# CCGS Nahidik, 20th July-20th August, 2007.
# Northern Coastal Marine Studies on the Canadian Beaufort Shelf.


There are several components to the Department of Fisheries and Oceans science program on the Nahidik which together form an integrated study of the physical oceanography, phytoplankton, zooplankton, ichthyoplankton, fish and benthos of the Canadian Beaufort Shelf. The various components and the scientists on board this year were:

| | |
|---|---|
| Physical oceanography | Bill Williams, Peter van Hardenberg |
| Carbon studies | Patricia Ramlal |
| Ichthyoplankton and zooplankton | Sally Wong, Wojtek Walkusz |
| Fish | Brad Park, Mark Lowdon |
| Acoustics | John Jorgenson |
| Geotechnical sampling | Kevin MacKillop |
| Benthic ecology | Christine McClelland, Alec Aitken |
| Macrobenthic diversity | Megan Foss |
| Hydrographic support | Dave Tobio, Bill Briggs, Jim Wheedon |

Most of the goals of the different groups of scientists aboard were completed and the cruise was a success.

There were three primary study areas: Cape Bathurst, Herschel Island and the Mackenzie River plume (see Figure 2). Cape Bathurst was studied as a site of topographically enhanced wind-driven upwelling, Herschel Island was the primary location for fishing activities, and the Mackenzie River plume was sampled at the beginning and end of the cruise to study its zooplankton community. In addition, we visited many benthic features, including ice scours, knolls and artificial islands, which were of interest to the benthic ecology and geotechnical sampling groups, and did a 24 hour station in Mackenzie Bay for the carbon studies group.

The Nahidik is not ice-strengthened and it is typical for our sampling to be restricted by sea-ice. This year, at the beginning of the cruise, ice charts (see Figure 3) and satellite images (see Figure 4) showed the Canadian Beaufort Shelf to be ice-free. This is an unusual occurrence. Several factors likely contributed to the large area of open water, but we expect that the dominant factor were persistent winds from the east and southeast that pushed the ice offshore. During the cruise, the easterlies continued (see Figure 5) so the sampling area remained ice-free and we were able to study wind-driven upwelling at Cape Bathurst and Herschel Island.

Our cruise track is shown in Figure 1, a time line for the cruise is given in Table 1 and detailed event log and cruise track data can be found at ftp://ftp.eos.ubc.ca/pub/wwilliam/Nahidik_2007.

This is an interdisciplinary research program and so, if possible and appropriate, all scientists sample at each station. As last year, the sampling for a 'full' station was typically structured as follows:

| **SAMPLING** | **LOCATION** |
|---|---|
| CTD/Rosette cast on arrival at the station. | Aft deck hydro-winch |
| 2 x Algae net casts (to catch phytoplankton) | Aft deck hydro-winch |
| 3 x Vertical net casts (to catch zooplankton) | Aft deck hydro-winch |
| 2 x Bongo net tows (to catch ichthyoplankton) | Fore deck large winch and crane |
| 2 x Bottom trawl | Fore deck large winch and crane |
| 3 x Box cores | Fore deck large winch and crane |
| 1 x Gravity core | Fore deck large winch and crane |
| Bottom camera | Aft deck hydro-winch |

Near the beginning of the work day, if weather conditions allowed, the Widgeon would also be deployed to run a dense grid of acoustic lines in the 2x2 nm box that defined the station. The Widgeon was usually recovered towards the end of the afternoon.

In addition to the point sampling performed at stations, there was also continuous acoustic mapping of the water column and seafloor, via the instruments attached to the acoustic arm, and continuous measurement of sea-surface water properties, via seawater pumped into the forward hold.

It has been typical to have only one deck hand up at night on the Nahidik, but this year the deck crew was organized differently. Two deck hands and the bosun were on the day shift (6am to 6pm) and two deck hands were on the night shift (6pm to 6am). This made it much easier to work into the evening on the foredeck, with box cores and towed nets, as only the bosun would require overtime. It also made the bottom camera and CTD/Rosette work at night easier and a little safer with two deck-hands present.

