# Ryan Chouest Cummulative Cruise 8 Report

## *Period covered: 2303 07/14/2010 - 2157 07/19/2010*

## *564.614 - Nautical miles covered*

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## Cruise Objectives:

The mission for Cruise 8 was to monitor surface slick conditions after the capping of the Macondo well and to investigate potential surface slicks resulting from natural seeps identified around the Deepwater Horizon incident site.

## Science results and preliminary interpretation:

Underway Fluorometry Results

The Chelsea, Trios, and Contros fluorometery data show low to medium inferred hydrocarbon Concentrations over much of the route covered with medium to higher levels observed closer to the incident site (Figures 2-4). Chelsea data show the lowest values throughout the entire course (Figure 2), whereas the Trios and Contros show relatively higher medium level values primarily along the 5 statute mile cirrcular path (Figures 3-4).

In general, the Trios and Contros fluorometery data correlated very well. However, high Contros responses not observed in the Trios data may not truly reflect the concentration of PAH but instead be due to the temporal accumulation of thin oil film/ droplets on the sensor window.

Surface Observations

A diverse range of slick features was observed during Cruise 8. On the transit out to the outer circle around the incident site, convergence lines and dull sheens were occasionally observed. However, as we approached the inner circular path we noted convergence lines with white particulates (Figure 1a and Photographs 1-2). Rainbow sheens were observed on the 5 statute mile route closest to the incident site (Figure 1b and Photograph 3). Brown mousse and brown oil were observed mainly around the perimeter of the incident site (Figure 1b and Photographs 4-5).

Examples of surface sheens and changes in seawater color were noted at Cast station #7. Water at that location appeared to be browner and greener than the usual deep blue color. In addition, Greenish colored water was observed as we were sailing away from Cast #7 and may be a result of algal blooms in the upper photic zone (Photographs 6-8). Most surface sheens were dull, but some locations included small pieces of brown mousse (Photographs 9-10). A waxier surface sheen was noted at one location and may not be genetically related to the dominant surface sheen (Photograph 11).

Brown oil was observed at three locations around the incident site (Figure 1b). Foamy streamers of finely dispersed brown mousse and small oil droplets are shown in Photographs 12 and 13 and may result from effective dispersant usage. However, thicker oil was observed as we began our transit back into port. Fresh brown oil streamers with abundant fresh brown mousse were observed on the northeastern segment of the outer 5 NM circle (Figure 1b and Photographs 14-15). Oil formed into thick streamers as it drifted towards the ship (Photographs 16-17) and was characterized by a frothy brown texture (Photograph 18).

Vertical Casts Fluorometry Results

One vertical cast was carried out in the red snapper fishery area, south of Port Theodore (Cast # 1 / Cruise 8, 2010/07/15, N 30 02.8425, W 088 01.8437). Fluorometry result of the cast is shown in Figure 5A. Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump. The vertical profile in Figure 5A shows elevated sensor responses from 5m water depth and reaches maximum values at the surface while the conductivity reduces to minimum. Noting that one previous vertical cast in the fishery area (Cast # 4 / Cruise 7 conducted on 2010/07/12 at N 30 02.8430, W 088 01.8456) also displays the same vertical profile feature with minor sensor reading increase and reduced conductivity at the surface . GC MS analysis of the water samples collected during Cast#1/Cruise 8 at 30m and at 1m depth yielded 0.359 ppb and 0.554ppb of total poly aromatic hydrocarbon concentration respectively, both of which are close to the background level. Further analysis for Aliphatics revealed no detectable Aliphatics in the surface water sample and an aliphatic profile for the bottom water sample that suggests either heavily degraded oil or lube oil residues (Figure 8).

A total of eleven vertical casts were conducted in the vicinity of the well site (Table 1).

Three vertical casts were carried out between 07/16/2010 and 07/17/2010. The locations of Cast #2 is outside the oil extent area, Cast #3 is within the oil slick coverage and Cast #4 lies close to the edge of the oil slick. The highest sensor responses were observed to the surface water of Cast #3 (Figure 5B). All three vertical profiles show maximum sensor readings close to sea surface and close to baseline readings below ~10m along the water columns.

Four vertical casts were performed between 07/17/2010 and 07/18/2010. All 4 stations lie within the oil extent coverage. The incompleteness of vertical profiles of cast#7 and cast#8 is because Ryan Chouest was asked to move to minimum distance of 7.5nm away from the well site and the interruption caused by the vessel movement during the vertical cast, the remainder of the 5m and surface sampling had to be abandoned in both cases. The vertical profile of Cast #5 (Figure 5C) shows much higher poly aromatic hydrocarbon concentration at the surface compared to that of Cast #6 (Figure 5D). This concentration difference might be due to the gradual migration of the oil slick extent towards the north west of the

well site according to ERMA's 07/16 ~ 07/18 composite maps. All four vertical profiles show elevated readings close to sea surface and close to baseline responses below ~20m along the water columns.

Four vertical casts (Cast #9~Cast #12) were performed between 07/18/2010 and 07/19/2010. Cast #9 and Cast #12, conducted on July 18$^{th}$ and July 19$^{th}$ respectively, are located at the same drop cast station. Their vertical profiles display similar features with sub surface waters showing higher PAH concentration compared to cast 10 and cast 11 and greatly reduced conductivity (Figure 5E and Figure 5F). Most PAH for Cast #9 was still confined within the 0-5m water column while for Cast #10 PAH gradually extended down to 10m depth of water. Cast # 10 shows elevated PAH concentration starting from 10m. Cast #11 (Figure G) is on top of a dense cluster of natural seeps. All sensors display constant readings from the surface down to 10m of water and decrease to close to baseline level of PAH below 20m.

Geochemistry

The general scheme of the geochemical analysis has been to run all samples by SIM so we could quantify any poly aromatics. If anything is detected in the m/z 57 trace then a full scan is performed to detect any aliphatics.

22 water samples were analyzed during this cruise for dissolved aromatic compounds. The majority of these contained only low levels (≤ 1µg/L; ppb) of total poly aromatics (≥2-rings; results in electronic form available upon request).

Of the 22 samples analyzed, 12 samples exhibited a response in the *m/z* 57 ion trace, suggesting the presence of aliphatic hydrocarbons. These samples were re-analysed using the full scan mode and the hydrocarbon content quantified (Table 2).

All the samples which contained hydrocarbon residues with abundant *n*-alkanes (at this stage assumed to be derived from the MC252) exhibited chromatographic profiles consistent with oil that had undergone evaporation but no biodegradation. The degree of evaporation can be assessed by the change in *n*-C17/*n*-C18 and Pr/Ph values. Both these parameters have a value of around 1.4 in the fresh oil (Table 2) but show a high degree of variability, with values as low as 0.3-0.5 in highly weathered samples. Some samples retain low levels of *n*-alkanes below n-C17 (Figure 6) while others have lost all of the lighter compounds (Figure 7).

The biodegradation indicators *n*-C17/Pr and *n*-C18/Ph remain largely unaltered in all the samples where they could be measured, indicating little biodegradation has occurred. The ratio of resolved to unresolved components (R/UCM; Table 2) is often used to indicate biodegradation. The UCM in this oil appears to start above *n*-C18, thus removal of the light components increases it's prominence without the occurrence of biodegradation. However, subsequent changes in this ratio would indicate the onset of this process.

There was also the occasional sample which had a profile consistent with either heavily degraded oil or lube oil residues (Figure 8).

In conclusion, all the samples found to contain aliphatic hydrocarbon residues assumed to be from the MC252 spill exhibited characteristics consistent with a high degree of evaporation but to date little or no biodegradation

To date we have assumed all oil residues with abundant *n*-alkanes are derived from the MC252 spill. In order to confirm this both now and in the future, there is a need to analyse extracts for aliphatic biomarkers. During this cruise we have made initial attempts to do this but at this stage it appears that a lack of capacity to fractionate the sample, coupled with no means to concentrate the solvent extract, might limit the detection of some of the relevant compounds. However, there is scope to try and improve this in the near future.

## Science Operations:

Fluorometer measurements were logged and observations of sea-surface conditions were made throughout the majority of the period. Vertical fluorometry casts and water samples were taken along the circular path. We continue to perform liquid-liquid extractions on seawater samples and analyze the extracted material by GCMS. We are also continuing to collect midwater and deep echosounder contacts.

