P6314 / ENGI 9098 : Field Oceanography

Cruise Report

Leg 1: Oct 6 - 7, 2008

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Introduction

This cruise report details the first leg (1.5 days) of a week-long scientific cruise, as part of the course requirements for a multi-disciplinary graduate course at Memorial University, titled Field Oceanography. Specifically, this report will outline the relevant technical details of the cruise, the scientific objectives of the first leg, results, and problems encountered. As well, potential avenues for further scientific analysis will be presented.

Vessel Background

The Anne S. Pierce is a research vessel owned and operated by the Memorial University of Newfoundland's Marine Institute. Intended specifically for scientific research, it was ideally suited to the needs of the Field Oceanography class, given the wide variety of equipment and instrumentation to be used. The relevant technical details of the Anne S. Pierce can be seen below:

Ship Name: **Anne S. Pierce**
Official Ship Number: **802013** *(Transport Canada)*
Owner & Operator:
Memorial University of Newfoundland
FISHERIES AND MARINE INSTITUTE
P.O. BOX 4920
ST. JOHN'S NL A1C 5R3
709-778-0305
Port of Registry: **ST. JOHN'S**
Date of Registry: **1982/08/10**

Gross Tonnage: **296 t**
Net Tonnage: **89 t**

Length: **29.90 m**
Breadth: **8.00 m**
Depth: **4.20 m**

Self-Propelled Power: **1,125 brake horsepower**
Speed: **10.0 knots**
Fuel Type: **Diesel**

Cruise Background

The cruise was scheduled for Monday, October 6, 2008 until Friday, October 10, 2008. The intention of this cruise was for all students to gain experience with at-sea operations, and the collection of oceanographic data, specifically outside of their area(s) of expertise. The governing disciplines were Geology, Biology, Physical Oceanography, and Ocean Engineering, and data was gathered in all of these disciplines.

Due to the large number of students, the cruise was divided into three legs, and subsequently students were divided into six teams, with two teams per cruise. While clear scientific goals were established for the week, the actual timing and execution of the specific sampling tasks was largely left very flexible, as it was very time- and schedule-dependent.

This report pertains to the first 1.5 day leg of the cruise. Note that data presented is divided into "Day 1 Data", "Day 2 Data", and "Additional Data" collected throughout the entire week.

Scientific Objectives

Leg 1 had a number of scientific responsibilities

1. Transit to Conception Bay from St. John's Harbour
2. Perform Large-scale CTD survey of Conception Bay during transit
3. Perform ADCP/Sonar transects near Bell Island
4. Deploy ADCP mooring(s), to be recovered on the final day of the cruise

The resulting scientific data would later be used to analyse the thermal layers and movement of currents throughout Conception Bay. This would hopefully be used to identify the warming of ocean water as it enters and exits the bay. As well, sonar transects were performed on areas of interest near Bell Island, in hopes of observing both (a) a shipwreck, and (b) the slope of the Bell Island Tickle.

Ship Track

The course of the ship throughout the first leg of the cruise was plotted using Matlab's M_map mapping package, which allowed for placement of the CTD Survey stations and Sonar Transects along the track line. This can be seen in Figure 1 below.

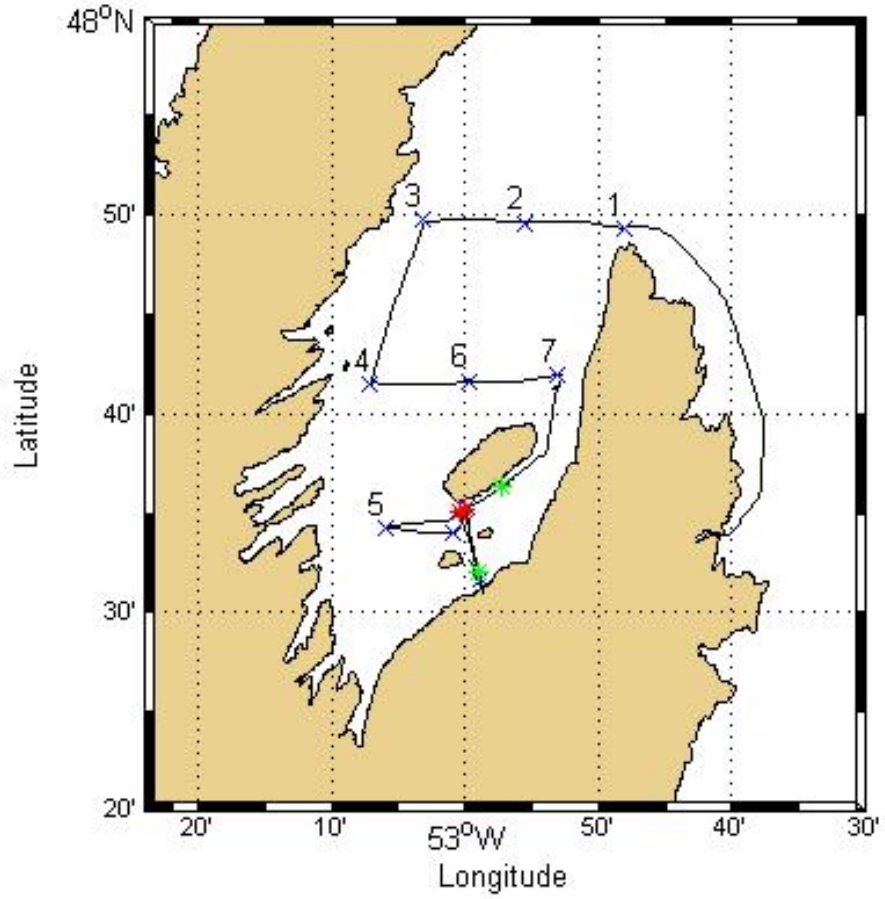

Figure 1: Ship Track with CTD Stations and Transects

As can be seen above, the large-scale CTD Survey stations are numerically labelled "1" through "7", and were performed during ship transit from the St. John's harbour (the Easterly starting location). The green and red markers indicate the two sonar transects, parallel and perpendicular to Bell Island. Green indicates the start of a transect, whereas red indicates the end of a transect.

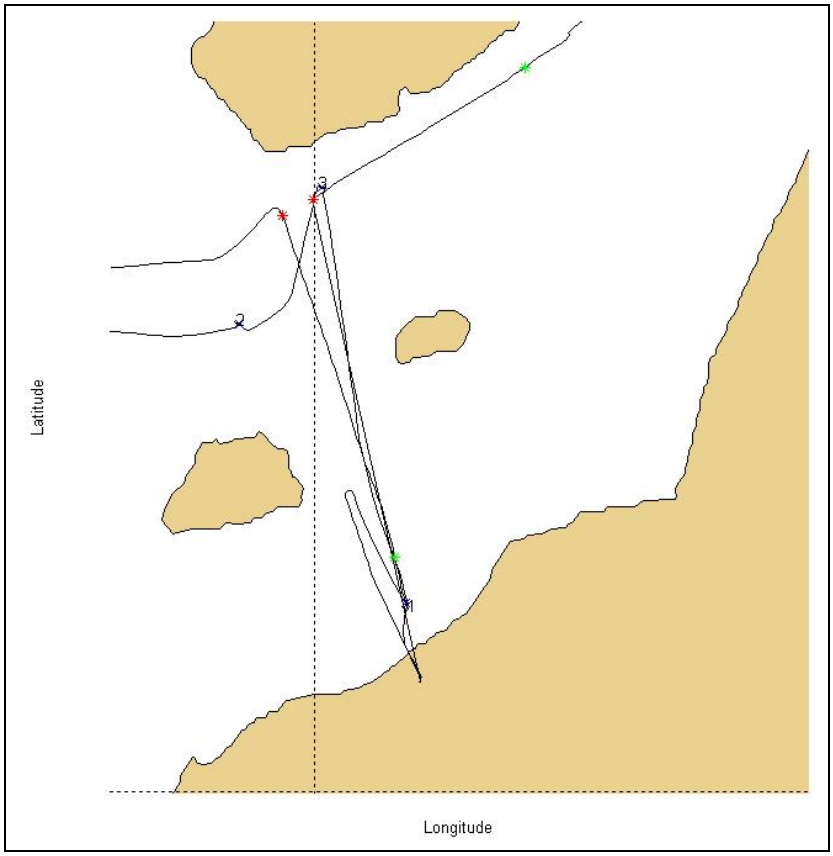

Figure 2: Detailed View of Sonar Transects

A detailed view of the sonar transect locations is shown above, in Figure 2. As well, the small-scale CTD survey locations are shown numerically labelled as "1" through "3". As this leg of the cruise only had time to perform three of the four small-scale CTD surveys, only three survey locations are shown on the track.

