants of higher salinity waters from below. In general, the apparent, depth offsets arising from insufficient bottle flushing were < 5 m. That is to say, that the bottle salinities = a value that could be found within 5 m of the target depth, assuming linear gradients between bottle samples. In some cases, small apparent density inversions arose between the deepest and next deepest bottle sampling depths presumably because of insufficient bottle flushing. This can be explained as follows; the deepest bottle's salinity is low-biased because it contains remnants of water from the upper layers, and the bottle tripped just above this depth is high-biased because it contains remnants of water from below the target depth. Because bottle salinities were run on most bottle samples, it is possible for the interested user to make estimates of the impact of bottle flushing on sample integrity for most individual samples. We attempt to note those cases where apparent depth offsets based on differences between CTD and bottle salinites, exceeded 5 m in comments appended to this submission, but we may not have noted every case.

Therefore, we urge the user who is interested in detailed vertical gradients to compare CTD and bottle salinities. Another issue that arises when taking data from large ships in the Arctic is that the vessel may disturb the surface layer. The *Healy* draws about 10 m, and tests on previous cruises suggests that data from the upper ~10-15 m have to be interpreted with the possibility of ship disturbance in mind.

CTD INSTRUMENTATION

At the time of finalizing this report, the post cruise CTD report was unavailable from Pickard, WHOI. The instrumentation information here is summarized from shipboard notes by Zimmermann. See also Cruise Report from Chief Scientist Rebecca Woodgate located on NCAR's Earth Observing Laboratory website, www.eol.ucar.edu/projects/sbi. CTD casts were performed with the US Coast Guard Cutter Healy's Seabird rosette system consisting of a 24-place rosette frame with 10-Liter Niskin-type bottles equipped with internal plastic coated springs and a 24-place SBE-32 Carousel pylon. Underwater electronic components included the following:

- Sea-Bird Electronics, Inc. (SBE) 911plus CTD,
- WetLabs C-Star transmissometer with a 25cm pathlength and 660nm wavelength,
- Chelsea MkIII Aquatracka fluorometer, and
- Simrad, 5 volt = 500 meters altimeter.

Additionally, a Woods Hole Oceanographic Institution (WHOI) Lowered ADCP pair was mounted on the rosette. The CTD, transmissometer and fluorometers were mounted horizontally along the bottom of the rosette frame. All sensors except the LADCP were interfaced with the CTD system. This instrument package provided pressure, dual temperature and dual conductivity channels as well as light transmissivity and fluorometric signals at a sample rate of 24 scans per second.

The rosette system was suspended from a standard UNOLS 3-conductor 0.322" electromechanical cable.

CTD serial number 069 with a 401K-105 pressure sensor, S/N 83012 was used. Serial numbers for other sensors are listed in Table 1. Mounting heights for sensors are listed in Table 2. Occasionally (casts 81-90), bottles were removed from the rosette to lower the drag of the package.

TABLE 1. Instrument/Sensor Serial Numbers

Primary Temperature	Primary Conductivity	Secondary Temperature	Secondary Conductivity	Pressure	Transmissometer
SBE 3plus	SBE 4C	SBE 3plus	SBE 4C	401K-105	C-Star
03-2841	04-2561	03-2945	04-2575	83012	CST-390DR

Dissolved Oxygen	Fluorometer	Altimeter
SBE 43	Chelsea Aqua 3	Simrad
458	88234	

Equipment Positions

TABLE 2. Instrument mounting heights

Sensor	Height above base of rosette	Sensor	Height above base of rosette
Altimeter	2 cm	Pressure	18 cm
Transmissometer	32 cm	T (pri)	9 cm
Fluorometer (Chelsea)	11 cm	T (sec)	9 cm

The temperature, conductivity, and oxygen sensors were mounted horizontally on the base of the rosette frame. Oxygen was in line with primary temperature and conductivity. Both T/C pairs were pumped flow. Fluorometer and transmissometer were not pumped systems. The distance of the mid-points of the 10-Liter Niskin bottles from the bottom-mounted sensors was ~0.111 m.

The 10-Liter Niskin-type bottles were equipped with Buna-N O-rings and the springs were coated with epoxy to minimize the occurrence of rust. They were inspected before the cruise.

BOTTLE DATA

Salinity

1044 salinity samples were analyzed.

Materials and Methods

Salinity samples were drawn into 200 ml high alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This container provides very low container dissolution and sample evaporation.

A Guildline Autosal 8400B #65-715, standardized with IAPSO Standard Seawater (SSW) batch P-141, was used to measure the salinities. Prior to the analyses, the samples were stored to permit equilibration to laboratory temperature, usually 8-20 hours. The salinometer contained a Guildline-supplied interface with ODF-developed acquisition software for computer-aided measurement. The salinometer was standardized with a new vial of standard seawater at the beginning and end of each run. The SSW vial at the end of the run was used as an unknown to check for drift. The salinometer cell was flushed until two successive readings met software criteria for consistency; these were then averaged for a final result. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular standard seawater batch used. A cursory review of the salinity data has been performed post-cruise. There are a couple questionable salinity runs and the data needs further investigation.

