CSS DAWSON CRUISE 90-030

NOVEMBER 14 - NOVEMBER 26, 1990

R. R. LIVELY

Department of Fisheries and Oceans

Physical and Chemical Sciences Branch

Scotia-Fundy Region

Bedford Institute of Oceanography

Dartmouth, N.S. B2Y 4A2

Canada

Cruise Particulars

Cruise Number:	90-030
Vessel:	CSS Dawson
Dates:	November 14-26, 1990
Area:	Gulf of St. Lawrence
Responsible Agency:	Dept. of Fisheries and Oceans
	Physical and Chemical Sciences Branch
	Scotia-Fundy Region
	Bedford Institute of Oceanography
Ship's Master:	Captain R. Heath
Senior Scientist:	R. Lively (PCS)
Scientific Personnel:	L. Bellefontaine (PCS)
	G. Bugden (PCS)
	R. Ryan (PCS)
	M. D. Scotney (PCS)

Purpose

1. Obtain temperature-salinity soundings from 77 stations in the Gulf of St. Lawrence for preparation of seasonal ice predictions by the Ice Climatology Branch of the Atmospheric Environment Service.

2. Acquire dissolved oxygen and nutrient data from these 77 stations in aid of ongoing PCS climatological studies.

3. Acquire phytoplankton data from selected stations (45 in all) to aid J. C. Smith's (Biological Services Branch, Gulf Region) studies in the area.

4. Deploy an Atmospheric Platform (*PADIRT mooring)* on the LaHave Basin near the Minimet mooring array to help Metrology Division calibrate the Atmospheric Platform.

<u>Precruise Obstacles</u>

Due to operational problems with the Atmospheric Platform and not being able correct these problems before the Dawson's sailing date, the deployment of the platform was deleted from the cruise itinerary.

The Dawson's new Hawbolt CTD winch overheated and seized while doing a CTD station on the previous cruise. As a result the CTD had to be brought aboard by the use of the capstan and the cruise was called to an end. The Dawson then returned to the Bedford Institute for repairs to the winch and preparation for the Ice Forecast Cruise (90-030). The first prediction for repairs for the Hawbolt CTD winch was mid-day on November 14 thus delaying the sailing time by 6 hours. On November 14 it was estimated that at least another day would be required to repair the winch, this was due to the problem of salt water (used as a coolant for the winch) leaking into the hydraulic lines, as a result all the lines had to be flushed out. This meant the sailing time was now delayed to mid-day on November 15, as a result an extension of 1 day for the cruise was requested and granted. Repairs actually finished at approximately 17:00 and the ship sailed at 18:00 November 15 for a test station in the Bedford Basin. During the test station the winch overheated and seized again, the CTD had to be recovered using the capstan (by hand). Dawson returned to BIO wharf and a decision was made to replace the Hawbolt winch with an old Swan 50 hp winch. While along side the wharf John O'Niell was requested to fix a minor software problem with the shipboard data acquisition system. Since the Swan winch was dismantled from the Hudson some time ago, it was in need of repairs and a retired CTD cable had to be resurrected and respooled on the winch. The winch had to welded to the Dawson's deck, fitted with slip-rings and a cable splice had to be made for the CTD.

Sailed for test station in the Bedford Basin at 22:03 November 16, started the station at 22:20 and at 22:30 there were three major power failures on the ship causing the computer to fail (see computer report section). Over-tiredness and trying to bring the computer back up in a hurry caused the problem of the acquisition system not being able to log data. After three phone calls to John O'Niell a decision was made to go back to the wharf and pick him up to solve the problem. The problem was solved (without knowing how) before John was picked up. Once John came aboard the ship returned to the basin test station. John explained the one in a million chance of getting into that problem and how to get out of it. Finished the test station at 02:40 on November 17,dropped John off at BIO wharf at 03:00 and proceeded to the Gulf of St. Lawrence CTD stations. Thus the cruise was delayed approximately 2.5 days.

Operation and Nature of Data Gathered

CTD Stations

Strong winds during the cruise and the precruise delay of approximately 2.5 days caused the intended 77 CTD stations (Table 1, Fig. 1)to be reduced to 54 CTD stations (Table 2, Fig. 2). Even with the 1 day extension there was not enough time to do all of the stations. Since the 54 stations completed were the main stay of the Ice Forecast Cruise, the cruise was considered a success.

CTD-Rosette

Temperature and salinity profiles were obtained at all stations using a Guildline Digital CTD (S/N47956, P sensor S/N47718, T sensor S/N44494, C sensor S/N57029). The instrument also included a BIO refurbished oxygen sensor. A rosette sampler fitted with 1.7 liter bottles was used with the CTD to collect water samples at several depths at each station for dissolved oxygen, and nutrient analysis. Samples were drawn at specified stations from the surface bottle only for phytoplankton analysis, except at station 5 where 3 samples (surface, mid-depth and bottom) were drawn. Nutrient samples were frozen for later analysis and the phytoplankton samples were kept in a cool lab for later analysis. Oxygen samples were processed during the cruise using the new *Automated* oxygen titration system. One rosette bottle (deepest bottle) was fitted with a digital reversing thermometer between a pair of mercury reversing thermometers for CTD temperature calibration. Two salinity samples for CTD conductivity calibration were also drawn from this bottle. One salinity sample was analyzed during the cruise using a Guildline Autosal Salinometer and the duplicate salinity sample was retained for analysis upon return to BIO. Data were logged, processed and displayed using a MicroVax II computer system.

The temperature channel performed well and appeared to be accurate when compared to both the digital and mercury reversing thermometers (Table 3). The mean offset between the averaged reversing thermometers and the CTD was 0.002°C with a standard deviation of 0.006°C over 40 values. A more detailed view of the thermometers indicate that the mean offset between the mercury reversing thermometers and the CTD was 0.004°C with a standard deviation of 0.007°C over 40 values, while the digital reversing thermometers and the CTD had a mean offset -0.001°C with a standard deviation of 0.005°C over 30 values. A comparison between the digital and the mercury thermometers indicated a mean offset of 0.005°C with a standard deviation of 0.005°C over 38 values. The mercury thermometers used had ice point determinations done in January 1990, these values were used within Coastal's *Bottle System* to calculate the corrected thermometer readings. Since both the digital and mercury thermometers compared well with each other and the CTD, some confidence in our measurement of this parameter was felt.