Day 1 Data

Instructors: Sam Bentley, Brad deYoung, Ralf Bachmayer and Jack Foley
Students: Team 1 - David Shea, Ray Roche, Tristan Hauser and Zhimin Ma
Team 2 - Andre Roy, Renita Aranha, William Fowler and Sara Best

Overview of work accomplished

- Completed Large-scale CTD survey of stations 1 through 7, except 5
- Completed sonar & ADCP transect of Bell Island Tickle (parallel transect)

Problems encountered

- Some CTD stations needed to be replotted due to typographical errors
- Parallel transect near Bell Island Tickle was replotted, as it came too close to a shoal

Large-scale CTD Survey

Seven stations were identified throughout Conception Bay, with the intention of obtaining a large-scale survey of the conductivity and temperature relative to depth throughout the bay. These stations were to be surveyed on the first and last day of the cruise, and a comparative analysis performed.

Due to time constraints, Station 5 was surveyed on Day 2 instead of Day 1.

Station 1
Time: 14:03 UTC, Oct. 6, 2008
Latitude: 47 49.319 N
Longitude: 52 48.101 W
Depth: 136M

Station 2
Time: 15:01 UTC, Oct. 6, 2008
Latitude: 47 39.627 N
Longitude: 52 55.597 W
Depth: 194M

Station 3
Time: 15:59 UTC, Oct. 6, 2008
Latitude: 47 39.769 N
Longitude: 53 03.251 W
Depth: 80M

Station 4
Time: 17:02 UTC, Oct. 6, 2008
Latitude: 47 41.541 N
Longitude: 53 07.086 W
Depth: 135M

Station 6
Time: 17:41 UTC, Oct. 6, 2008
Latitude: 47 41.665 N
Longitude: 52 59.765 W
Depth: 120M

Station 7
Time: 18:18 UTC, Oct. 6, 2008
Latitude: 47 41.997 N

Longitude:	52 53.019 W	Depth:	120M

The following figures show the relevant data from all seven CTD stations plotted. Note that Station 5, which was surveyed on Day 2, is also included in these plots for completeness.

