CRUISE REPORT
(C.M. Young, January 8, 2014)

University of Oregon
North Carolina State University
Duke University

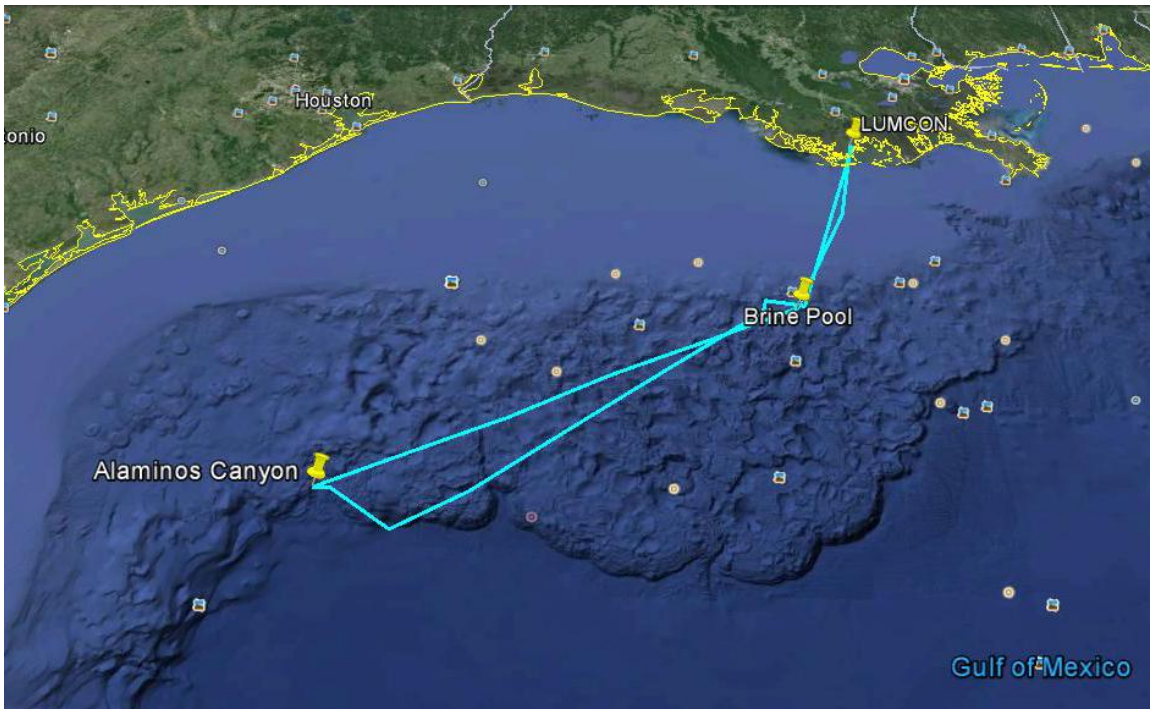
Ship: R/V Pelican **Cruise Dates:** November 4-8, 2013

Scientific Party:

Dr. Craig Young, Chief Scientist, University of Oregon
Dr. Brandon Puckett, Postdoctoral Fellow, North Carolina State University
Amy Burgess, PhD student, University of Oregon
Joe Zambon, PhD student, North Carolina State University
Doreen McVeigh, PhD student, North Carolina State University
Jordan Byrum, Research Assistant, North Carolina State University
Andrew Margolin, PhD student, University of Miami
Bernie Ball, Research Associate, Duke University
Rachel Hubbard, undergraduate student, University of Oregon
Caitlin Plowman, undergraduate student, University of Oregon

Area of Operation and Cruise Track:

Louisiana and Texas shelf and slope (Brine Pool NR1, Alaminos Canyon, Green Canyon lease blocks) as shown in the following Google Earth image.



Cruise Objectives:

1. Deploy two deep-water moorings, each with larval traps, current meters, recruitment substrata (bones, wood) and one with a hydrophone. .
2. Collect CTD samples over the deployment sites and at intervals along the cruise track.
3. Collect CTD samples over other methane seep sites.
4. Collect one deep-water CTD sample over 3000m water depth.

Cruise Narrative:

Sunday, March 3.

Scientific party arrived in New Orleans around noon and drove to LUMCON in Cocodrie, LA. Ship was loaded and equipment stowed for an expected rough transit. Components of the moorings were assembled prior to departure.

The two acoustic releases were bench tested as follows:

-Edgetech CART acoustic release serial #028286 (to be deployed at Brine Pool)
- -Enabled unit by sending command 374400, unit returned 7 pings = tilted (unit was laying on side on bench)
- -Armed unit by sending release command 353521, "cup" turned arming unit
- -Tested release by sending command 353521, unit released
- -Armed unit by sending release command 353521, "cup" turned arming unit
- -Disabled unit by sending command 374423, unit returned 7 pings

-Edgetech PORT acoustic release serial # 34608 (to be deployed in Alaminos Canyon)
- -Opened device and inspected connections, everything looked good
- -Enabled unit by sending command 136223, unit returned 7 pings = tilted (unit was laying on side on bench)
- -Tested release by sending command 134621, unit released
- -Disabled unit by sending command 136246, unit returned 7 pings

Monday, November 4

Although a 9:00 departure was anticipated, sailing was delayed while awaiting delivery of a refurbished current meter by UPS. Because of a mix-up at UPS, the meter was placed on the wrong truck. Eventually, LUMCON marine superintendent Joe Malbrough tracked down the delivery and we sailed around 1300, steaming toward the Brine Pool deployment site ($27^{o}43.4$, $91^{o}16.7$), a distance of 140 nm. Seas were very rough.

After the ship was underway (15:13), the CTD electronics were deck tested successfully.

Tuesday, November 5

CTD profiles (Appendix III, IV) were taken approximately every 40 nautical miles to characterize the water-column salinity and temperature structure. Water samples were also collected on each CTD cast for use by U. Miami graduate student Andrew Margolin, who is analyzing concentration and composition of dissolved organic matter in the water column above seeps. The first two CTD casts were taken over the continental shelf (2:11 a.m at 28.556°N, 90.835°W; 6:49 a.m. at 28.103°N, 91.082°W).

The first mooring (Appendix I, II) was dropped at the Brine Pool Cold Seep site at 8:30 by streaming the float and instruments behind the ship, with instruments horizontal, then dropping the train-wheel weight. The ship did not have a quick release hook mechanism on board, so the drop was accomplished using a creative system of slip lines. Mooring coordinates: 27°43.394'N, 091°16.753'W (736m depth). The mooring consisted of (from bottom to top):

1) train wheel with cow bones, wood blocks and one 4-tube PVC larval trap, all attached with polypropylene line and cable ties that can be broken by a manipulator arm.
2) Acoustic release.
3) 4-tube "home-made" PVC larval trap.
4) Small hydrophone.
5) 4-tube larval trap
6) Falmouth Scientific current meter
7) 4-tube larval trap,
8) 3 plastic trawl floats, connected by line to a smaller trawl float with spar and orange flag.

After deployment, we communicated with the acoustic release as follows:

1) ranged acoustic release, receiving signal from 650m after ~10 minutes, indicating a rate of descent of approximately 150m/min.
2) Disabled acoustic release, receiving 15 return pings, indicating that the instrument was upright.

The commands for this acoustic release (Edgetech CART, serial number 08286) are:

-Enable: 374400
-Release/Arm: 353521
-Disable: 374423

The ship continued steaming toward Alaminos Canyon, collecting two additional CTD samples (10:48 a.m., 27.723°N, 91.282°W; 19:14 p.m., 27.433°N, 91.950°W).

<u>Wednesday, November 6</u>

Two early morning CTD casts (1:14 a.m., 27.167°N, 92.650°W; 7:28 a.m., 26.850°N, 94.619°W) were taken in transit to the Alaminos Canyon drop site. Following the second CTD cast, the ship was repositioned over a known seep site at Alaminos Canyon and a mooring (Appendix I, II) was deployed at

14:48 at a depth of 2257m. Mooring coordinates: 26°21.300'N, 095°29.799'W. Mooring consisted of (from bottom to top):

1) Train wheel with bones, wood and 4-tube PVC larval trap.
2) Acoustic release
3) PVC larval trap
4) large hydrophone
5) current meter
6) Technicap sediment trap
7) 1-m diameter syntactic float.

After deployment, we ranged the acoustic release, receiving return from 2200m after about 23min (rate of descent: 100m/min. Release was disabled and returned 15 pings indicating that it was upright.

Commands for this acoustic release (Edgetech PORT, serial number 34608) were:

-Enable: 136223
-Release: 134621
-Disable: 136246

Two additional CTD casts were made in the evening hours. The first cast was made to a depth of 2352.93m at 17:47. The coordinates were 26.357N, 94.619W. The second cast to a depth of 2216.82m was taken at 21:18 at coordinates of 26.356N, 94.497W.

Wednesday, November 7

The ship steamed offshore to take casts through a deep water column that was away from the direct influence of methane seepage. Two casts were taken at the same site, the first to collect water from the lower two-thirds of the water column and the second to obtain samples from the top 1000m. The details of the casts are as follows. Cast 1 to a depth of 3064.02m was done at 2:19 at coordinates 26.083N, 94.081W. Cast 2 to a depth of 1001.36m was taken at 5:35 at coordinates 26.083N, 94.084W.

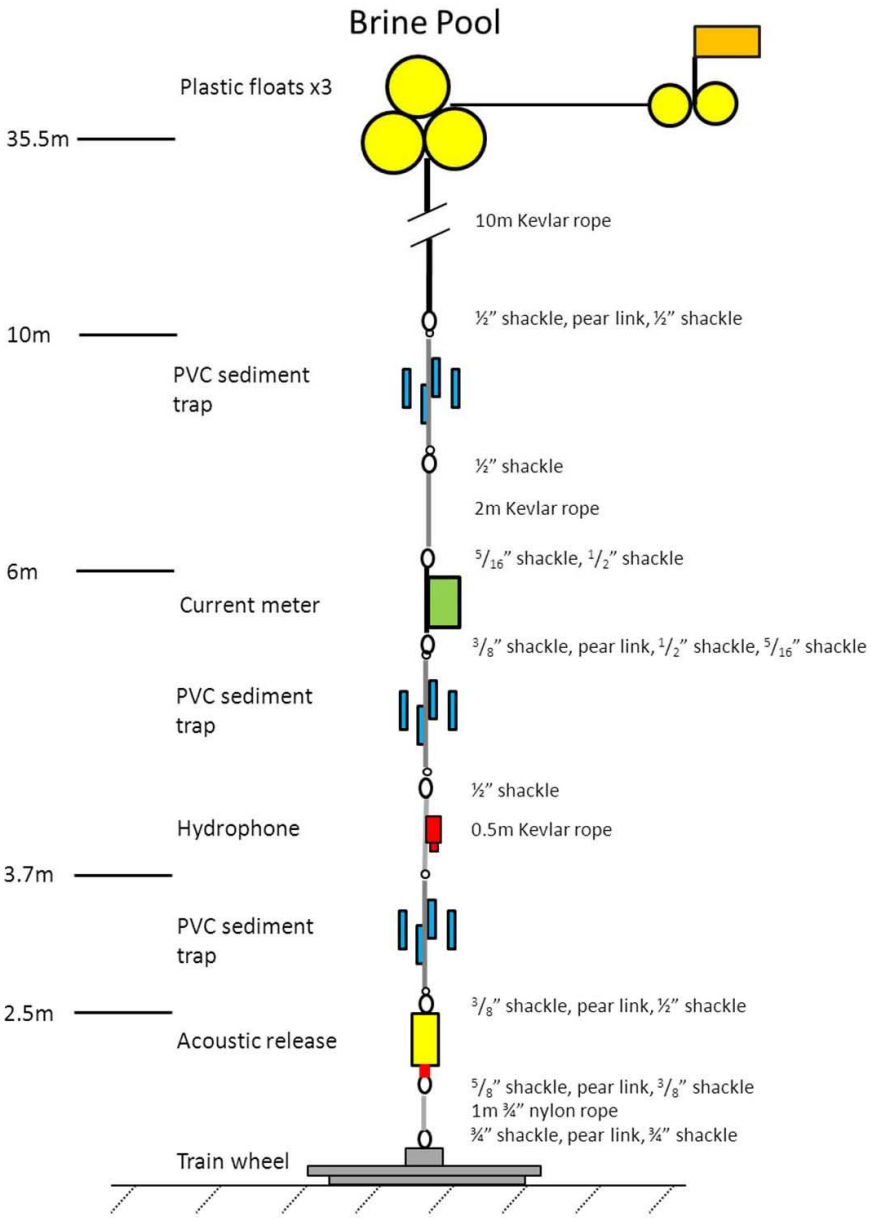
The remainder of the day was spent steaming back toward the Green Canyon lease blocks, near the location of the first mooring deployment. One additional CTD cast was taken during this steam, at 10:44, coordinates 26.335N, 93.588W to a depth of 2014.76m.