The salinity (conductivity) channel performed below an anticipated standard. An apparent offset of approximately 0.057°/oo with a standard deviation of 0.013°/oo over 36 values between the Autosal salinometer and the CTD (Table 4) was found to exist. This seemed a little high because during the previous cruise the offset was 0.009°/oo with a standard deviation of 0.003°/oo over 81 values. Some of the salinity samples drawn may have been faulty because of the rain mixing with the sample before it was capped, also a problem existed with one of the Autosal's heater bulbs being burnt out while analyzing samples 79538 to 79606. Results from suspect samples were not used when generating the above salinity offset. After the duplicate salinities are processed at BIO it will be known if the Autosal Salinometer was faulty or if the CTD's conductivity sensor has problems. Noise problems with the CTD cable on the up traces for the last 6 CTD stations made calibrations for these stations impossible. There was a problem with the median routine in the PCS data acquisition system (see computer report) which caused the processed ascii file to be rougher than the real time data. This problem could affect the generated ascii bottle file, thus giving erroneous calibration points. A further study of the above possibilities at BIO will indicate which problem or combination of problems existed with the salinity channel.

The pressure sensor offset for the up trace drifted from the down trace due to warming of the probes electronics. An offset of -2.8 dbars with a standard deviation of 1.7 dbars over 42 values was detected for the down trace, while an offset of -1.6 dbars with a standard deviation of 1.7 dbars over 43 values was detected for the up trace (Table 5). The way to avoid the drift between the up and down trace would be to wait longer at the surface, but when the cruise is pressed for time this is not always possible.

Four different oxygen sensors were used during the cruise, sensor 1 worked for the test station in the Bedford basin, but had to be replaced for station 1 (see equipment malfunctions), sensor 5 was used for stations 1 to 11, sensor 4 was used for stations 12 to 13and 48 to 49, sensor 7 was used for stations 14 to 47 and 50 to 54 (Table 6). Sensor 5 had an offset of -0.66 ml/l with a standard deviation of 0.28 ml/l over 7 values, Sensor 4 had an offset of 0.38 ml/l with a standard deviation of 0.079 ml/l over 2 values, Sensor 7 had an offset of 0.53 ml/l with a standard deviation of 0.27 ml/l over 34 values. The *Automated O2 Titration System* worked well for most of the cruise.

A decimated temperature and salinity profile data set (after suitable corrections) was sent to Ice Central and to MEDS immediately after the cruise.

Computer Report

MicroVax II and the Shipboard Data Acquisition System

While trying to log Loran and CTD data during the test station in the Bedford Basin the ship experienced three major black outs within minutes of each other, thus causing the MicroVax II computer system to go down. Since the cruise was pressed for time, the system was brought back up in a hurry, not using the normal procedures. As a result the data acquisition system could not recognize the cruise number, therefore the logger could not log data causing the acquisition system to go into the break routine. The only way to get out of this routine when no data is being logged is to hit ctrl Y. Every time the logger command was invoked the above procedures would happen. At this point it was felt necessary to call John O'Niell for help. John gave several suggestions over the phone, but the commands given would not work in the CRUISE account, the next step was to try them in the PCSLIB account, still without any success. A decision was made to go pick John up at the wharf so he could see the problem for himself. While proceeding to the wharf to pick up John the logger was tried again in the CRUISE account,this time it worked. Once aboard John explained the problem and said the probable chance of this situation happening was one in a million. While configuring the acquisition system the CRUISE account was logged on. This was done before the system had a chance to configure the cruise number, thus causing the logger command (when invoked in the CRUISE account) not to recognize the cruise number. The simple way to solve the problem is to logout of the CRUISE account and back on again, this will let CRUISE recognize all of the configured elements in PCSLIB. Start up procedures are there for a reason and should be followed at all times without trying to take short-cuts. This has been a lesson well learned and never to be forgotten. The MicroVax and the Shipboard Data Acquisition System seemed to have worked well for the rest of the cruise, but it should be noted that the processed data appears to have more noise at times than the real time data. A problem with the median routine in the Data Acquisition System was the source of the induced noise in the processed salinity data. It caused the salinity time sequence to be different than the time sequences of the other processed channels, thus inducing errors into the ascii files. This would also affect the ascii bottle file, giving bad calibration values. The ascii bottle file will have to be regenerated and a new set of salinity calibrations will have to be calculated.

Software Development

Some changes had to be made to the thermometer correction program within Coastal Oceanography's version of the *Bottle System*. A bug was found in the thermometer correction program causing the wrong correction being made to the reversing thermometers. The bug was detected and corrected by G.Bugden.

Equipment Malfunctions

CTD-System

Problems were encountered with the sliprings at Station 38. Water had intruded into the slipring connector from the cable drum. This connector was cleaned and resealed. A further problem occurred with the mating of this connector to the slipring assembly. The alignment of pins to sockets was faulty, forcing the data contact against the ground contact. This was overcome with careful realignment of the contacts. During the latter part of the cruise (stations 47 to 54) the CTD data became increasingly noisy. Electrical checks of the cable showed that it was operating within acceptable parameters. The fact that this noise was occurring mostly during the up-cast, when tension was applied, indicates that there may be some deterioration of this cable. A suggestion has been made that from 100 to 400 meters of cable be cut from the end of this spool.

Metering Block System

The Winch display's 'Sonalert' gave a steady output during the Basin Trials. This component was replaced. The entire system worked well for the remainder of the cruise.

Oxygen Sensors

Some problems were encountered in obtaining a working Oxygen Sensor, during the early part of the cruise. Sensor #1 worked for the Basin test station only, sensor #5 was used for stations 1 through 11, sensor #4 was used for stations 12 to 13 and 48 to 49, sensor #7 was used for stations 14 through 47 and 50 through 54. Sensors 1,5,4 all seemed to develop water or air bubbles in the chamber containing the oil. Sensor #7 was the only sensor to work properly for all the stations where it was used.

Autosal Salinometer

After the salinity samples were analyzed for stations 8 through 17 it became apparent that there was something wrong with the results. The Autosal was checked, which revealed a heater bulb was burnt out. This caused the Autosal's bath not to warm up properly. The bulb was replaced and the results of further samples seemed better. However there was still some question if the Autosal was working properly. Once the duplicate salinity samples are run at BIO, the results will indicate if there is still a problem with the Autosal.

Raytheon Sounder

The sounder stopped printing during station 13,this was due to a broken stylus and a re-rolled roll of paper had been installed on the sounder. A new roll of paper was installed and the stylus replaced.