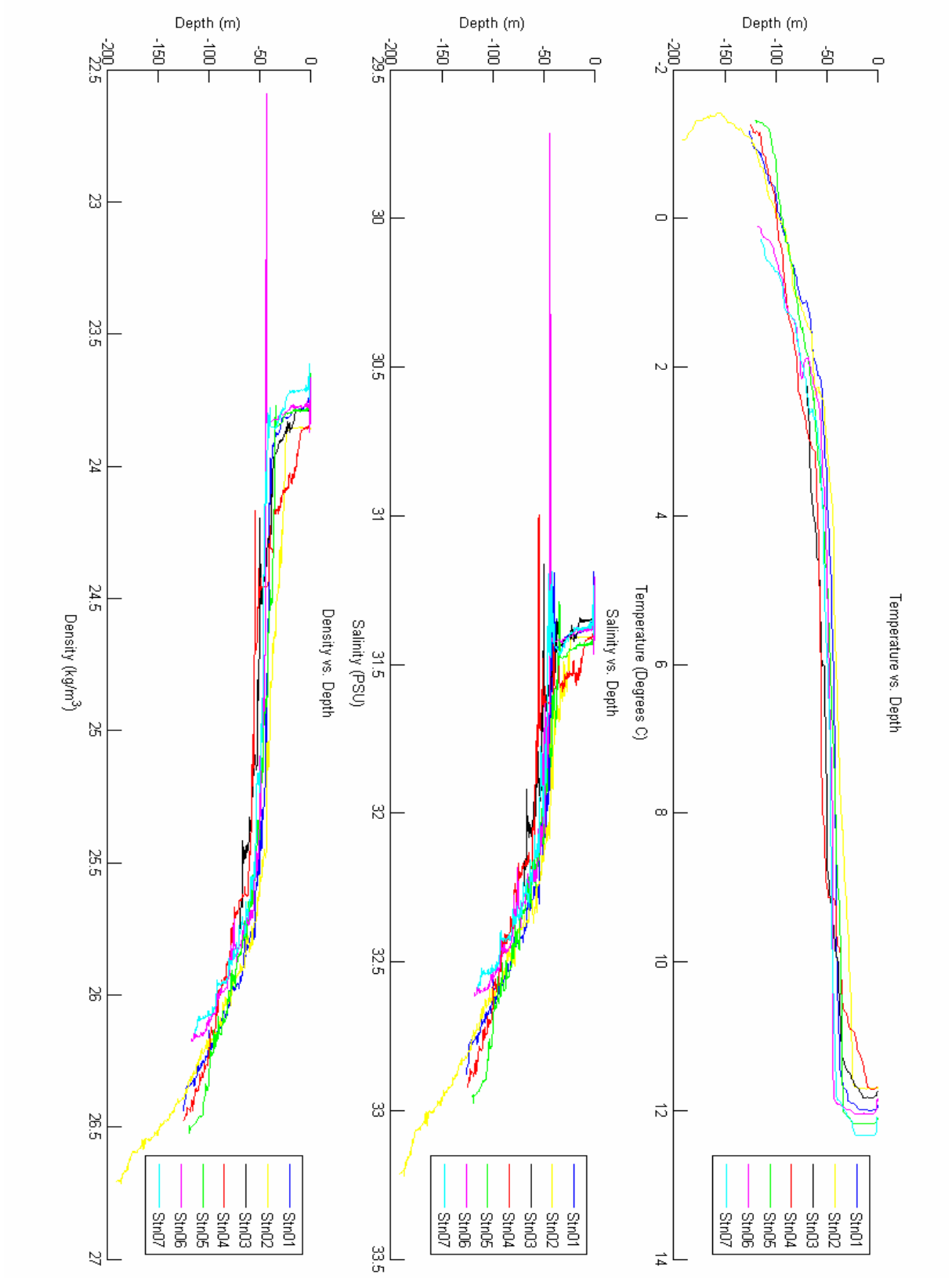

Figure 3: Large Scale CTD Survey Data Set #1

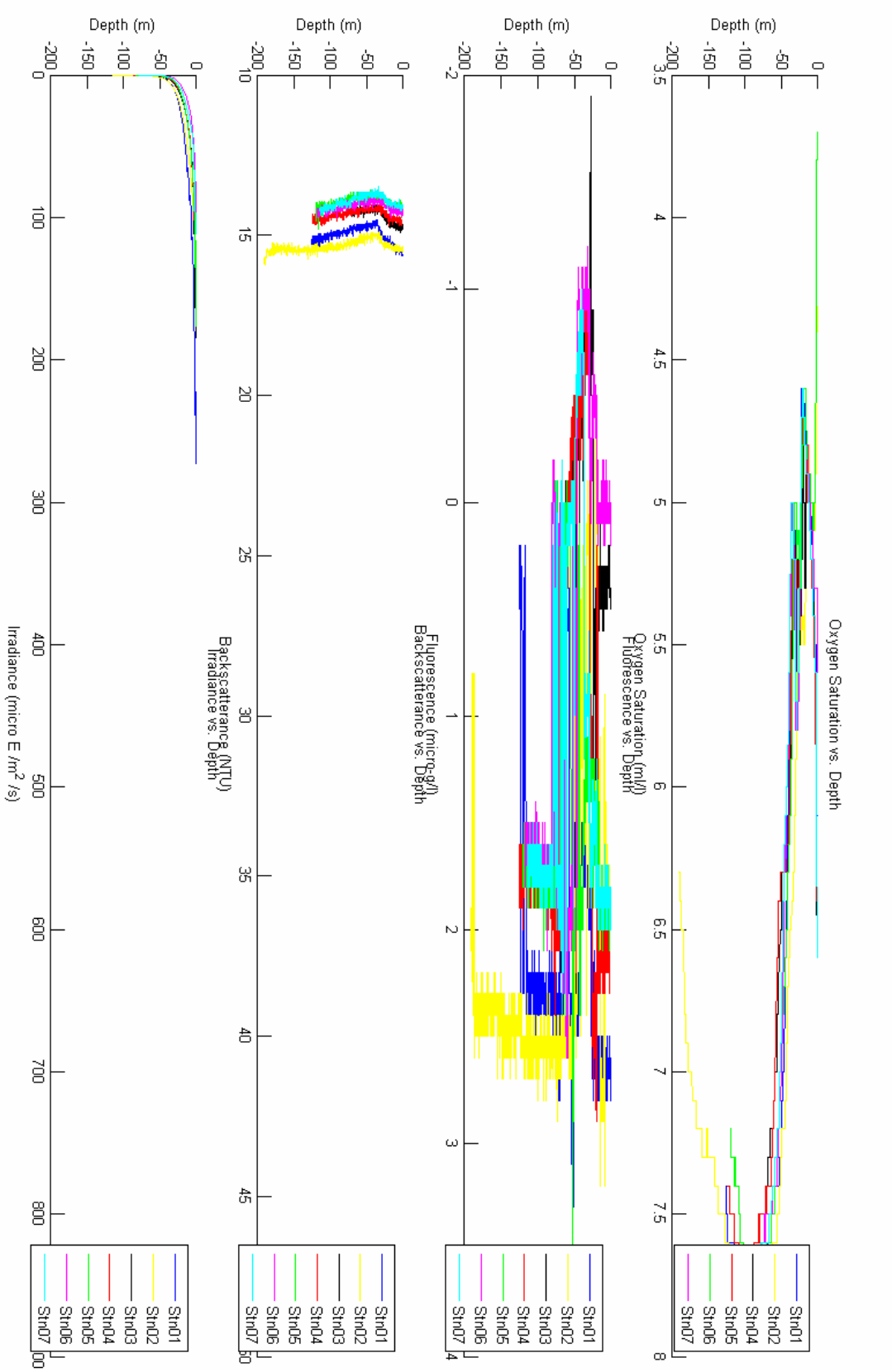

Figure 4: Large Scale CTD Survey Data Set #2

Bell Tickle Parallel Transect Data

A towed-array transect parallel to Bell Island was performed, utilizing two arrays. The first array consisted of an Imagenex Delta-T multibeam sonar, a Biosonics Echosounder, and a Teledyne RD Instruments ADCP. The second array consisted of an Edgetech Sidescan Sonar.

Transect Specifications

Start

Time:	19:23 UTC, Oct. 6, 2008
Latitude:	47.36.31760 N
Longitude:	52.57.27260 W

Stop

Time:	20:02 UTC, Oct. 6, 2008
Latitude:	47.35.166880 N
Longitude:	53.00.02880 W

Transect Data

An example of typical un-processed data from the Imagenex Delta-T Multibeam can be seen below in Figure 5. This image in particular shows what is believed to be a shipwreck.

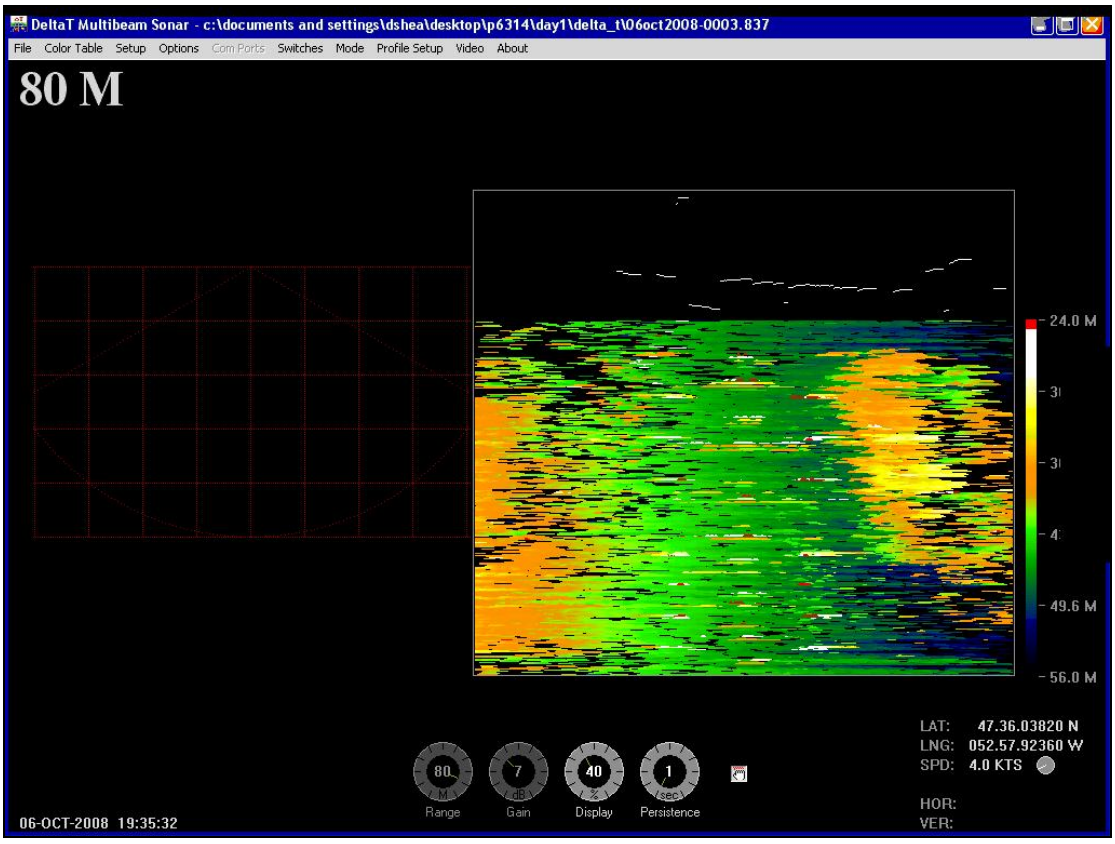

Figure 5: Example multibeam data showing shipwreck

An example of typical un-processed data from the Biosonics Echosounder is shown below in Figure 6. The profile of the bottom can be clearly seen by the distinct red line, with some noise indicating possible creatures or structures near the bottom. Also, note the "shadow" of the profile, seen faintly at the bottom of the graph; this is a product of the acoustic reflection of the echosounder ping off of the ocean surface.