Laboratory Temperature

The temperature stability in the salinometer laboratory was fair, sometimes varying as much as 4.5ºC during a run of samples. The laboratory temperature was generally 1-2ºC lower than the Autosal bath temperature.

Oxygen

839 samples were analyzed for oxygen.

Materials and Methods

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. The ODF method used a whole-bottle modified-Winkler titration following the procedure of Carpenter (1965) with modifications by Culberson (1991), but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (55 g/l). Standard KIO3 solutions prepared ashore were run at the beginning of each run. Reagent and distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed, then filled and allowed to overflow for at least 3 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were usually analyzed within a few hours of collection. Thiosulfate normalities were calculated from each standardization and corrected to 20ºC. The 20ºC normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated as a linear function of time, if warranted. The oxygen data were recalculated using the smoothed normality and an averaged reagent blank. Some problems were encountered during standardizations, however deletion of errant standard values during post cruise data processing revealed an analytical error of less than one percent for the Thiosufate normality (and thus the samples). Oxygens were converted from milliliters per liter to micromoles per kilogram using the sampling temperature.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure.

Nutrients

1036 samples were analyzed for nutrients.

Materials and Methods

Nutrient analyses (nitrate+nitrite, nitrite, ortho-phosphate, and silicate) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated for longer periods and the data are annotated if it was felt that the storage time had a significant effect. The analog outputs from each of the four channels were digitized and logged automatically by computer (PC) at 2-second intervals.

A modification of the Armstrong *et al*. (Armstrong 1967) procedure was used for the analysis of nitrate and nitrite. For the nitrate plus nitrite analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was bypassed, and a 50mm flowcell was employed. Periodic checks of the column efficiency were made by running alternate equal concentrations of NO2 and NO3 through the NO3 channel to ensure that column efficiencies were high (> 95%). Nitrite concentrations were subtracted from the nitrate+nitrite values to obtain nitrate concentrations.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (Bernhardt, 1967) procedure. The reaction product was heated to ~55ºC to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Silicate was analyzed using the procedure of Armstrong *et al*., (Armstrong, 1967). The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

Sampling and Data Processing

Nutrient samples were drawn into 45 ml polypropylene, screw-capped “oak-ridge type” centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample three times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically 6-24 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre-weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 7 different standard concentrations covering the range of sample concentrations were analyzed periodically to determine the deviation from linearity, if any, as a function of concentration for each nutrient analysis. A 3rd-order correction for non-linearity was applied to the final nutrient concentrations when necessary. After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording. A stable deep seawater check sample was run frequently as a substandard check.

Nutrients, when reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), *in situ* salinity, and an assumed laboratory temperature of 25ºC.

Nutrient Standards

Na_2SiF_6, the silicate primary standard, was obtained from Johnson Matthey Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Company. The supplier reported purities of 99.999%, 97%, and 99.999%, respectively.

Note:
The nutrients for stations 318-321 were run on frozen samples at the University of Alaska, Fairbanks by Dr. T.E. Whitledge's group. The methods employed are similar to those employed during the cruise and are more fully described in Whitledge et al., 1981. [Whitledge, T.E., S.C. Malloy, C.J. Patton, and C.D. Wirick, Automated Nutrient Analyses in Seawater, Oceanographic Sciences Division, Department of Energy and Environment, Brookhaven National Laboratory, BNL 51398.]. Also, note that the procedure using a sampling rate that produced "flat top" peaks was employed, for these frozen samples as was the case for the samples analyzed at sea.

Bottle Data Footnoting

WHP water bottle quality flags were assigned as defined in the WOCE Operations Manual [Joyce]. These flags and interpretation are tabulated in the Data Distribution, Bottle Data, Quality Flags section of this document.

Data Distribution

The CTD and bottle data can be obtained through NCAR's Earth Observing Laboratory website, www.eol.ucar.edu/projects/sbi. The data are reported using the WHP-Exchange (WOCE Hydrographic Program) format and the quality coding follows those outlined by the WOCE program (Joyce, 1994). In addition, the format can be obtained through the Carbon and CLIVAR Hydrographic Program website, www.cchdo.ucsd.edu. The descriptions in this document have been edited from the reference to annotate the format specific to this data distribution. ASCII files for each station were created with comments recorded on the CTD Station Logs during data acquisition. These ASCII files include data processing comments noting any problems, their resolution, and footnoting that may have occurred. A separate ASCII file was also created with the comments from the Sample Log Sheets that include problems with the Niskin bottles that could compromise the samples. Comments arising from inspection and checking of the data are also included in the ASCII file. These comment files are also in the JOSS database. Raw (unprocessed) CTD data are located in the EOL/JOSS database as well. The file hly0402_ctd_raw.zip contains ssscc.cfg, ssscc.con, ssscc.dat and ssscc.hdr (where sss = station number and cc = cast number) files as acquired by the SeaBird SeaSave acquisition program, sbscan.sum file and calibration information for all sensors. The *.cfg file is datcnv.cfg with the beginning scan number and *.con files may include a correction based on the bottle salinity samples. The sbscan.sum file is a list of stations and beginning scan number. Raw (unprocessed) CTD data are located in the EOL/JOSS database as well. The file hly0303_ctd_raw.zip contains ssscc.cfg, ssscc.con, ssscc.dat and ssscc.hdr (where sss = station number and cc = cast number) files as acquired by the SeaBird SeaSave acquisition program, sbscan.sum file and calibration information for all sensors. The *.cfg file is datcnv.cfg with the beginning scan number and *.con files may include a correction based on the bottle salinity samples. The sbscan.sum file is a list of stations and beginning scan number. Configuration files for the various SeaBird CTD processing programs are also included where applicable.