The remainder of the report consists of a wish list of recommendations followed by individual reports from the various science teams aboard.

**Recommendations:**

**1. Additional Deckhand.** An additional deckhand would allow 3 deck crew during the day and 3 during the night. This would enable us to have full science operations 24 hours a day.

**2. Additional Scientist.** With one more scientist it might be possible to reorganize the scientists into day and night teams, enabling full science operations 24 hours per day.

[Having two additional people on the ship is contingent on upgrading the sewage system (which is at capacity at the moment), having larger capacity life-rafts (so that more than 30 people can be on board) and installing special lockers for the emergency medical equipment (which is currently occupying one of the spare bunks)]

**3. Laboratory Space.** More lab space is needed on the Nahidik. This can be achieved by extending the lab on the helicopter deck and by installing a lab in the forward hold. The lab in the forward hold would be on the starboard side and replace some of the lockers there.

**4. Drop keel for acoustics. ($lots, $500K at *least*, ask CCG))**
The acoustic arm was rebuilt during the winter of 2006. The new arm is stronger and has less vibration than the previous version. Consequently, the acoustic data seems to be of a higher quality. Nonetheless, the arm must still be manually raised whenever the *Nahidik* is in shallow water or when there is debris or ice in the water. The arm is also close to the area where most of the box coring and trawling is done. There is a constant threat of entangling the gear in the arm. The arm is also close to the docking area for the *Widgeon* which can be a concern in rough seas. Ultimately, the solution to this problem is to engineer and install an acoustic keel similar to those used on the *Amundsen* and *Martha Black*. This would be a major refit item but acoustics are likely to be a major component of the *Nahidik's* program for the foreseeable future and it is therefore worth considering.

**5. Acoustic arm to starboard side (see 'Drop keel for acoustics' also). ($?)**
There were a couple of close calls in 2006 where gear being towed along the portside snagged the acoustic arm. There was no damage to the arm this year, but it would be more ideally situated on the starboard side. The presence of the acoustic arm on the portside not only puts it in harms way while towing gear, but also affects our ability to tow gear in a straight line under certain conditions, forcing us to maintain a portside turn while trawling or towing bongos. The acoustic arm would be modified so that it could be installed either in the new fitting on the starboard side or in the original fitting on the port side. The arm would be used on the starboard side for leg 1 (to be out of the way of fishing nets and the *Widgeon*) and then moved to the port side for leg 2 (to be out of the way of the *Petrel*)

**6. Fuel port on front of superstructure. ($? Ask CCG)**
A diesel fuelling station on the front of the *Nahidik* was requested but not done. This would make it much easier to refuel both the Widgeon and Petrel. It should be strongly considered in the future if possible.

**7. Green winch on foredeck. ($?)**
The wire on the green winch needs a new certified eye on the end. The cheapest way to do this is to buy a new wire with a certified eye already on it and to ship it to the Nahidik. The wire should be 6-strand, non-rotational wire. It may be possible to have a certified eye on each end of the wire, so that if one of the eyes fails inspection in the future the other end of the wire could be used.

**8. Line-out metre for the green winch ($?, <$10K?)**
The winch needs a metre installed that indicates how much cable has been let out. We rely on the angle of the cable, and the amount of cable that has been released, to calculate the approximate depth of the equipment. This year, we stretched out 250m of cable and put marks every 10m to enable us to count the length of cable, however these marks wear away quickly and, while sampling deep stations (>100m), we often require that more that 250m of cable be released.

**9. Lab-space.**
There is very little laboratory space on the Nahidik, the only bona-fide lab being the short aft container. The lab was often very crowded. During the 2007 cruise there were 6 researchers trying to use the same space, frequently at the same time. Storage of lab supplies is a challenge. The container needs to be at least double the size.

**10. Aft video cameras. ($? Ask CCG)**
Ceiling mounted cameras that relay to the bridge the winch operations on the aft deck. These cameras need to be weatherproof.

**11. E-mail. ($? Ask CCG))**
While all scientists are interested in receiving email on a personal basis, there are many instances where communication of the needs of the scientists to support staff at work is best served by email rather than the intermittent satellite phones (see ‘phones’). ‘Email at sea’ should be fully implemented on this ship.