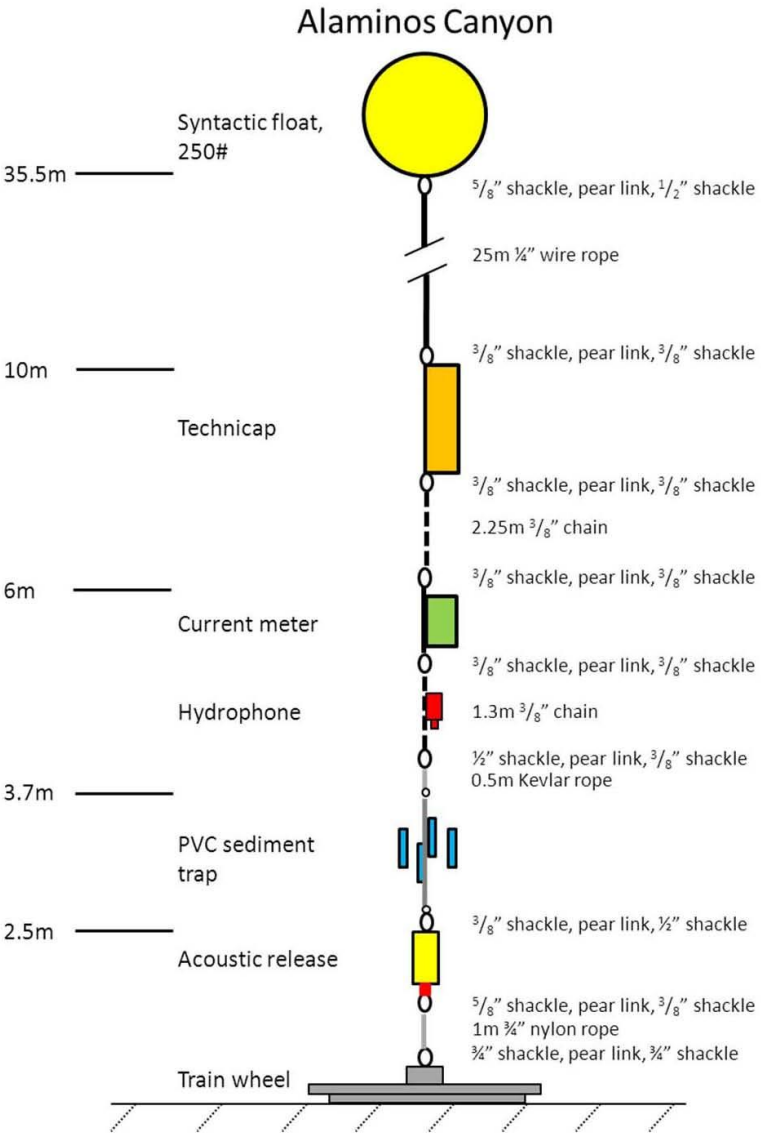
Thursday, November 8

Two CTD casts were taken at seep sites in the Green Canyon Blocks of the upper Louisiana Slope. The first was at 6:08 at a depth of 623.22m; coordinates: 27.700N, 91.533W. The second cast was at 9:31 at a depth of 525.52m; coordinates: 27.743N, 91.225W.

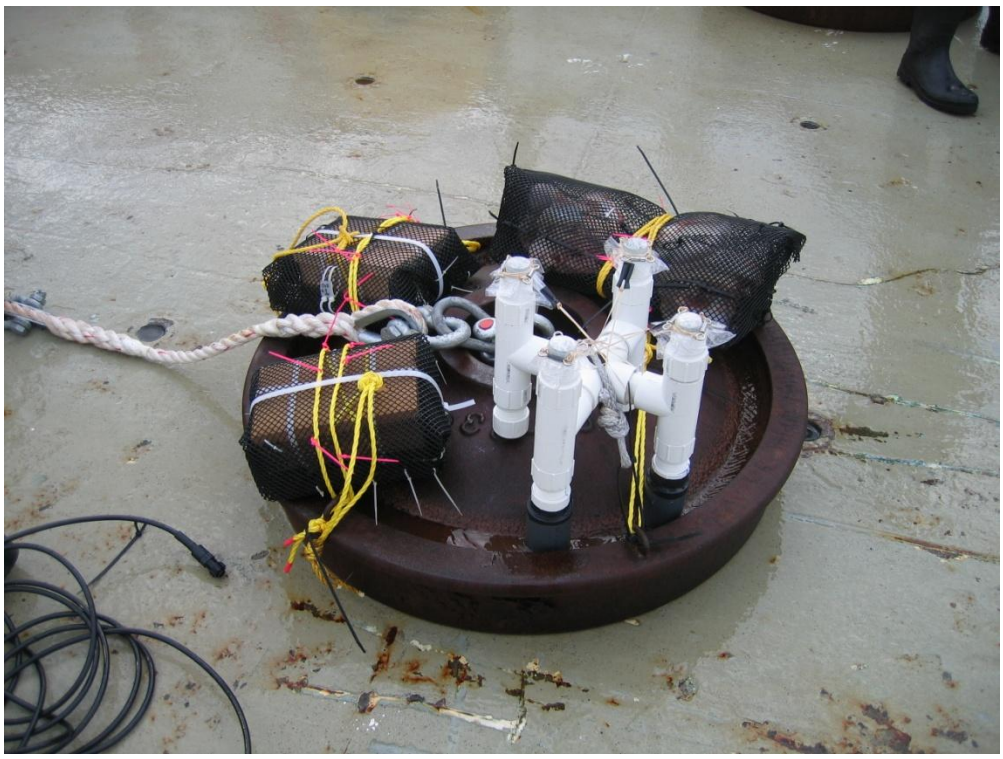
The ship then steamed North toward the coast, entering the LUMCON harbor at Cocodrie just after sundown. The scientific party remained on the ship that evening and disembarked the following morning.

Appendix I. Mooring Diagrams (Brandon Puckett)



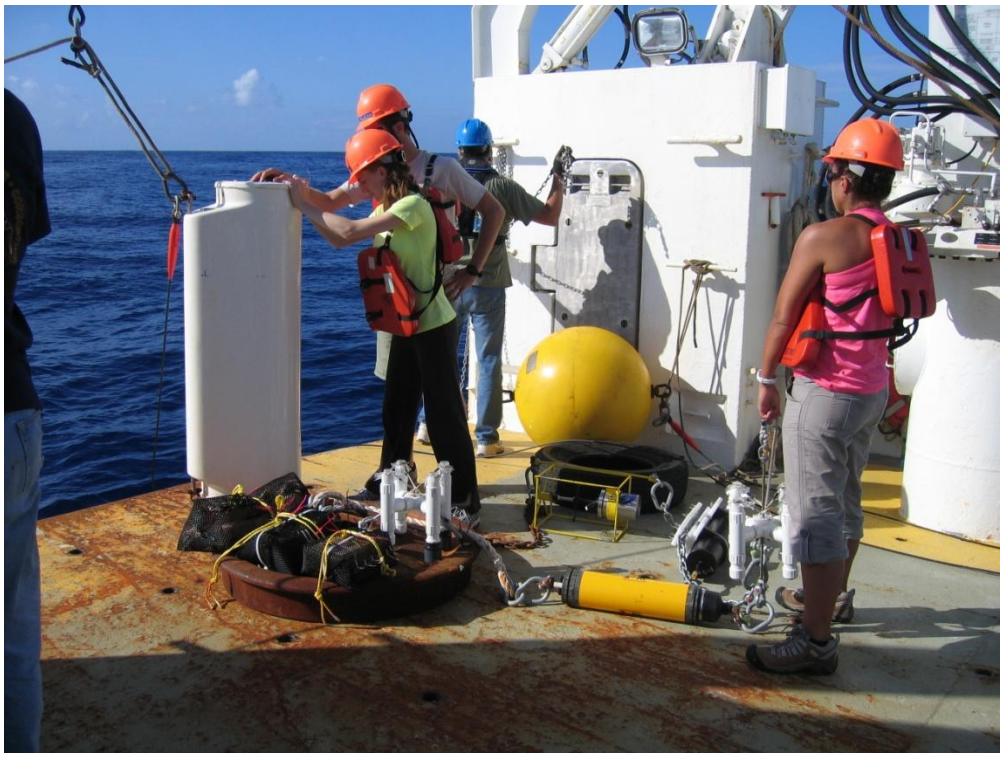

Alaminos Canyon
Syntactic float, 250#
35.5m
5/8" shackle, pear link, 1/2" shackle
25m ¼" wire rope
3/8" shackle, pear link, 3/8" shackle
10m
Technicap
3/8" shackle, pear link, 3/8" shackle
2.25m 3/8" chain
3/8" shackle, pear link, 3/8" shackle
6m
Current meter
3/8" shackle, pear link, 3/8" shackle
Hydrophone
1.3m 3/8" chain
½" shackle, pear link, 3/8" shackle
0.5m Kevlar rope
3.7m
PVC sediment trap
3/8" shackle, pear link, ½" shackle
2.5m
Acoustic release
5/8" shackle, pear link, 3/8" shackle
1m ¾" nylon rope
¾" shackle, pear link, ¾" shackle
Train wheel

Appendix II. Photographs of Mooring Components (Craig Young)



Brine Pool train-wheel weight with larval tube trap, wood blocks and cow bones attached with lines and cable-ties.

Triple plastic trawl floats with attached spar floats and flag deployed on the Brine Pool Mooring.



Alaminos Canyon mooring components just before deployment showing larval traps, sediment trap, current meter, syntactic float, weight with attached recruitment samplers, and acoustic release.

Larval tube traps showing details of the magnesium fusible link release system. Traps were filled with saturated DMSO/NaCl solution.