General rules for WHP-exchange:

1. Each line must end with a carriage return or end-of-line.
2. With the exception of the file type line, lines starting with a "#" character, or including and following a line which reads "END_DATA", each line in the file must have exactly the same number of commas as do all other lines in that file.
3. The name of a quality flag always begins with the name of the parameter with which it is associated, followed by an underscore character, followed by "FLAG", followed by an underscore, and then followed by an alphanumeric character, W.
4. The "missing value" for a data value is always defined as -999, but written in the decimal place format of the parameter in question. For example, a missing salinity would be written -999.0000 or a missing phosphate -999.00.
5. The first four characters of the EXPOCODE are the U.S. National Oceanographic Data Center (NODC) country-ship code, then followed by up to an 8 characters expedition name of cruise number, i.e. 32H1HLY0303.

CTD Data

CTD data was acquired and processed by the Woods Hole Oceanographic Institution (WHOI) Pickard group. WHOI CTD files were reformatted by the Oceanographic Data Facility (ODF) to comply with WHP-Exchange format standards. WHP-Exchange formatted CTD data is located in file 32H1hly0303_ct1.zip. This file contains ssscc_ct1.csv files for each station and cast where sss=3 digit station identifier and cc=2 digit cast identifier.

Description of ssscc_ct1.csv file layout.

1st line — File type, here CTD, followed by a comma and a DATE_TIME stamp

YYYYMMDDdivINSwho

YYYY	4 digit year
MM	2 digit month
DD	2 digit day
div	division of Institution

	INS Institution name
	who initials of responsible person
# lines	A file may include 0-N optional lines at the start of a data file, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history may be included here, for example.
2nd line	NUMBER_HEADERS = n (n = 10 in this table and the example_ct1.csv file.)
3rd line	EXPOCODE = [expocode] The expedition code, assigned by the user.
4th line	SECT_ID = [section] The SBI station specification. *Optional.*
5th line	STNNBR = [station] The originator's station number
6th line	CASTNO = [cast] The originator's cast number
7th line	DATE = [date] Cast date in YYYYMMDD integer format.
8th line	TIME = [time] Cast time that CTD was at the deepest sampling point.
9th line	LATITUDE = [latitude] Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
10th line	LONGITUDE = [longitude] Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude
11th line	DEPTH = [bottom] Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*
next line	Parameter headings.
next line	Units.
data lines	A single _ct1.csv CTD data file will normally contain data lines for one CTD cast.
END_DATA	The line after the last data line must read END_DATA, and be followed by a carriage return or end of line.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Parameter names, units, format, and comments

Parameter	Units	Format	Comments
CTDPRS	DB	F7.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
CTDTMP	ITS-90	F8.3	CTD temperature, degrees C (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDSAL		F8.3	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
CTDOXY	UMOL/KG	F7.1	CTD oxygen, micromoles/kilogram

CTDOXY_FLAG_W		I1	CTDOXY quality flag
STHETA		F8.3	Sigma Theta
STHETA_FLAG_W		I1	Sigma Theta quality flag
XMISS	%TRANS	F7.1	Transmissivity, percent transmittance
XMISS_FLAG_W		I1	XMISS quality flag
FLUOR	ug/L	F8.3	Fluorometer, voltage
FLUOR_FLAG_W		I1	Fluorometer quality flag

Quality Flags

CTD data quality flags were assigned to the CTDTMP (CTD temperature), CTDSAL (CTD salinity) and XMISS (Transmissivity) parameters as follows:

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly bottle data comparisons). The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The CTD data were determined to be unusable.*

5 Not reported. *The CTD data could not be reported, typically when CTD salinity is flagged 3 or 4*.

9 Not sampled. *No operational sensor was present on this cast*

WHP CTD data quality flags were assigned to the FLUOR (Fluorometer) and TURBITY (Turbidity) parameters as follows:

1 Not calibrated. *Data are uncalibrated*.

9 Not sampled. *No operational sensor was present on this cast. Either the sensor cover was left on or the depth rating necessitated removal.*

Bottle Data

Description of 32H1HLY0303_hy1.csv file layout.