CTD Sensor Heater

The heating cable for the sensor heater burnt out and was not repairable. *These heaters should be plugged into a GROUND FAULT INDICATOR OUTLET while at sea for safety reasons!*

Automated Oxygen Titration System

Crystals formed on the end point sensor during some of the later stations. The sensor was cleaned and it remained clean for the rest of the cruise. Near the end of the cruise the transmittance on the colorimeter could not be regulated to 100 %, this did not seem to hamper the sensor from finding the end point. When the equipment get back to BIO tests will be made to determine if the end points were correct.

Acknowledgements

I would like to sincerely thank the Captain, officers and crew of the

CSS Dawson for their cooperation and skill which helped to make the cruise a success. I also would like to thank the scientific staff for the diligent application of their skills, specially during the precruise problems. Special thanks to John O'Niell for his help at such late hours of the night and to Bill Moore and all those involved in replacing the Dawson's CTD winch in such a short span of time.

TABLE 1

Intended Ice Forecast

Station Positions

Station#	Latitude	Longitude
1	45°56.0'N	62°00.0'W
2	46°02.0'N	62°00.0'W
3	46°08.0'N	62°00.0'W
4	46°14.0'N	62°00.0'W
5	46°20.0'N	62°00.0'W
6	46°46.5'N	62°03.0'W
7	47°09.5'N	63°09.5'W
8	47°49.5'N	62°49.0'W
9	48°19.5'N	63°09.5'W
10	48°20.0'N	62°28.0'W
11	48°27.0'N	62°25.0'W
12	48°34.0'N	62°22.0'W
13	48°41.0'N	62°19.0'W
14	48°48.0'N	62°16.0'W
15	48°55.0'N	62°13.0'W
16	48°56.5'N	63°04.0'W
17	49°09.5'N	63°52.0'W
18	49°39.0'N	64°24.5'W
19	49°31.0'N	64°30.0'W
20	49°24.0'N	64°40.0'W
21	49°18.0'N	64°43.5'W
22	49°12.0'N	64°49.0'W
23	49°25.0'N	65°36.0'W

TABLE 1 (continued)

Station#	Latitude	Longitude
24	49°14.5'N	66°18.5'W
25	49°24.5'N	66°18.5'W
26	49°34.0'N	66°18.5'W
27	49°40.0'N	66°18.5'W
28	49°48.0'N	66°18.5'W
29	49°54.5'N	66°18.5'W
30	50°02.0'N	66°18.5'W
31	50°02.5'N	64°04.0'W
32	49°45.0'N	61°49.0'W
33	50°05.0'N	59°55.0'W
34	49°50.0'N	59°25.0'W
35	49°34.5'N	58°51.0'W
36	49°19.5'N	58°31.0'W
37	49°07.0'N	60°00.0'W
38	48°55.0'N	61°40.0'W
39	48°06.0'N	61°44.0'W
40	48°12.0'N	61°37.5'W
41	48°18.0'N	61°31.0'W
42	48°23.5'N	61°24.0'W
43	48°30.0'N	61°18.0'W
44	48°36.0'N	61°11.0'W
45	48°42.0'N	61°04.5'W
46	48°47.5'N	60°58.5'W
47	48°53.5'N	60°51.5'W
48	48°21.5'N	60°39.0'W
49	47°40.0'N	60°41.5'W

TABLE 1 (continued)

Station#	Latitude	Longitude
50	47°46.0'N	60°34.0'W
51	47°51.5'N	60°27.5'W
52	47°58.0'N	60°20.0'W
53	48°03.5'N	60°13.5'W
54	48°09.0'N	60°06.5'W
55	48°15.0'N	59°59.5'W
56	48°20.5'N	59°52.5'W
57	48°26.5'N	59°45.5'W
58	48°32.5'N	59°38.5'W
59	48°00.0'N	59°30.0'W
60	47°35.0'N	59°20.0'W
61	47°30.0'N	59°28.0'W
62	47°25.5'N	59°35.5'W
63	47°18.0'N	59°44.0'W
64	47°13.0'N	59°49.0'W
65	47°09.0'N	59°54.0'W
66	47°04.0'N	60°00.0'W
67	46°55.0'N	60°10.5'W
68	46°12.8'N	57°10.0'W
69	46°08.4'N	57°15.5'W
70	46°04.0'N	57°21.0'W
71	45°59.6'N	57°26.5'W
72	45°55.3'N	57°32.0'W
73	45°50.9'N	57°37.5'W
74	45°46.5'N	57°43.0'W
75	45°42.1'N	57°48.5'W

TABLE 1 (continued)