**12. Ice-Vue. ($? Ask CCG)**
Ice and weather forcast information is limited on the Nahidik. This information should arrive via radio fax from Inuvik Coast Guard Radio, but this system has not worked well for the last three years. All ice and weather information was available this year from an ftp site created by the Canadian Ice Service for us. This was much appreciated and very helpful, but could only be downloaded when in Tuktoyaktuk for resupply or bad weather. Given that the Nahdik is not ice strengthened but works in the Arctic any ice information received is closely considered. The additional detail provided by the Radarsat images provided was also much appreciated as it is often useful to know the location of individual ice floes or the pattern of ice distribution within low ice concentration areas. Ice Vue needs to be implemented on the Nahidik. I understand that a version of Ice Vue called Ice Vue Lite is being created that would not require an ice observer to be on board the Nahidik.

**13. Computer network. ($? Ask CCG)**
The ship’s computer network system should be developed to enable science staff to access common data from their cabins. Optical fibres are already in place for this. A small system was tried this year linking together linking together several computers on the bridge and in the container behind the bridge. A network can allow for easy access to stored data while at sea and for automated backup of data. The system should be designed so that eventually an e-mail/internet link can be added to the system.

**Thanks:**

We would like to thank Captain Jean Cloutier and the excellent crew of the Nahidik. They made an exceptionally friendly, accommodating and hardworking boat and I look forward to sailing on the Nahidik again. I would also like to extend thanks to Dave Tobio who, once again, managed to bring what we forgot and fix what we broke.

**Contact information for the scientists and hydrographers on board:**

| | | |
|---|---|---|
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| Wong | Sally | wongsv@dfo-mpo.gc.ca |

***Time Line - Beaufort Sea 2007***

| DATE | LOCATION |
|---|---|
| 16-Jul-07 | Inuvik |
| 17-Jul-07 | Inuvik |
| 18-Jul-07 | Inuvik |
| 19-Jul-07 | Inuvik |
| 20-Jul-07 | Inuvik |
| 21-Jul-07 | Inuvik |
| 22-Jul-07 | Sail down-river to Tuktoyaktuk |
| 23-Jul-07 | Fuel and water in Tuktoyaktuk |
| 24-Jul-07 | Plume front study with FJMC students |
| 25-Jul-07 | Plume front study/Issungnak artificial island |
| 26-Jul-07 | Issungnak artificial island/Plume front study |
| 27-Jul-07 | Plume front study |
| 28-Jul-07 | Kugmallit GasVents |
| 29-Jul-07 | Upwelling at Cape Bathurst |
| 30-Jul-07 | Upwelling at Cape Bathurst |
| 31-Jul-07 | Upwelling at Cape Bathurst |
| 01-Aug-07 | Tuktoyaktuk Peninsula: Ice scours 6870 and 6854 |
| 02-Aug-07 | Herschel Island |
| 03-Aug-07 | Herschel Island/Mackenzie Bay 24 hour station |
| 04-Aug-07 | Mackenzie Bay 24 hour station/Herschel Island |
| 05-Aug-07 | Herschel Island |
| 06-Aug-07 | Herschel Island |
| 07-Aug-07 | Herschel Island |
| 08-Aug-07 | Herschel Island |
| 09-Aug-07 | West of Herschel Island/Herschel Knolls |
| 10-Aug-07 | West of Herschel Island |
| 11-Aug-07 | West of Herschel Island |
| 12-Aug-07 | West of Herschel Island |
| 13-Aug-07 | Herschel Island / MacKenzie Trough / Mac Scours/Garry Line |
| 14-Aug-07 | Garry Line / Garry Knolls / MacKenzie Trough |
| 15-Aug-07 | MacKenzie Trough / Scours / Kaubvik |
| 16-Aug-07 | Plume front study |
| 17-Aug-07 | Plume front study |
| 18-Aug-07 | Travel up-river to Inuvik |
| 19-Aug-07 | Inuvik |
| 20-Aug-07 | Inuvik |