**Planned versus actual route taken cruise 8:**

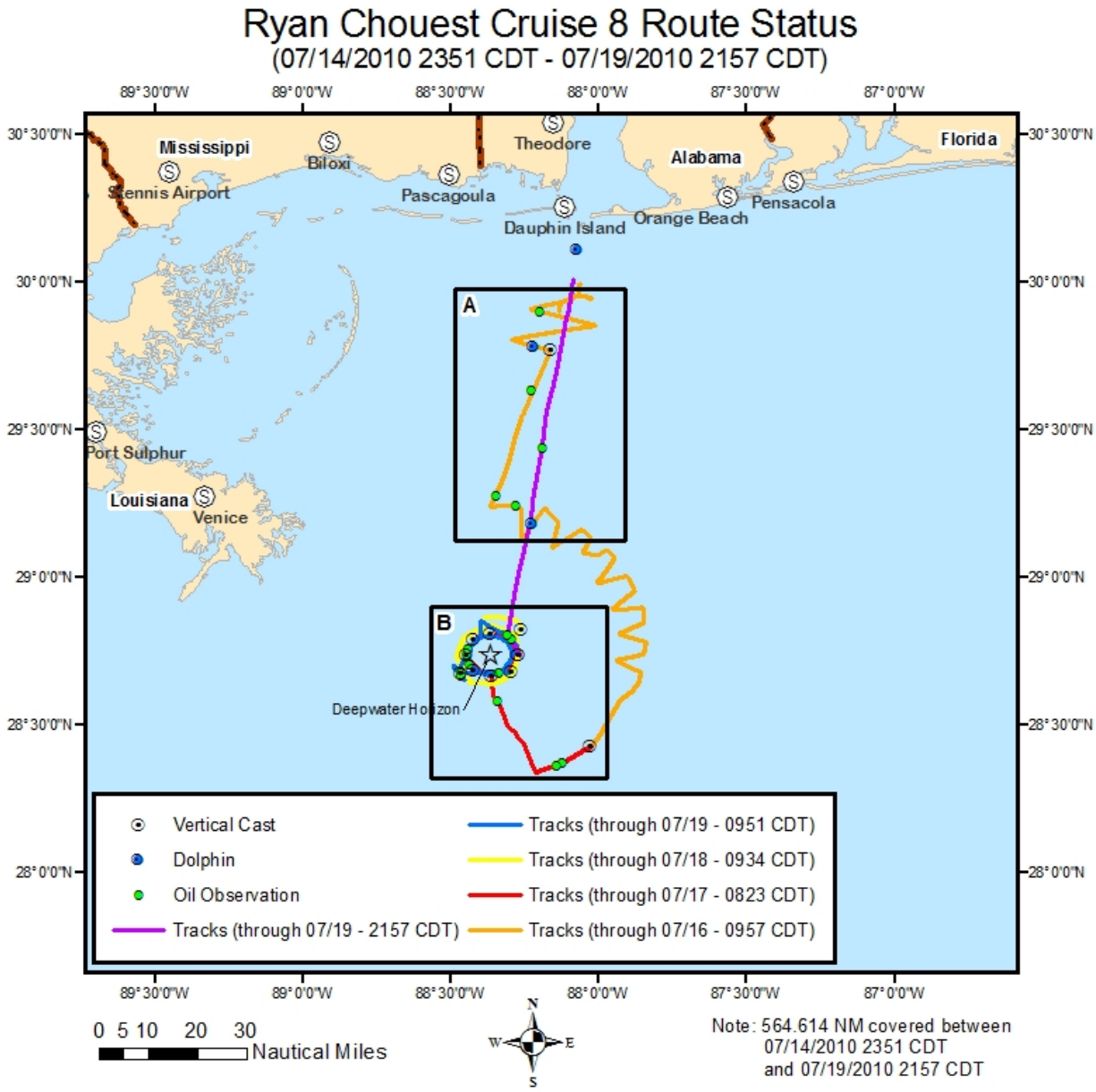



**Figure 1:** Traveled route plotted between 2351 07/14 – 2157 07/19.

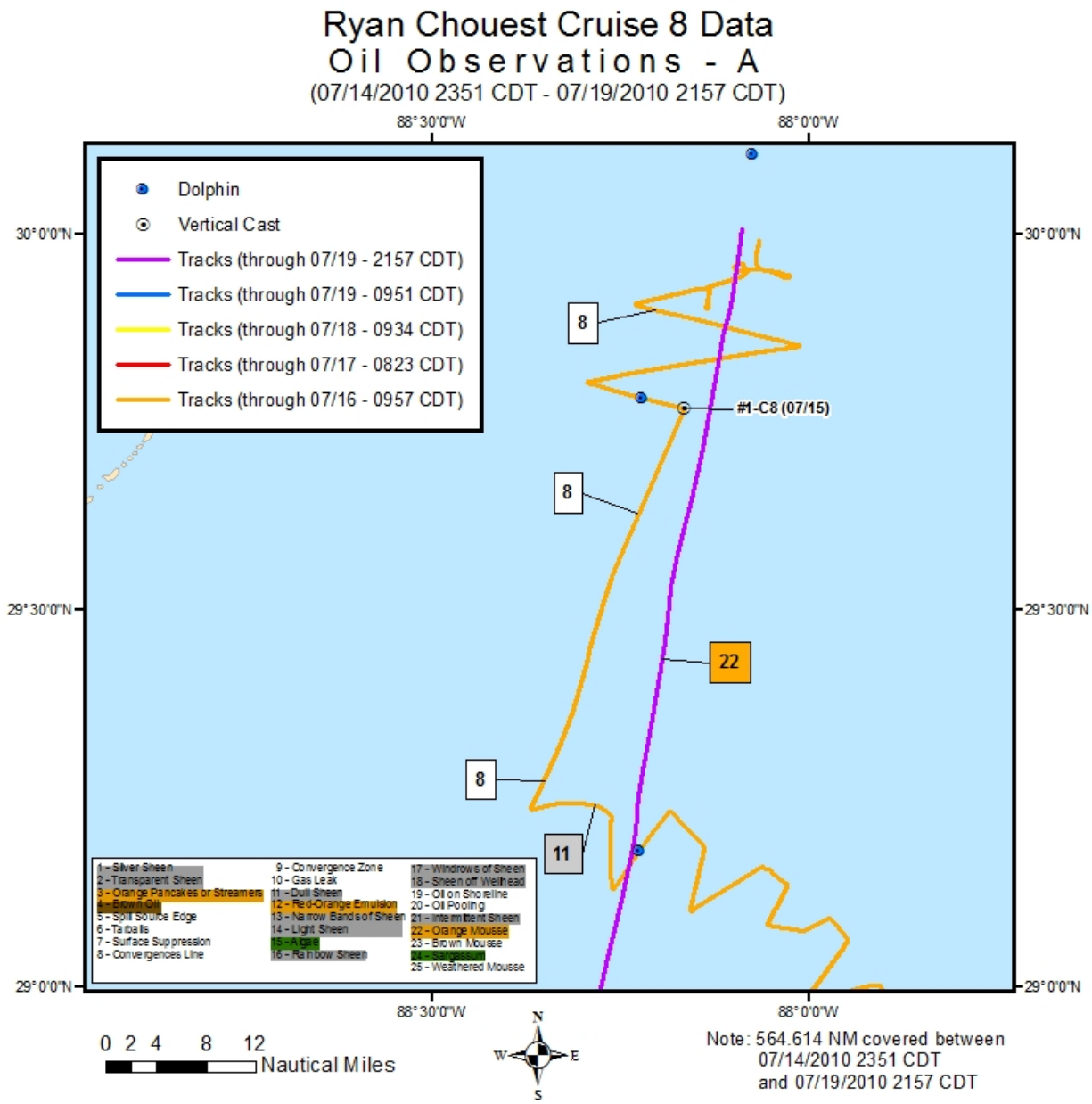



**Figure 1a:** Zoomed view of box A from Figure 1 plotted between 2351 07/14 – 2157 07/19.

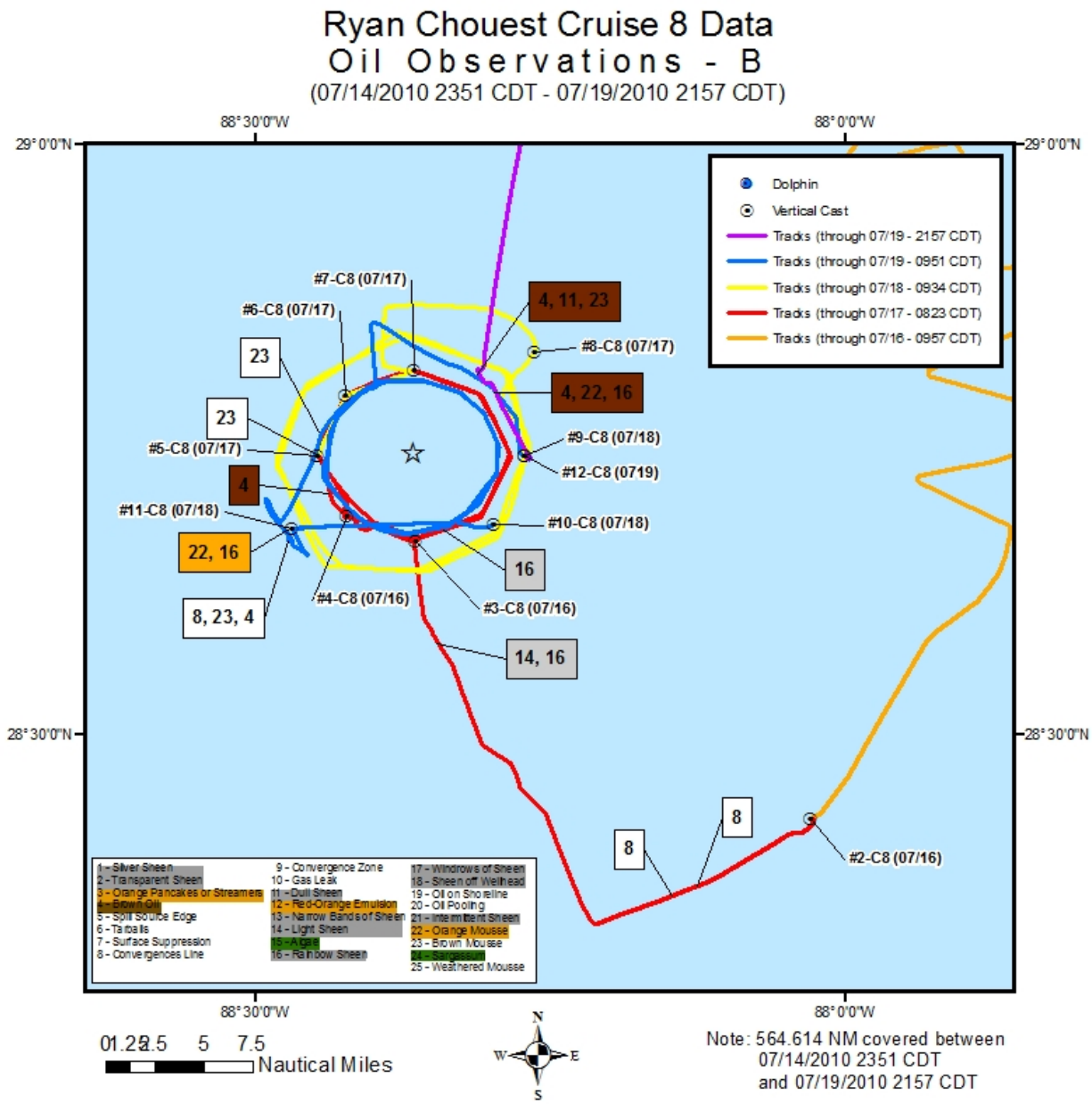



**Figure 1b:** Zoomed view of box B from Figure 1 plotted between 2351 07/14 – 2157 07/19.

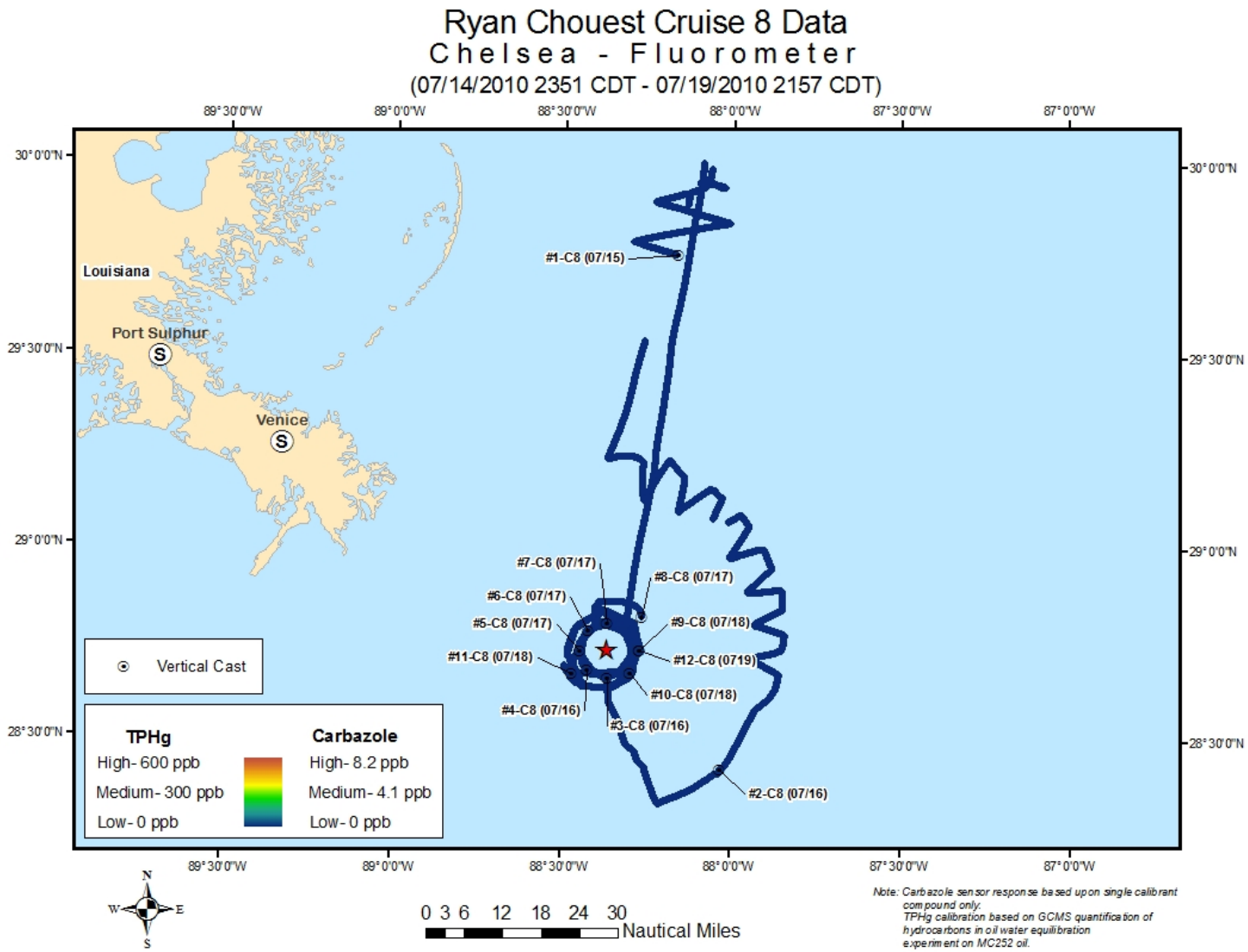



**Figure 2.** Chelsea fluorometer results plotted with location on cruise track 8. Breaks in data occur when either data quality is poor or the systems were turned off due to pump problems.

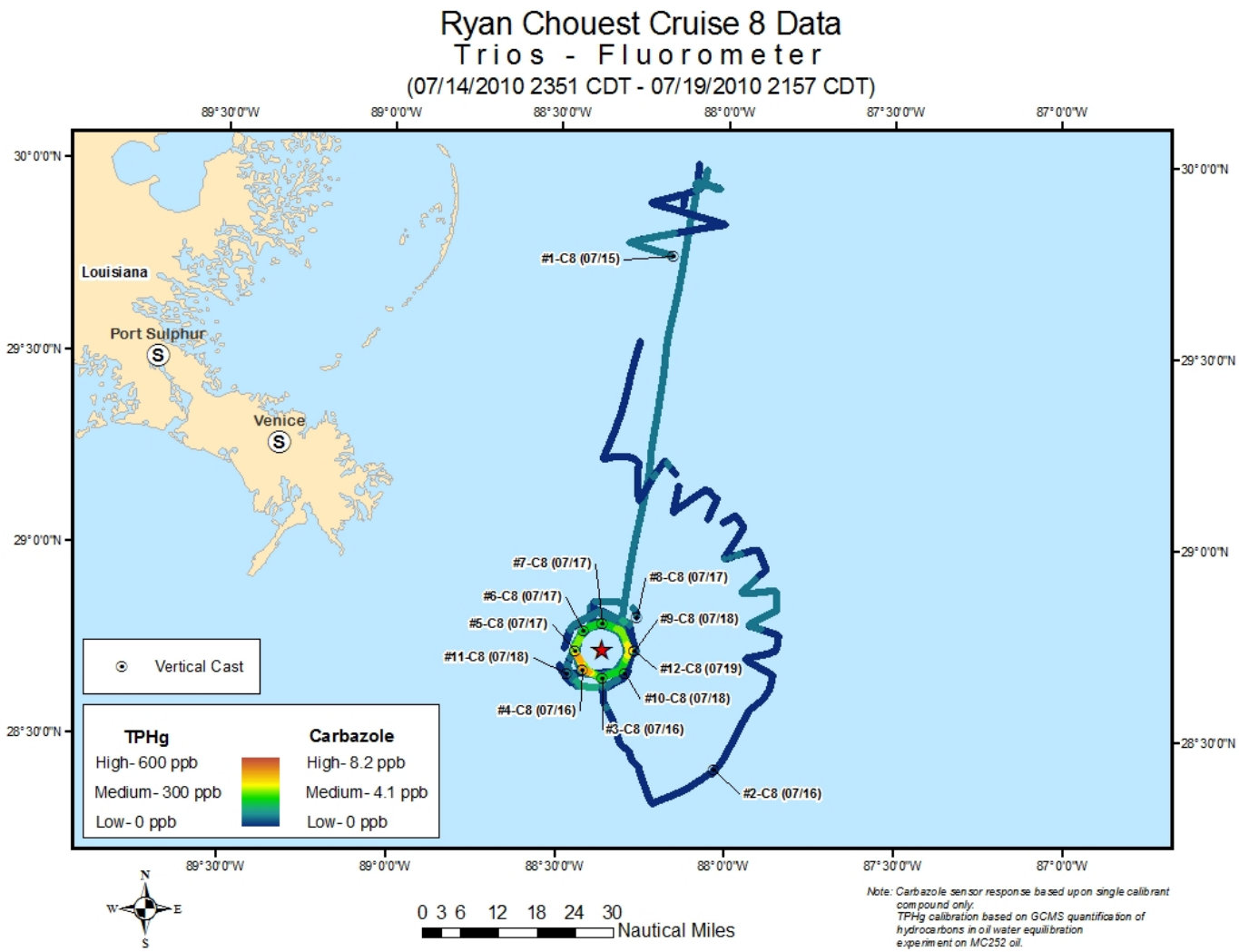



**Figure 3.** Trios fluorometer results plotted with location on cruise track 8. Breaks in data occur when either data quality is poor or the systems were turned off due to pump problems.

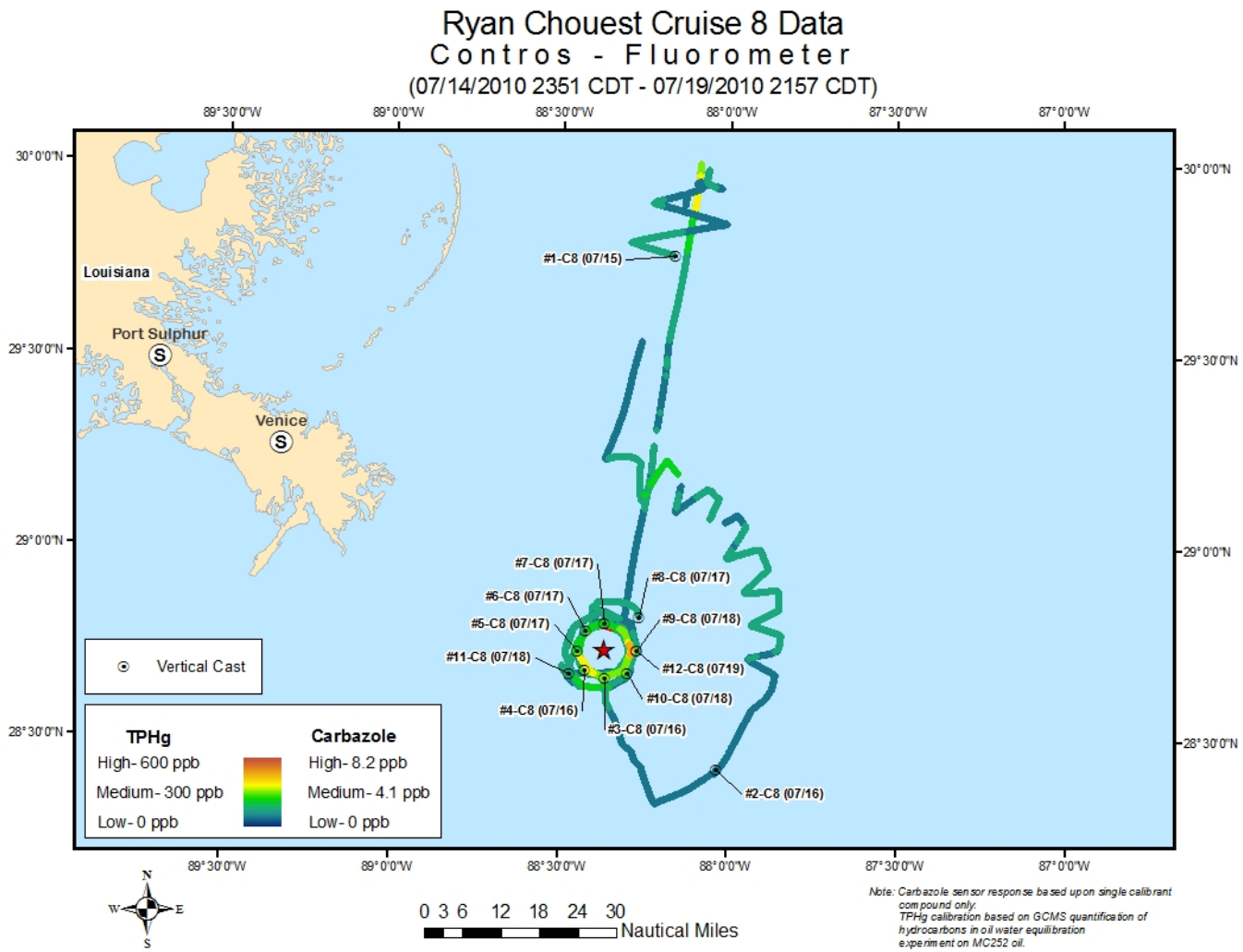



**Figure 4.** Contros fluorometer results plotted with location on cruise track 8. Breaks in data occur when either data quality is poor or the systems were turned off due to pump problems.

**Table 1.** Summary of the vertical casts conducted in cruise 8

| Cast numer/ Cruise number | CDT Date | UTC Date | Co-ordinates | |
|---|---|---|---|---|
| | | | N | W |
| Cast #1/Cruise 8 | 07/15/10 | 07/15/10 | 29 46.0861 | 088 09.9173 |
| Cast #2/Cruise 8 | 07/16/10 | 07/16/10 | 28 25.6954 | 088 01.7758 |
| Cast #3/Cruise 8 | 07/16/10 | 07/16/10 | 28 39.8432 | 088 21.9242 |
| Cast #4/Cruise 8 | 07/16/10 | 07/17/10 | 28 41.1172 | 088 25.4235 |
| Cast #5/Cruise 8 | 07/17/10 | 07/17/10 | 28 44.2002 | 088 26.8834 |
| Cast #6/Cruise 8 | 07/17/10 | 07/17/10 | 28 47.2791 | 088 25.4480 |
| Cast #7/Cruise 8 | 07/17/10 | 07/17/10 | 28 48.5460 | 088 22.0067 |
| Cast #8/Cruise 8 | 07/17/10 | 07/18/10 | 28 49.5023 | 088 15.8001 |
| Cast #9/Cruise 8 | 07/18/10 | 07/18/10 | 28 44.2107 | 088 16.2996 |
| Cast #10/Cruise 8 | 07/18/10 | 07/18/10 | 28 40.7069 | 088 17.9101 |
| Cast #11/Cruise 8 | 07/18/10 | 07/18/10 | 28 40.4882 | 088 28.1961 |
| Cast #12/Cruise 8 | 07/19/10 | 07/19/10 | 28 44.2020 | 088 16.3156 |

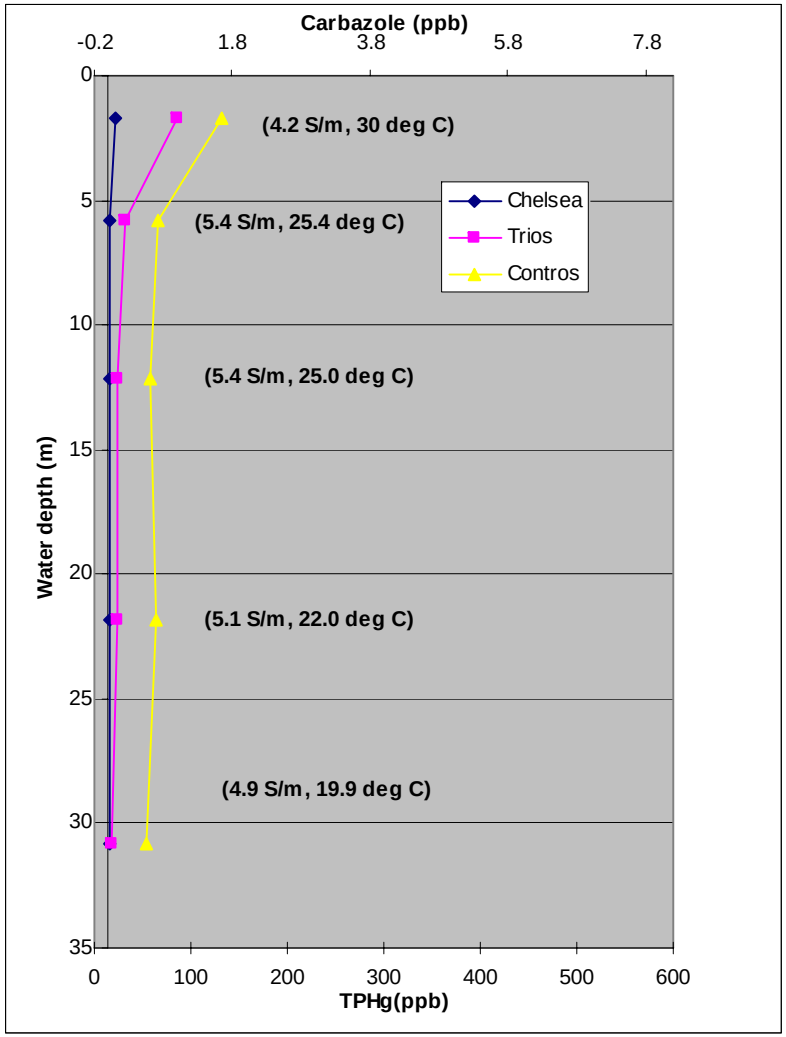



**Figure 5A** Fluorometer response vs. water depth for vertical Cast # 1 / Cruise 8 conducted on 2010/07/15 at N 30 02.8425, W 088 01.8437. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CDT unit attached to the vertical cast pump.)