Station#	Latitude	Longitude
76	45°37.7'N	57°54.0'W
77	45°33.3'N	57°59.5'W

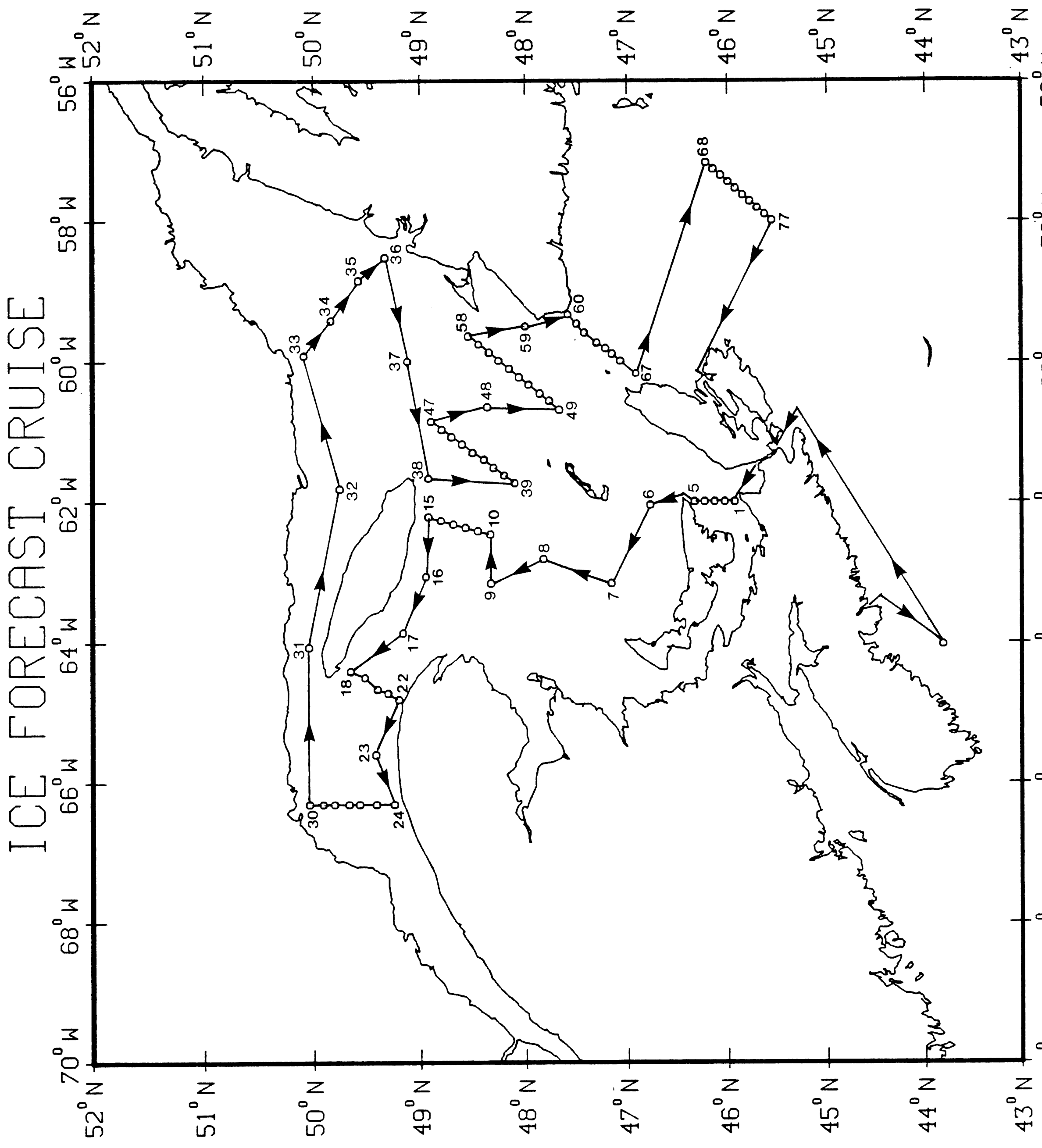

Figure 1: Intended CTD Stations

TABLE 2

Actual Ice Forecast

Station Positions

Station (#)	Latitude (N)	Longitude (W)	Depth (M)	Date	Time (Z)	Oxy. *	Nutr. **	Phytop. ***	Sal. ****
1	45°56.60	62°00.28	43	18/11/90	05:02	0	0	0	0
@ 1	45°56.70	61°59.70	43	18/11/90	05:48	2	4	0	0
2	46°02.50	62°00.00	46	18/11/90	06:56	4	6	0	2
3	46°08.00	61°59.98	42	18/11/90	08:02	4	6	0	2
4	46°14.03	62°00.05	42	18/11/90	09:04	4	6	0	2
5	46°19.98	62°00.14	38	18/11/90	10:11	4	6	3	2
6	46°46.00	62°02.98	69	18/11/90	13:42	5	8	1	2
7	47°10.14	63°09.59	62	18/11/90	19:55	5	8	1	2
8	47°50.21	62°49.27	72	19/11/90	05:59	6	8	1	2
9	48°19.43	63°08.75	55	19/11/90	11:33	4	6	1	2
10	48°20.26	62°28.00	159	19/11/90	15:52	8	12	1	2
11	48°27.75	62°25.49	385	19/11/90	18:06	12	20	1	2
12	48°34.04	62°22.13	398	19/11/90	20:52	12	20	1	2
13	48°40.97	62°19.10	407	19/11/90	23:39	12	20	1	2
14	48°47.87	62°15.84	350	20/11/90	02:01	12	20	1	2
15	48°55.28	62°13.09	235	20/11/90	03:52	10	16	1	2
16	48°56.48	63°03.78	402	20/11/90	08:08	12	20	1	2
17	49°09.47	63°51.97	383	20/11/90	12:45	12	20	1	2
18	49°39.67	64°25.30	190	20/11/90	17:32	9	14	1	2
19	49°31.53	64°30.57	304	20/11/90	19:15	11	18	1	2
20	49°24.02	64°39.77	379	20/11/90	21:05	12	20	1	2
21	49°18.11	64°43.33	372	20/11/90	22:42	12	20	1	2

TABLE 2 (continued)

Station (#)	Latitude (N)	Longitude (W)	Depth (M)	Date	Time (Z)	Oxy. *	Nutr. **	Phytop. ***	Sal. ****
22	49°13.00	64°48.49	235	21/11/90	00:19	10	16	1	2
23	49°24.80	65°36.03	345	21/11/90	05:07	12	20	1	2
24	49°14.48	66°18.52	213	21/11/90	09:36	9	14	1	2
25	49°24.52	66°18.52	328	21/11/90	11:41	12	20	1	2
26	49°34.01	66°18.50	330	21/11/90	13:35	12	20	1	2
27	49°40.00	66°18.62	323	21/11/90	15:05	12	20	1	2
28	49°47.93	66°18.60	307	21/11/90	16:52	11	18	1	2
29	49°54.27	66°18.76	260	21/11/90	18:26	10	16	1	2
30	50°02.00	66°18.69	137	21/11/90	20:06	8	12	1	2
31	50°02.59	64°04.35	112	22/11/90	05:52	7	10	1	2
32	49°44.96	61°49.23	256	22/11/90	16:19	10	16	1	2
33	50°05.07	59°55.02	75	23/11/90	01:40	6	8	1	2
34	49°50.00	59°24.70	267	23/11/90	04:44	10	16	1	2
35	49°34.55	58°50.99	148	23/11/90	08:16	8	12	1	2
36	49°19.53	58°31.17	61	23/11/90	10:55	6	8	1	2
37	49°07.21	60°00.47	261	23/11/90	16:40	10	16	1	2
38	48°55.01	61°39.85	143	23/11/90	23:33	0	0	0	0
@ 38	48°54.95	61°40.24	149	24/11/90	02:45	8	12	1	2
39	48°30.03	61°18.03	415	24/11/90	06:09	12	20	0	2
40	48°35.96	61°10.93	400	24/11/90	07:50	12	20	1	2
41	48°42.00	61°04.65	356	24/11/90	09:31	12	20	0	2
42	48°21.40	60°39.01	443	24/11/90	12:53	9	16	1	2
43	47°51.70	60°27.33	442	24/11/90	16:50	12	20	0	2
44	48°09.00	60°06.70	475	24/11/90	19:35	12	20	1	2
45	48°26.57	59°45.31	270	24/11/90	22:41	10	16	0	2

TABLE 2 (continued)