**Table 1.** A time line for the DFO leg of the Nahidik cruise in 2007.

**Figure 1:** The Nahidik in Pauline Cove on Herschel Island during high winds.

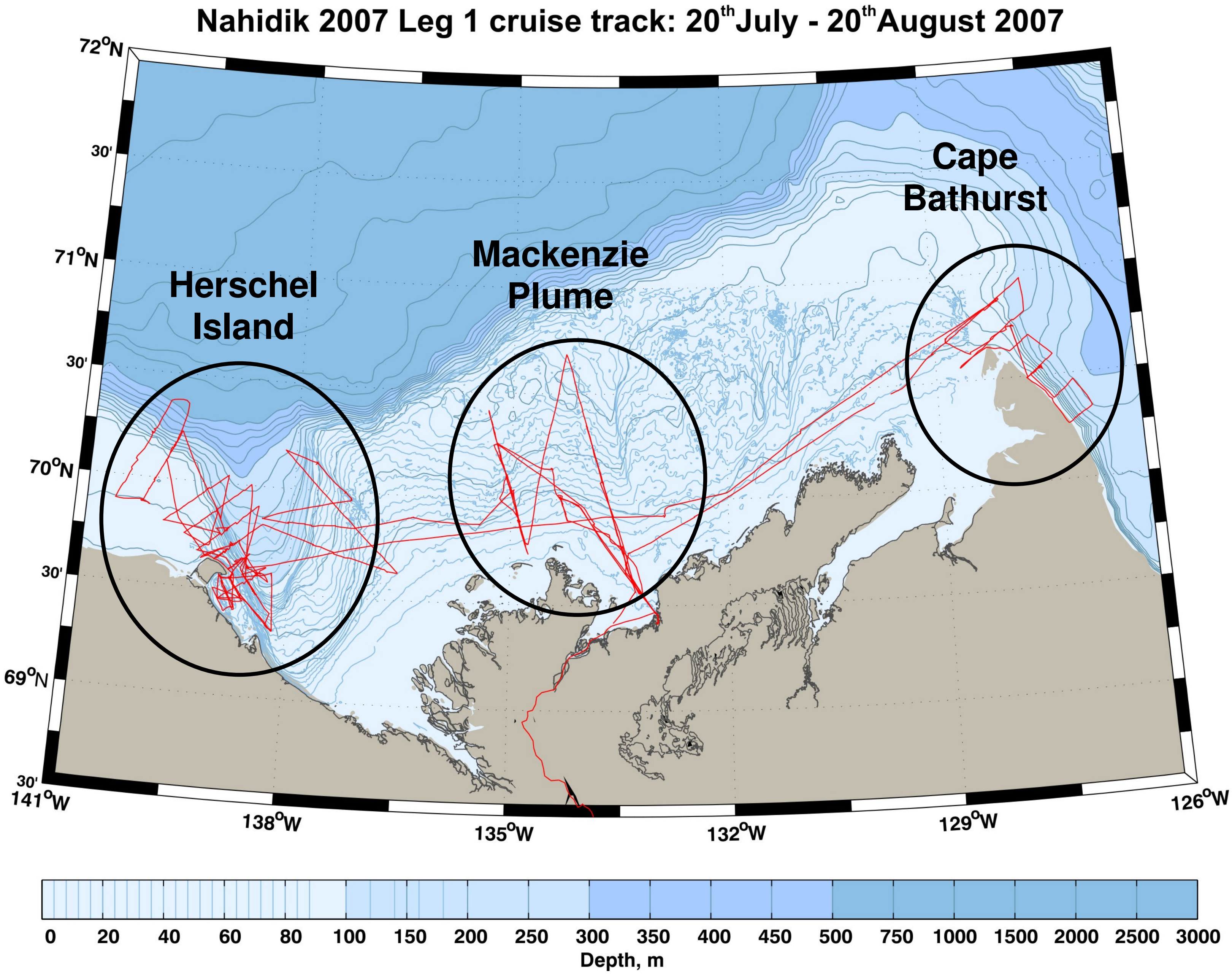



**Figure 2:** A map of the Canadian Beaufort Shelf showing this year's cruise track (red) and the three main study areas: Herschel Island, the Mackenzie plume and Cape Bathurst.