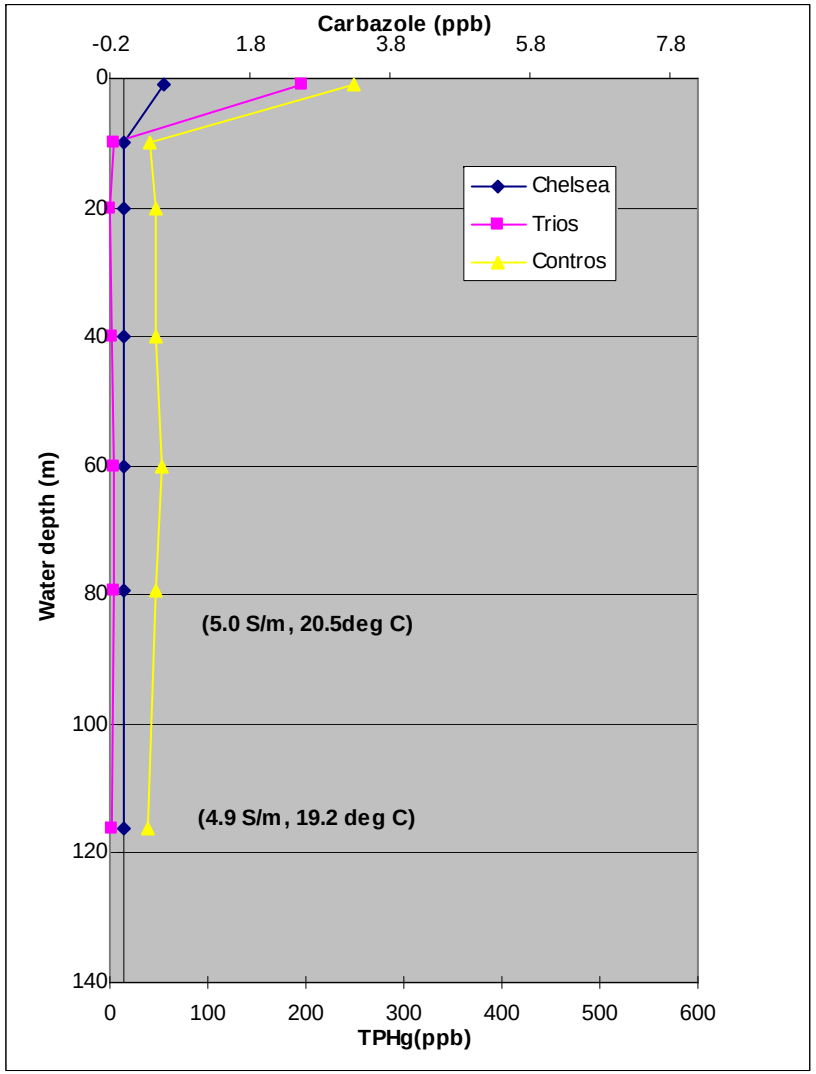



**Figure 5B** Fluorometer response vs. water depth for vertical Cast # 3 / Cruise 8 conducted on 2010/07/16 at N 28 39.8432, W 088 21.9242. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

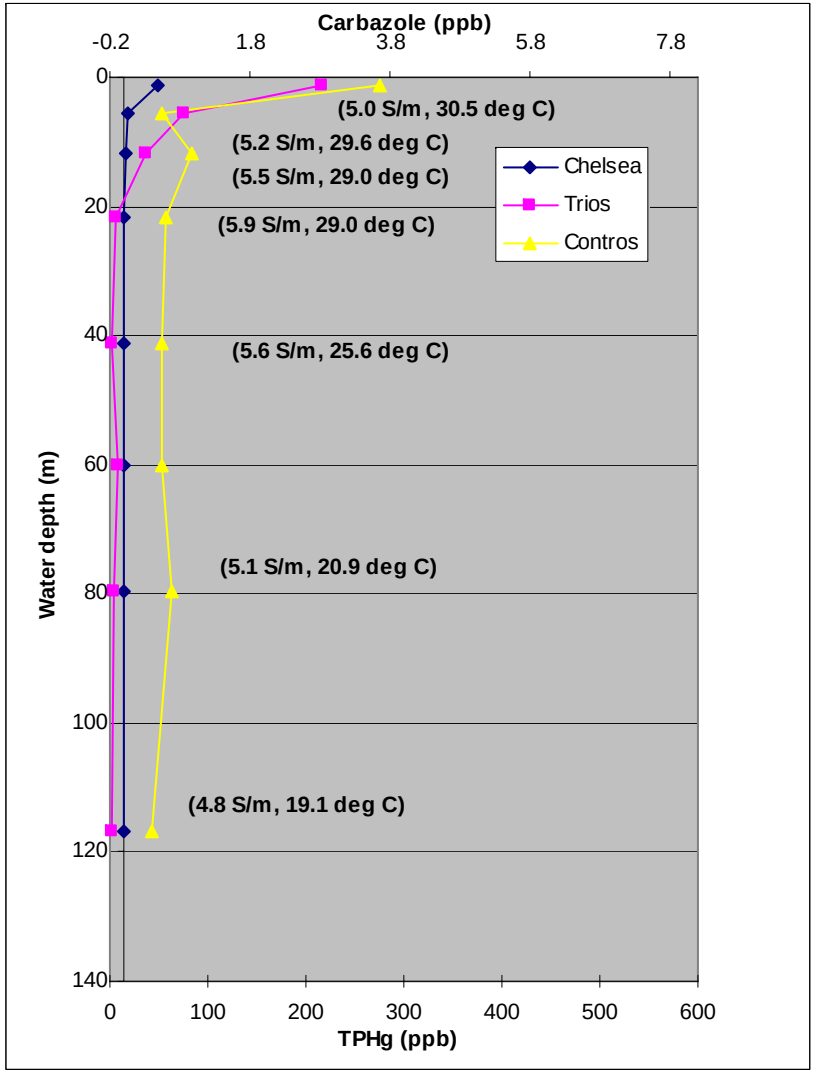



**Figure 5C** Fluorometer response vs. water depth for vertical Cast # 5 / Cruise 8 conducted on 2010/07/17 at N 28 44.2007, W 088 26.8844. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

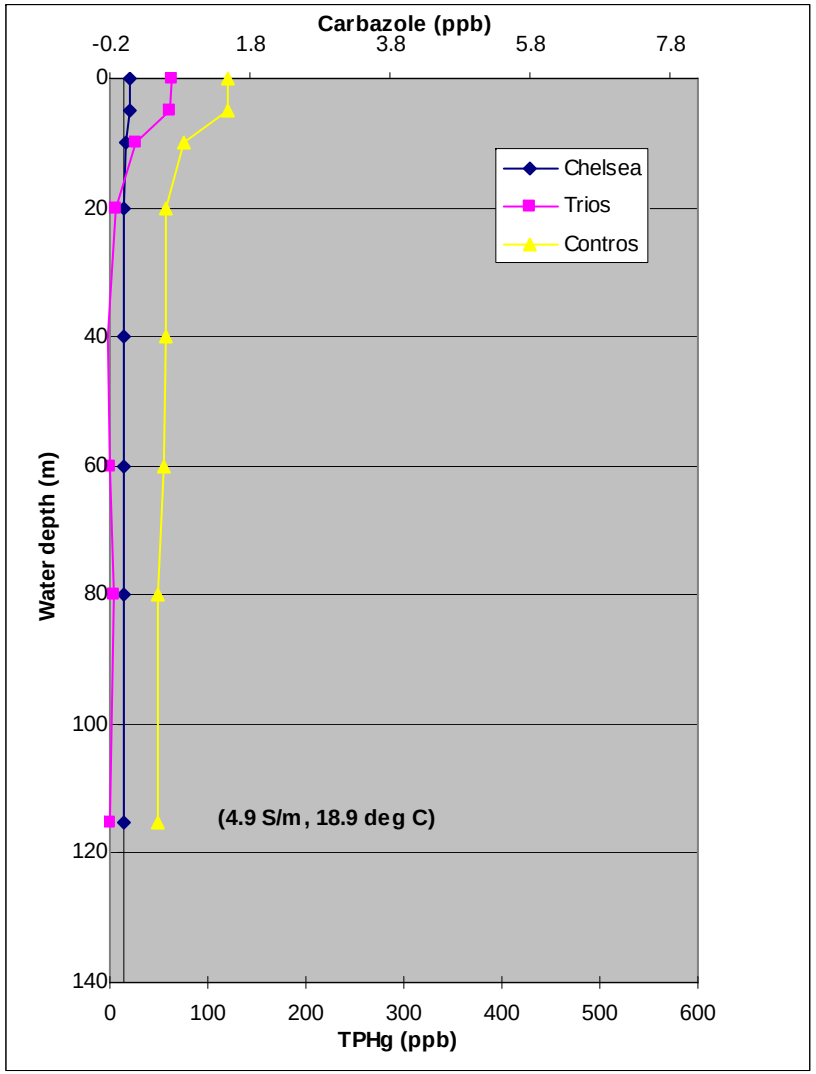



**Figure 5D** Fluorometer response vs. water depth for vertical Cast # 6 / Cruise 8 conducted on 2010/07/17 at N 28 47.2667, W 088 25.4587. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

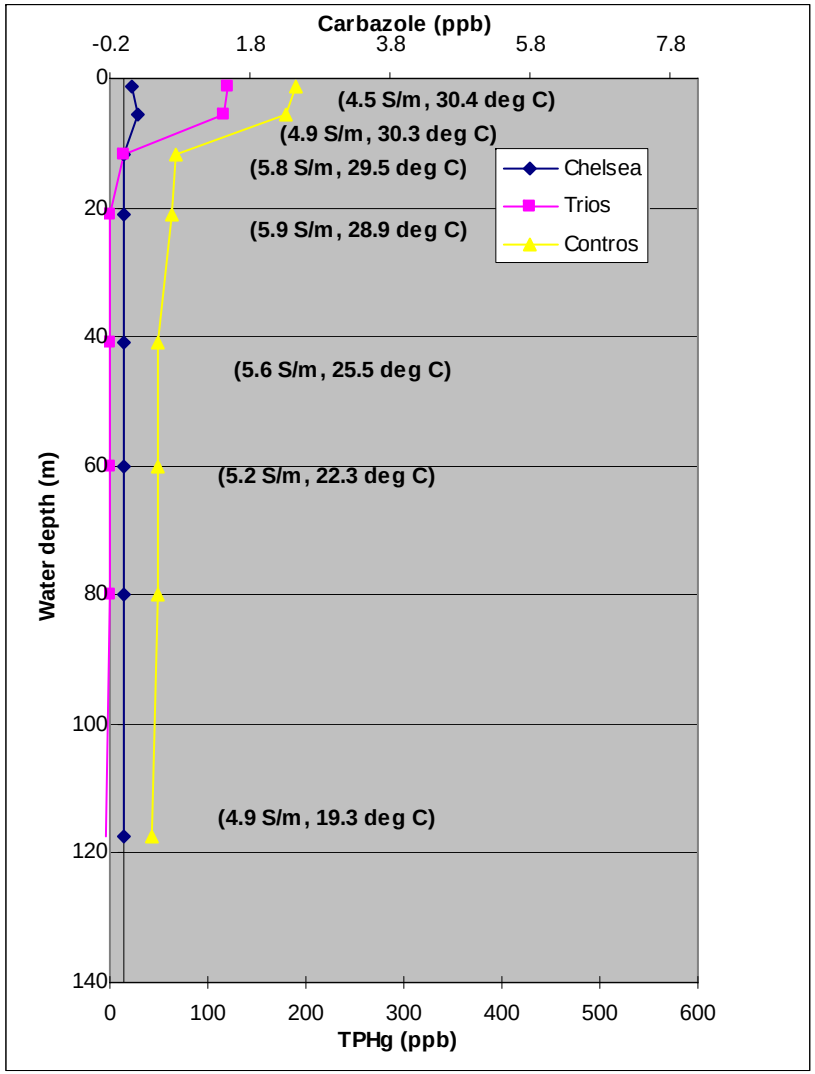



**Figure 5E** Fluorometer response vs. water depth for vertical Cast # 9 / Cruise 8 conducted on 2010/07/18 at N 28 44.2068, W 088 16.3142. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

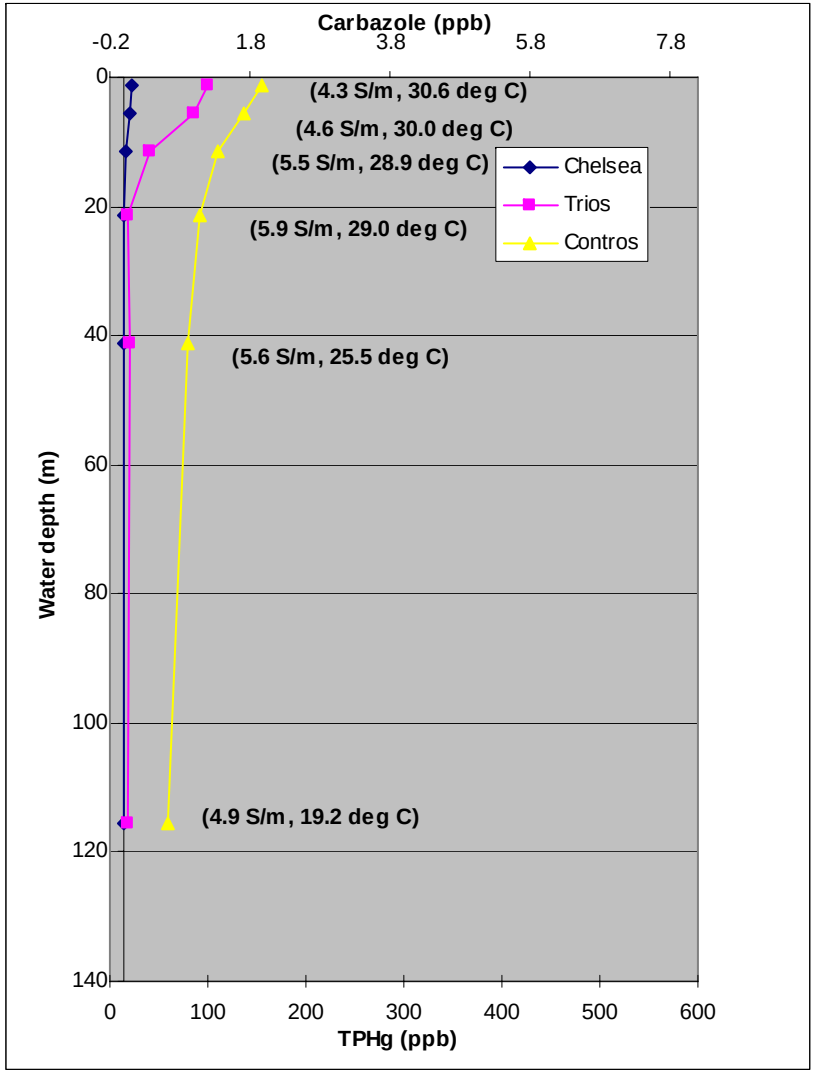



**Figure 5F** Fluorometer response vs. water depth for vertical Cast # 12 / Cruise 8 conducted on 2010/07/19 at N 28 44.2035, W 088 16.3146. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

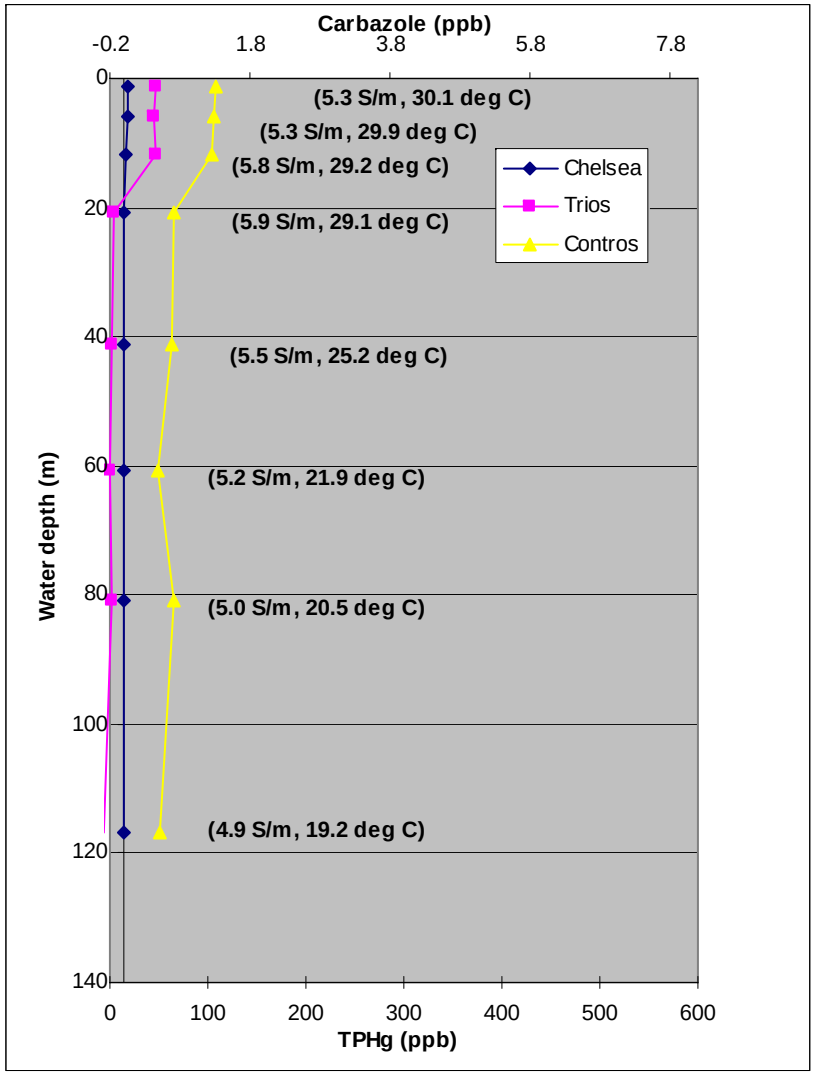



**Figure 5G** Fluorometer response vs. water depth for vertical Cast # 11 / Cruise 8 conducted on 2010/07/18 N 28 40.4922, W 088 28.2010. (Conductivity and temperature values at each sampling depth, as indicated in the graph, are from the CTD unit attached to the vertical cast pump.)