1st line File type, here BOTTLE, followed by a comma and a DATE_TIME stamp

YYYYMMDDdivINSwho

YYYY 4 digit year
MM 2 digit month
DD 2 digit day
div division of Institution
INS Institution name
who initials of responsible person

#lines A file may include 0-N optional lines, typically at the start of a data file,

	but after the file type line, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history of the file itself may be included here, for example.
2nd line	Column headings.
3rd line	Units.
data lines	As many data lines may be included in a single file as is convenient for the user, with the proviso that the number and order of parameters, parameter order, headings, units, and commas remain absolutely consistent throughout a single file.
END_DATA	The line after the last data line must read END_DATA.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Header columns

Parameter	Format	Description notes
EXPOCODE	A12	The expedition code, assigned by the user.
SECT_ID	A7	The SBI station specification. *Optional*.
STNNBR	A6	The originator's station number.
CASTNO	I3	The originator's cast number.
BTLNBR	A7	The bottle identification number.
BTLNBR_FLAG_W	I1	BTLNBR quality flag.
DATE	I8	Cast date in YYYYMMDD integer format.
TIME	I4	Cast time (UT) as HHMM
LATITUDE	F8.4	Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
LONGITUDE	F9.4	Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude
DEPTH	I5	Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*

Parameter names, units, and comments:

Parameter	Units	Format	Comments
CTDPRS	DB	F9.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
SAMPNO		A7	Cast number *100+BTLNBR. *Optional*
CTDTMP	ITS-90	F9.4	CTD temperature, degrees C, (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDCOND	MS/CM	F9.4	CTD Conductivity, milliSiemens/centimeter

CTDCOND_FLAG_W		I1	CTDCOND quality flag
CTDSAL		F9.4	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
SALNTY		F9.4	bottle salinity
SALNTY_FLAG_W		I1	SALNTY quality flag
SIGMA	THETA	F9.4	Sigma Theta
SIGMA_FLAG_W		I1	Sigma Theta quality flag
CTDOXY	UMOL/KG	F9.1	CTD oxygen, micromoles/kilogram
CTDOXY_FLAG_W		I1	CTDOXY quality flag
CTDOXY	ML/L	F9.3	CTD oxygen, milliliters/liter
CTDOXY_FLAG_W		I1	CTDOXY quality flag
OXYGEN	UMOL/KG	F9.1	bottle oxygen
OXYGEN_FLAG_W		I1	OXYGEN quality flag
OXYGEN	ML/L	F9.3	bottle oxygen, milliliters/liter
OXYGEN_FLAG_W		I1	OXYGEN quality flag
O2TEMP	DEGC	F6.1	Temperature of water from spigot during oxygen draw, degrees C
O2TEMP_FLAG_W		I1	O2TEMP quality flag
SILCAT	UMOL/KG	F9.2	SILICATE, micromoles/kilogram
SILCAT_FLAG_W		I1	SILCAT quality flag
SILCAT	UMOL/L	F9.2	SILCATE, micromoles/liter
SILCAT_FLAG_W		I1	SILCAT quality flag
NITRAT	UMOL/KG	F9.2	NITRATE, micromoles/kilogram
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRAT	UMOL/L	F9.2	NITRATE, micromoles/liter
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRIT	UMOL/KG	F9.2	NITRITE, micromoles/kilogram
NITRIT_FLAG_W		I1	NITRIT quality flag
NITRIT	UMOL/L	F9.2	NITRITE, micromoles/liter
NITRIT_FLAG_W		I1	NITRIT quality flag
PHSPHT	UMOL/KG	F9.2	PHOSPHATE, micromoles/kilogram
PHSPHT_FLAG_W		I1	PHSPHT quality flag
PHSPHT	UMOL/L	F9.2	PHOSPHATE, micromoles/liter
PHSPHT_FLAG_W		I1	PHSPHT quality flag
FLUORO	VOLTS	F8.3	Fluorometer, voltage
FLUORO_FLAG_W		I1	Fluorometer quality flag
CHLORO	UG/L	F8.2	Chlorophyll, micrograms/liter

CHLORO_FLAG_W		I1	Chlorophyll quality flag
PHAEO	UG/L	F8.2	Phaeophytin, micrograms/liter
PHAEO_FLAG_W		I1	Phaeophytin quality flag
BTL_DEP	METERS	F5.0	bottle depth, meters
BTL_LAT		F8.4	Latitude at time of bottle trip, decimal degrees
BTL_LONG		F9.4	Longitude at time of bottle trip, decimal degrees
JULIAN		F8.4	Julian day and time as fraction of day of the bottle trip.

Quality Flags

CTD data quality flags were assigned to CTDPRS (CTD pressure), CTDTMP (CTD temperature), CTDCOND (CTD Conductivity), and CTDSAL (CTD salinity) as defined in Data Distribution, CTD Data, Quality Flags section of this document. CTDOXY (CTD O_2) and FLUORO (Fluorometer) parameters are flagged with either a 2, acceptable or 9, not drawn.

Bottle quality flags were assigned to the BTLNBR (bottle number) as defined in the WOCE Operations Manual (Joyce and Corry, 1994) with the following additional interpretations:

2 No problems noted.

3 Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a flag of 3 on the bottle and a flag of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*

4 Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a flag of 4. There may be no problems with the associated water sample data.*

9 The samples were not drawn from this bottle.

WHP water sample quality flags were assigned to the water samples using the following criteria:

1 The sample for this measurement was drawn from the water bottle, but the results of the analysis were not (*yet*) received.