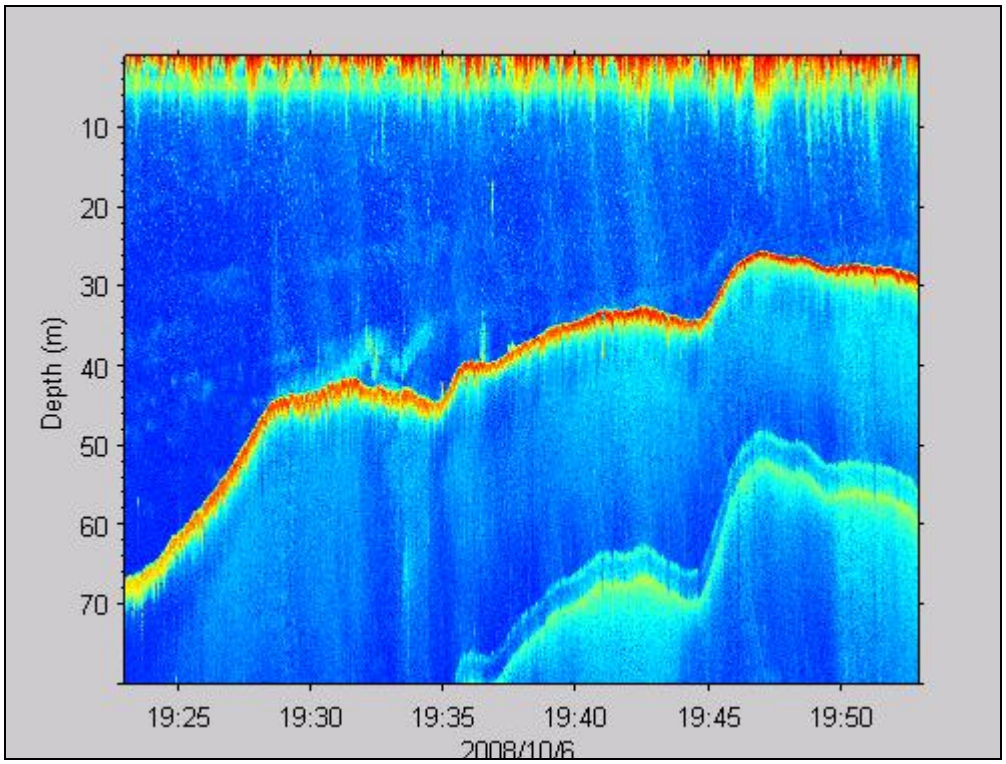

Figure 6: Biosonics Echosounder Data

An example of typical un-processed ADCP data is shown below in Figure 7. Data is plotted against a time scale measured in fractions of a day, where zero is the start time of the transect. This was done to facilitate processing and manipulation of the data.

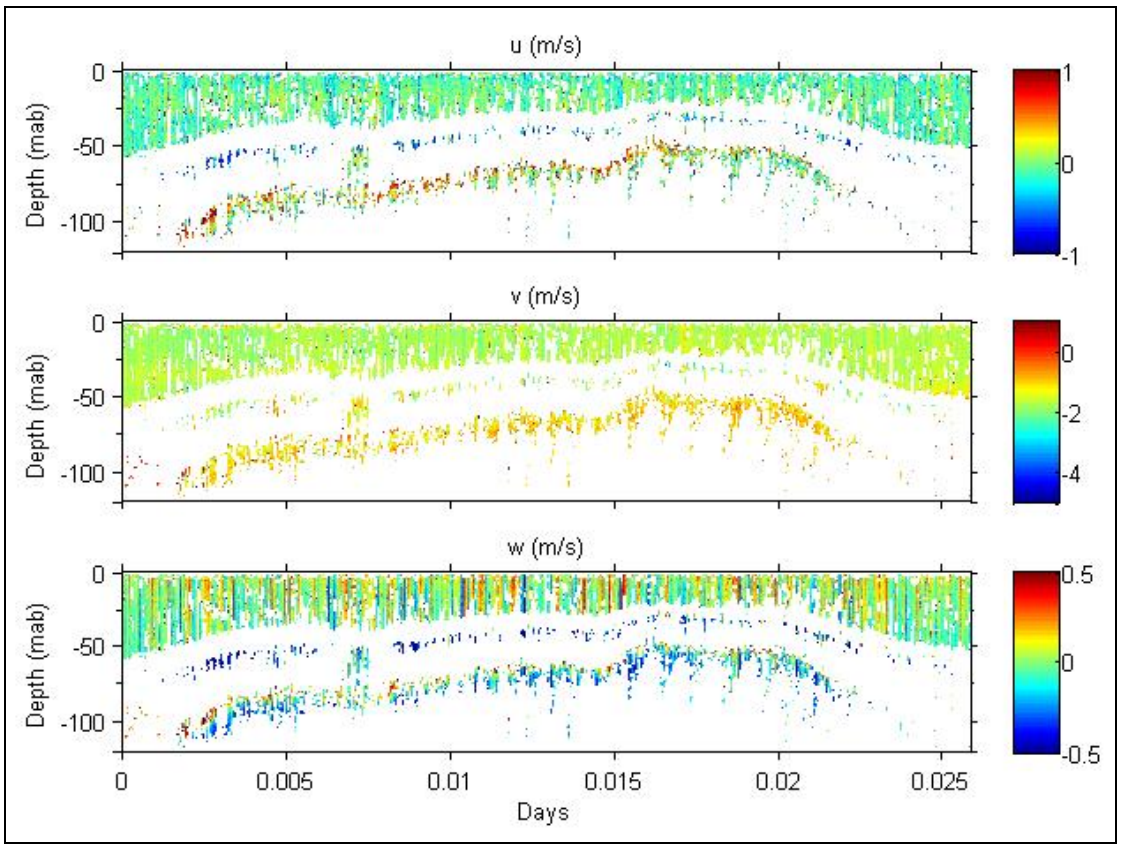

Figure 7: RD Instruments ADCP Data

A typical example of data from the Edgetech Sidescan Sonar Towfish can be seen below in Figure 8. In this example, what is believed to be a school of fish is observed as a "cloud".

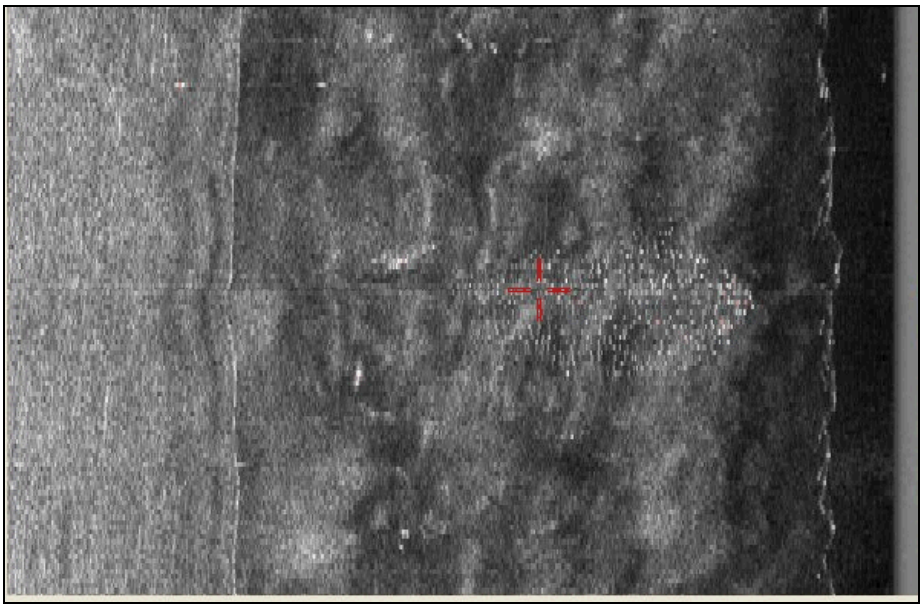

Figure 8: Edgetech Sidescan data showing a school of fish

Day 2 Data

Instructors: Sam Bentley, Brad deYoung
Students: Team 1 - David Shea, Ray Roche, Tristan Hauser and Zhimin Ma
Team 2 - Andre Roy, Renita Aranha, William Fowler and Sara Best

Overview of work accomplished

- Completed Large-scale CTD survey station 5
- Completed Small-scale CTD stations 1,2 and 3
- Completed ADCP & sonar cross-channel transect

Problems encountered

- Ran out of time, were unable to perform CTD small-scale survey station #4

Small & Large scale CTD Survey

A series of small-scale CTD stations were surveyed, with the intention of correlating CTD data with ADCP and towed-array data from the cross-channel transect. Four small-scale CTD stations were designated, but only the first three were surveyed in this leg of the cruise, due to time constraints.

The final large-scale CTD station was surveyed as well.