**Table 2**: Samples analyzed for Aliphatic hydrocarbons

| Date UTC | Description | TPH (µg/L) | $C_{17}$/Pr | $C_{18}$/Ph | $C_{17}/C_{18}$ | Pr/Ph | R/UCM | Comments |
|---|---|---|---|---|---|---|---|---|
| | Reference oil (MC252)analyzed externally | | 1.9 | 2.3 | 1.1 | 1.3 | | |
| | Reference oil (MC252)analyzed on-board | | 2.3 | 2.4 | 1.4 | 1.4 | 1.3 | |
| 07/15/2010 | Vertical Cast #1-cruise 8. Bottom water | 39.1 | n.d. | n.d. | n.d. | n.d. | 0.3 | Highly weathered mid-high end UCM (Lube oil?) |
| 07/15/2010 | Vertical Cast #1-cruise 8, pump at surface. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | Very weak response to M/z 57 |
| 07/16/2010 | Sample taken from tank while traveling through area of rainbow sheen | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | Very weak response to M/z 57 |
| 07/16/2010 | Sample taken with bottle taped to pole to sample rainbow sheen. | 290.9 | 1.7 | 2.5 | 0.5 | 0.8 | 0.0 | Evaporated oil with prominent UCM - Still some light alkanes |
| 07/17/2010 | Vertical Cast #3-cruise 8. Sample taken with pump at surface. | 153.4 | 1.6 | 2.6 | 0.7 | 1.2 | 0.7 | Evaporated oil with prominent UCM |
| 07/17/2010 | Sample taken with bottle taped to pole to sample rainbow sheen. | 618.1 | 1.9 | 2.7 | 0.8 | 1.2 | 0.7 | Evaporated oil with prominent UCM - Still some light alkanes |
| 07/17/2010 | Sample taken with bottle taped to pole. | 97.3 | n.d. | n.d. | n.d. | n.d. | 0.6 | Evaporated oil with prominent UCM - Still some light alkanes |
| 07/17/2010 | Vertical Cast #5-cruise 8. Increasing sensor responses. | 117.5 | 1.8 | 2.4 | 0.8 | 1.1 | 0.8 | Evaporated oil with prominent UCM - Still some light alkanes |
| 07/17/2010 | Vertical Cast #5-cruise 8, top water. Pump at surface. | 439.9 | 1.8 | 2.6 | 0.7 | 1.0 | 0.7 | Evaporated oil with prominent UCM |
| 07/17/2010 | During vertical Cast #5-cruise 8. Surface sample taken with bottle taped to pole. | 321.0 | 2.1 | 2.6 | 0.8 | 1.1 | 0.7 | Evaporated oil with prominent UCM - Still some light alkanes |

| Date UTC | Description | TPH (µg/L) | $C_{17}$/Pr | $C_{18}$/Ph | $C_{17}/C_{18}$ | Pr/Ph | R/UCM | Comments |
|---|---|---|---|---|---|---|---|---|
| 07/17/2010 | Vertical Cast #6-cruise 8. Bottom water 120m | 64.3 | n.d. | n.d. | n.d. | n.d. | 0.3 | Highly weathered mid-high end UCM (Lube oil?) |
| 07/17/2010 | Vertical Cast #6-cruise 8. Taken in response to rising sensor values. | 42.1 | n.d. | n.d. | n.d. | n.d. | 0.4 | Highly weathered mid-high end UCM (Lube oil?) |

n.d. = not detected; n.m. = not measured; $C_n$ = n-alkane with n carbons; Pr = pristane; Ph = phytane R/UCM = total resolved components over unresolved complex mixture.

For example chromatograms see Figure 6, Figure 7 and Figure 8

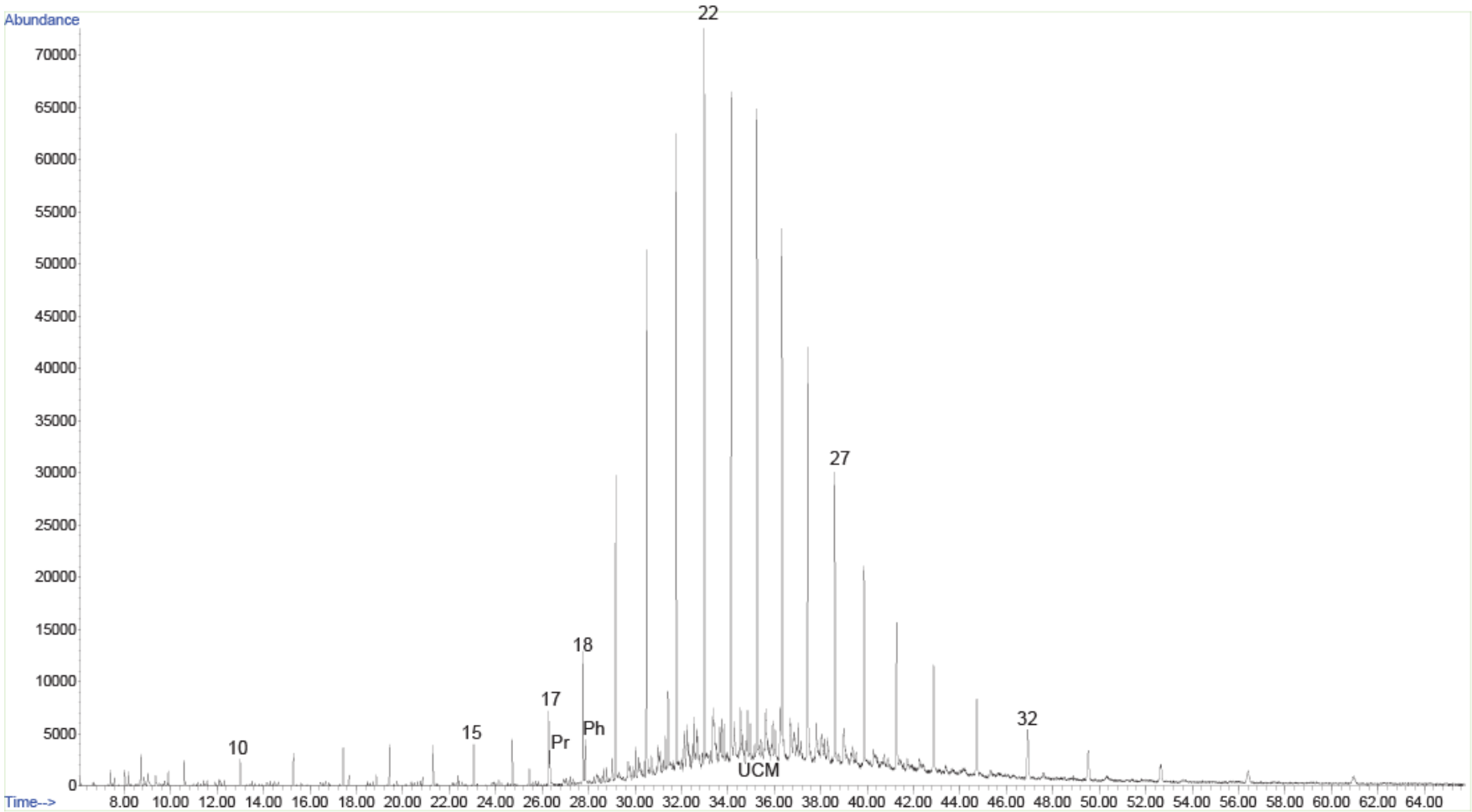



Figure 6: Chromatogram of oil which has undergone evaporation but still has some light alkanes remaining

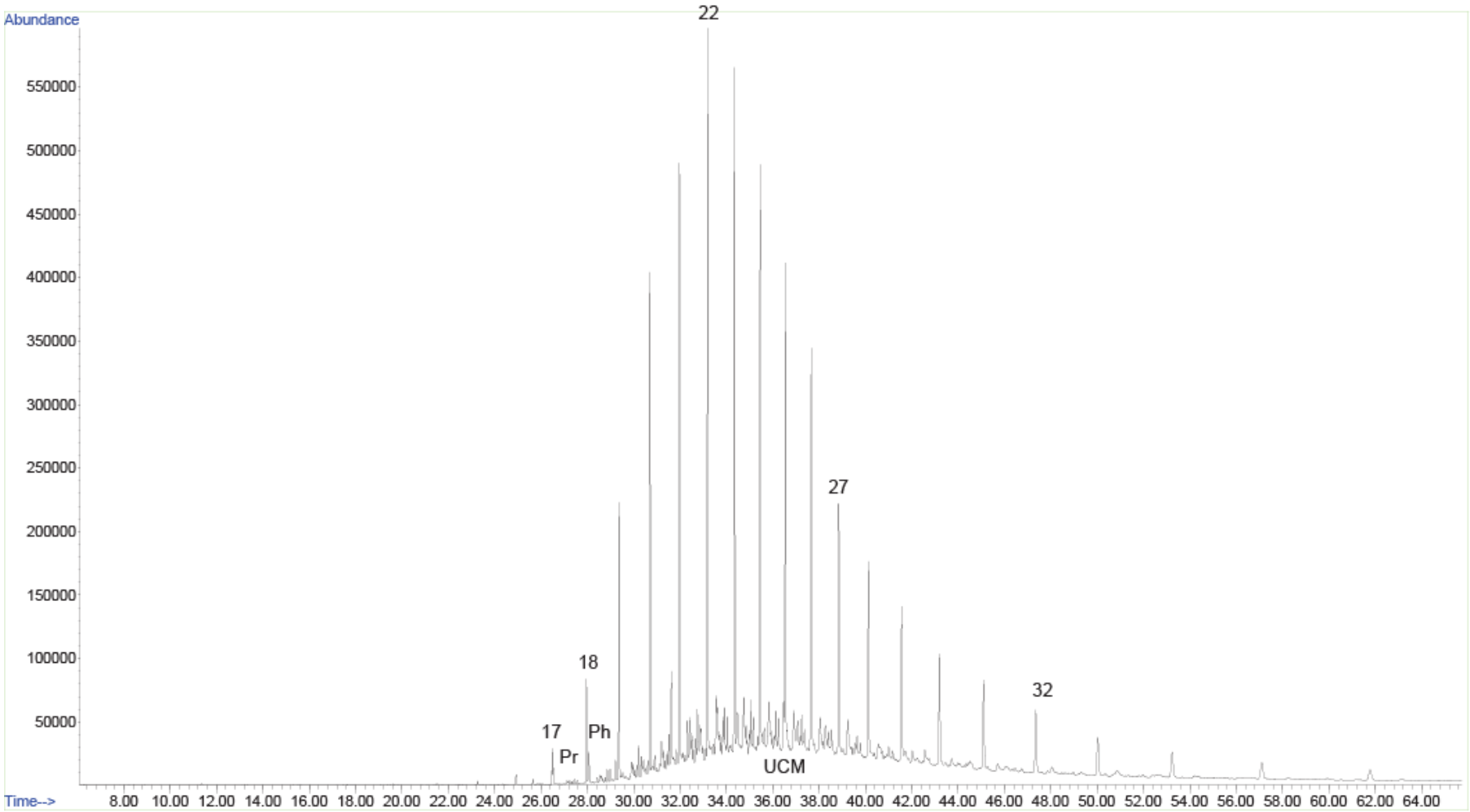



Figure 7: Chromatogram of oil which has undergone extensive evaporation.