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The data did not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also flagged as 4.*

5 Not reported. *The sample was lost, contaminated or rendered unusable.*

9 The sample for this measurement was not drawn.

Not all of the quality flags are necessarily used on this data set.

APPENDIX A: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from SBI Mooring, HLY-03-03. Comments from the Sample Logs and the results of ODF's investigations are included in this report. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e. nutrients). Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, Phosphate and Urea and Ammonium, if appropriate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 004.001
105 SiO3value looks off compared to adjacent stations. No analytical errors noted. Code SiO3 questionable.
Station 010.001
101-105 Autoanalyzer error. Nitrate okay. Code NO2 bad.
Station 011.001
101-105 Autoanalyzer error. Nitrate okay. Code NO2 bad.
Station 012.001
101 Oxygen Analyses: "copepod found in sample." CTD oxygen does not fit profile. Code CTD oxygen and NO2 bad.
101-105 Autoanalyzer error. Nitrate okay. Code NO2 bad.
102 Sample Log: "Bottle noisy (air intake)." Oxygen Analyses: "review-high." CTD oxygen does not fit profile. Code CTD oxygen and NO2 bad.
103 Sample Log: "Bottle noisy (air intake)." Very poor agreement between CTD and bottle
salinity and oxygen. CTD oxygen does not fit profile. Code bottle 3, leaking,
CTD oxygen questionable and samples bad, NO2 bad.
104-105 Very poor agreement between CTD and bottle salinity and oxygen. Code bottle 3,
leaking, and samples questionable, NO2 bad.
Station 013.001
101-106 Autoanalyzer error. Nitrate okay. Code NO2 bad.
Station 014.001
101 CTDand bottle salinity and oxygen comparison, density inversion and nutrient profile
indicate mis-trip. Code bottle 3, leaking, samples bad.
Station 016.001
103 CTDcomparison with bottle salinity and oxygen indicates poor bottle flushing. Leave as is per DQE.
Station 020.001
101-105 Oxygen not drawn per sampling strategy.
Station 021.001
101-104 No oxygen drawn per sampling strategy.

Station 022.001
101 CTDcomparison with bottle salinity and oxygen, density inversion and nutrient profile
indicate poor bottle flushing. Leave as is per DQE.
Station 024.001
102 Oxygennot drawn per sampling strategy.
104 Oxygennot drawn per sampling strategy.
106 Oxygennot drawn per sampling strategy.
107 SampleLog: "Erratic flow during sampling."
108 Oxygennot drawn per sampling strategy.
Station 025.001
102 Oxygennot drawn per sampling strategy.
103 SiO3 does not fit adjacent stations. No analytical errors noted. Code SiO3 questionable.
104 Oxygennot drawn per sampling strategy.
104-106 CTD comparison with bottle salinity and oxygen comparison indicates poor bottle
flushing. Leave as is per DQE.
106 Oxygennot drawn per sampling strategy.
108 Oxygennot drawn per sampling strategy.
110 Oxygennot drawn per sampling strategy.
Station 026.001
101 CTD comparison with bottle salinity and oxygen and significant density inversion indicates poor bottle flushing. Leave as is per DQE.
105 Salinity and oxygen not drawn per sampling strategy.
107 Salinity and oxygen not drawn per sampling strategy.
108 Salinity not drawn per sampling strategy.
Station 027.001
102 Salinity and oxygen not drawn per sampling strategy.
104 Salinity and oxygen not drawn per sampling strategy.
106 Salinity not drawn per sampling strategy.
108 Salinity and oxygen not drawn per sampling strategy.
Station 028.001
101 SampleLog: "Bottle did not trip, lanyard on wrong latch."
103 Salinity and oxygen not drawn per sampling strategy.
105 Salinity and oxygen not drawn per sampling strategy.
107 Salinity not drawn per sampling strategy.
108 CTDcomparison with bottle salinity and oxygen indicates poor bottle flushing. Leave as is per DQE.
109 Oxygennot drawn per sampling strategy.
Station 029.001
101 Salinity not drawn per sampling strategy.
102 Salinity and oxygen not drawn per sampling strategy.
108 Salinity and oxygen not drawn per sampling strategy.
Station 031.001
101 SampleLog: "No water for salinity."

102 SampleLog: "No water for salinity." No water samples were taken.
Cast 1 Sample Log: "Duplicate bottles were tripped, bottles 2, 4, 6, 8 and 10, with 1, 3, 5, 7
and 9, respectively, no samples were taken except salinity."

Station 034.001

105-106 Oxygen not drawn per sampling strategy.

Station 035.001

105-106 Oxygen not drawn per sampling strategy.

Station 036.001

101 Salinity about 5 units low. No notes or problems during analyses. Footnote salinity bad. Oxygen: "Overtitrate and backtitrate."
105-106 Oxygen not drawn per sampling strategy.
107 Salinity and oxygen not drawn per sampling strategy.