Station 1 (Small Scale)

Time: 11:42 UTC, Oct. 7, 2008
Latitude: 47 31.642 N
Longitude: 52 58.830 W
Depth: 18M

Station 2 (Small Scale)

Time: 13:58 UTC, Oct. 7, 2008
Latitude: 47 34.079 N
Longitude: 53 00.989 W
Depth: 30M

Station 3 (Small Scale)

Time: 14:23 UTC, Oct. 7, 2008
Latitude: 47 35.275 N
Longitude: 52 59.919 W
Depth: 45M

Station 5 (Large Scale)

Time: 13:13 UTC, Oct. 7, 2008
Latitude: 47 34.258 N
Longitude: 53 05.894 W
Depth: 120M

The following figures show the relevant data from the three small-scale CTD stations plotted. Note that the data from Station 5 is included in the previous Large-scale CTD Survey plots.

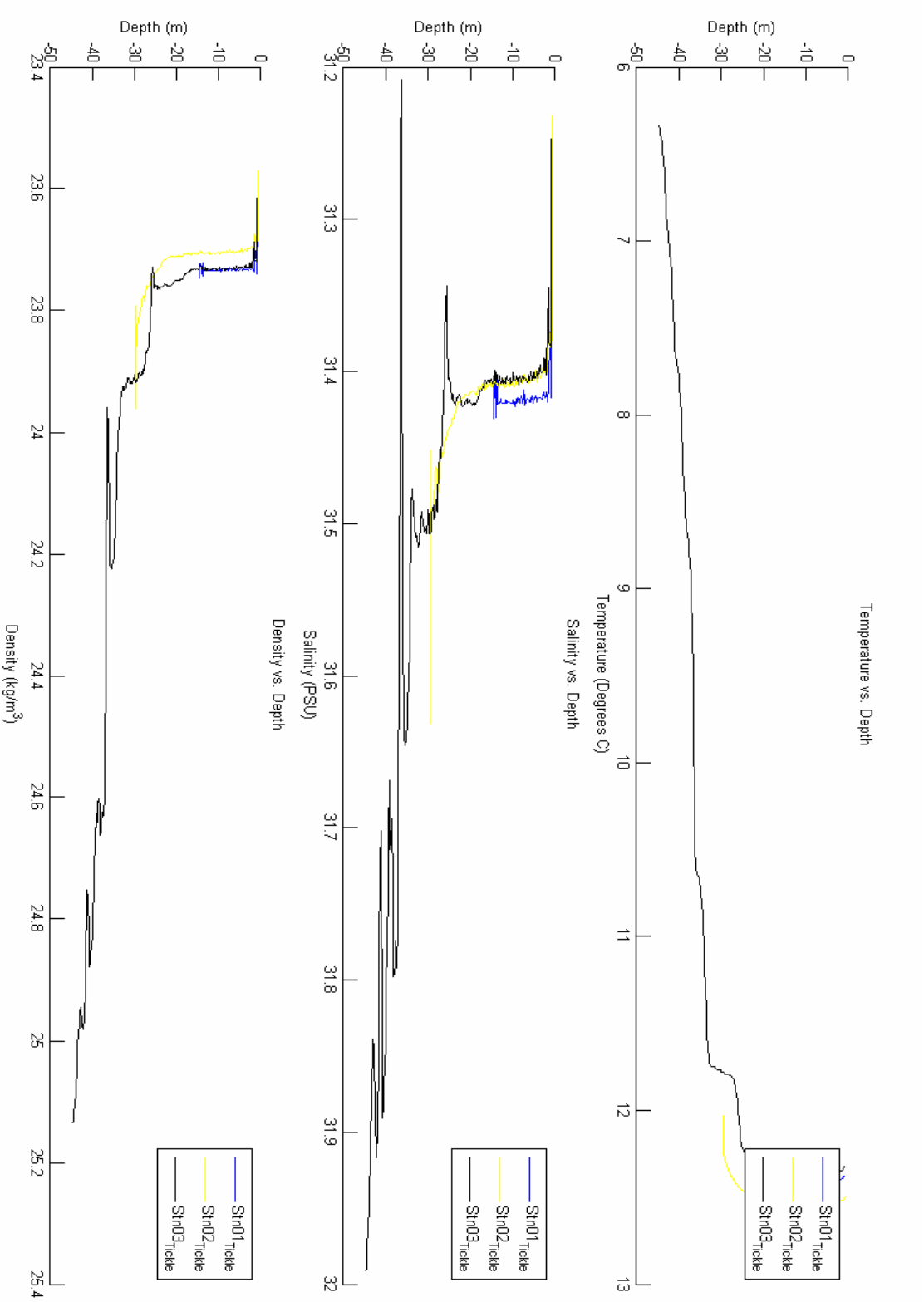

Figure 9: Small-scale CTD Data Set #1

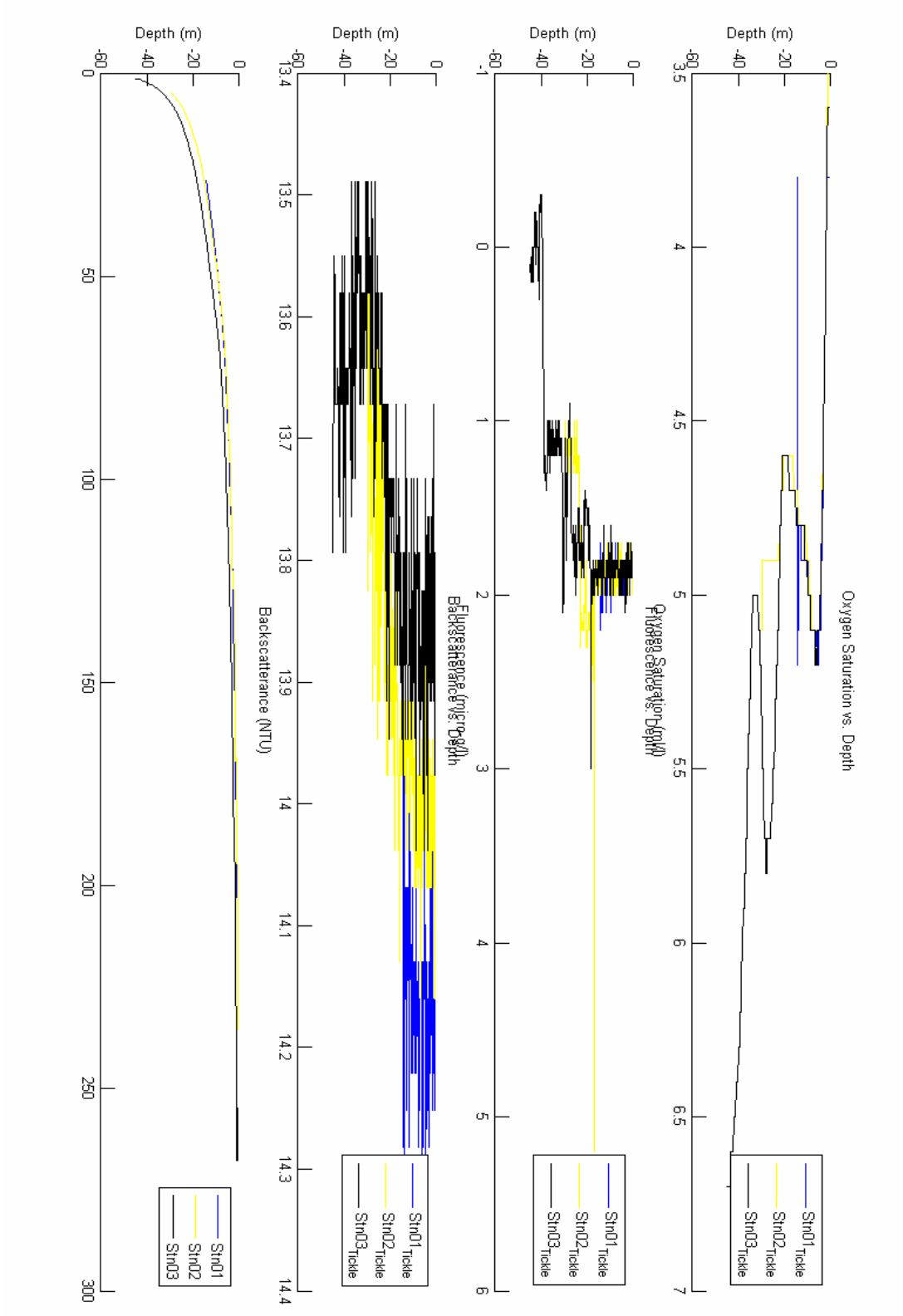

Figure 10: Small-scale CTD Data Set #2

Bell Tickle Cross Channel Transect Data

A towed-array transect perpendicular to Bell Island (across the channel) was performed, utilizing two arrays. The first array consisted of an Imagenex Delta-T multibeam sonar, a Biosonics Echosounder, and a Teledyne RD Instruments ADCP. The second array consisted of an Edgetech Sidescan Sonar.