Appendix III. CTD Log Data (Joe Zambon)

Station	Date (2013)	Time (UTC)	Lat (ºN)	Lon (ºW)	Depth (m)	Bottle #	Bottle Depths (m)	Notes
Test	4-Nov	15:13	26.250	-90.650	N/A		N/A	Deck test
1	5-Nov	2:11	28.556	-90.835	22.93	1	21.64	
						2	22.35	
						3	20.61	
						4	21.01	
						5	10.34	
						6	9.32	
						7	3.14	
						8	2.21	
2	5-Nov	6:49	28.103	91.082	105.34	1	101.44	
						2	101.64	
						3	91.98	
						4	82.55	
						5	74.02	
						6	66.03	
						7	55.68	
						8	41.85	
						9	22.62	
						10	15.07	
						11	1.84	
						12	2.51	
3	5-Nov	10:48	27.723	91.282	618.52	1	616.60	
						2	502.09	
						3	401.32	
						4	302.44	
						5	202.78	
						6	101.89	
						7	75.21	
						8	65.15	did not fire
						9	51.32	
						10	24.37	
						11	1.24	
						12	2.21	
4	5-Nov	19:14	27.433	91.950	893.91	1	891.94	
						2	799.64	
						3	700.73	
						4	600.15	

						5	500.37	
						6	402.24	
						7	301.87	
								did not
						8	200.76	fire
						9	100.07	
						10	69.50	
						11	34.78	
						12	2.01	
5	6-Nov	1:14	27.167	92.650	1083.08	1	1078.04	
						2	990.97	
						3	899.33	
						4	797.20	
						5	605.96	
						6	504.83	
						7	400.50	
						8	304.22	
						9	202.65	
						10	100.70	
						11	66.98	
						12	1.10	
6	6-Nov	7:28	26.850	93.362	1277.97	1	1275.55	
						2	1203.43	
						3	1002.21	
						4	800.09	
						5	599.38	
						6	499.37	
						7	401.74	
						8	302.39	
						9	201.32	
						10	98.80	
						11	76.38	
						12	2.30	
7	6-Nov	17:47	26.357	94.619	2352.93	1	2351.23	
						2	2351.56	
						3	2201.99	
						4	2201.34	
						5	1999.63	
						6	2000.08	
						7	1801.50	
						8	1800.70	
						9	1600.16	

						10	1601.61	
						11	1399.60	
						12	1398.90	
8	6-Nov	21:18	26.356	94.497	2216.82	1	2215.50	
						2	2000.13	
						3	1798.38	
						4	1596.99	
						5	1398.72	
						6	1199.82	
						7	999.63	
						8	598.70	
						9	390.04	
						10	197.32	
						11	87.29	
						12	1.26	
9	7-Nov	2:19	26.083	94.081	3064.02	1	3060.45	first cast
						2	3059.24	
						3	2849.42	
						4	2599.05	
						5	2201.75	
						6	1998.12	
						7	1801.76	
						8	1600.85	
						9	1599.84	
						10	1399.87	
						11	1199.63	
						12	1201.08	
9	7-Nov	5:35	26.083	94.084	1001.36	1	997.00	second cast
						2	799.10	
						3	601.82	
						4	601.83	
						5	403.88	
						6	405.44	
						7	254.92	
						8	203.53	
						9	203.93	
						10	87.70	
						11	88.73	
						12	1.78	
10	7-Nov	10:44	26.335	93.588	2014.76	1	2003.14	
						2	1750.17	

						3	1498.72
						4	1249.21
						5	1001.31
						6	801.81
						7	600.28
						8	399.50
						9	201.06
						10	88.41
						11	74.25
						12	1.64
11	8-Nov	6:08	27.700	91.533	623.22	1	618.54
						2	495.42
						3	401.43
						4	303.41
						5	204.26
						6	97.55
						7	50.51
						8	2.58
12	8-Nov	9:31	27.743	91.225	525.52	1	520.61
						2	499.81
						3	400.76
						4	302.32
						5	202.08
						6	100.15
						7	51.11
						8	3.55

Hydrography Data

SEEP Project

November 2013 Cruise

4-8 November 2013

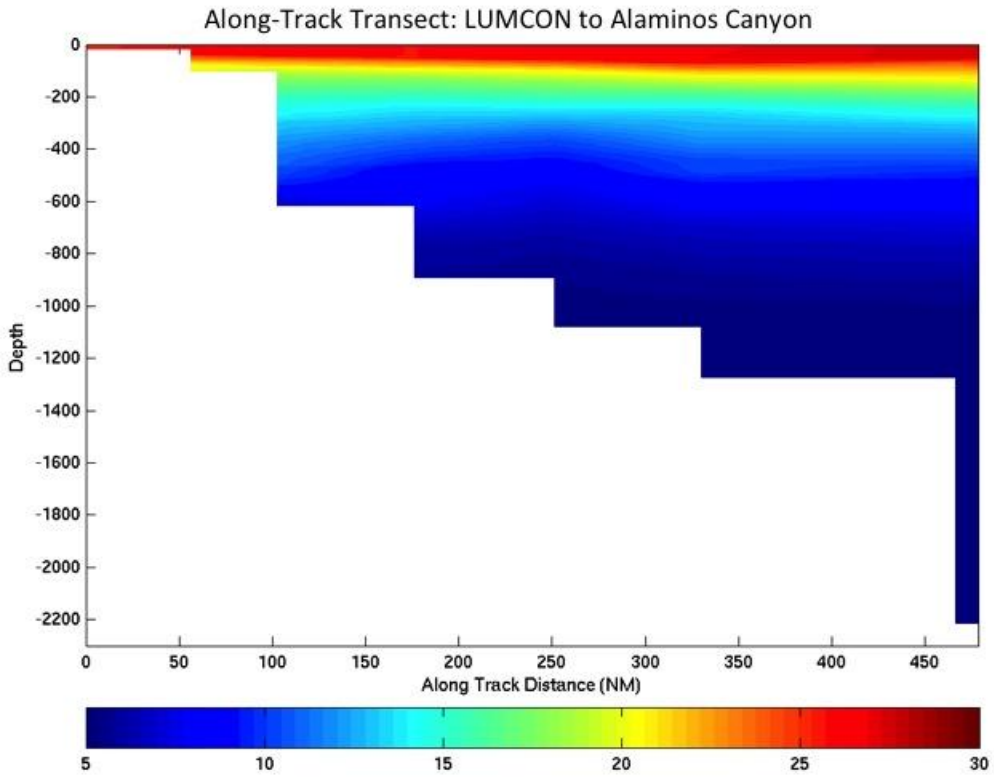
R/V Pelican

Joseph B. Zambon **NC State University**

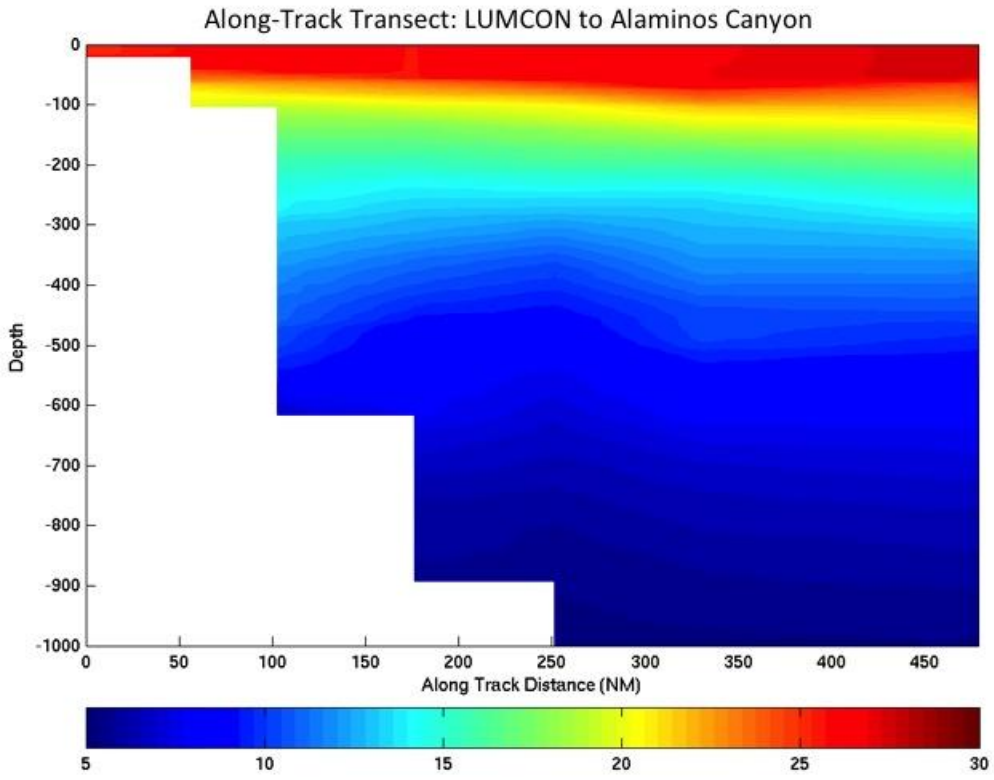
jbzambon@ncsu.edu **14 November 2013**

Contents:

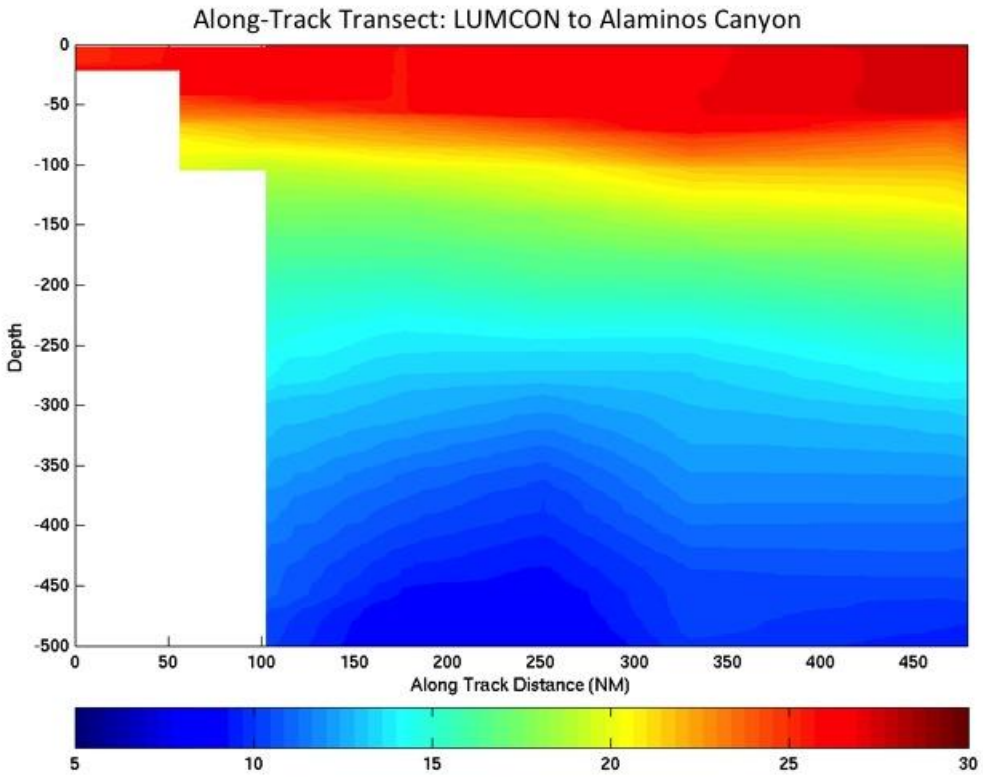
Transect: 0m to 2210m



Transect: 0m to 1000m



Transect: 0m to 500m



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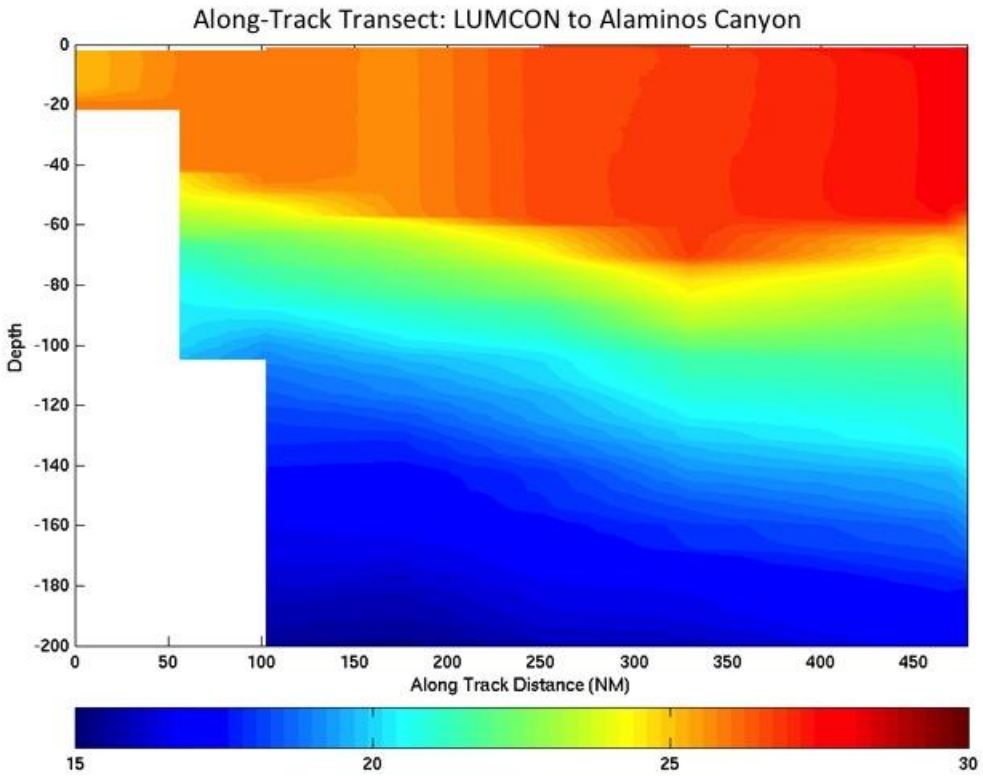
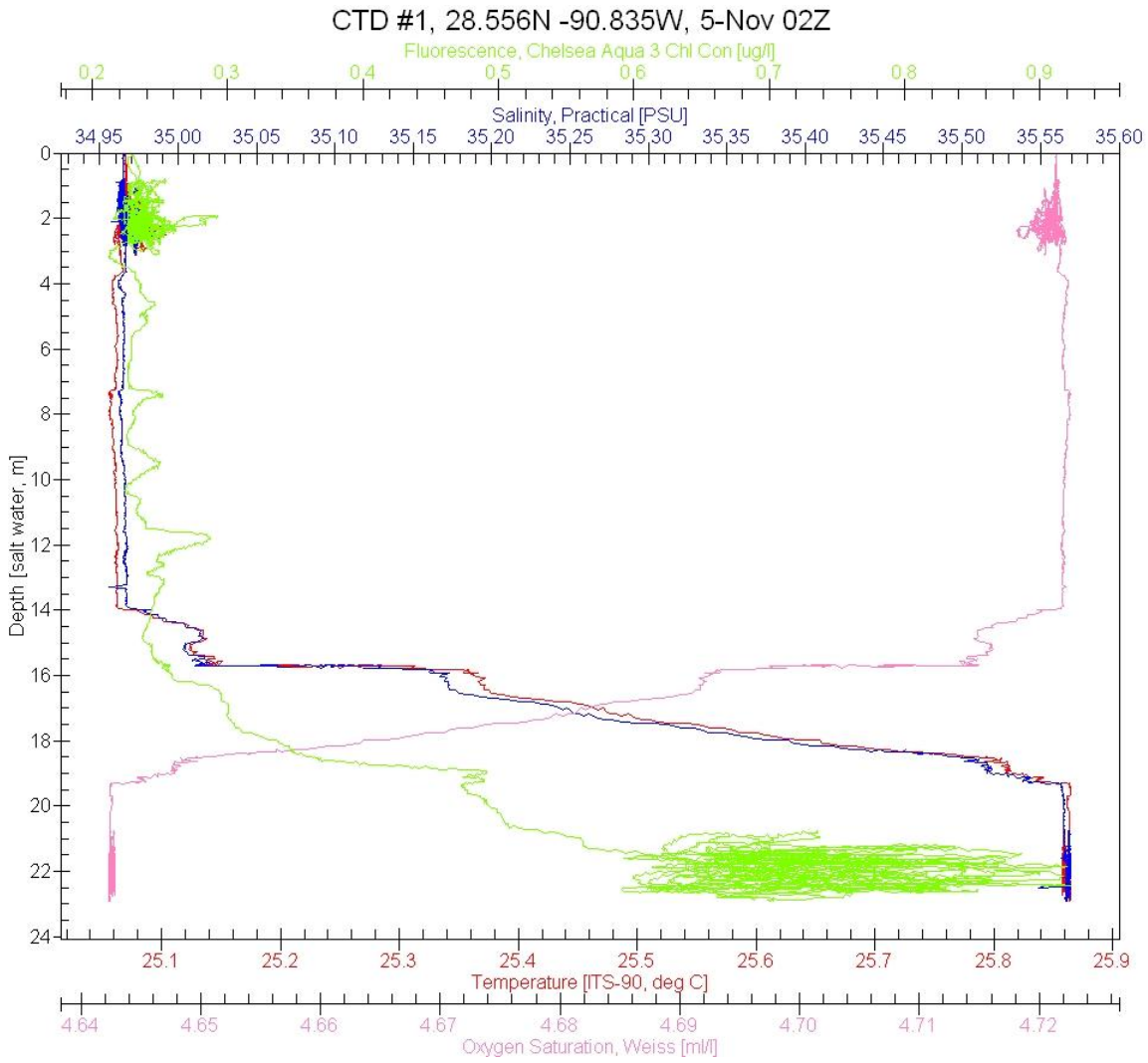
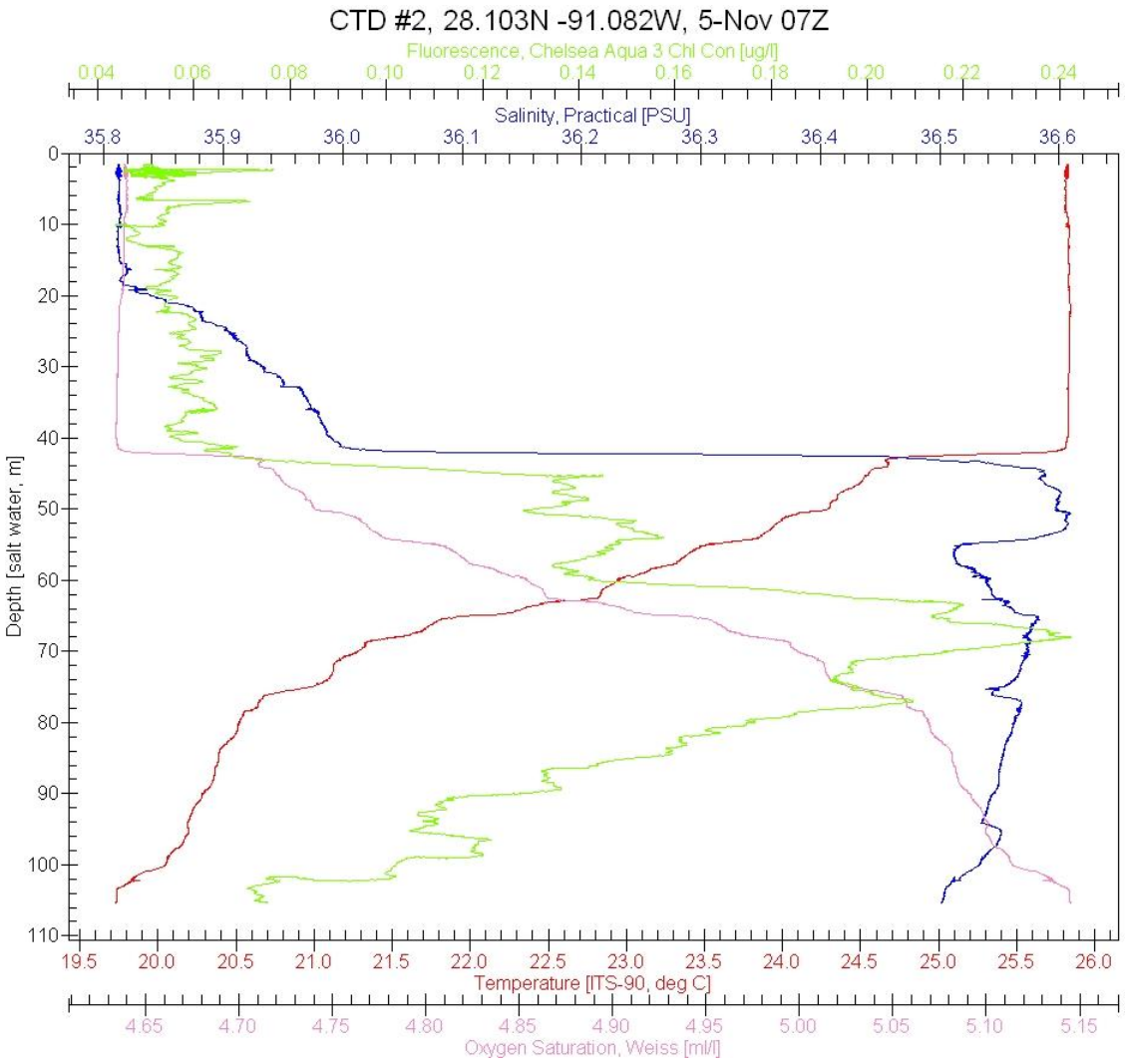
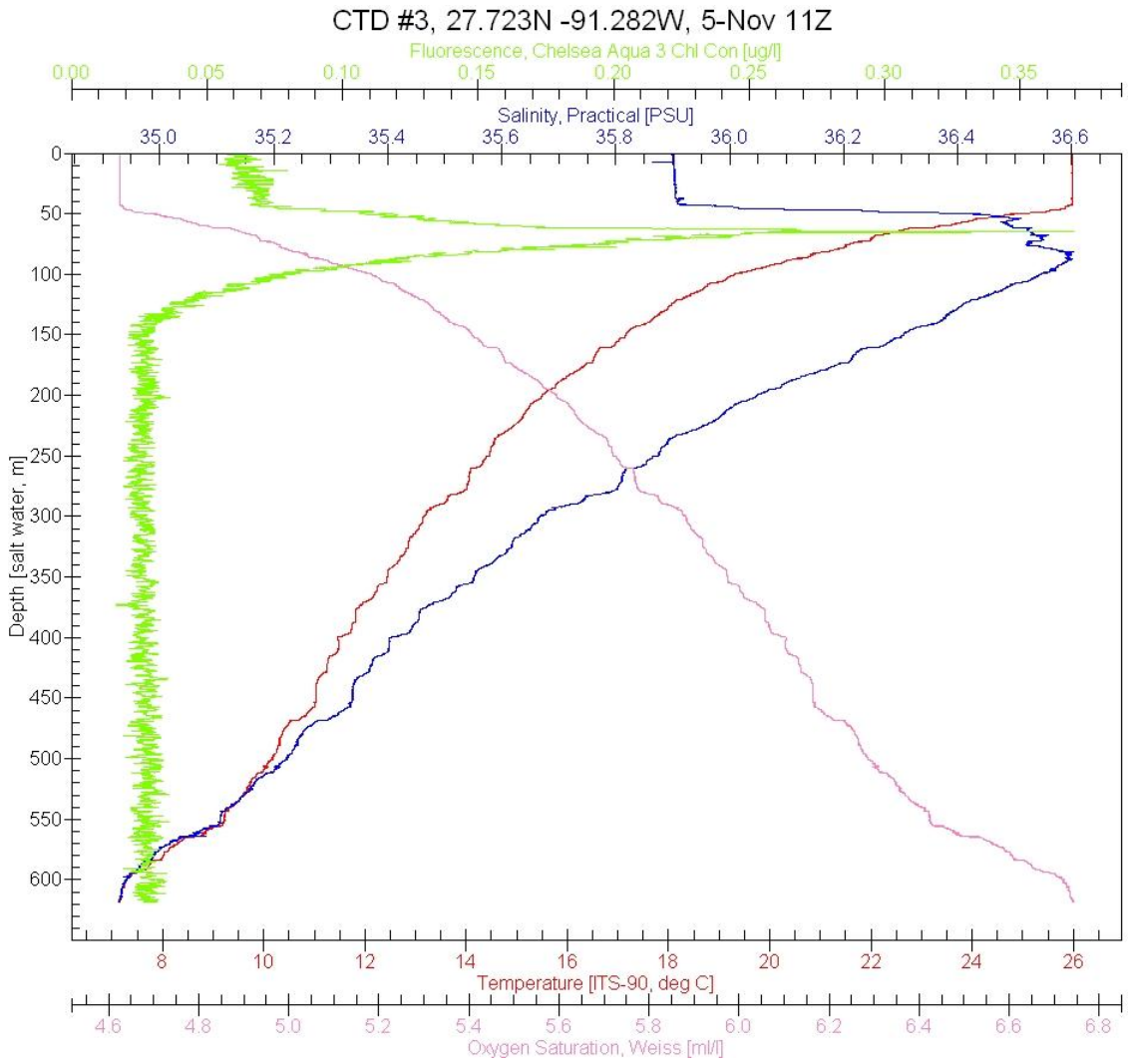
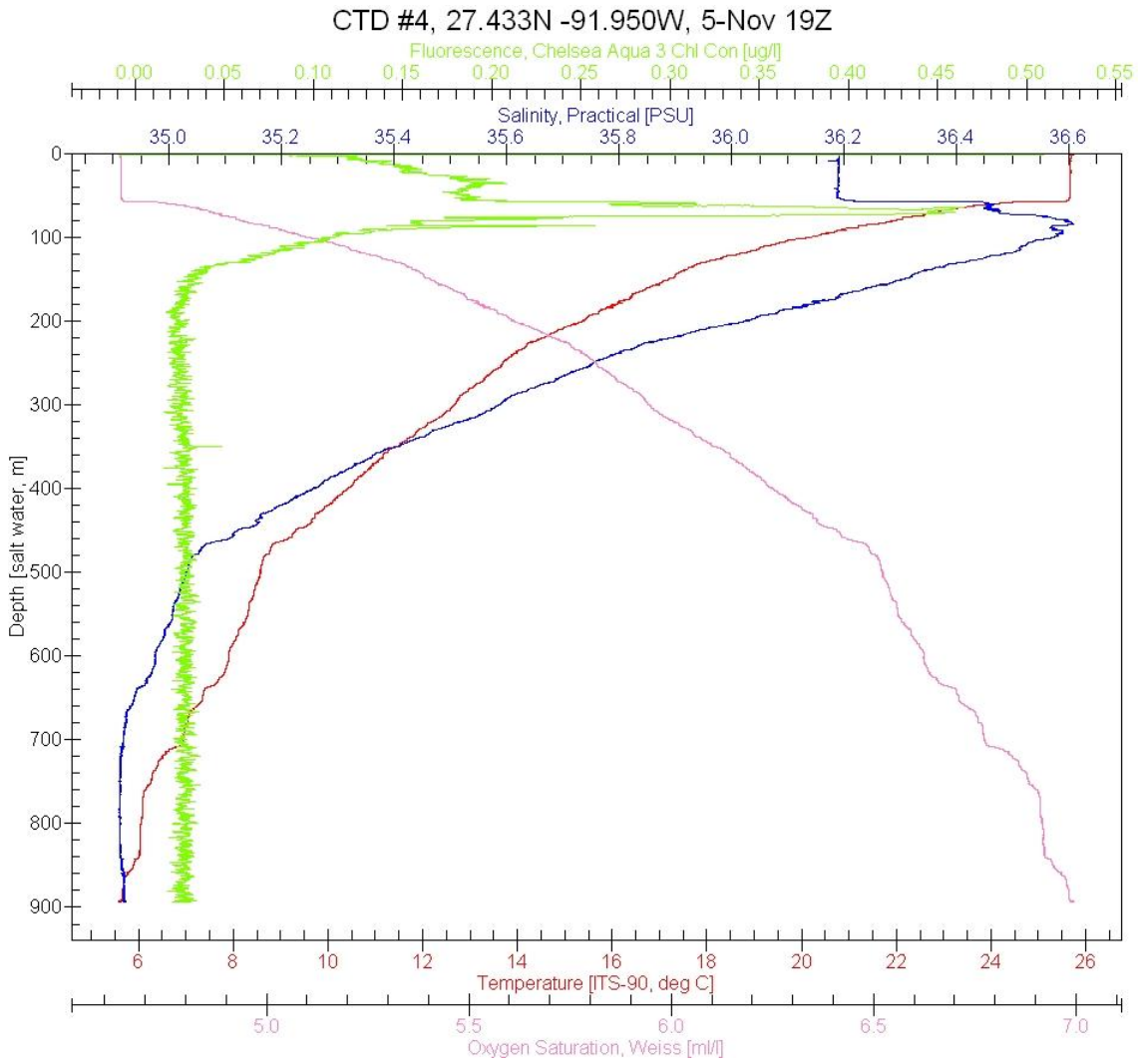