Station (#)	Latitude (N)	Longitude (W)	Depth (M)	Date	Time (Z)	Oxy. *	Nutr. **	Phytop. ***	Sal. ****
46	47°59.70	59°29.94	170	25/11/90	02:40	9	14	1	2
47	47°34.88	59°20.40	257	25/11/90	06:46	10	16	1	2
@ 47	47°35.55	59°21.34	267	25/11/90	08:02	10	16	1	2
48	47°29.90	59°27.88	447	25/11/90	10:36	12	20	1	2
49	47°25.34	59°35.39	476	25/11/90	12:58	12	20	1	2
50	47°18.17	59°43.90	475	25/11/90	16:14	12	20	1	2
51	47°12.93	59°49.00	450	25/11/90	18:14	12	20	0	2
52	47°08.94	59°54.25	404	25/11/90	19:45	12	20	1	2
53	47°04.06	60°00.07	297	25/11/90	21:20	11	18	0	2
54	46°54.69	60°10.23	91	25/11/90	23:14	7	10	0	2

CTD station locations,depths and times along with number of discrete samples collected for cruise 90-030.

* Oxy. = number of oxygen samples

** Nutr. = number of nutrient samples

*** Phytop. = number of phytoplankton samples

**** Sal. = number of salinity samples

@ Problems with the CTD during the station made it necessary to redo the station as cast 2.