Transect Specifications

Start

Time:	11:55 UTC, Oct. 7, 2008
Latitude:	47 32.03990 N
Longitude:	52 58.96500 W

Stop

Time:	12:38 UTC, Oct. 7, 2008
Latitude:	47 35.03000 N
Longitude:	53 00.42470 W

Transect Data

An example of typical un-processed data from the Imagenex Delta-T Multibeam can be seen below in Figure 11. This image in particular shows what is believed to be a shipwreck.

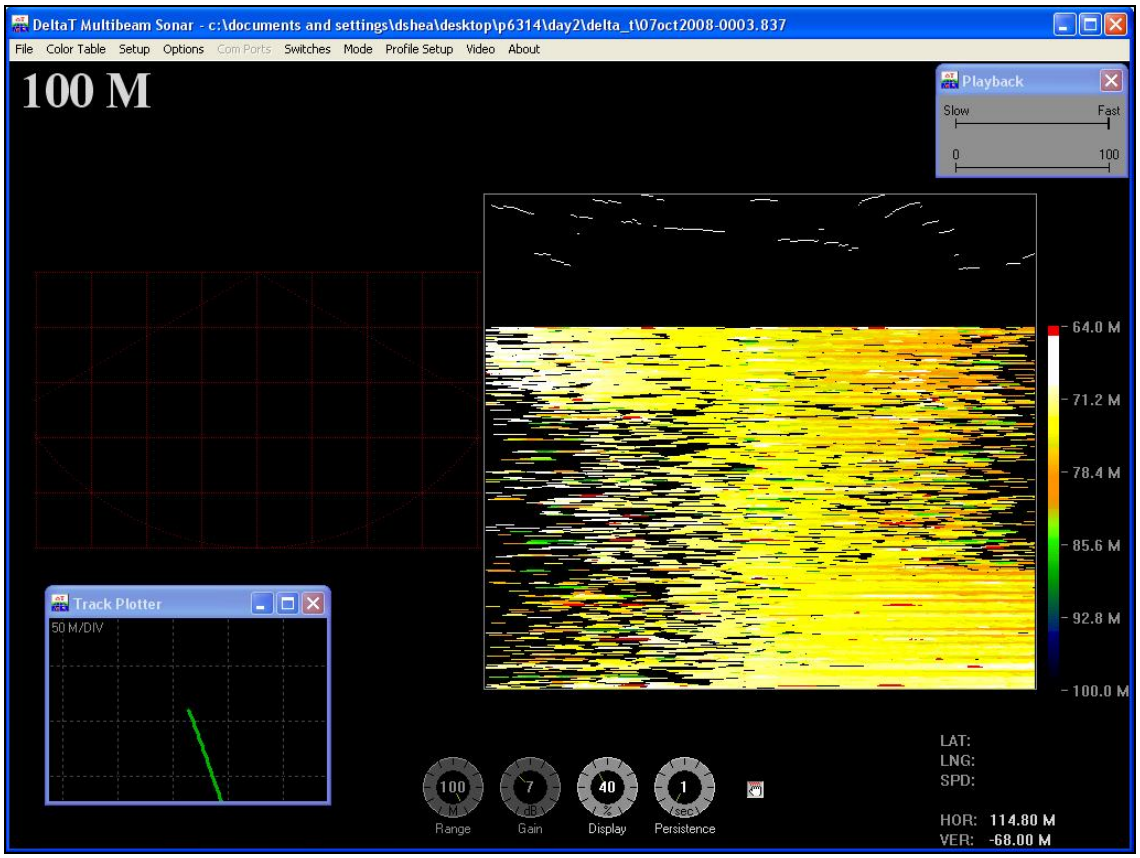

Figure 11: Typical Cross-Channel Multibeam Data

An example of typical un-processed cross-channel data from the Biosonics Echosounder is shown below in Figure 12. Note the significant difference in quality between this data, and that of Day 1. This is believed to be caused by limitations in the Echosounder itself (maximum range, etc.), but further investigation and analysis will have to be done to verify this.

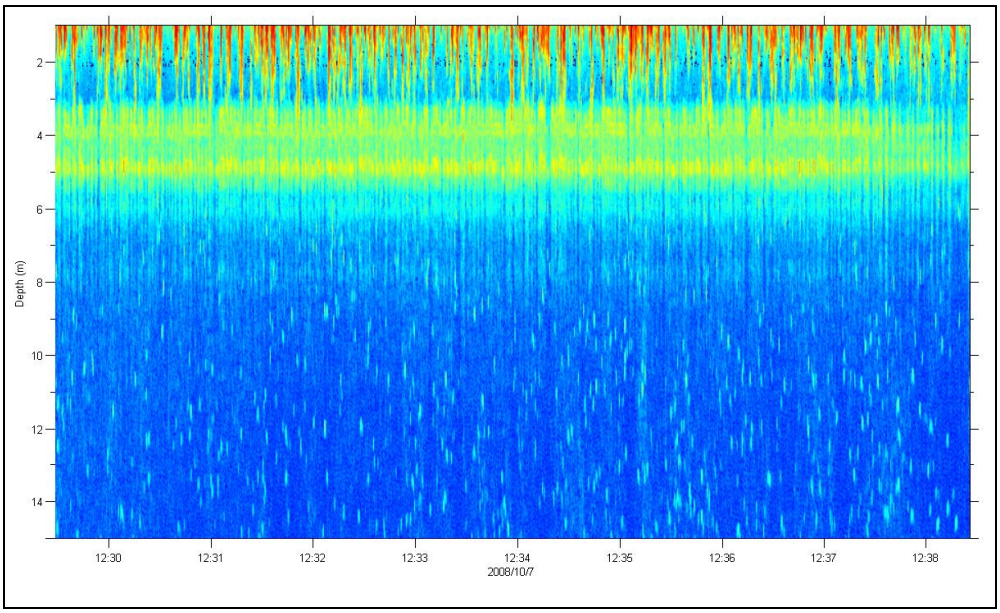

Figure 12: Biosonics Echosounder Data

An example of typical un-processed ADCP data is shown below in Figure 13. Data is plotted against a time scale measured in fractions of a day, where zero is the start time of the transect. This was done to facilitate processing and manipulation of the data.