CTD #1, 28.556N -90.835W, 5-Nov 02Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Salinity, Practical [PSU]
34.95
35.00
35.05
35.10
35.15
35.20
35.25
35.30
35.35
35.40
35.45
35.50
35.55
35.60
Depth [salt water, m]
0
2
4
6
8
10
12
14
16
18
20
22
24
25.1
25.2
25.3
25.4
25.5
25.6
25.7
25.8
25.9
Temperature [ITS-90, deg C]
4.64
4.65
4.66
4.67
4.68
4.69
4.70
4.71
4.72
Oxygen Saturation, Weiss [ml/l]


CTD #2, 28.103N -91.082W, 5-Nov 07Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24
Salinity, Practical [PSU]
35.8 35.9 36.0 36.1 36.2 36.3 36.4 36.5 36.6
Depth [salt water, m]
0 10 20 30 40 50 60 70 80 90 100 110
19.5 20.0 20.5 21.0 21.5 22.0 22.5 23.0 23.5 24.0 24.5 25.0 25.5 26.0
Temperature [ITS-90, deg C]
4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15
Oxygen Saturation, Weiss [ml/l]


CTD #3, 27.723N -91.282W, 5-Nov 11Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
50
100
150
200
250
300
350
400
450
500
550
600
8
10
12
14
16
18
20
22
24
26
Temperature [ITS-90, deg C]
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
Oxygen Saturation, Weiss [ml/l]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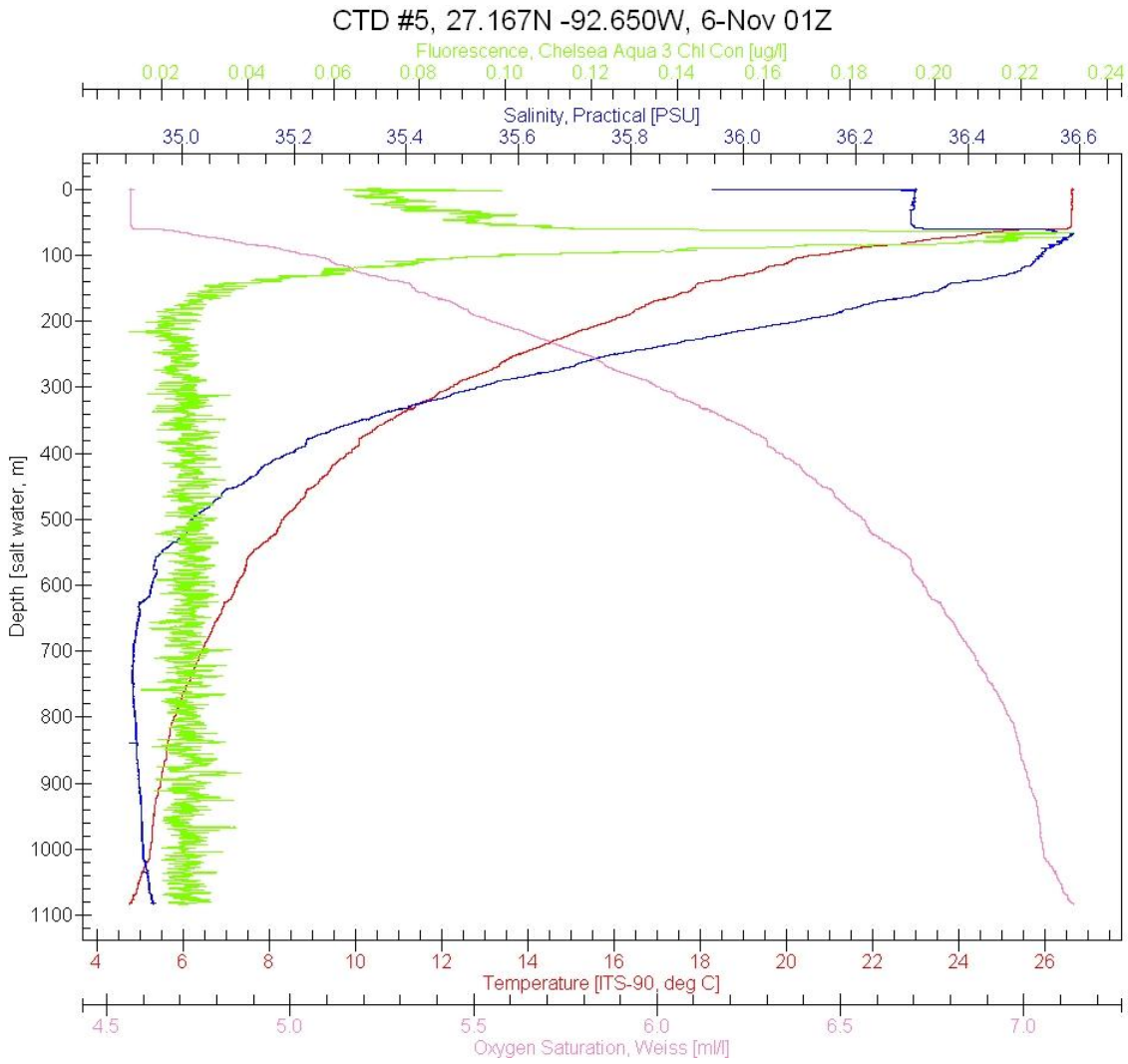
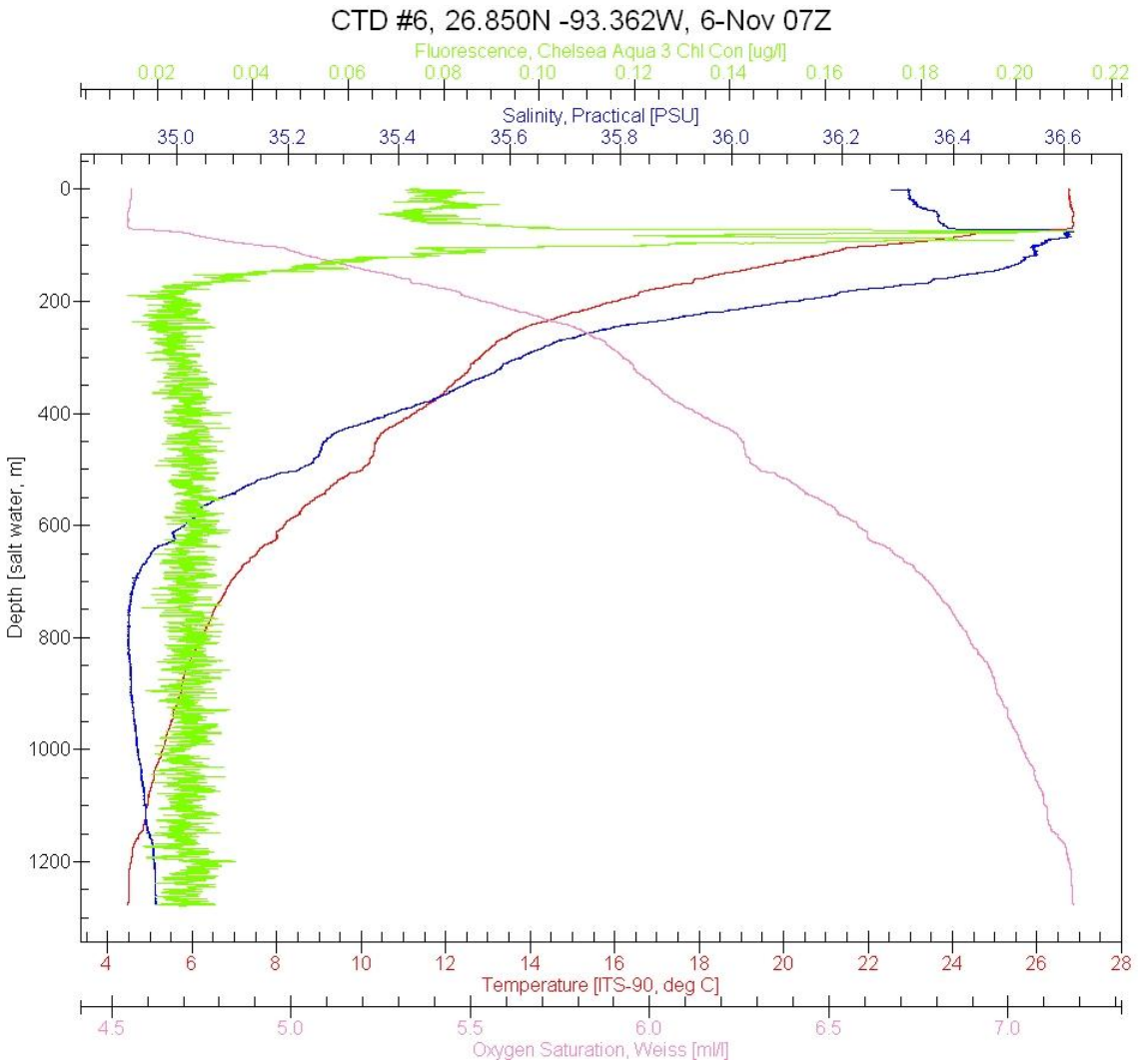
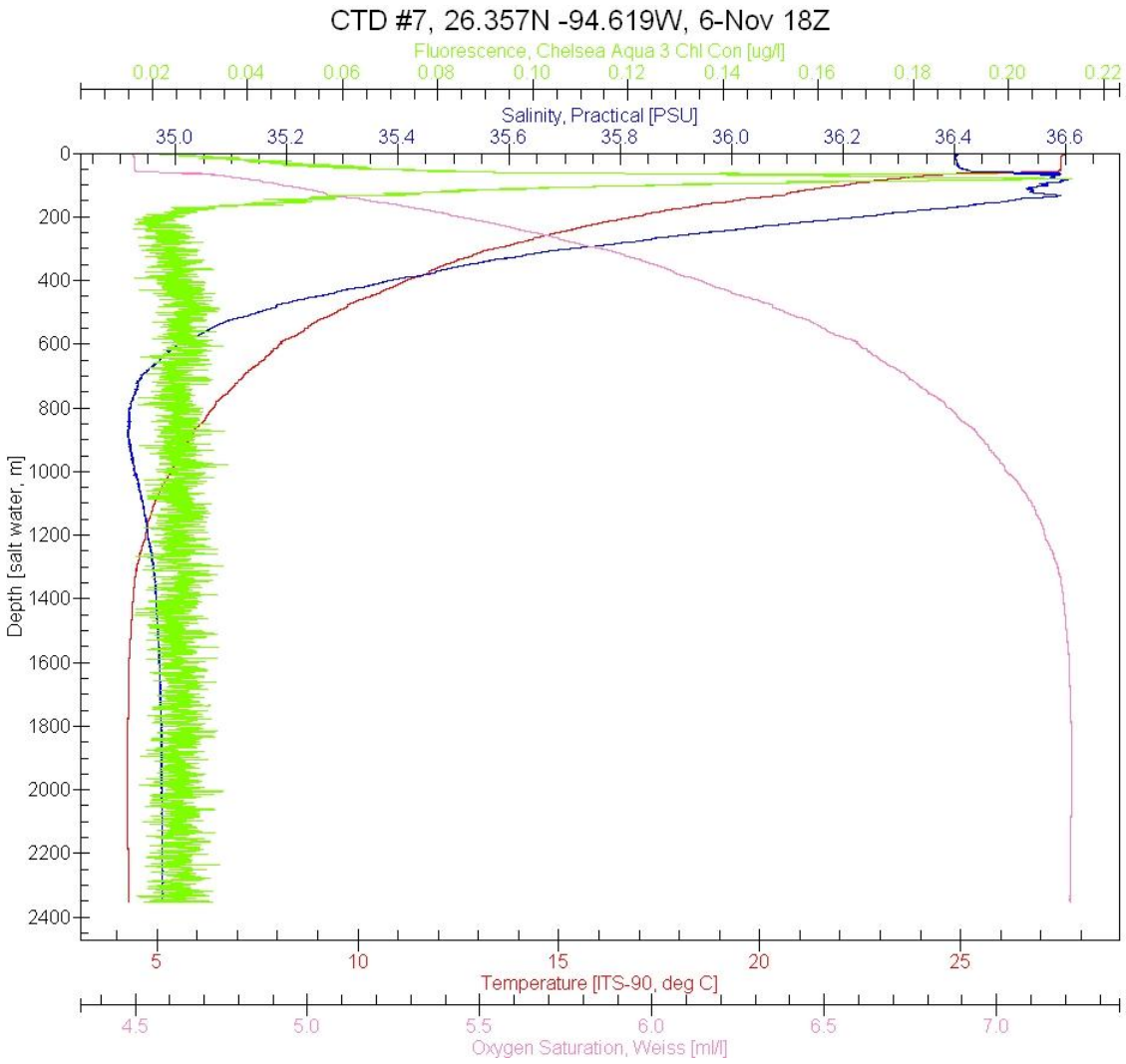
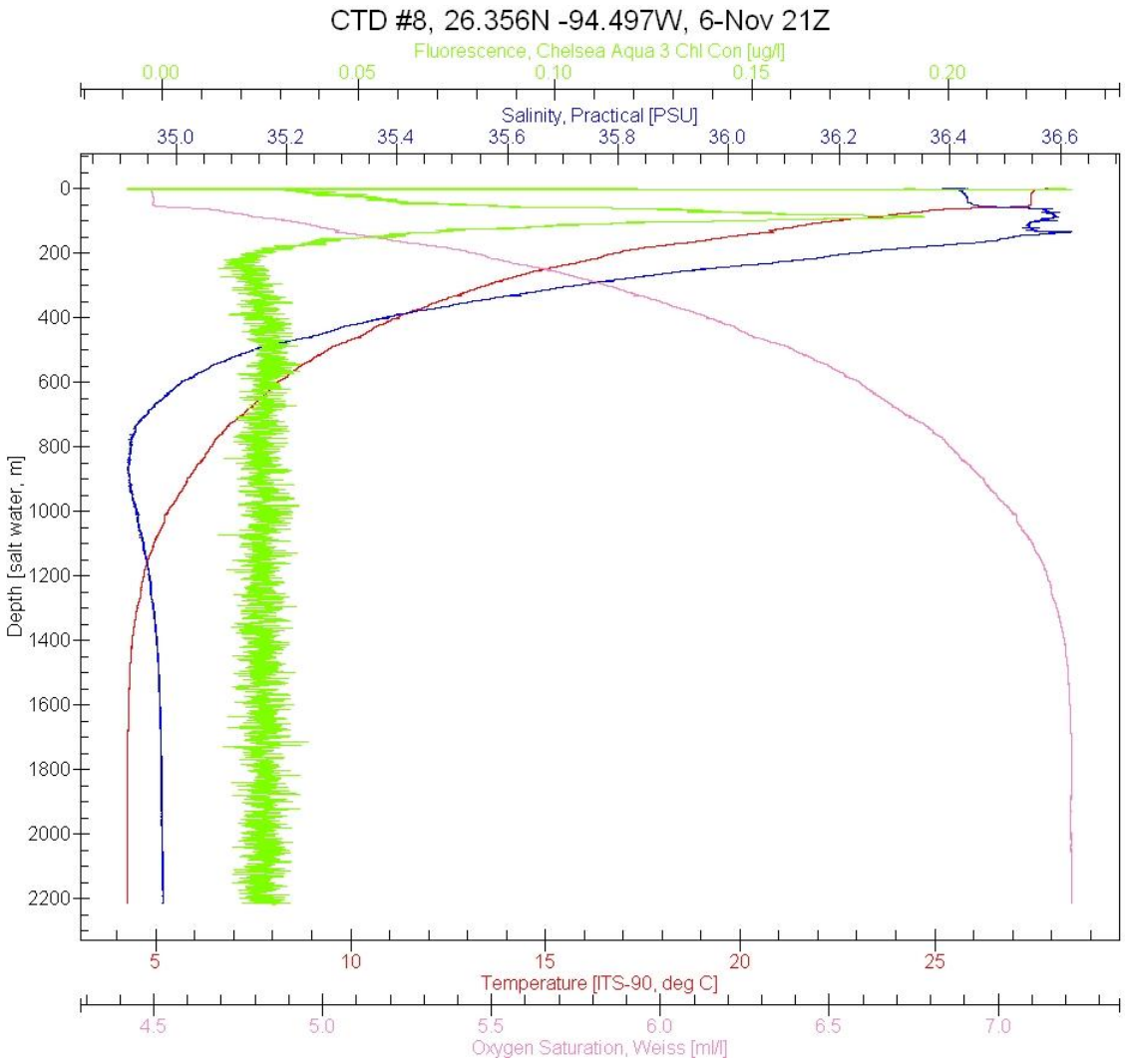
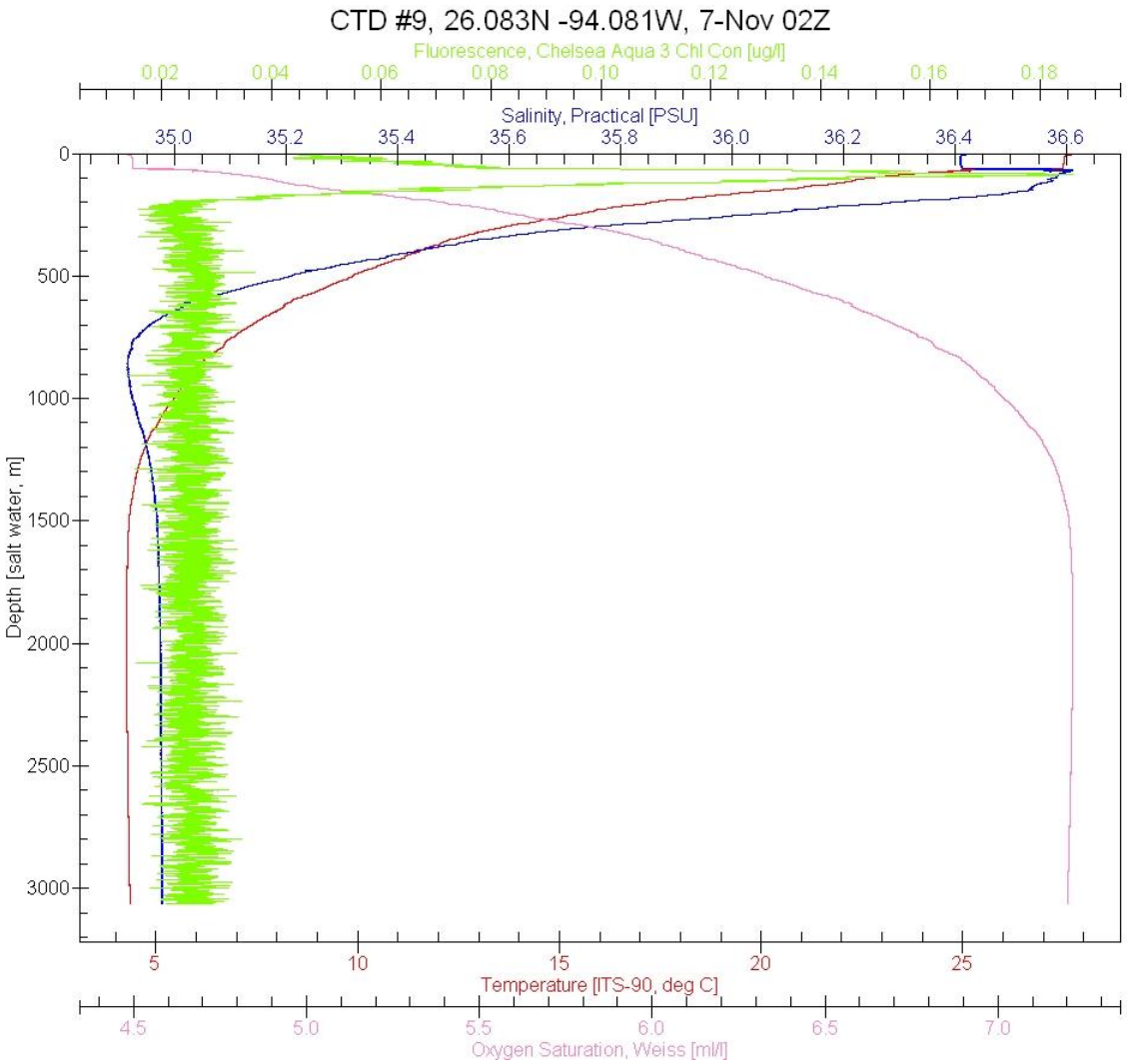
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
Salinity, Practical [PSU]
35.0 35.2 35.4 35.6 35.8 36.0 36.2 36.4 36.6
Depth [salt water, m]
0 100 200 300 400 500 600 700 800 900
6 8 10 12 14 16 18 20 22 24 26
Temperature [ITS-90, deg C]
5.0 5.5 6.0 6.5 7.0
Oxygen Saturation, Weiss [ml/l]