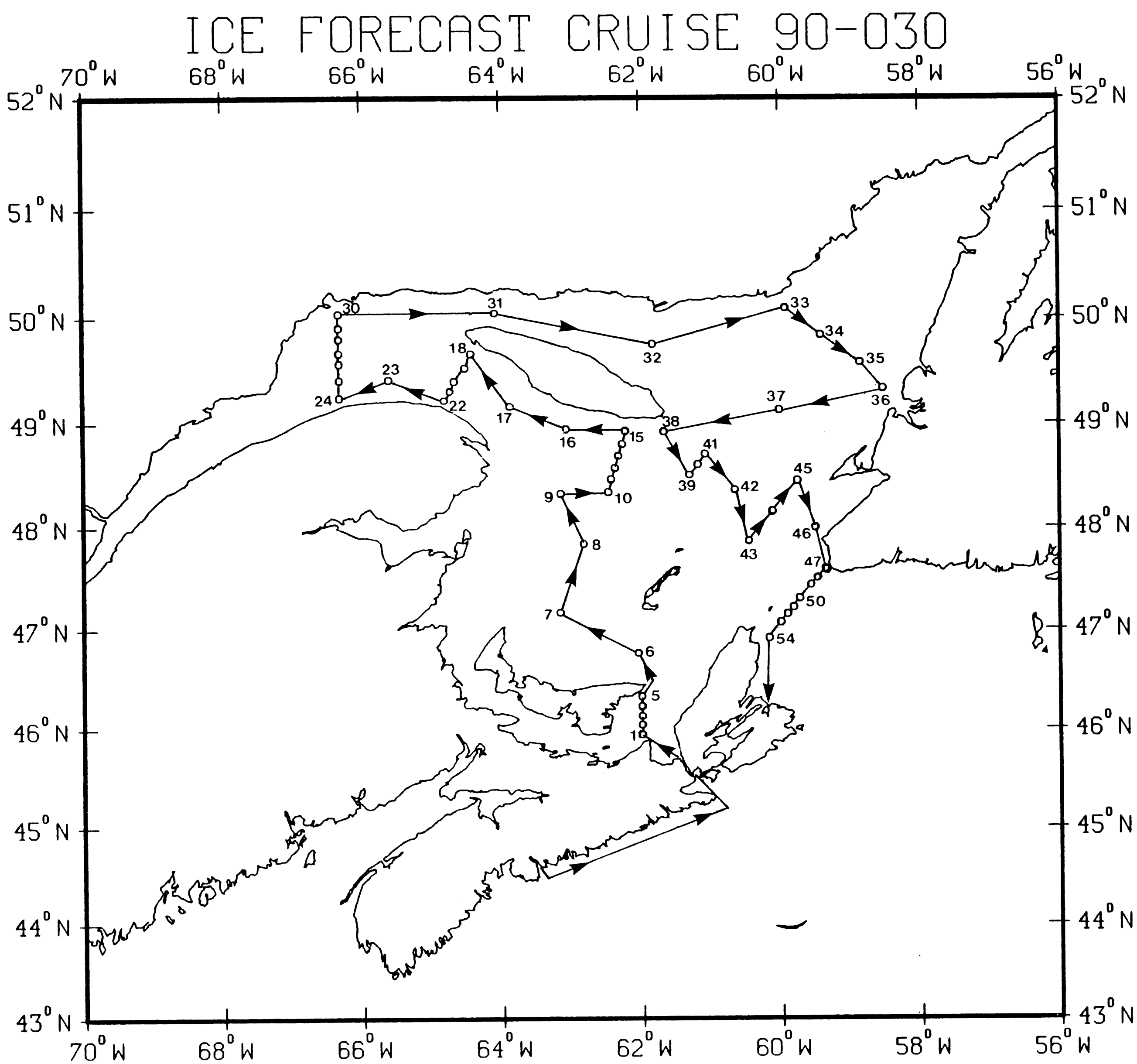

Figure 2: Final CTD Station Positions

TABLE 3

Temperature Calibration

Stn. No.	Hg Therm. Y6991	Hg Therm. 09599	Digital Therm. T-348	Aver. Hg Therm.	Aver. Therm.	CTD Temp.	Digital - Hg	Aver. Hg - CTD	Digital - CTD	Aver. Therm. - CTD
1	7.637	STUCK	NOT SET	7.637	7.637	7.632		0.005		0.005
2	ALL THERMOMETERS NOT SET									
3	LANYARD HUNG-UP									
4	7.399	3.528*	NOT SET	7.399	7.399	7.398		0.001		0.001
5	7.300	3.530*	NOT SET	7.300	7.300	7.296		0.004		0.004
6	5.024	*07396* 5.028	5.058*	5.026	5.027	5.035	0.031*	-0.008	0.023*	-0.008
7	2.026	2.024	2.005*	2.025	2.025	2.026	-0.020*	-0.001	-0.021*	-0.001
8	0.842	0.835	0.832	0.839	0.836	0.839	-0.007	0.000	-0.007	-0.003
9	2.637	0.837*	NOT SET	2.637	2.637	2.598		0.039*		0.039*
10	2.578	2.571	NOT SET	2.575	2.575	2.562		0.013		0.013
11	*08220* 5.252	5.246	5.251	5.249	5.250	5.254	0.002	-0.005	-0.003	-0.004
12	5.206	5.200	5.198	5.203	5.201	5.201	-0.005	0.002	-0.003	0.000
13	5.299	5.294	5.294	5.297	5.296	5.299	-0.003	-0.002	-0.005	-0.003
14	5.415	5.422	5.412	5.419	5.416	5.404	-0.007	0.015	0.008	0.012
15	4.336	4.341	4.332	4.339	4.336	4.361	-0.007	-0.022*	-0.029*	-0.025*
16	5.324	5.324	5.319	5.324	5.322	5.314	-0.005	0.010	0.005	0.008
17	5.406	5.394	5.398	5.400	5.399	5.393	-0.002	0.007	0.005	0.006
18	2.858	2.853	2.862	2.856	2.858	2.861	0.006	-0.005	0.001	-0.003
19	5.355	5.354	5.357	5.355	5.355	5.353	0.002	0.002	0.004	0.002
20	5.432	5.429	5.427	5.431	5.429	5.422	-0.004	0.009	0.005	0.007
21	5.437	5.440	5.431	5.439	5.436	5.423	-0.006	0.016	0.008	0.013
22	4.133	4.132	4.114*	4.133	4.133	4.138	-0.019*	-0.005	0.024*	-0.005
23	5.408	5.410	*T-347* 5.403	5.409	5.407	5.400	-0.006	0.009	0.003	0.007

TABLE 3 (continued)

Stn. No.	Hg Therm. Y6991	Hg Therm. 09599	Digital Therm. T-348	Aver. Hg Therm.	Aver. Therm.	CTD Temp.	Digital - Hg	Aver. Hg - CTD	Digital - CTD	Aver. Therm. - CTD
24	2.970	2.965	2.921*	2.968	2.968	3.058	-0.047*	-0.090*	0.137*	-0.090*
25	5.416	5.419	NOT SET	5.418	5.418	5.414		0.004		0.004
26	5.396	5.394	5.372*	5.395	5.395	5.387	-0.023*	0.008	-0.015*	0.008
27	5.342	5.342	5.340	5.342	5.341	5.341	-0.002	0.001	-0.001	0.000
28	5.295	5.293	5.291	5.294	5.293	5.292	-0.003	0.002	-0.001	0.001
29	4.592	4.591	4.588	4.592	4.590	4.590	-0.004	0.002	-0.002	0.000
30	LANYARD HUNG-UP									
31	0.166	0.152	0.144	0.159	0.154	0.151	-0.015	0.008	-0.007	0.003
32	5.042	5.039	FAILED	5.041	5.041	5.037		0.004		0.004
33	1.963	1.961	1.960	1.962	1.961	1.962	-0.002	0.000	-0.002	-0.001
34	5.174	5.171	5.171	5.173	5.172	5.173	-0.002	0.000	-0.002	-0.001
35	1.351	1.345	1.337	1.348	1.344	1.342	-0.011	0.006	-0.005	0.002
36	0.681	1.342*	0.677	0.681	0.679	0.646	-0.004	0.035*	0.031*	0.033*
37	5.339	5.339	5.338	5.339	5.339	5.350	-0.001	-0.011	-0.012	-0.011
38	0.766	0.762	0.752	0.764	0.760	0.760	-0.012	0.004	-0.008	0.000
39	5.231	5.235	5.222	5.233	5.229	5.220	-0.011	0.013	0.002	0.009
40	5.135	5.138	5.131	5.137	5.135	5.129	-0.006	0.008	0.002	0.006
41	5.276	5.273	5.268	5.275	5.272	5.260	-0.007	0.015	0.008	0.012
42	ROSETTE POINTER SET IN THE WRONG POSITION									
43	5.139	5.137	5.128	5.138	5.135	5.128	-0.010	0.010	0.000	0.007
44	5.059	5.055	5.051	5.057	5.055	5.057	-0.006	0.000	-0.006	-0.002
45	4.134	4.132	4.130	4.133	4.132	4.190	-0.003	-0.057*	-0.060*	-0.058*
46	1.755*	1.745	1.735	1.745	1.740	1.737	-0.010	0.008	-0.002	0.003
47	4.973	4.971	4.971	4.972	4.972	4.973	-0.001	-0.001	-0.002	-0.001
48	4.961	4.955	4.960	4.958	4.959	4.966	0.002	-0.008	-0.006	-0.007

TABLE 3 (continued)

Stn. No.	Hg Therm. Y6991	Hg Therm. 09599	Digital Therm. T-348	Aver. Hg Therm.	Aver. Therm.	CTD Temp.	Digital - Hg	Aver. Hg - CTD	Digital - CTD	Aver. Therm. - CTD
49	5.058	5.059	5.050	5.059	5.056	5.055	-0.009	0.004	-0.005	0.001
50	5.096	5.094	5.084	5.095	5.091	5.046	-0.011	0.049*	0.038*	0.045*
51	5.236	5.229	5.222	5.233	5.229	5.173	-0.011	0.060*	0.059*	0.059*
52	5.376	5.371	5.371	5.374	5.373	5.330	-0.003	0.044*	0.041*	0.043*
53	4.808	4.806	4.793	4.807	4.802	4.773	-0.014	0.034*	0.020*	0.029*
54	3.911	3.906	3.902	3.909	3.906	3.858	-0.007	0.051*	0.044*	0.048*

Digital - CTD

Offset = -0.001°C

Standard Deviation = 0.005°C

No. of Values = 30

Mercury - CTD

Offset = 0.004°C

Standard Deviation = 0.007°C

No. of Values = 40

Digital - Mercury

Offset = 0.005°C

Standard Deviation = 0.005°C

No. of Values = 38

Average Thermometers - CTD

Offset = 0.002°C

Standard Deviation = 0.006°C

No. of Values = 40

* These values were not used when calculating the above mean offsets and standard deviations for temperature.