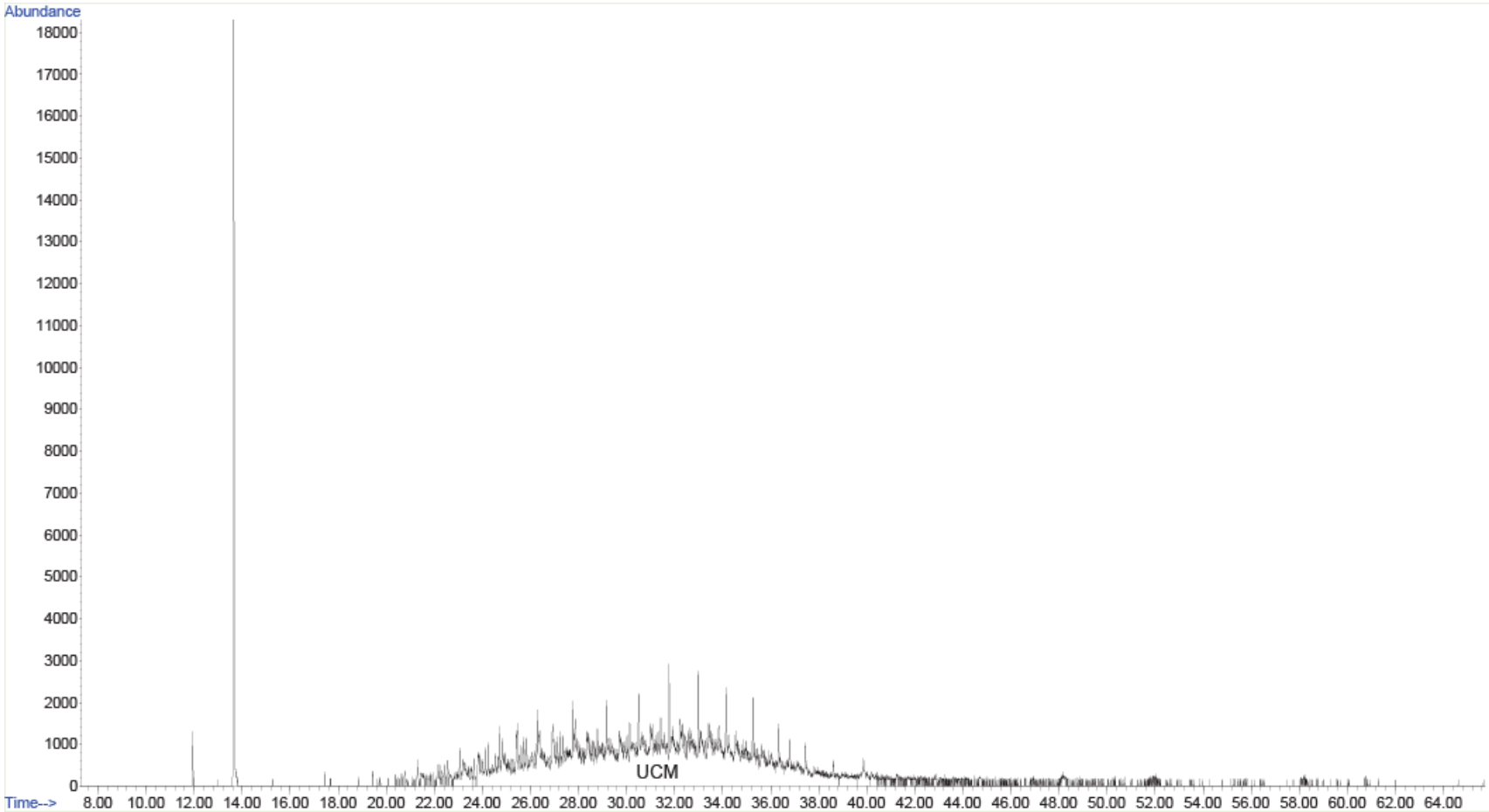



Figure 8: Chromatogram of highly degraded oil or lubricating oil residue

## Problems/operational issues:

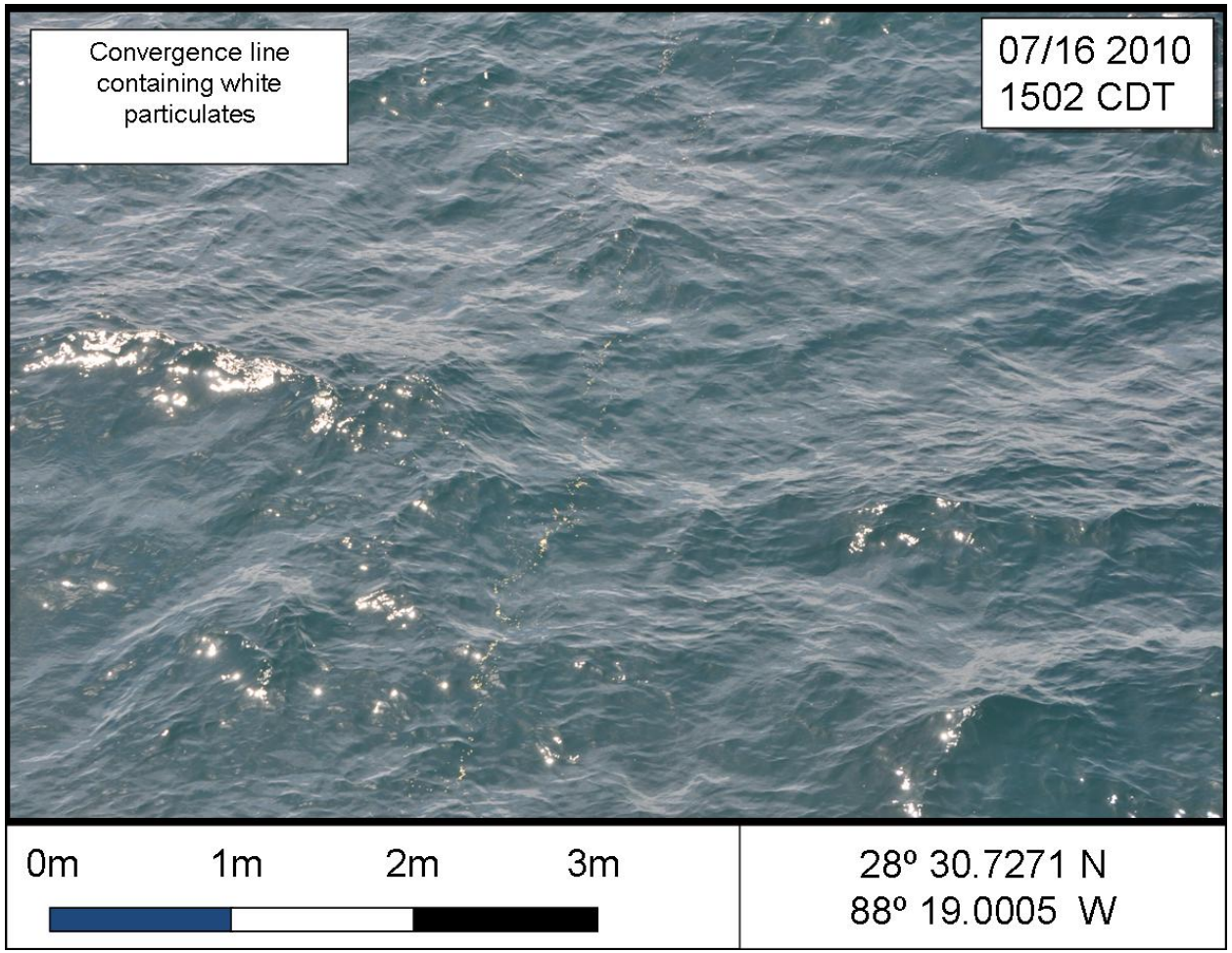
(Includes items up to report submission time)

The ship received a new generator for the C&C container and members of the crew were PFT and Fit tested by Total Safety for organic vapor masks. We also received a volatile organic compound detector to test air quality in the event we transit inside of the 5 nautical mile perimeter of the incident site. We have also added a dissolved oxygen meter to the CTD and CSIRO scientists brought a methane sensor to deploy on the vertical casts.

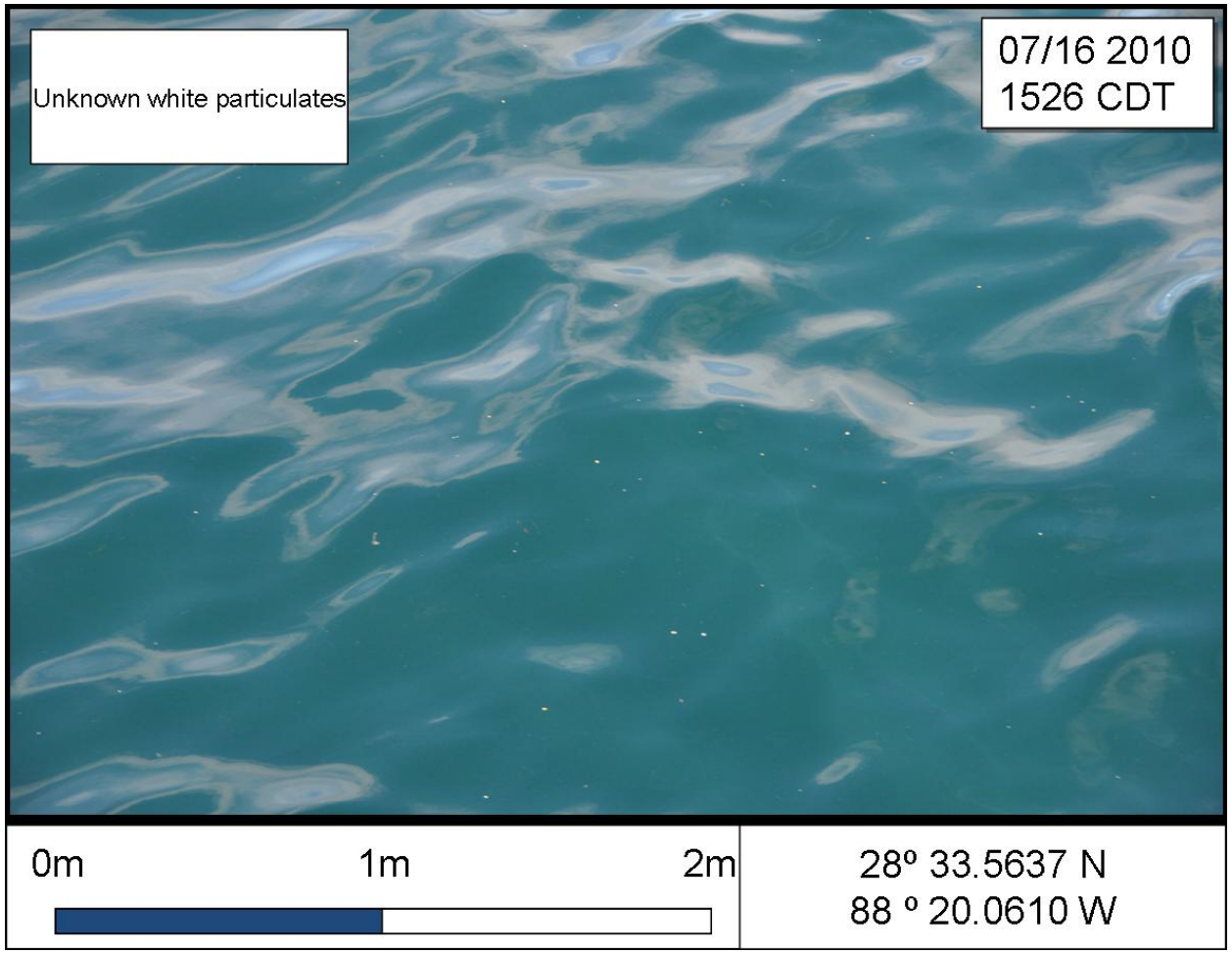
## Planned activities for next 24 hours:

Prepare for and execute Cruise 9.

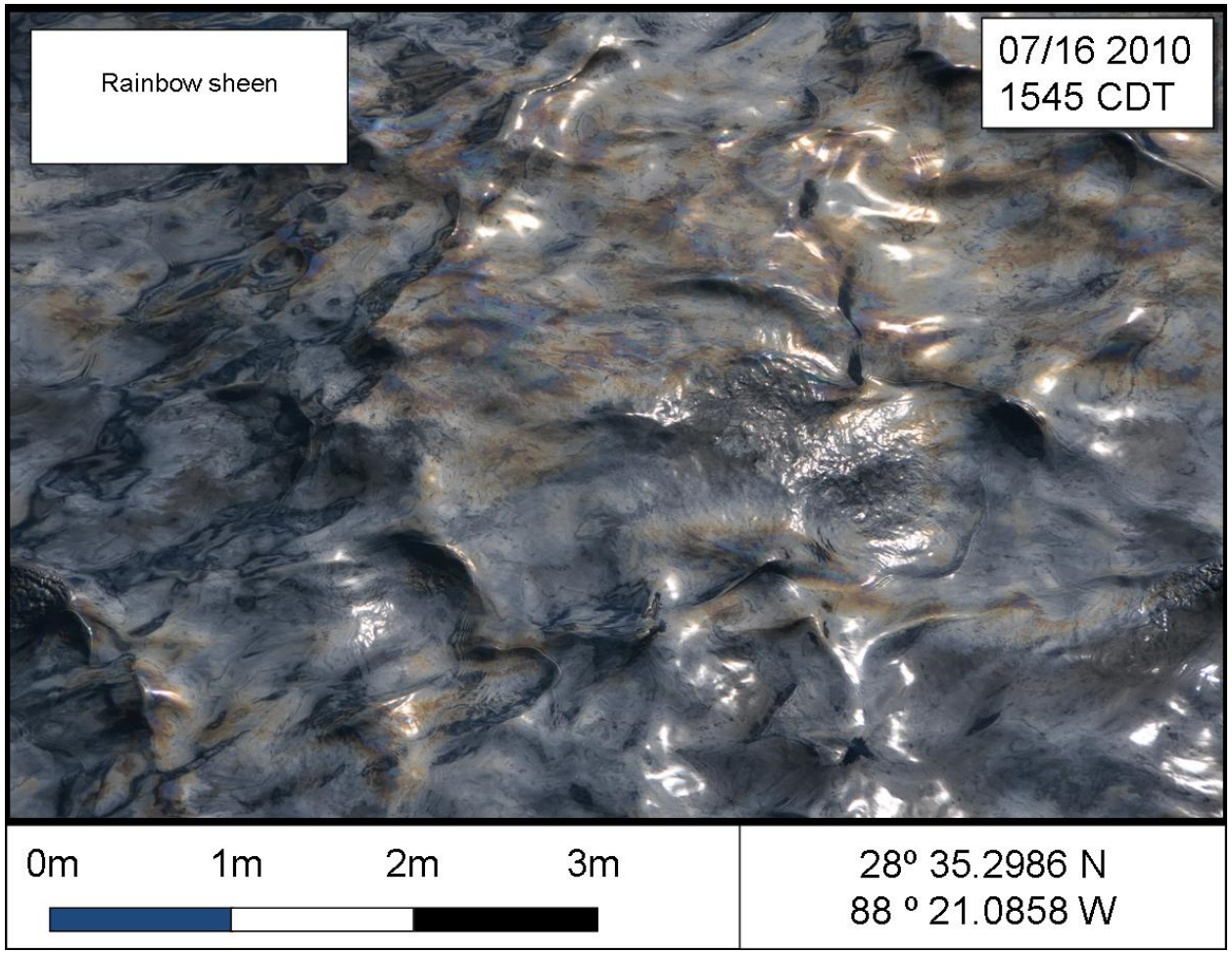
## Selected Photos:



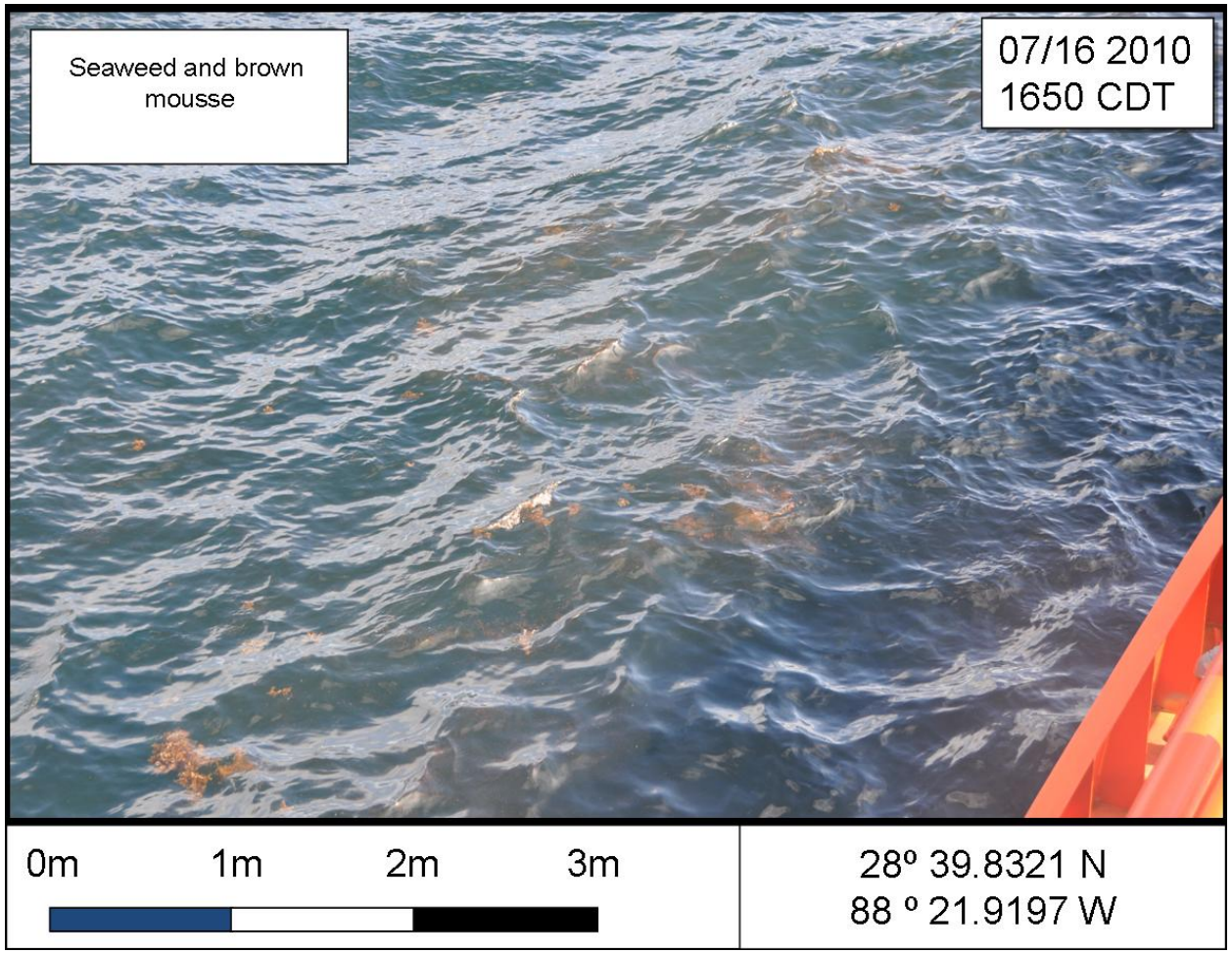
Photograph 1. Dull surface sheen with unknown white particulates forming a convergence line.