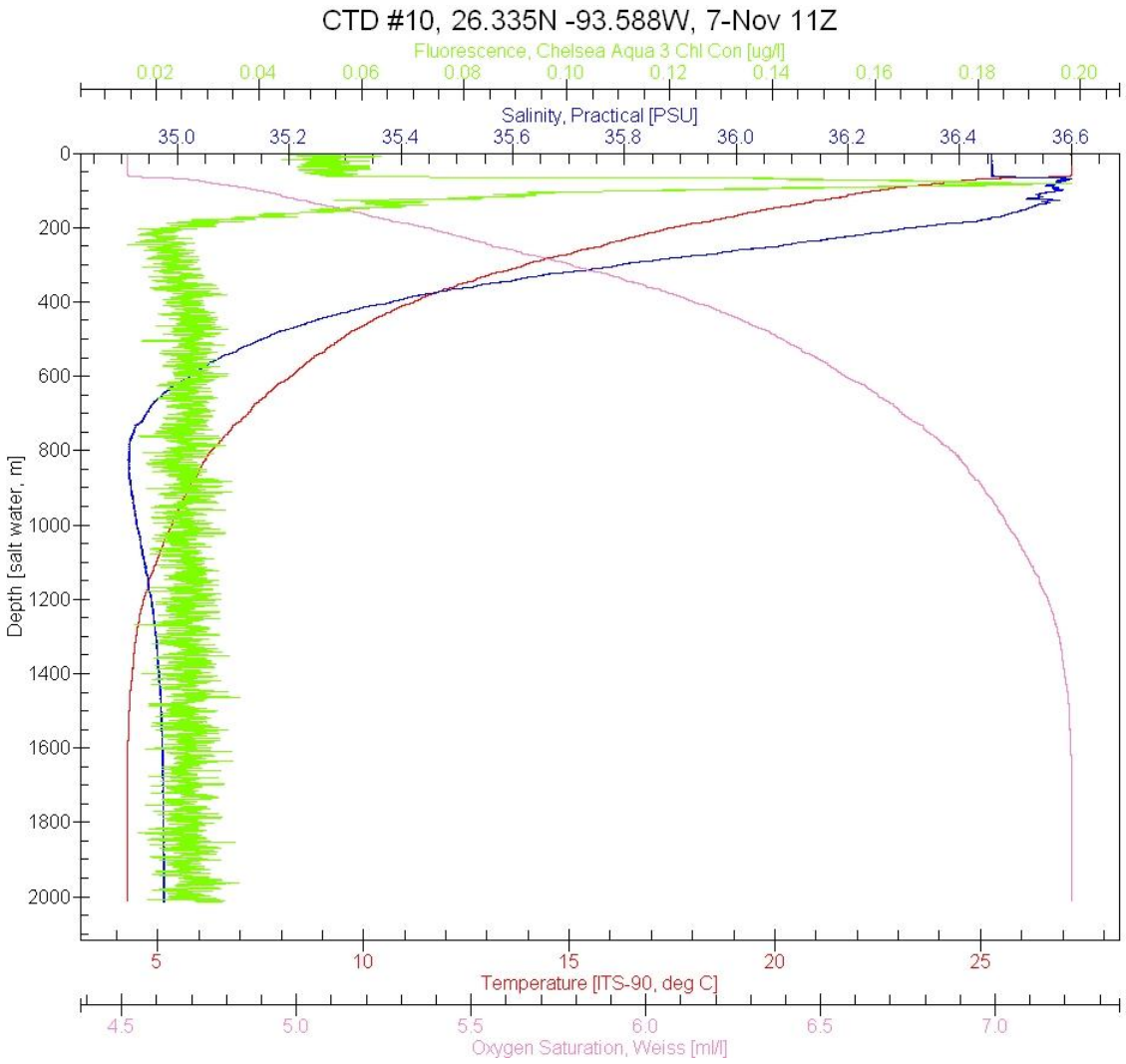

CTD #5, 27.167N -92.650W, 6-Nov 01Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24
Salinity, Practical [PSU]
35.0 35.2 35.4 35.6 35.8 36.0 36.2 36.4 36.6
Depth [salt water, m]
0 100 200 300 400 500 600 700 800 900 1000 1100
4 6 8 10 12 14 16 18 20 22 24 26
Temperature [ITS-90, deg C]
4.5 5.0 5.5 6.0 6.5 7.0
Oxygen Saturation, Weiss [ml/l]

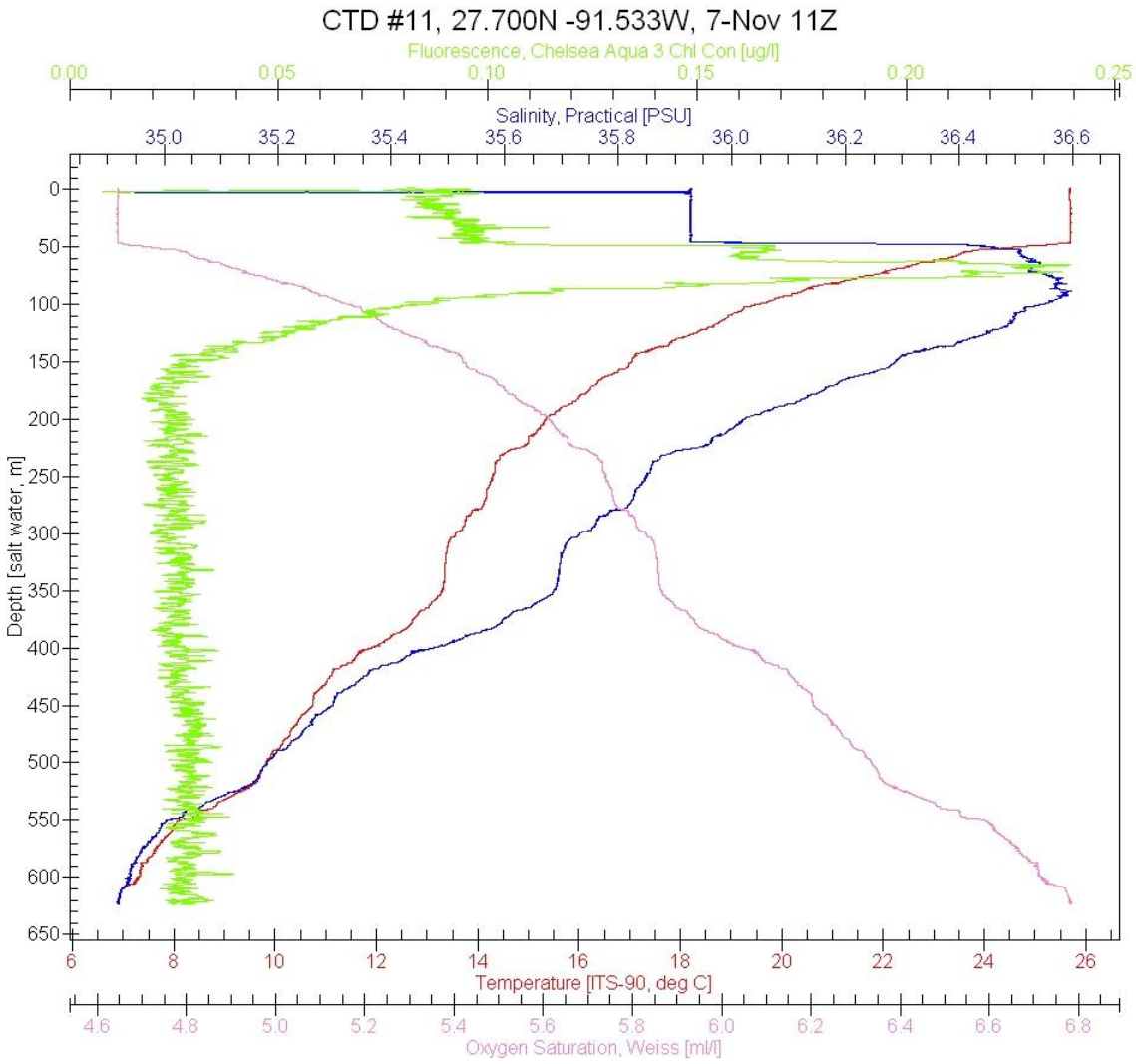

CTD #6, 26.850N -93.362W, 6-Nov 07Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
200
400
600
800
1000
1200
4
6
8
10
12
14
16
18
20
22
24
26
28
Temperature [ITS-90, deg C]
4.5
5.0
5.5
6.0
6.5
7.0
Oxygen Saturation, Weiss [ml/l]