Station 037.001

102 Oxygennot drawn per sampling strategy.
103 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
104 Oxygennot drawn per sampling strategy.
107 Salinity, oxygen and nutrients not drawn per sampling strategy.

Station 038.001

101 Oxygennot drawn per sampling strategy.
106 Oxygennot drawn per sampling strategy.

Station 039.001

102 Oxygen not drawn per sampling strategy. CTD comparison with bottle salinity indicates
poor bottle flushing. Leave as is per DQE.
104 Oxygennot drawn per sampling strategy.

Station 040.001

102 Oxygennot drawn per sampling strategy.
105 Oxygennot drawn per sampling strategy.
106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.

Station 041.001

102 Oxygennot drawn per sampling strategy.
103 Oxygen: "Trouble with sample flask 638. Voltage at 0.71xx at 0.6ml add-addition continued to 1.3ml-aborted sample. Suspect new sample draw person did 2ml add of MnCl. Oxygen not reported.
104 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
105 Oxygennot drawn per sampling strategy.

Station 042.001

105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.

Station 043.001

105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.

Station 044.001
105-106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per
DQE.
Station 046.001
102 CTDcomparison with bottle salinity and oxygen indicates poor bottle flushing. Leave as is per DQE.
Station 047.001
102 Oxygen not drawn per sampling strategy. CTD and bottle salt comparison indicates poor bottle flushing.
104 Oxygennot drawn per sampling strategy.
105-106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per
DQE.
Station 048.001
101 Nutrients sampled, but not analyzed. No notes as to what happened. Code nutrients not reported.
104-105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per
DQE.
105-106 Oxygen not drawn per sampling strategy.
Station 049.001
101-104 Sample Log: "Vent open." No oxygen drawn.
106 Oxygennot drawn per sampling schedule.
Station 052.001
101 CTDcomparison with bottle salinity and oxygen and density inversion indicates poor bottle flushing. Leave as is per DQE.
105 Oxygennot drawn per sampling strategy.
Station 054.001
101 CTDcomparison with bottle salinity and oxygen and density inversion indicate poor bottle flushing. Leave as is per DQE.
102 Oxygennot drawn per sampling strategy.
Station 056.001
101 CTDcomparison with bottle salinity and oxygen and density inversion indicates poor bottle flushing. Leave as is per DQE.
101-103 Sample Log: "Bottom three bottles, homogenous layer."
102 Oxygennot drawn per sampling strategy.
Station 059.001
101 Bottle tripped, but no samples taken per sampling strategy.
Station 094.001
101 CTD comparison with bottle salinity indicate poor bottle flushing. Leave as is per DQE.
Station 097.001
101 CTDcomparison with bottle salinity and oxygen, density inversion and nutrient profile
indicate mis-trip. Code bottle 3, leaking, samples bad.

Station 099.001
103-105 Sample Log: "No O2 samples were taken, vents were open."
Station 102.001
104 Salinity was not drawn, this appears to be a sampling error. Code salinity not drawn.
Station 104.001
101 CTDcomparison with bottle salinity and oxygen and density inversion indicate poor bottle flushing. Leave as is per DQE.
Station 106.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
104 Salinity not drawn per sampling strategy.
Station 107.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
Cast 1 Sample Log: "O2 sample draw delayed ˜10 minutes from on deck time."
Station 108.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
Station 109.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
Station 110.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
102 CTDcomparison with bottle salinity and oxygen indicate poor bottle flushing. Leave as is per DQE.
Station 111.001
101-104 Large drift during course of run. Nitrate okay. Code NO2 bad.
Station 114.001
114 CTDcomparison with bottle salinity and oxygen, density inversion and nutrient profile
indicate poor bottle flushing. Leave as is per DQE.
Station 116.001
101-103 Sample Log: "Comment on 117 Sample Log-O2 samples possibly had the MnCl2 up
to 2 on dispenser."
103 SampleLog: "Nutrient sampled after salinity."
Station 117.001
101 SampleLog: "Suspect too much MnCl2 for O2." Code oxygen not reported.
Station 119.001
101-110 Oxygen and nutrients not drawn.
111-116 Does not appear to be any samples taken.
Station 120.001
101-110 Oxygen and nutrients not drawn.
109-110 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per
DQE.
Station 122.001
101-110 Oxygen and nutrients not drawn.
111-112 Appears that samples were not drawn.
Station 123.001

101-110 Oxygen and nutrients not drawn.
106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
109 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
111-113 Appears that samples were not drawn.
Cast 1 Sample log sheet missing for station 123.

Station 124.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 125.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 126.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 127.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 128.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 144.001

101-114 Bottles tripped, but no samples taken per sampling strategy.

Station 145.001

101-110 Bottles tripped, but no samples taken per sampling strategy.

Station 146.001

101-110 Bottles tripped, but no samples taken per sampling strategy.

Station 172.001

101-106 Bottles tripped, but no samples taken per sampling strategy.

Station 174.001

101-113 Bottles tripped, but no samples taken per sampling strategy.

Station 175.001

101-102 Bottles tripped, but no samples taken per sampling strategy.