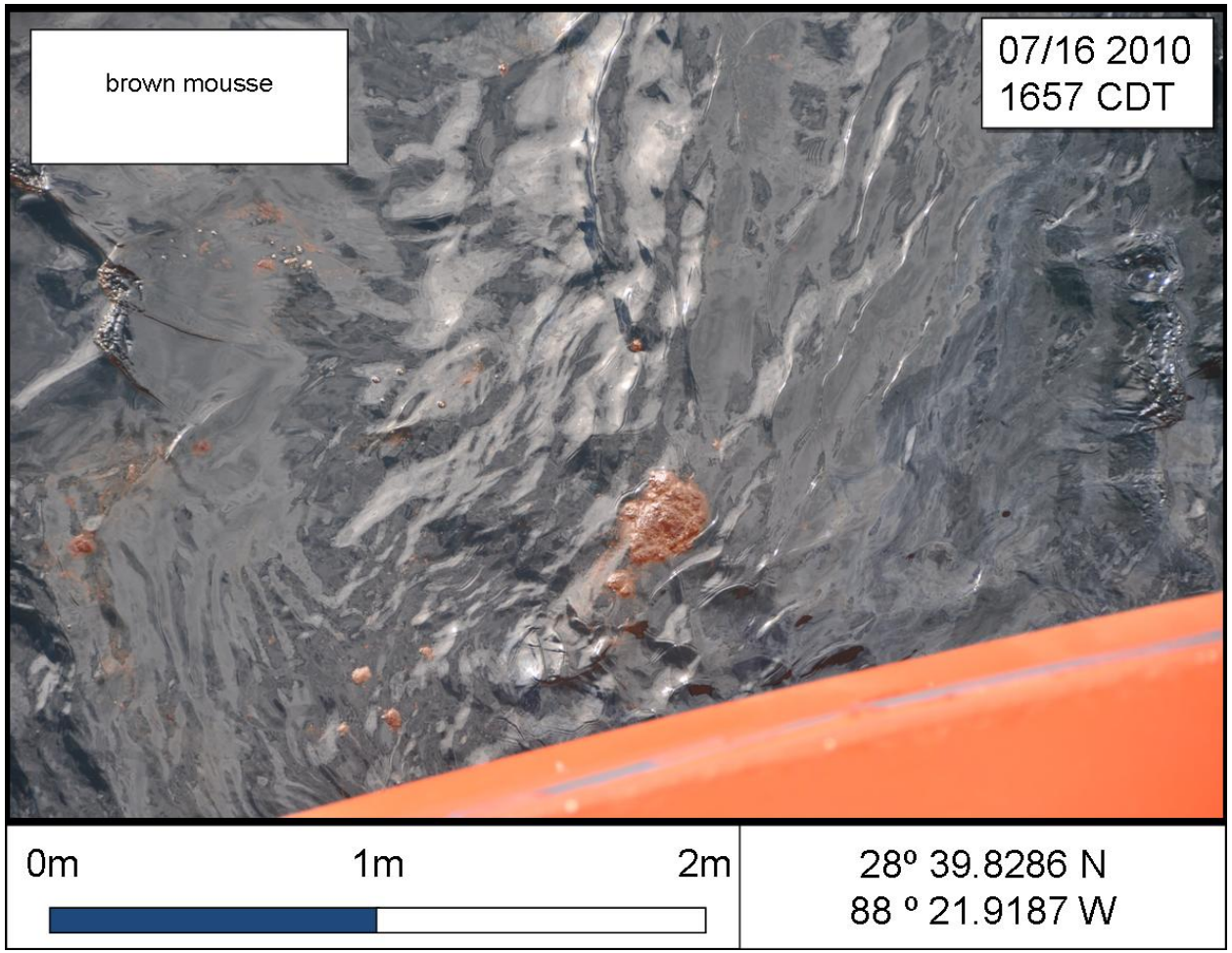

Photograph 2. Dull surface sheen with white particulates.



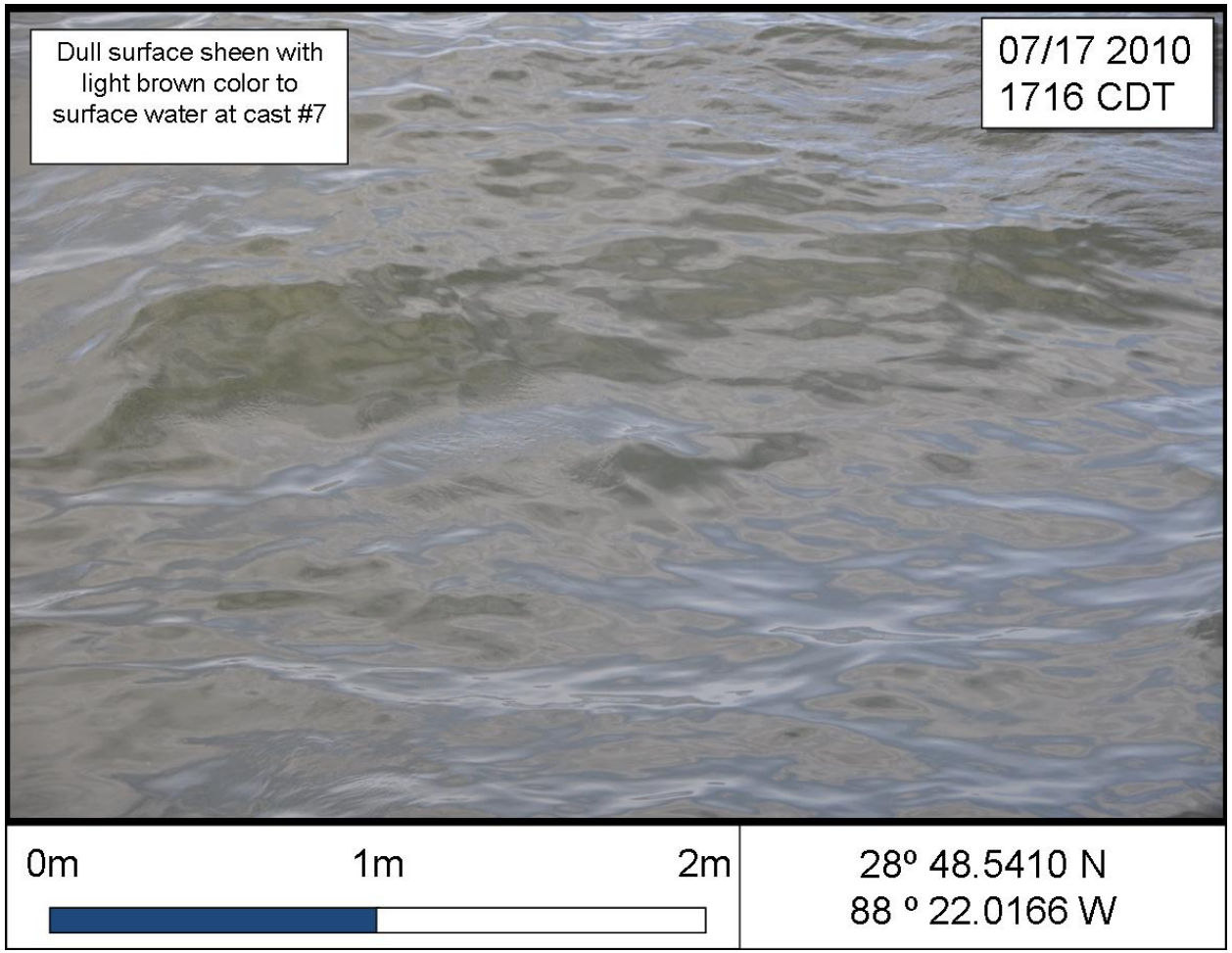

Photograph 3. Rainbow surface sheen.



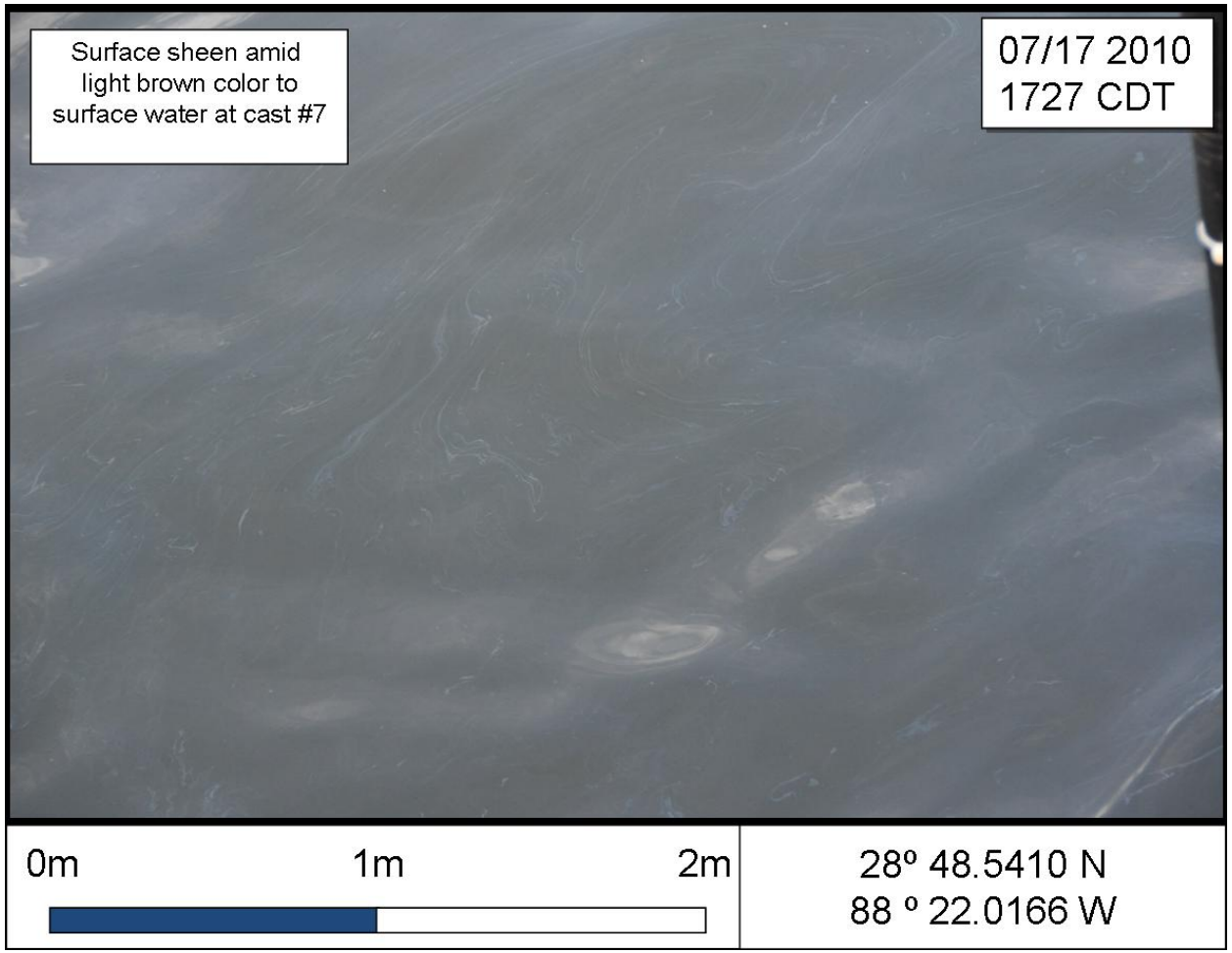

Photograph 4. Brown oil and seaweed co-occuring making it difficult to discern the differences. Note surface sheen.



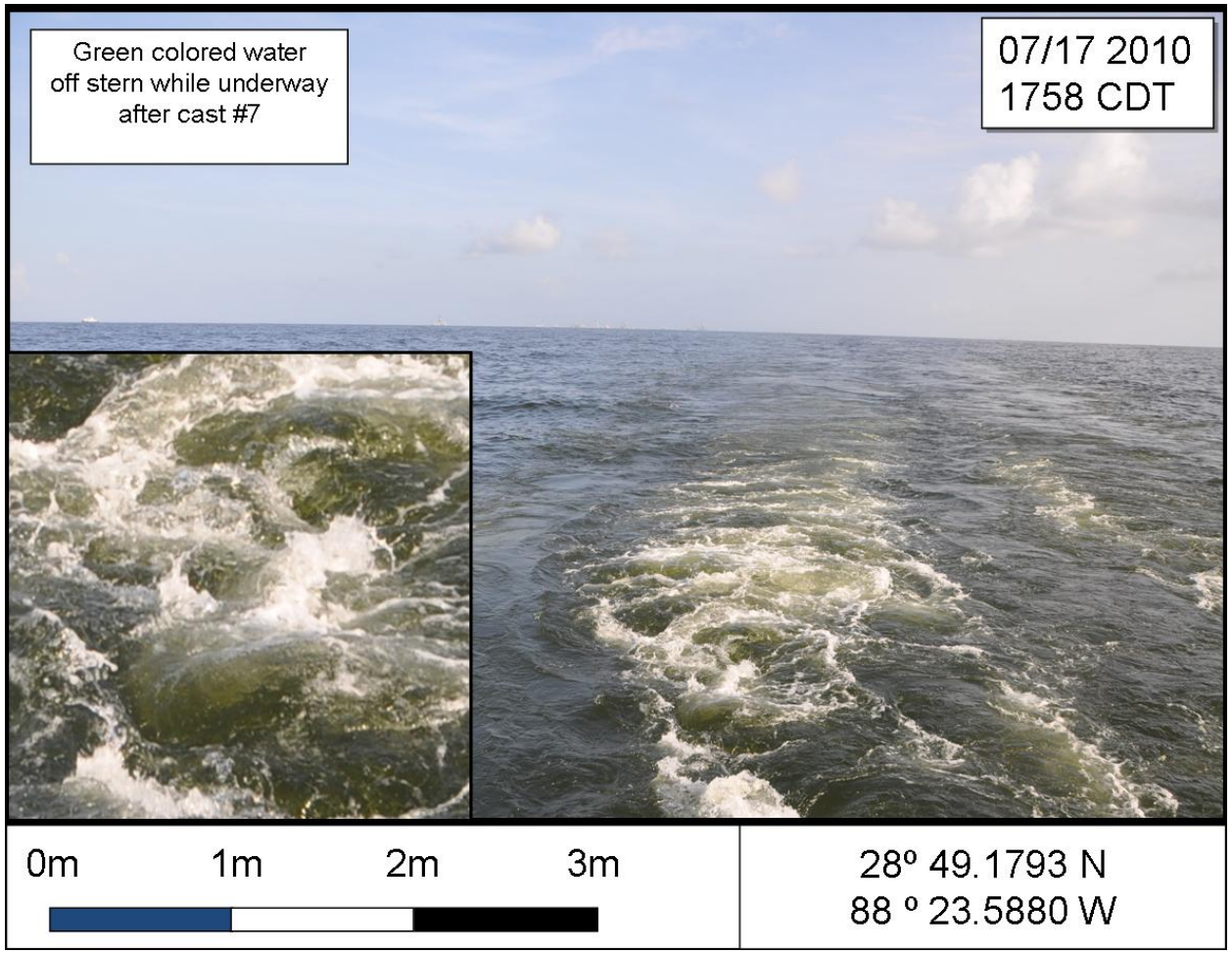

Photograph 5. Brown mousse amid surface sheen.



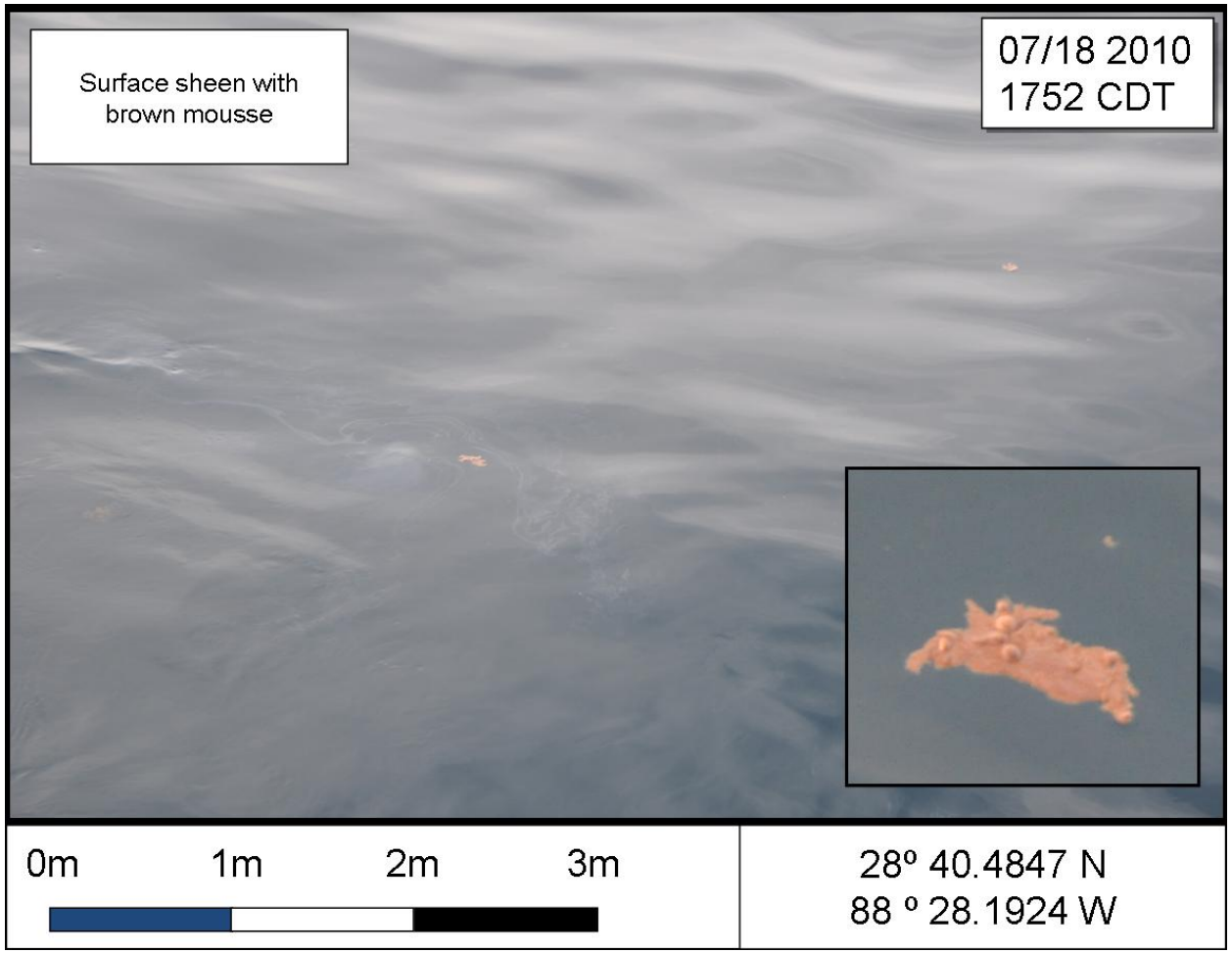

Photograph 6 Dull surface sheen in a brown colored water located at Cast #7.