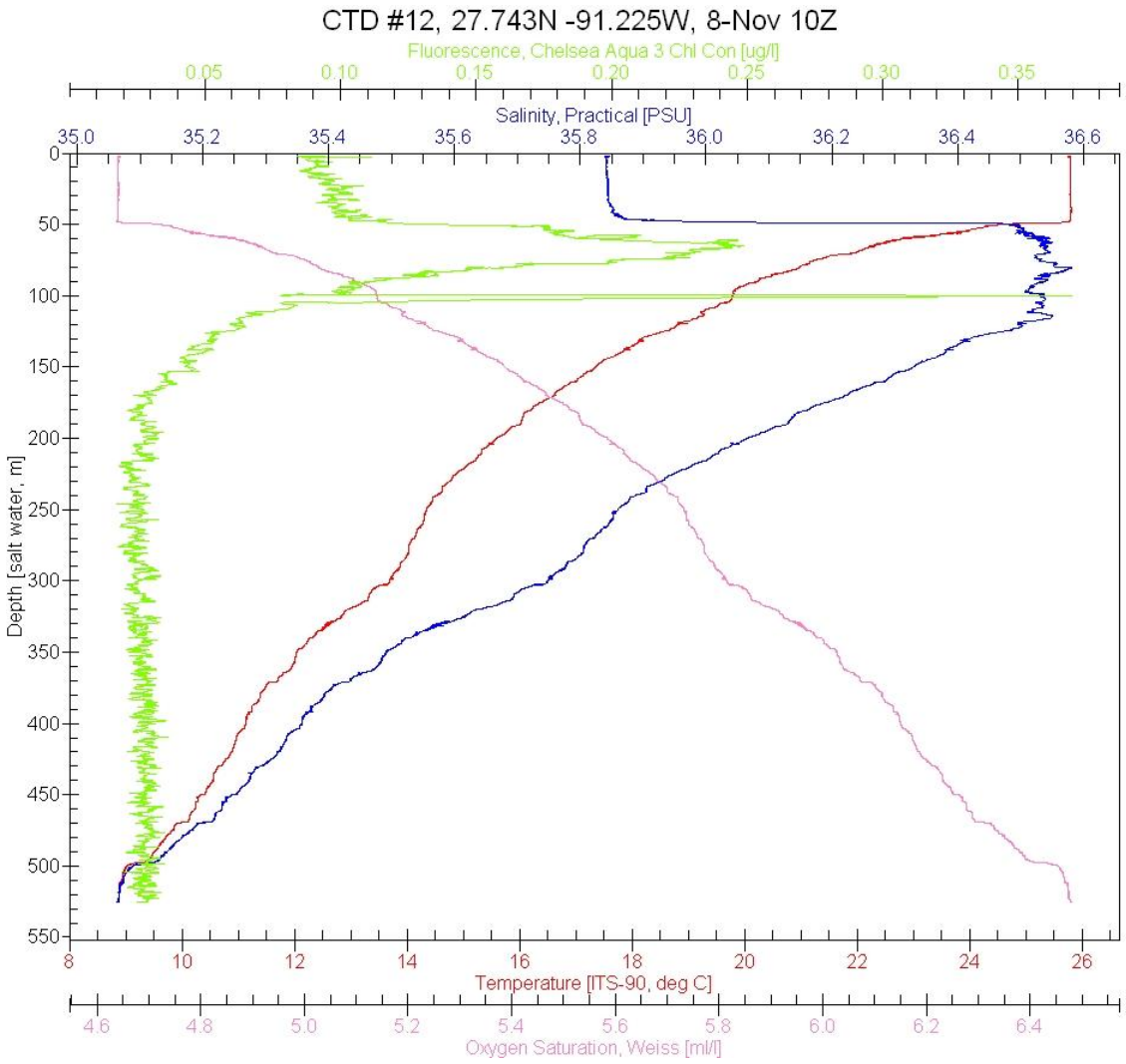

CTD #7, 26.357N -94.619W, 6-Nov 18Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
5
10
15
20
25
Temperature [ITS-90, deg C]
4.5
5.0
5.5
6.0
6.5
7.0
Oxygen Saturation, Weiss [ml/l]


CTD #8, 26.356N -94.497W, 6-Nov 21Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.00
0.05
0.10
0.15
0.20
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
5
10
15
20
25
Temperature [ITS-90, deg C]
4.5
5.0
5.5
6.0
6.5
7.0
Oxygen Saturation, Weiss [ml/l]


CTD #9, 26.083N -94.081W, 7-Nov 02Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
500
1000
1500
2000
2500
3000
5
10
15
20
25
Temperature [ITS-90, deg C]
4.5
5.0
5.5
6.0
6.5
7.0
Oxygen Saturation, Weiss [ml/l]


CTD #10, 26.335N -93.588W, 7-Nov 11Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
200
400
600
800
1000
1200
1400
1600
1800
2000
5
10
15
20
25
Temperature [ITS-90, deg C]
4.5
5.0
5.5
6.0
6.5
7.0
Oxygen Saturation, Weiss [ml/l]


CTD #11, 27.700N -91.533W, 7-Nov 11Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.00
0.05
0.10
0.15
0.20
0.25
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
50
100
150
200
250
300
350
400
450
500
550
600
650
6
8
10
12
14
16
18
20
22
24
26
Temperature [ITS-90, deg C]
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
Oxygen Saturation, Weiss [ml/l]


CTD #12, 27.743N -91.225W, 8-Nov 10Z
Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Salinity, Practical [PSU]
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
Depth [salt water, m]
0
50
100
150
200
250
300
350
400
450
500
550
8
10
12
14
16
18
20
22
24
26
Temperature [ITS-90, deg C]
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
Oxygen Saturation, Weiss [ml/l]

ctd.m

```
function [depth,salinity,temp,oxygen,flourescence,bottles]=ctd(file)

% Joseph B. Zambon
% 12-November 2013
%Input: CTD CSV-file
% Columns:
%   1. Depth
%   2. Salinity
%   3. Temperature
%   4. Flourescence
%   5. Bottles Fired
%Output: Date/Time, Lat, Lon, Bottle Depths, CTD array
%   1. Depth
%   2. Salinity
%   3. Temperature
%   4. Flourescence
%   5. Bottles Fired

disp(['Filename:  ' file])

%Find start of data, one line after "*END*"
eval(['!grep -nr END /var/www/html/joseph/nov13/PE14_11_Young_CTD/Station1_Cast1.cnv | cut -f1 -d: > filenum']);
row_start = csvread('filenum'); row_start = row_start + 1;
eval(['!rm -rf filenum'])
```

```
disp(['Row Start: ' num2str(row_start)])


fileid = fopen(file);

%textscan(fileid,'%s',row_start+1)

ctd_ar = textscan(fileid,'%f%f%f%f%f%d%f%f%s','headerLines',row_start);

depth = ctd_ar{1};

salinity = ctd_ar{2};

temp = ctd_ar{3};

oxygen = ctd_ar{4};

flourescence = ctd_ar{5};

bottles = ctd_ar{6};
```

plot_transect.m

```
% Matlab Script to Plot transects across CTD track
%
% Joseph B. Zambon
% 12-Nov 2013

location = [28.556, -90.835;
        28.103, -91.082;
        27.723, -91.282;
        27.433, -91.950;
        27.167, -92.650;
        26.850, -93.362;
        26.357, -94.619;
        26.356, -94.497;
        26.083, -94.081;
        26.083, -94.084;
        26.335, -93.588;
        27.700, -91.533;
        27.743, -91.225;];

files = ['/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station1_Cast1.cnv';
       '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station2_Cast1.cnv';
       '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station3_Cast1.cnv';
       '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station4_Cast1.cnv';
       '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station5_Cast1.cnv';
```

```
    '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station6_Cast1.cnv';
    '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station7_Cast1.cnv';
    '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station8_Cast1.cnv';
    '/var/www/html/joseph/nov13/PE14_11_Young_CTD/Station9_Cast1.cnv';];


% Outbound transect
%  Stations 1 through 9a
%
%Compute distance between stations
ns_station_start = 1;  %station ident of start
ns_station_end = 9;   %station ident of end
ns_stations = ns_station_end - ns_station_start + 1;  %number of stations in N-S
ns_dist(1,ns_station_start) = 0;      %distance of first station = 0km
for j=ns_station_start:1:ns_stations-1
lat1=location(j,1);
lat2=location(j+1,1);
lon1=location(j,2);
lon2=location(j+1,2);
ns_line(1,j-ns_station_start+1) = pos2dist(lat1,lon1,lat2,lon2,1)/2 + ns_dist(1,j); %distance to bisect plot
with line
ns_dist(1,j+1) = pos2dist(lat1,lon1,lat2,lon2,1) + ns_dist(1,j);
end
% Interpolate depth to defined (depth_int) intervals
grid_depth(:,1) = 0:1:3100;
% interpolate temps to gridded depth
for j=ns_station_start:1:ns_station_end
% Condition data for downcast only
```

```
[depth,salinity,temp,oxygen,flourescence,bottles]=ctd(files(j,:));

downcast = find(depth==max(depth));

ctd_ar =
[depth(1:downcast),salinity(1:downcast),temp(1:downcast),oxygen(1:downcast),flourescence(1:downca
st);];

% Sort according to depth

ctd_ar = sortrows(ctd_ar,1);


[a,b] = size(ctd_ar)

for k=1:a-1

if ctd_ar(k,1) == ctd_ar(k+1,1)

ctd_ar(k+1,:) = NaN;

end

end


ctd_ar1 = isnan(ctd_ar(:));


grid_temp(:,j) = interp1(depth,temp,grid_depth,'linear');

eval(['grid_temp(:,' num2str(j) ') = interp1(xbt' num2str(j) '.data(:,1),xbt' num2str(j)
'.data(:,2),grid_depth(:,1),''linear'');'])

grid_temp(:,j)=interp1(

end

% Place data in (X-Y) distance-depth grid

[X,Y] = meshgrid(ns_dist(1,:),grid_depth(:,1));
```

find_bottles.m

```
function [bottle] = find_bottles(file);

[depth,salinity,temp,oxygen,flourescence,bottles]= ctd(file);
max_bottles = max(bottles);

for j=1:max_bottles
find(bottles==j);
bottle(j) = depth(ans(1));
end
```

Appendix V. Survivors