Station 190.001

101-106 Bottles tripped, but no samples taken per sampling strategy.

Station 193.001

101-110 Bottles tripped, but no samples taken per sampling strategy.

Station 195.001

101-105 Oxygen and nutrients not drawn per sampling strategy.
106-109 Bottles tripped, but no samples taken per sampling strategy.

Station 210.001

101 CTDcomparison with bottle salinity and oxygen indicates poor bottle flushing. Leave as is per DQE.

Station 212.001

101 Oxygen: "Overtitrate and backtitrate." Oxygen value impossible, code oxygen not reported.
101-104 Sample Log: "All samples suspect due to suspended particles." Autoanalyzer error.
Nitrite (NO2) errors possibly large enough to affect Nitrate (NO3). Code NO3 questionable,

NO2 bad.
104 Oxygen drawn but not analyzed, no end point after 1.2ml thio added, sample aborted, suspended silt. Code oxygen not reported.
Station 213.001
101-104 Sample Log: "Nutrient and Oxygen samples suspect due to suspended particles." Autoanalyzer error. Nitrite (NO2) errors possibly large enough to affect Nitrate (NO3). Code NO3 questionable, NO2 bad.
103-104 Oxygen: "Overtitrate and backtitrate." Impossible oxygen values, code oxygen lost.
Station 214.001
101-104 Autoanalyzer error. Nitrite (NO2) errors possibly large enough to affect Nitrate (NO3). Code NO3 questionable, NO2 bad.
Station 215.001
101-105 Autoanalyzer error. Nitrite (NO2) errors possibly large enough to affect Nitrate (NO3). Code NO3 questionable, NO2 bad.
Station 216.001
101-107 Autoanalyzer error. Nitrite (NO2) errors possibly large enough to affect Nitrate (NO3). Code NO3 questionable, NO2 bad.
Station 217.001
104 CTD comparison with bottle salinity indicates poor bottle flushing (offset >5 m). Leave as is per DQE.
105 CTD comparison with bottle salinity indicates poor bottle flushing (offset >5 m). Leave as is per DQE.
108 CTD comparison with bottle salinity indicates poor bottle flushing (offset >5 m). Leave as is per DQE.
Station 218.001
107 Salinity appears to have been drawn from bottle 8. Code salinity bad.
111 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 219.001
107 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
109 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
113 Poorfit between CTD and bottle salinity and oxygen indicates mis-trip. Code bottle 3,
leaking, samples bad.
Station 220.001
111 CTD comparison with bottle salinity and oxygen indicates mis-trip. Code bottle 3, leaking, samples bad.
Station 222.001
107-111 CTD comparison with bottle salinity and oxygen indicates poor bottle flushing. Leave
as is per DQE.
Station 223.001
101 Nutrients not drawn per sampling strategy.

112 Salinity notes indicate that there was a bottle tripping problem on 12 as well as 13. However, all other samples were taken except salinity. Sample log sheet also indicates that salinity was not drawn from bottle 12.
113 SampleLog: "Did not trip, it tripped while sampling."
Station 224.001
105 Salinity: "Sampling error, no sample."
109 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
111 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 225.001
115-111 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per
DQE.
117 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 226.001
110 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
112 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
115 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 249.001
101 Questionable salinity value at this level causing density inversion. Code salinity questionable.
Station 263.001
101-102 Autoanalyzer error. Nitrate okay. Code NO2 bad.
Station 266.001
101-102 Autoanalyzer error. Nitrate okay. Code NO2 bad.
Station 267.001
104 Oxygennot drawn per sampling strategy.
Station 268.001
103 Oxygennot drawn per sampling strategy.
105 Oxygennot drawn per sampling strategy.
Station 269.001
102 Oxygennot drawn per sampling strategy.
104 Oxygennot drawn per sampling strategy.
109 Sample Log: "Came up with bottom endcaps closed (loose Springs). There were no samples nor bottles tripped so this is a maintenance issue, that may have effected earlier station’s samples.
114 Sample Log: "Came up with bottom endcaps closed (loose Springs). There were no samples nor bottles tripped so this is a maintenance issue, that may have effected earlier station’s samples.
Station 270.001
102 Oxygennot drawn per sampling strategy.

104 Oxygennot drawn per sampling strategy.
106 Oxygennot drawn per sampling strategy.
108-111 Sample log indicates no samples, yet CTD trip information has a level and the bottles
were tripped at the same depth as 7.

Station 271.001

102 Oxygennot drawn per sampling strategy.
104 Oxygennot drawn per sampling strategy.
106 Oxygennot drawn per sampling strategy.

Station 272.001

102 Oxygennot drawn per sampling strategy.
104 Oxygennot drawn per sampling strategy.

Station 273.001

102 Oxygennot drawn per sampling strategy.
104 Oxygennot drawn per sampling strategy.

Station 274.001

104 Oxygennot drawn per sampling strategy.
107 Oxygennot drawn per sampling strategy.

Station 275.001

102 Nooxygen drawn per sampling strategy.
107 Nooxygen drawn per sampling strategy.

Station 276.001

101-102 Sample Log: "Duplicate trip with 3 as blanks for nutrients and O2." No samples drawn per sampling strategy.