TABLE 4

Salinity Calibration

STATION	ID	DEPTH	CTD SALINITY	LAB. SAL. SALINITY	LAB. SAL. -CTD
1	79502	37.2	BOTTLE DRAINED BEFORE SALINITY SAMPLE WAS DRAWN		
2	79505	40.0	29.557	29.608	0.051
3	79508	37.0	29.668	29.715	0.047
4	79511	36.8	29.644	29.692	0.048
5	79514	35.8	29.538	29.576	0.038
6	79517	64.8	30.419	30.384	-0.035 *
7	79521	61.3	31.306	31.359	0.053
8	79525	71.9	32.061	32.113	0.052
9	79529	53.5	31.590	31.572	-0.018 *
10	79532	142.7	33.539	33.587	0.048
11	79538	369.5	34.763	34.717	-0.046 *
12	79548	431.4	34.655	34.818	0.163 *
13	79558	392.4	34.546	34.976	0.430 *
14	79568	335.9	34.570	34.684	0.114 *
15	79578	223.0	34.028	34.132	0.104 *
16	79586	387.0	34.657	34.775	0.118 *
17	79596	371.2	34.606	34.715	0.109 *
18	79606	183.1	33.555	33.673	0.118 *
19	79613	295.5	34.539	34.578	0.039
20	79622	367.6	34.622	34.699	0.077
21	79632	360.2	34.616	34.685	0.069
22	79642	226.8	34.021	34.100	0.079
23	79650	338.8	34.542	34.610	0.068
24	79660	209.0	33.669	33.708	0.039
25	79667	323.4	34.565	34.617	0.052
26	79677	317.0	34.554	34.607	0.053
27	79687	317.1	34.523	34.577	0.054
28	79697	299.0	34.500	34.541	0.041
29	79706	251.3	34.200	34.253	0.053
30	79714	127.4	32.792	32.857	0.065
31	79720	115.2	32.424	32.482	0.058
32	79725	245.7	34.351	34.383	0.032

TABLE 4 (continued)

STATION	ID	DEPTH	CTD SALINITY	LAB. SAL. SALINITY	LAB. SAL. -CTD
33	79733	72.4	31.669	31.753	0.084
34	79737	257.4	34.357	34.416	0.059
35	79745	144.7	33.122	33.196	0.074
36	79751	57.3	32.431	32.481	0.050
37	79755	256.9	34.512	34.568	0.056
38	79763	140.6	33.002	33.060	0.058
39	79769	405.9	34.755	34.806	0.051
40	79779	391.5	34.777	34.827	0.050
41	79789	347.4	34.730	34.782	0.052
42	79801	306.4	34.637	34.688	0.051
43	79809	434.1	34.767	34.828	0.061
44	79819	460.3	34.748	34.831	0.083
45	79829	260.0	34.020	34.085	0.065
46	79837	154.9	32.750	32.831	0.081
47	79844	252.8	34.255	34.325	0.070
47(2)	79852	261.9	34.380	34.383	0.003 *
48	79860	437.5	34.841	34.835	-0.006 *
49	79870	455.7	34.830	32.194	-2.636 *
50	79880	462.9	34.835	34.829	-0.006 *
51	79890	344.1	34.829	34.801	-0.028 *
52	79900	389.0	34.776	34.754	-0.022 *
53	79910	284.9	34.318	34 332	0.014 *
54	79919	89.3	31.308	31.333	0.025 *

Average Salinity Offset = 0.057°/oo

Standard Deviation = 0.013°/oo

Number of Values Used = 36

* These values were not used when calculating the above mean offsets and standard deviations for temperature.

TABLE 5

Pressure Calibration

STATION	DOWN TRACE	UP TRACE	ESTIMATED DEPTH	EST. DEPTH -DOWN	EST. DEPTH -UP
1	1.2	0.4	1.0	-0.2	0.6
2	1.6	0.4	1.0	-0.6	0.6
3	1.8	1.5	1.5	-0.3	0.0
4	2.1	1.3	1.5	-0.6	0.2
5	2.5	2.0	***		
6	###	2.6	2.0		-0.6
7	7.3	2.9	***		
8	8.3	5.4	3.0	-5.3	-2.4
9	7.2	6.8	3.0	-4.2	-3.8
10	5.9	5.3	3.5	-2.4	-1.8
11	8.0	6.3	4.0	-4.0	-2.3
12	6.6	4.6	3.0	-3.6	-1.6
13	5.7	2.4	3.0	-2.7	0.6
14	2.6	2.2	3.5	0.9	1.3
15	3.5	4.1	3.0	-0.5	-1.1
16	4.3	3.8	3.0	-1.3	-0.8
17	6.7	6.9	2.0	-4.7	-4.9
18	5.1	4.6	2.0	-3.1	-2.6
19	6.5	4.4	2.0	-4.5	-2.4
20	6.1	4.2	2.0	-4.1	-2.2
21	7.6	5.9	3.0	-4.6	-2.9
22	5.9	5.9	***		
23	7.4	5.7	***		
24	7.7	6.0	3.0	-4.7	-3.0
25	6.3	5.3	***		
26	7.3	5.1	2.0	-5.3	-3.1
27	6.2	4.9	***		
28	5.1	4.2	1.0	-4.1	-3.2
29	4.2	4.0	1.0	-3.2	-3.0
30	4.8	3.2	1.0	-3.8	-2.2
31	6.7	4.1	***		
32	6.8	4.9	2.0	-4.8	-2.9

TABLE 5 (continued)

STATION	DOWN TRACE	UP TRACE	ESTIMATED DEPTH	EST. DEPTH -DOWN	EST. DEPTH -UP
33	6.5	6.0	2.0	-4.5	-4.0
34	6.4	4.7	2.0	-4.4	-2.7
35	5.6	4.9	2.0	-3.6	-2.9
36	4.5	3.6	2.0	-2.5	-1.6
37	4.1	4.3	1.0	-3.1	-3.3
38	6.1	5.6	***		
39	6.1	4.8	2.0	-4.1	-2.8
40	4.8	3.7	3.0	-1.8	-0.7
41	5.5	4.2	***		
42	5.6	3.4	***		
43	4.3	2.6	***		
44	4.8	2.9	2.5	-2.3	-0.4
45	4.3	3.5	3.0	-1.3	-0.5
46	3.9	3.3	2.5	-1.4	-0.8
47	2.5	3.9	3.0	0.5	-0.9
48	7.3	2.0	3.0	-4.3	1.0
49	5.7	5.4	3.5	-2.2	-1.9
50	6.2	###	4.0	-2.2	4.0
51	6.5	6.4	3.0	-3.5	-3.4
52	4.9	3.9	3.0	-1.9	-0.9
53	4.2	5.1	4.0	-0.2	-1.1
54	3.1	2.8	2.0	-1.1	-0.8

DOWN TRACE

Average Offset = -2.8 dbar

Standard Deviation = 1.7 dbar

Number of Values Used = 42 dbar

UP TRACE

Average Offset = -1.6 dbar

Standard Deviation =1.7 dbar

Number of Values Used = 43 dbar

*** Indicates that no estimated depth was recorded for this station.

Indicates that the information was not available on the decwriter listings.