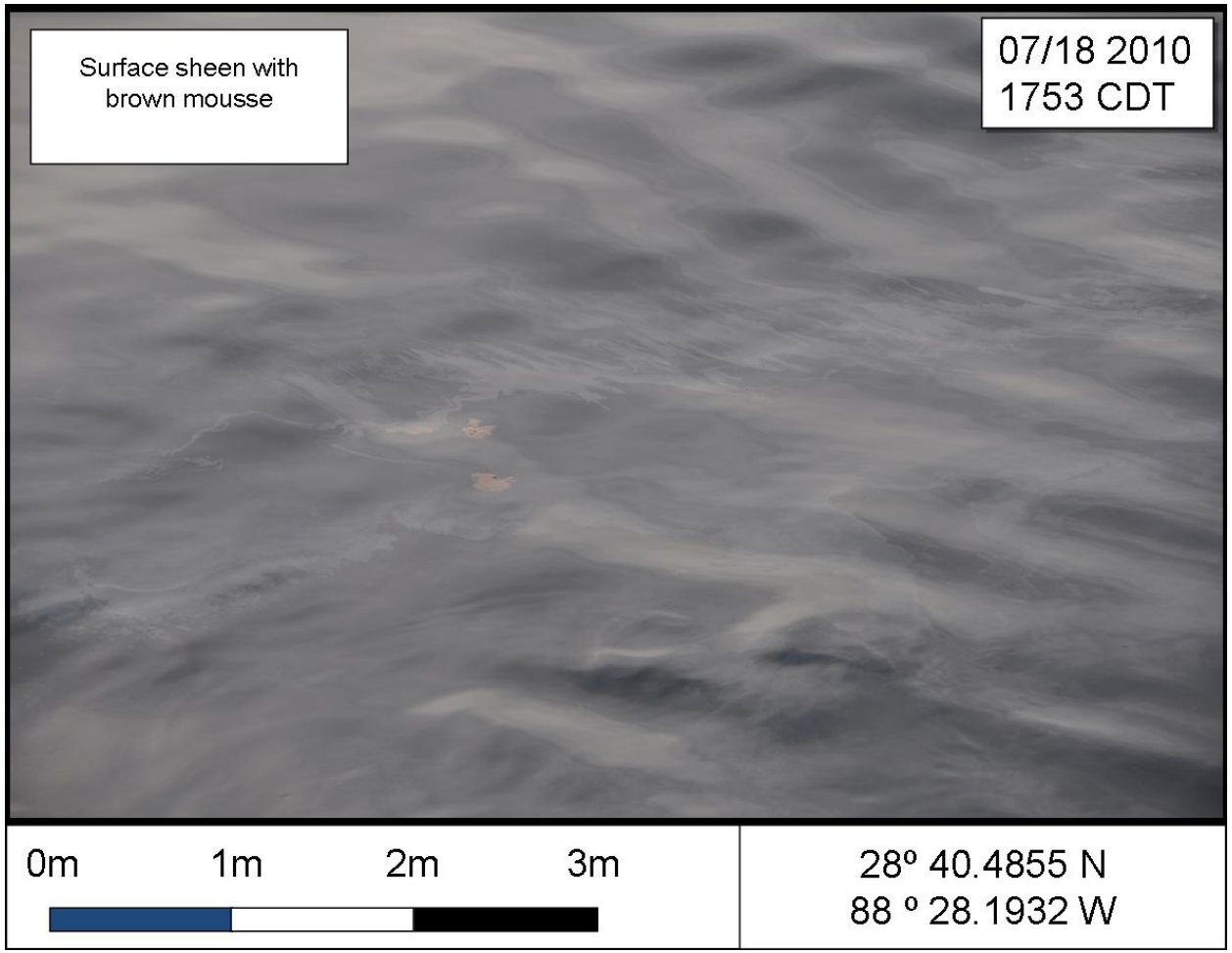

Photograph 7. Surface sheen in a brown colored water located at Cast #7.



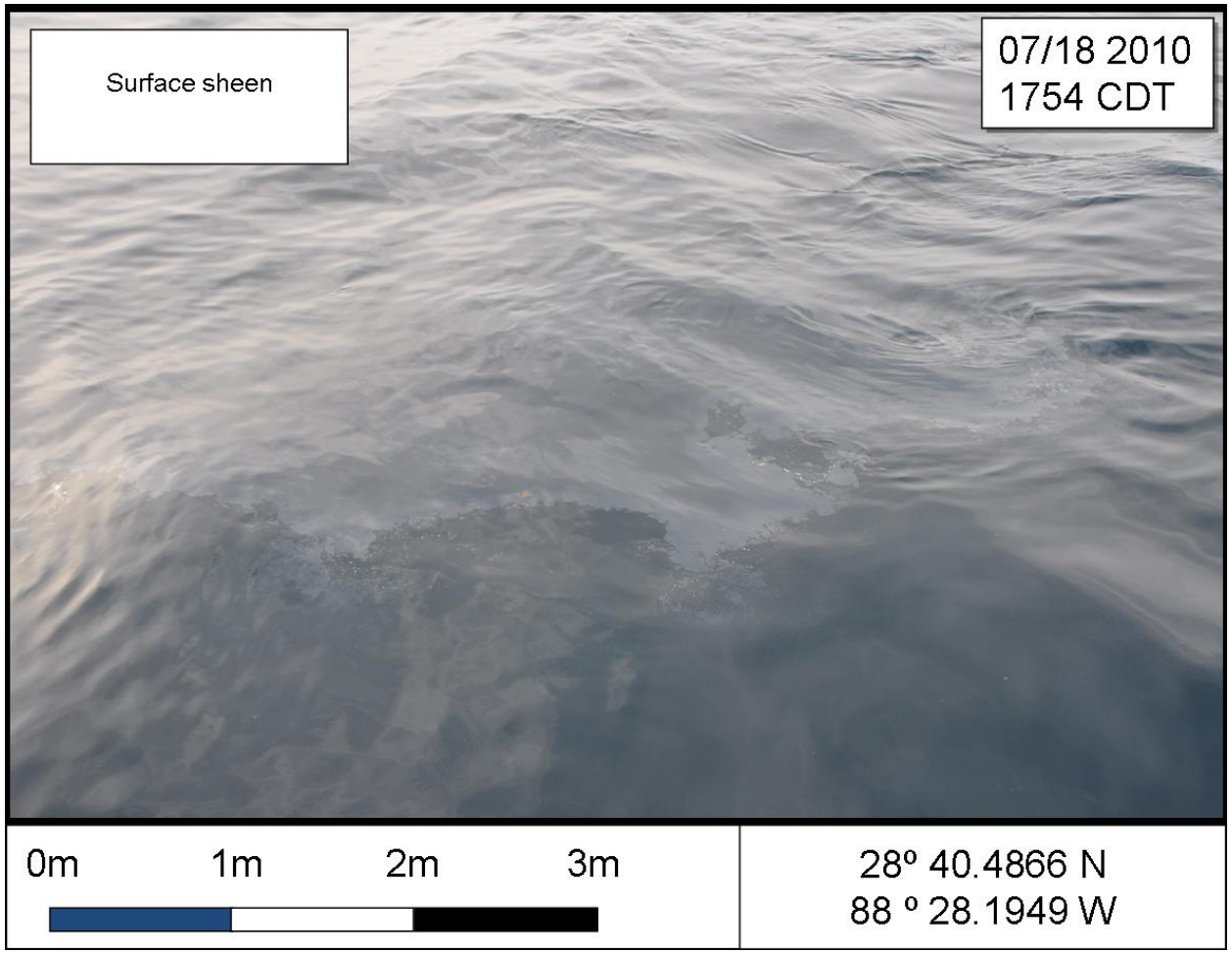

Photograph 8. Greenish colored water observed off the stern while underway after taking Cast #7. The color may be due to a combination of green, golden-brown (diatoms), and/or yellow-green algal blooms in the upper photic zone.



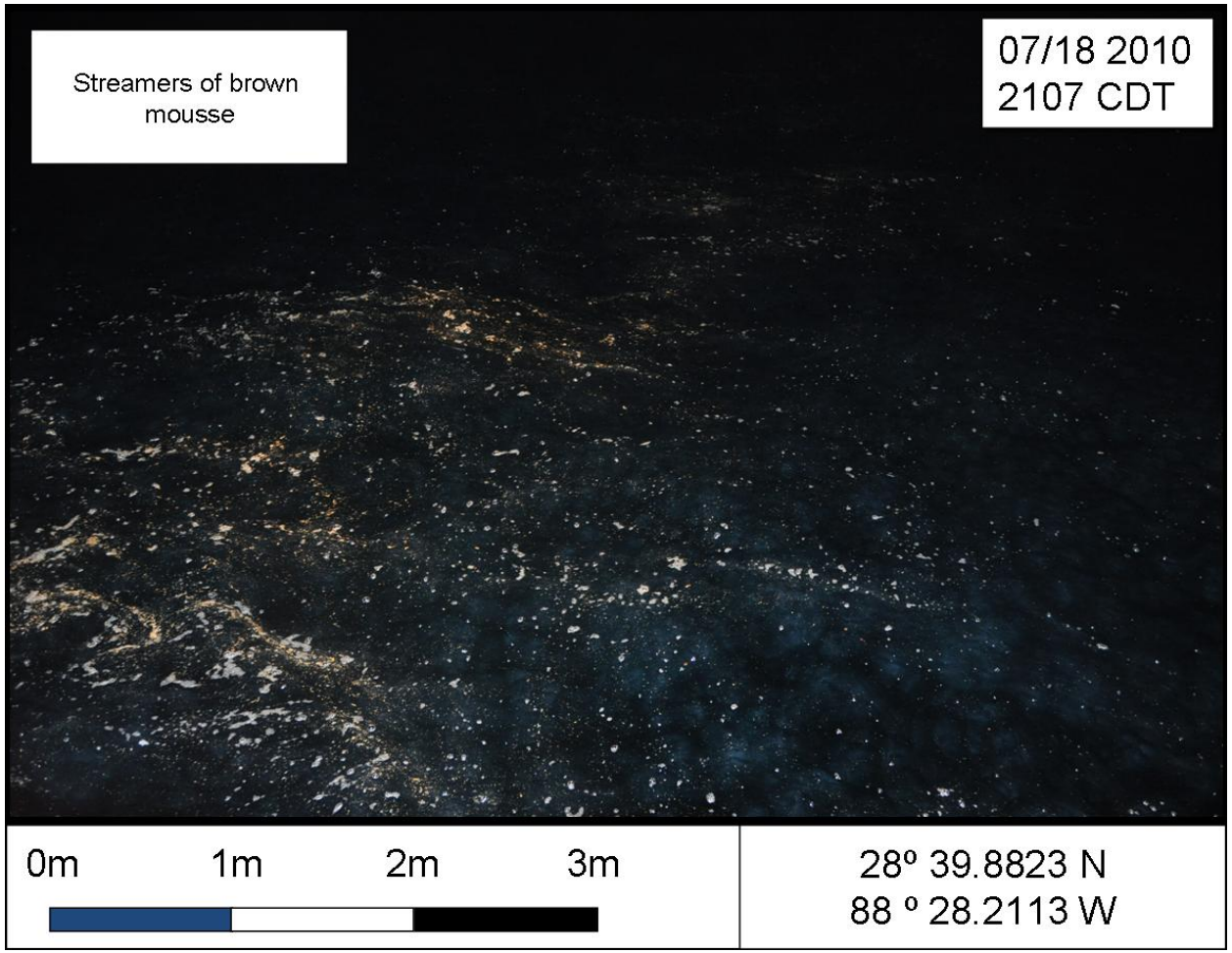

Photograph 9. Surface sheen with small pieces of brown mousse.



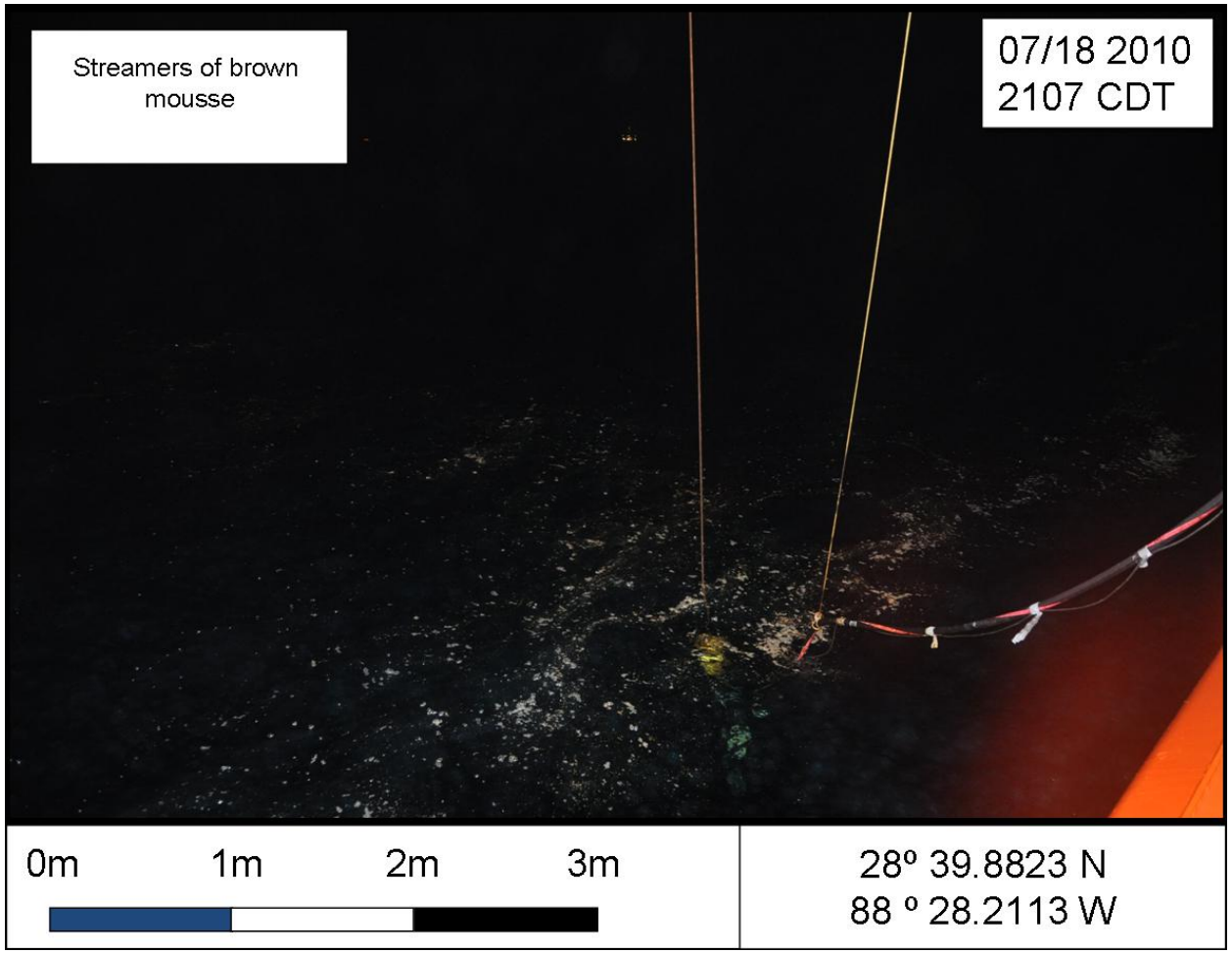

Photograph 10. Surface sheen with slight rainbow tint and pieces of brown mousse.



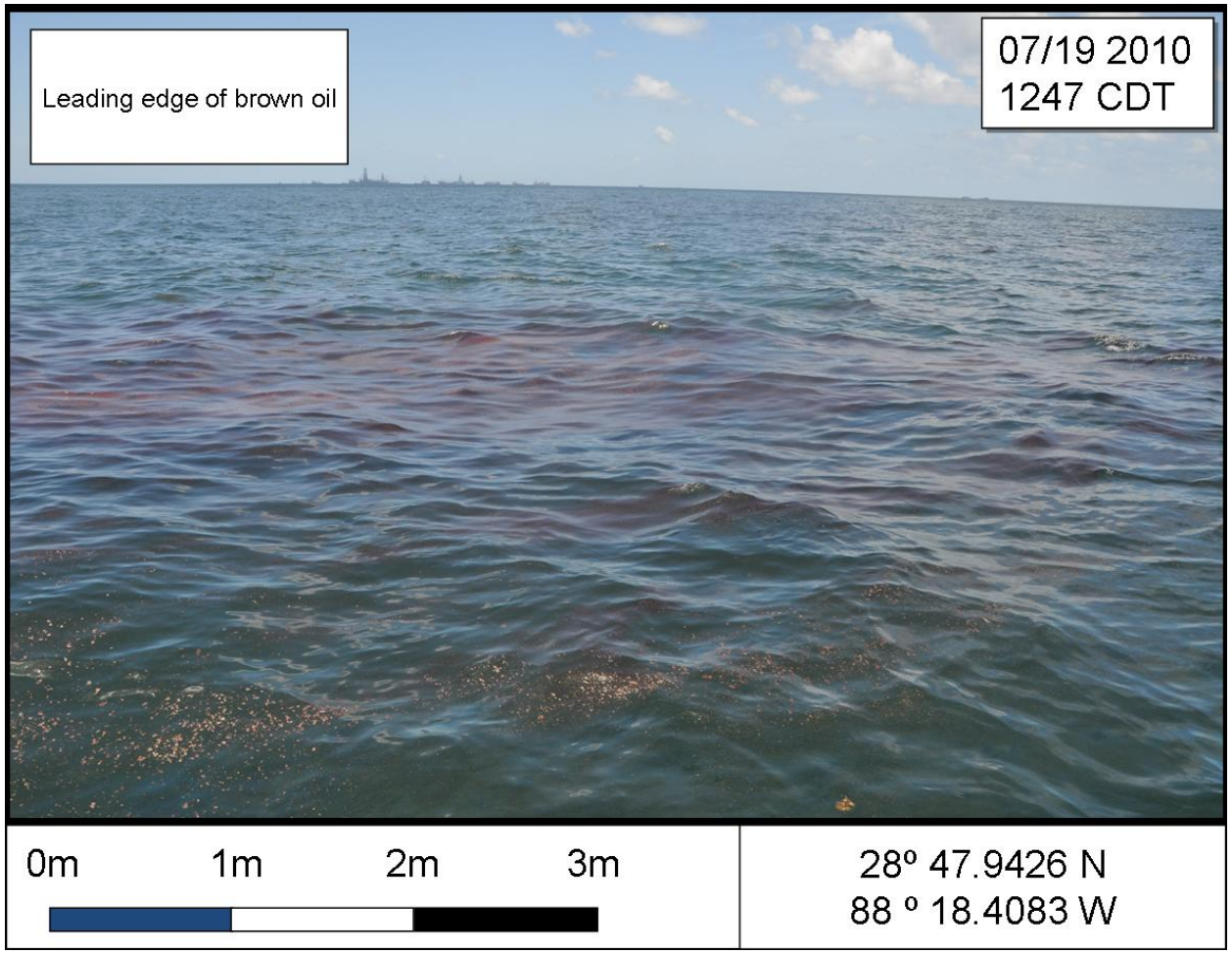

Photograph 11. Unusual surface sheen with a waxy appearance.