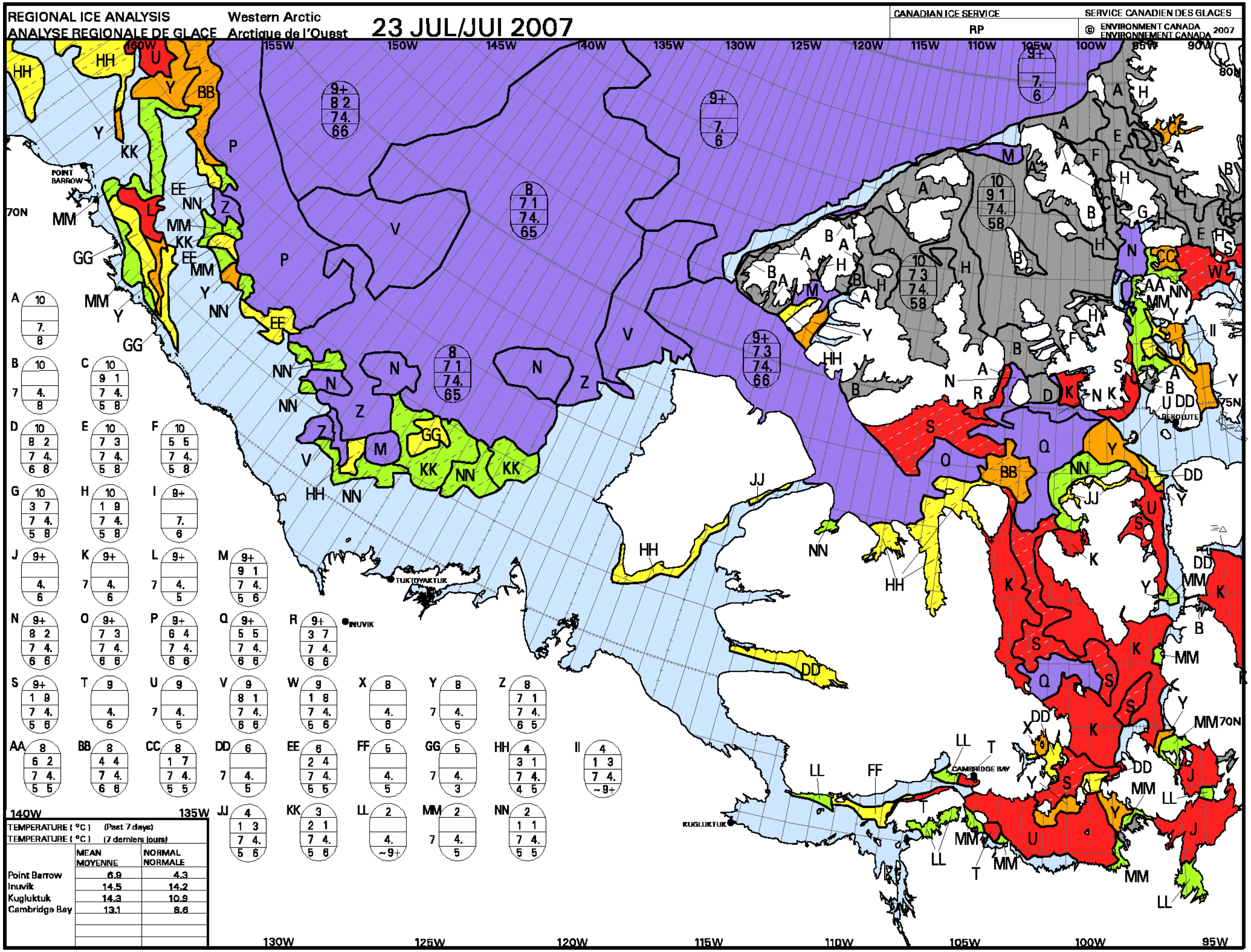



**Figure 3:** A Canadian Ice Service ice chart for 23 July 2007 showing the Canadian Beaufort Shelf to be ice free.