TABLE 6

Oxygen Calibration

STATION	PROBE	DEPTH	ID	TITRATION O_2	AVERAGE O_2	CTD O_2	AVER. O_2 -CTD	DELTA DUPLICATE
1	5	37.2	79502	6.945	6.936	7.45	-0.51	
				6.926				0.019
2	5	40.0	79505	6.977	6.980	7.57	-0.59	
				6.982				0.005
3	5	37.0	79508	6.943	6.929	8.08	-1.15	
				6.914				0.029
4	5	36.8	79511	7.081	7.037	7.67	-0.63	
				6.992				0.089
5	5	35.8	79514	7.019	7.008	7.26	-0.25	
				6.996				0.023
6	5	64.8	79517	7.209	7.182	8.04	-0.86	
				7.154				0.055
7	5	61.3	79521	5.179	5.127	5.45	-0.32 *	
				5.074				0.105 *
8	5	71.9	79525	5.867	5.705	5.88	-0.18 *	
				5.542				0.325 *
9	5	53.5	79529	7.716	7.705	8.37	-0.66	
				7.694				0.022
10	NO SAMPLES (Pickling Problems)							
11	5	369.5	79538	3.313	3.273	CTD Oxygen Probe not Working		
				3.233				0.080
12	4	431.4	79548	3.456	3.457	4.40	-0.94	
				3.458				0.002
13	4	392.4	79558	3.426	3.407	3.23	0.18	
				3.387				0.039
14	7	335.9	79568	3.298	3.298	3.27	0.03	
				3.298				0.000
15	7	223.0	79578	3.505	3.505	3.24	0.26	
				3.504				0.001
16	7	387.1	79586	3.139	3.116	2.88	0.24	
				3.092				0.047

TABLE 6 (continued)

STATION	PROBE	DEPTH	ID	TITRATION O_2	AVERAGE O_2	CTD O_2	AVER. O_2 -CTD	DELTA DUPLICATE
17	7	371.2	79596	2.588	2.571	2.37	0.20	
				2.553				0.035
18	7	183.1	79606	4.604	4.597	4.08	0.52	
				4.589				0.015
19	7	295.5	79613	2.255	2.244	1.95	0.29	
				2.232				0.023
20	7	367.6	79622	2.392	2.381	2.08	0.30	
				2.369				0.023
21	7	360.2	79632	2.239	2.255	1.93	0.33	
				2.271				0.032
22	7	226.8	79642	2.587	2.582	2.24	0.34	
				2.577				0.010
23	7	338.8	79650	1.797	1.758	1.37	0.39	
				1.719				0.078
24	7	209.0	79660	3.476	3.452	2.99	0.46	
				3.427				0.049
25	7	323.4	79667	1.627	1.642	1.34	0.30	
				1.657				0.030
26	7	317.0	79677	1.678	1.692	1.40	0.29	
				1.706				0.028
27	7	317.1	79687	1.724	1.720	1.40	0.32	
				1.716				0.008
28	7	299.0	79697	1.793	1.789	1.37	0.42	
				1.784				0.009
29	7	251.3	79706	2.26	2.269	1.91	0.36	
				2.277				0.017
30	7	127.4	79714	6.035	6.044	5.17	0.87	
				6.053				0.018
31	7	115.2	79720	7.183	7.164	6.44	0.72	
				7.145				0.038
32	7	245.8	79725	2.545	2.536	2.21	0.33	
				2.526				0.019
33	7	72.4	79733	7.829	7.856	7.10	0.76	
				7.883				0.054

TABLE 6 (continued)

STATION	PROBE	DEPTH	ID	TITRATION O_2	AVERAGE O_2	CTD O_2	AVER. O_2 -CTD	DELTA DUPLICATE
34	7	257.4	79737	2.409	2.419	1.98	0.44	
				2.428				0.019
35	7	144.7	79745	6.206	6.275	5.46	0.82 *	
				6.344				0.138 *
36	7	57.2	79751	7.114	7.123	6.13	0.99	
				7.132				0.018
37	7	256.9	79755	3.137	3.137	2.72	0.42	
				3.137				0.000
38	7	140.6	79763	5.645	5.894	5.23	0.66 *	
				6.143				0.498 *
39	7	405.9	79769	3.418	3.358	2.76	0.60 *	
				3.297				0.121 *
40	7	391.5	79779	3.586	3.586	2.90	0.69	
				3.586				0.000
41	7	347.4	79789	3.578	3.567	2.83	0.74	
				3.556				0.022
42	7	306.4	79801	3.358	3.358	2.73	0.63	
		No Duplicate Sample Drawn						
43	7	434.1	79809	3.501	3.518	2.86	0.66	
				3.534				0.033
44	7	460.3	79819	3.755	3.748	3.19	0.56	
				3.741				0.014
45	7	260.0	79829	4.819	4.812	3.91	0.90	
				4.804				0.015
46	7	154.9	79837	7.149	7.151	5.85	1.30	
				7.153				0.004
47	7	252.8	79844	4.613	4.595	3.78	0.81	
				4.576				0.037
48	4	437.5	79860	3.578	3.449	4.71	-1.26 *	
				3.319				0.259 *
49	4	455.7	79870	6.738	6.738	4.29	2.45 *	
		No Duplicate Sample Drawn						
50	7	462.9	79880	3.660	3.669	3.17	0.50	
				3.677				0.017

TABLE 6 (continued)

STATION	PROBE	DEPTH	ID	TITRATION O_2	AVERAGE O_2	CTD O_2	AVER. O_2 -CTD	DELTA DUPLICATE
51	7	433.1	79890	4.395	4.577	3.17	1.41 *	
				4.759				0.364 *
52	7	389.0	79900	3.508	3.470	2.83	0.64	
				3.431				0.077
53	7	284.9	79910	3.399	3.372	2.48	0.89	
				3.345				0.054
54	7	89.3	79919	6.897	7.036	5.29	1.75 *	
				7.174				0.277 *

Probe #4

Average Offset = 0.38 ml/l

Standard Deviation = 0.79 ml/l

Number of Values Used = 2

Probe #5

Average Offset = -0.66 ml/l

Standard Deviation = 0.28 ml/l

Number of Values used = 7

Probe #7

Average Offset = 0.53 ml/l

Standard Deviation = 0.27 ml/l

Number of Values used = 34

* These values were not used when calculating the above mean offsets and standard deviations for oxygen.