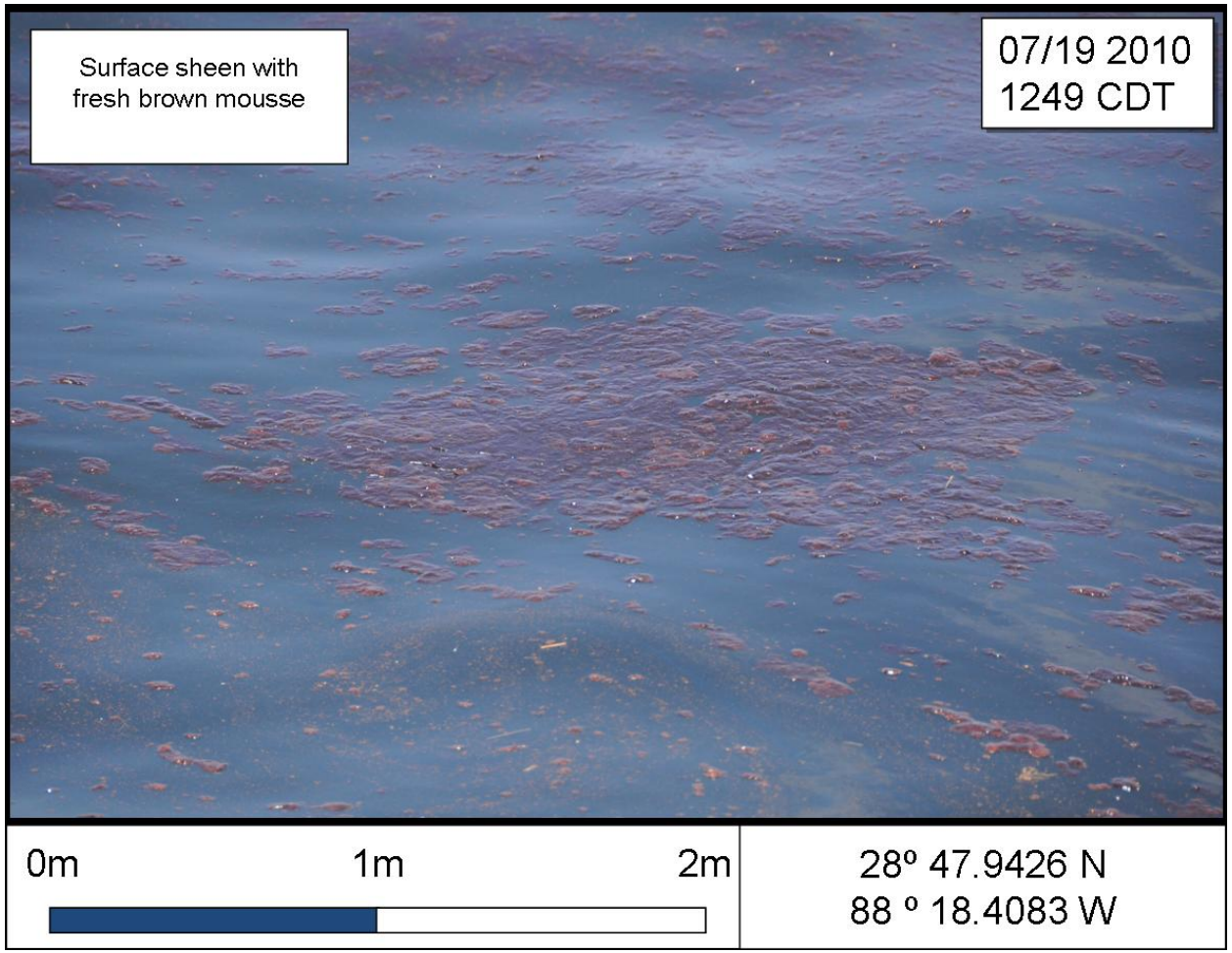

Photograph 12. Foamy streamers of brown mousse and possiblt brown oil droplets. Foam may have originated from dispersants.



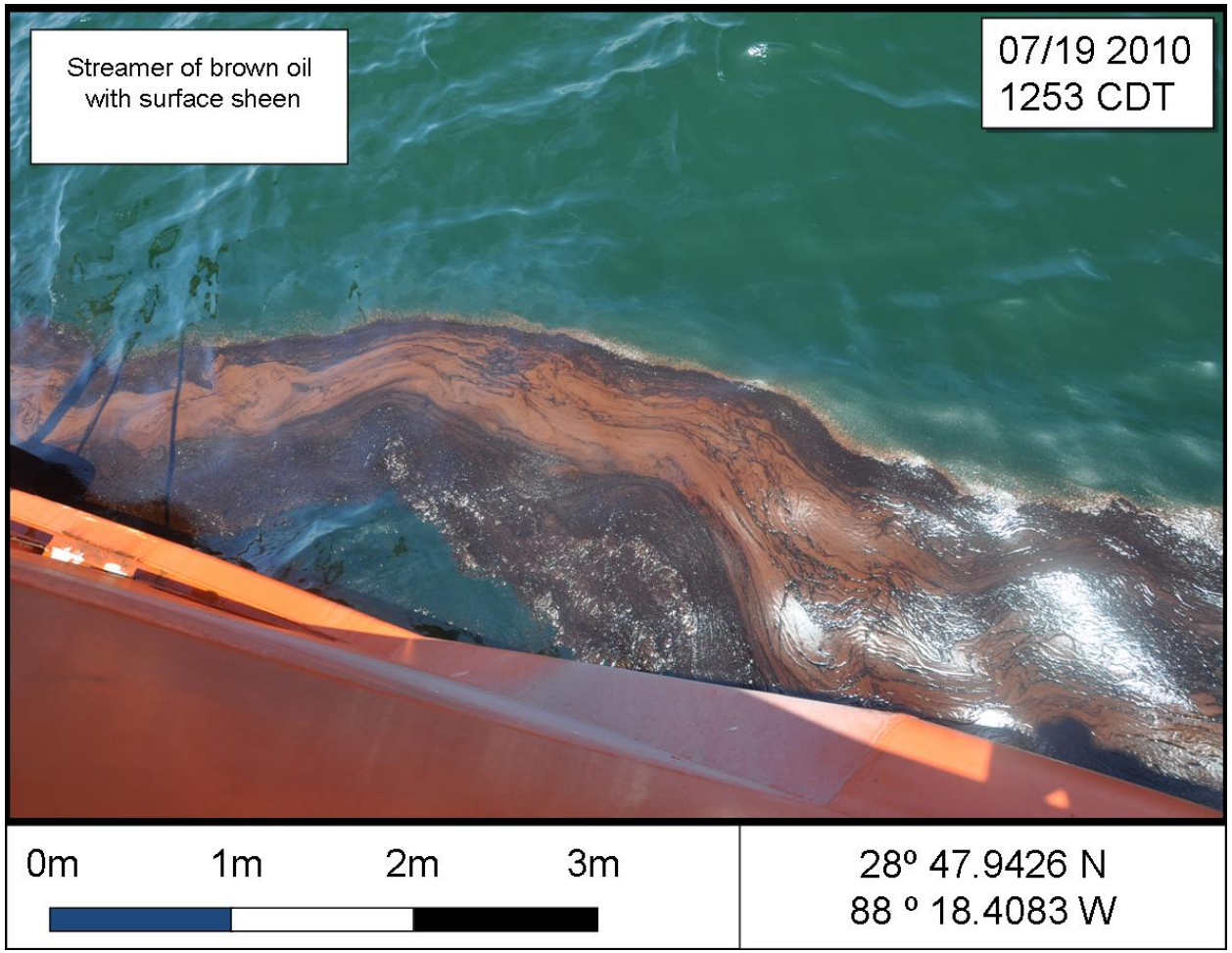

Photograph 13. Foamy streamers of brown mousse and possiblt brown oil droplets. The underway pump is seen along side the ship. Water samples and mousse were collected here.



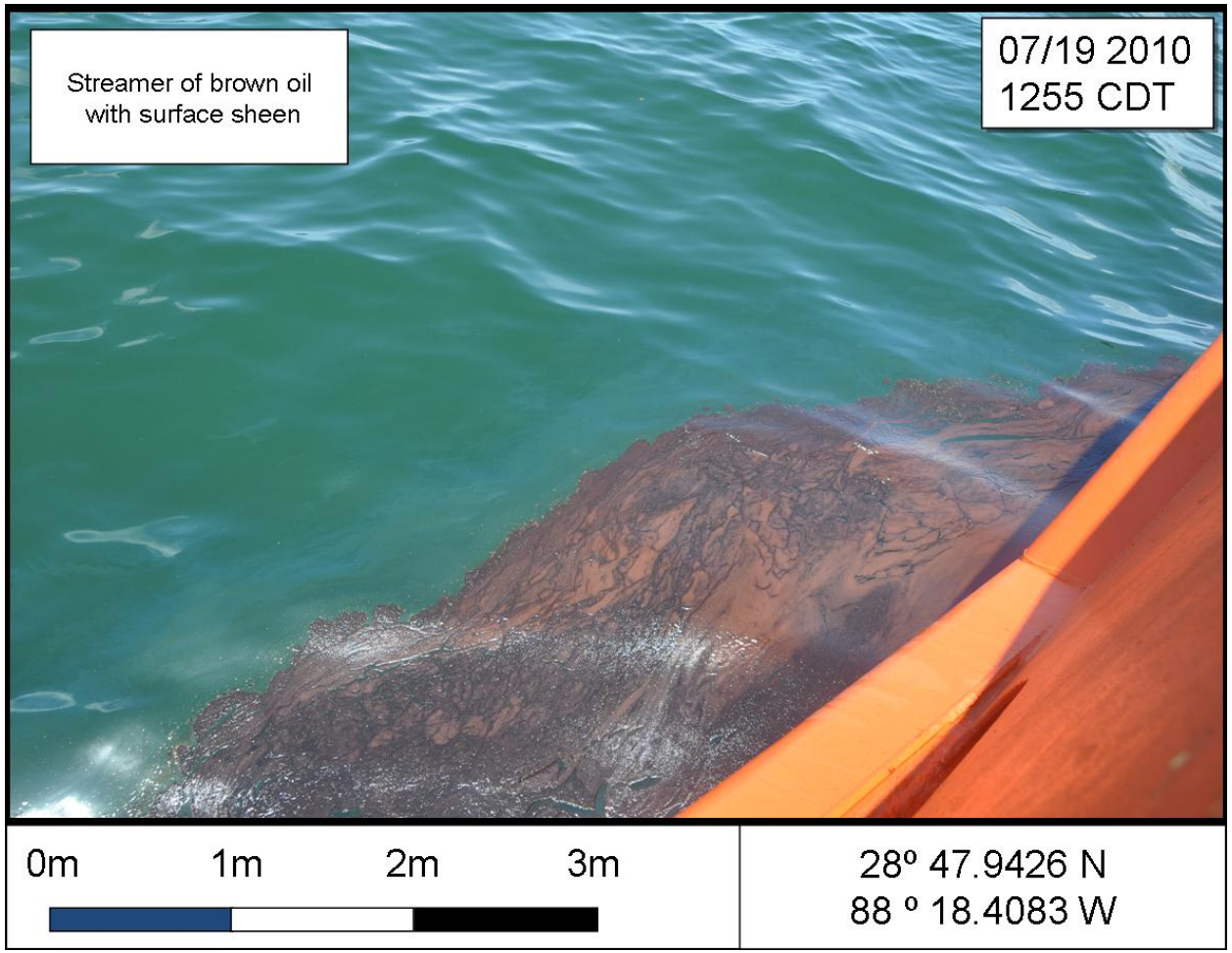

Photograph 14. Leading edge of fresh brown oil encoundered near the incident site.



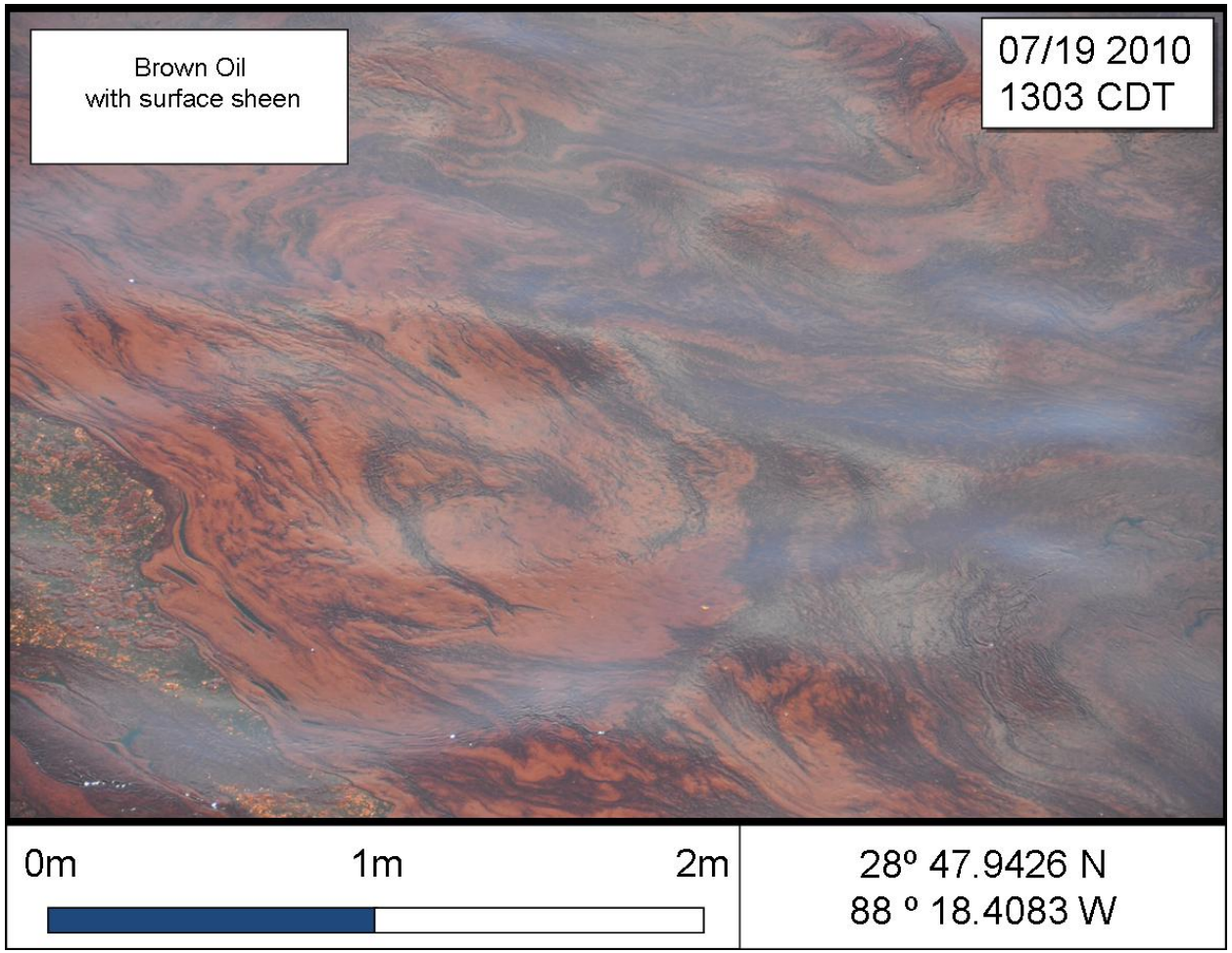

Photograph 15. Surface sheen with fresh pieces of brown mousse.




Photograph 16. Streamer of brown oil along the port side.




Photograph 17. Streamer of brown oil along the port side with frothy light brown wispy patterns.




Photograph 18. Close-up of frothy light brown oil.