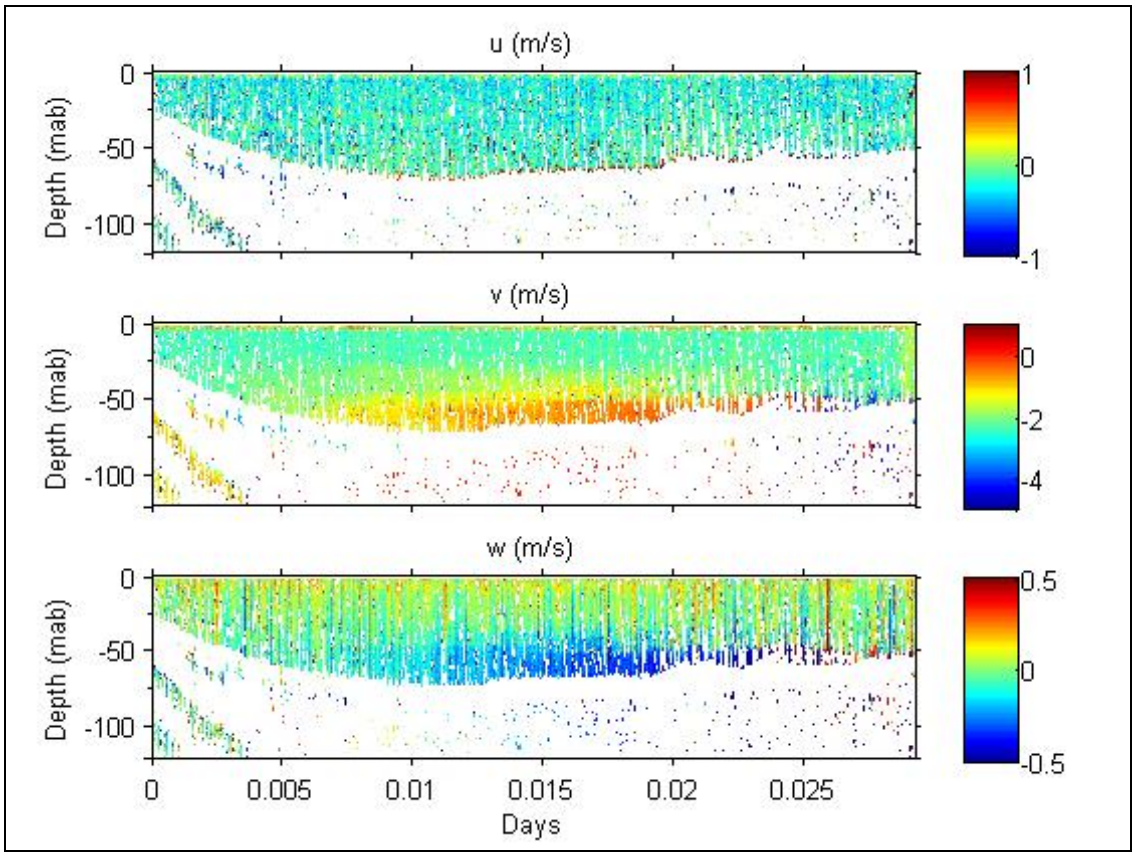

Figure 13: RD Instruments ADCP data from Cross-Channel Transect

A typical example of Day 2 data from the Edgetech Sidescan Sonar Towfish can be seen below in Figure 13. In this example, "waves" can be seen in the sediment on the seafloor.

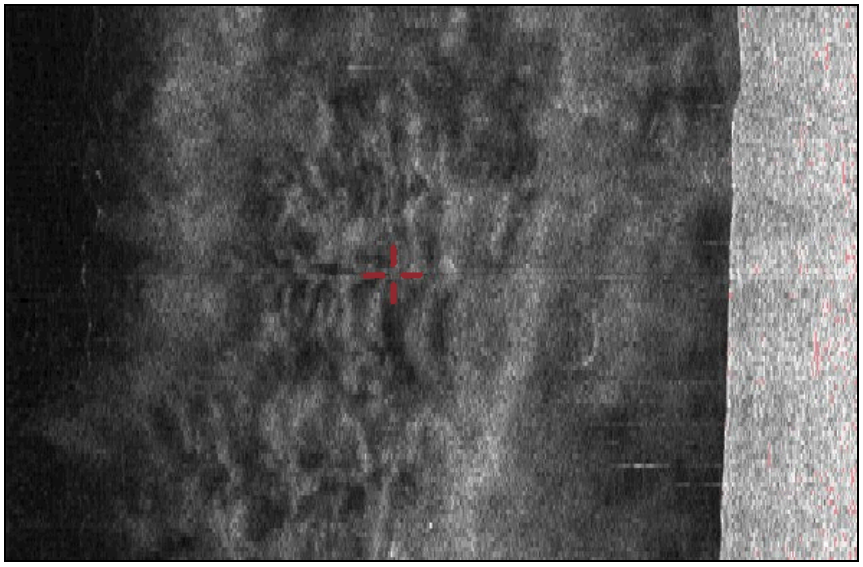

Figure 14: Edgetech Sidescan Sonar Data

Additional Data

Several sets of additional data were collected during other legs of the week-long cruise which were relevant to the first leg. Specifically, the additional data consists of biological samples from plankton nets, data collected from the week-long deployment of an ADCP mooring, and similar week-long moored thermistor chain data.

Biological Samples

A number of organisms were identified through post-cruise analysis and inspection of the biological samples. Shown below are two of the more interesting examples, a planktonic copepod and a shrimp larvae.

Figure 15: Planktonic Copepod Sample

Figure 16: Shrimp Larvae Sample

Moored ADCP Data

A Teledyne RD Instruments ADCP (identical to the one used in the towed array above) was affixed to a mooring, and deployed on Day 2. The intention was for the mooring to remain for the duration of the cruise, and be recovered on the final day, allowing for collection of tidal and time-series current data.

Mooring Location

Time:	13:57 UTC, Oct. 7, 2008
Latitude:	47.56841 N
Longitude:	53.01747 W
Depth:	30M

A versus-time plot of the moored ADCP data can be seen below in Figure 17.

Moored Thermistor Data

A chain of thermistors was used in conjunction with the ADCP mooring, with a ground line, secondary anchor and attached float. This was done to provide a long-duration temperature profile of the water column, to be correlated with the ADCP current data for analysis of thermo clines and calibration of the ADCP data.

Float Location

Time:	13:57 UTC, Oct. 7, 2008
Latitude:	47.56841 N
Longitude:	53.01691 W
Depth:	30M

A versus-time plot of the moored thermistor data can be seen below in Figure 18.