Station 277.001

105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
108-109 Oxygen not drawn per sampling strategy.

Station 278.001

102 Oxygennot drawn per sampling strategy.
105 Oxygennot drawn per sampling strategy.
107 Oxygennot drawn per sampling strategy.
109 Oxygennot drawn per sampling strategy.
111 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.

Station 279.001

105 Oxygennot drawn per sampling strategy.
107 Oxygennot drawn per sampling strategy.
108 Oxygennot drawn per sampling strategy.
110 Oxygennot drawn per sampling strategy.

Station 280.001

101-106 Salinity, oxygen and nutrients not drawn per sampling strategy.
107-112 Oxygen not drawn per sampling strategy.

Station 282.001

106 Oxygennot drawn per sampling strategy.
110 Oxygennot drawn per sampling strategy.

113 Bottle tripped in air or too close to surface. No samples drawn.
Station 283.001
106-108 CTD comparison with bottle salinity indicates poor bottle flushing. Code salinity questionable.
111 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 284.001
101 OxygenAnalyses: "No water seal."
102 OxygenAnalyses: "No water seal."
110 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 289.001
103 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 291.001
103 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 293.001
103 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
105 Sample log indicates no samples from bottle 5, yet CTD trip information has a level which indicates that the bottle may have tripped on deck.
Station 296.001
103 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 298.001
101-104 Nutrients not drawn per sampling strategy.
106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
111 Nutrients not drawn per sampling strategy.
Station 299.001
105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 300.001
104 Nosamples per sampling strategy.
Station 301.001
105 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 302.001
106 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.
Station 308.001
101 Salinity was not analyzed, no notes indicating a problem. Code salinity and oxygen not reported.
101-106 Sample Log: "All O2 lost-bad reagent addition during sampling." Code oxygen not

reported.
Cast 1 Oxygen: "Sampling reagent add errors affect several casts. Note indicates that on Station
313 MnCl dispenser was found set on 0 ml, but still got reagent from bottle.
Sampler reset Wheaton dispenser so 1 was visible in the window. After sampling cast, water sampler noted the dial on the MnCl was set at 0.55. The chemist reset the MnCl dispenser to 1.0ml add. Result-Station 313 samples have 1.55ml of MnCL2 and 1.0ml NaOH/NaI. Casts prior to 313 have only 0.55ml of MnCl2 and 1.0ml of NaOh/NaI. Visual inspection of settle indicates problem probably began at Station 308."

Station 309.001

101-106 Sample Log: "All O2 lost-bad reagent addition during sampling." See separate note
regarding oxygen dispenser, Station 308-313."
104 CTD comparison with bottle salinity indicates poor bottle flushing. Leave as is per DQE.

Station 310.001

101 CTD and bottle data comparison indicates bad salinity sample. Code salinity bad, oxygen questionable.
101-106 See separate note regarding oxygen dispenser, Station 308-313. Code oxygen questionable.

Station 311.001

101 CTD and bottle data comparison indicates bad salinity sample. Code salinity bad, oxygen questionable.
101-102 See separate note regarding oxygen dispenser, Station 308-313." Code oxygen questionable.
103 SampleLog: "Bottom endcap did not close properly; no samples drawn."
104-106 See separate note regarding oxygen dispenser, Station 308-313." Code oxygen questionable.

Station 312.001

101 No samples, appears that bottle was tripped shallower than the bottom of the cast. Reporting CTD data, temperature, salinity and oxygen since it is available.
102-105 See separate note regarding oxygen dispenser, Station 308-313." Code oxygen questionable.

Station 313.001

101 CTD comparison with bottle salinity indicates poor bottle flushing. Code oxygen questionable other data leave as is per DQE.
101-104 See separate note regarding oxygen dispenser, Station 308-313." Code oxygen questionable.

Station 316.001

101-103 Oxygen not drawn per sampling strategy.

Station 317.001

101-103 Oxygen and salinity not drawn per sampling strategy. Could not check for improper
flushing.
Cast 1 Frozen nutrient samples run by T.E. Whitledge Univ. Alaska Fairbanks.

Station 318.001

101-104 Salinity and oxygen not drawn per sampling strategy. Could not check for improper
flushing.
Cast 1 Frozen nutrient samples run by T.E. Whitledge Univ. Alaska Fairbanks.

Station 319.001

101-104 Salinity and oxygen not drawn per sampling strategy. Could not check for improper
flushing.
Cast 1 Frozen nutrient samples run by T.E. Whitledge Univ. Alaska Fairbanks.

Station 320.001

101-104 Salinity and oxygen not drawn per sampling strategy. Could not check for improper
flushing.
Cast 1 Frozen nutrient samples run by T.E. Whitledge Univ. Alaska Fairbanks.

Station 321.001

101-104 Oxygen and salinity not drawn per sampling strategy. Could not check for improper
flushing.
Cast 1 Frozen nutrient samples run by T.E. Whitledge Univ. Alaska Fairbanks.

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