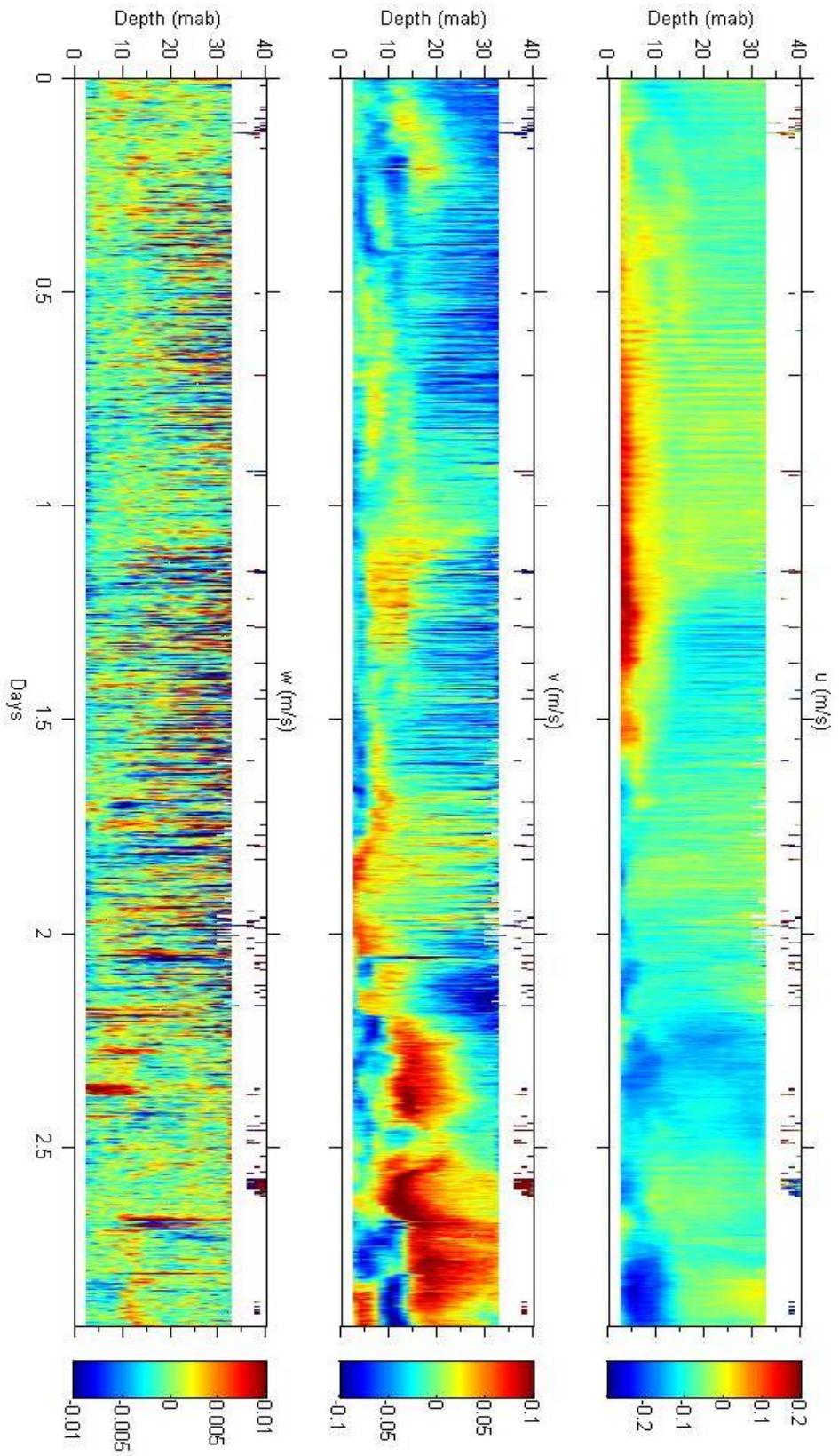

Figure 17: Moored ADCP Data

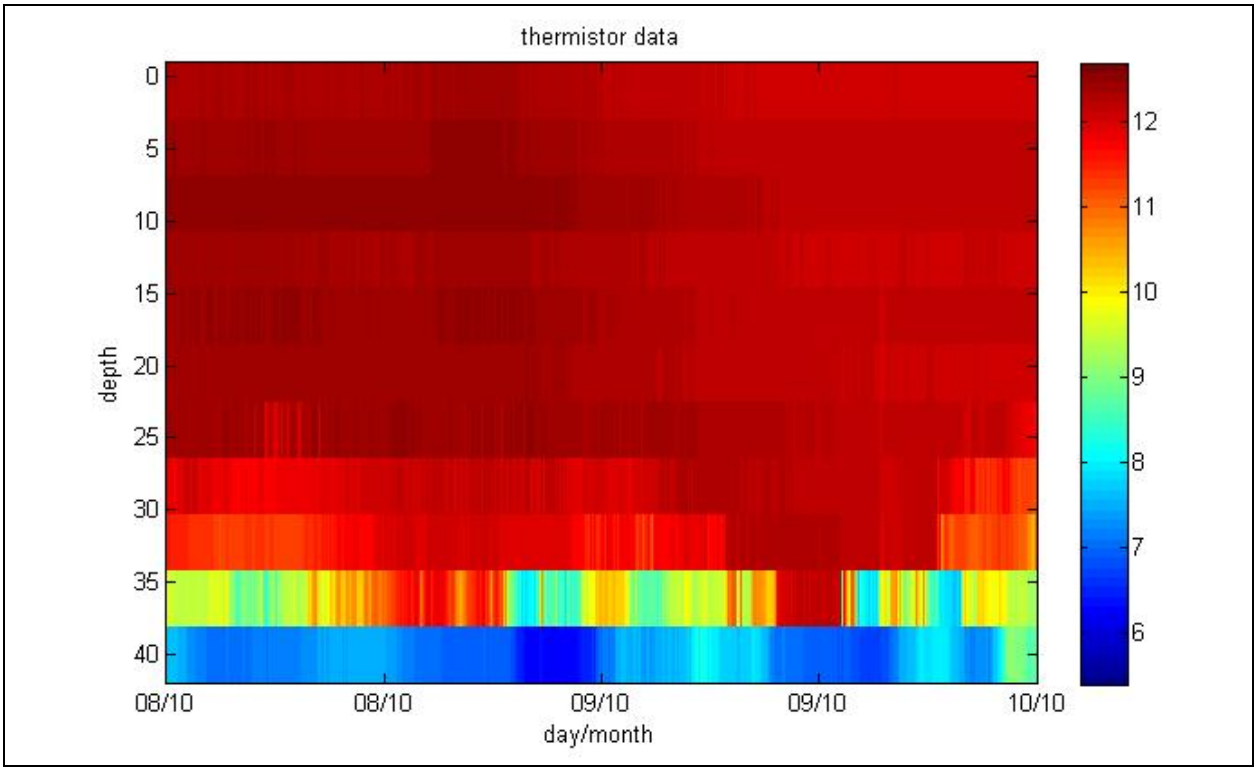

Figure 18: Moored Thermistor Data

Plans for Scientific Analysis

Multibeam Data

Post-processing of the Delta-T Multibeam data is absolutely necessary, as any attempts to plot raw data in Matlab would only yield noisy, unreadable results. This processing could be done either with Matlab, or with an open-source Multibeam processing package such as MB-System. The requirements for processing include correlating multibeam data with attitude data from the ADCP, to compensate for pitch/roll/yaw, geo-referencing the data with GPS coordinates, and finally removing "noise" and outliers from the data. Also, to make the data more visually appealing, an averaging algorithm can be applied to "smooth" out the data for higher-resolution imaging.

Sidescan Data

Similar to the multibeam data, the sidescan data requires post-processing. However, since no attitude information is available for the sidescan towfish, it cannot be corrected for. Since sidescan data does not give a calculated depth of the image, a comparative analysis can be performed with the multibeam data to give an accurate depth and range.

In the interests of Engineering in bathymetric imaging, a comparison could be performed between the sidescan and multibeam data. This would conclude whether a sidescan system is necessary for imaging, or if a multibeam system is sufficient. Comparison of two similarly "low-cost" sonar imaging systems would be of interest to the scientific community.

Towed ADCP Data

It is planned to produce a vector plot of the horizontal velocity components (u and v), cross-referenced to the actual cruise track of the ship while the ADCP was being towed. This will involve taking an average of the velocity values over the top ten meters at evenly spaced intervals and producing a vector which will be plotted at the appropriate point on the actual ADCP tow track. The ADCP data will be cross referenced to the vessel track using the GPS coordinates. This will produce a representation of the data which is better suited to visual interpretation.

Moored ADCP Data

Since the type of spatial vector plot planned for the towed ADCP data will not work for the moored ADCP, another approach will be used. In this case the data represent a time series at a single point in space. As such, a sequence of gif or jpg images will be produced showing a vector representation of the horizontal components of the velocity at regularly spaced time intervals. These images can then be combined into a single animation which will show how the velocity changes in time at the mooring point. This representation of the data will also be geo-referenced using the Matlab mapping script and the GPS coordinates.

Moored Thermistor Data

As can be seen from the plot, the temperature of water column is almost constant over approximately the top 35 meters, and then shows a rapid decrease over the remaining 10 meters. Plans for further analysis of this data include attempting to explain the rapid decrease in the water temperature over approximately the bottom 10 meters of the water column.

CTD Survey Data

Since both a large- and small-scale CTD survey were performed, a comparison of the resolution and accuracy of resulting data could be performed, to quantify the advantages/disadvantages of each approach. This could result in an optimization of the quantity and distribution of future CTD casts, depending on the scientific interest.

As per the intention of the CTD surveys, an analysis of the thermal profiles of water entering and exiting Conception Bay can be performed. This would result in detailed information about the warming of water in Conception Bay, and can be correlated directly with biological samples collected, as well as current profiles from the ADCP data.