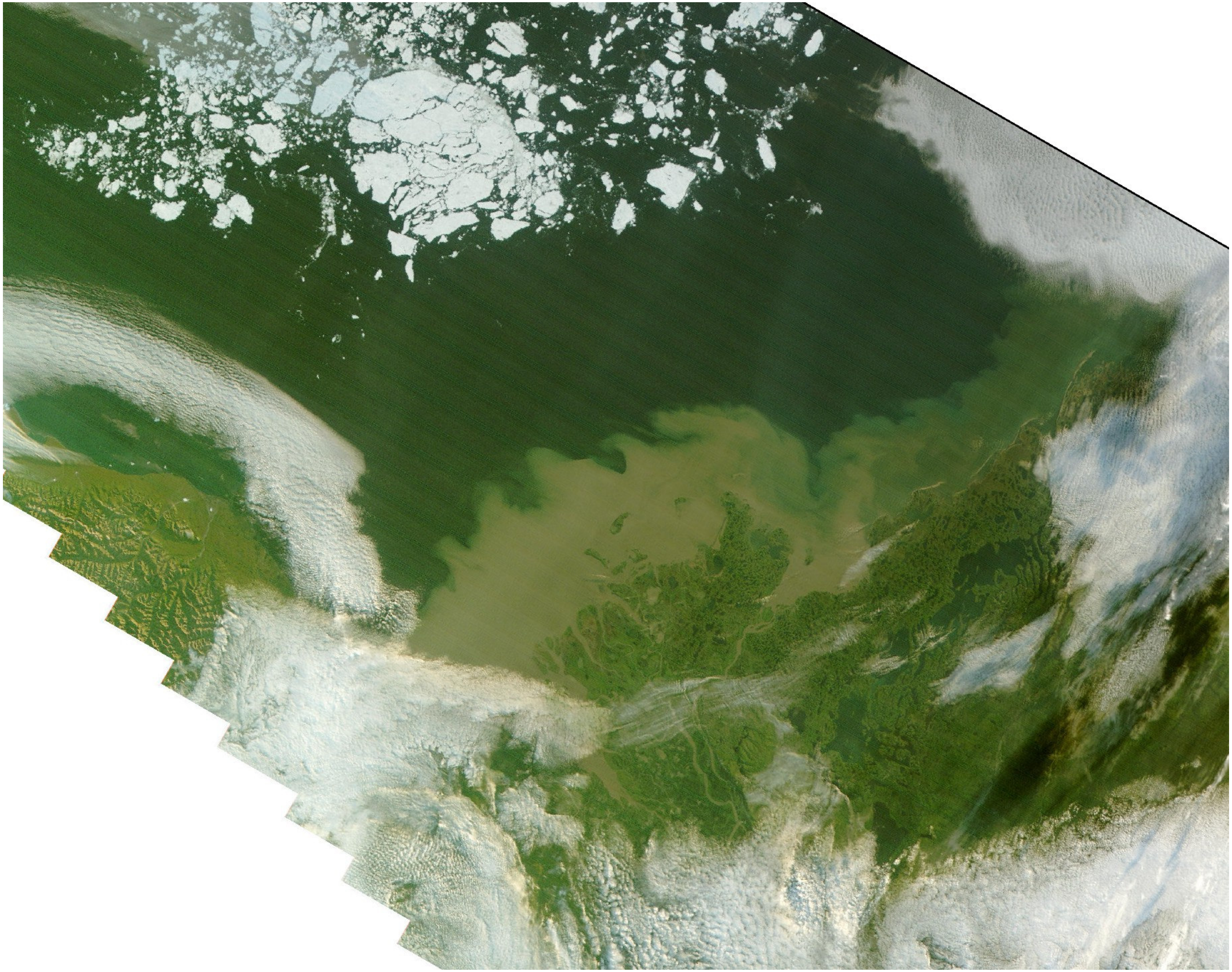


**Figure 4:** A MODIS true-color satellite image taken on 26 July 2007. Note the wave-like features in the Mackenzie River plume front.

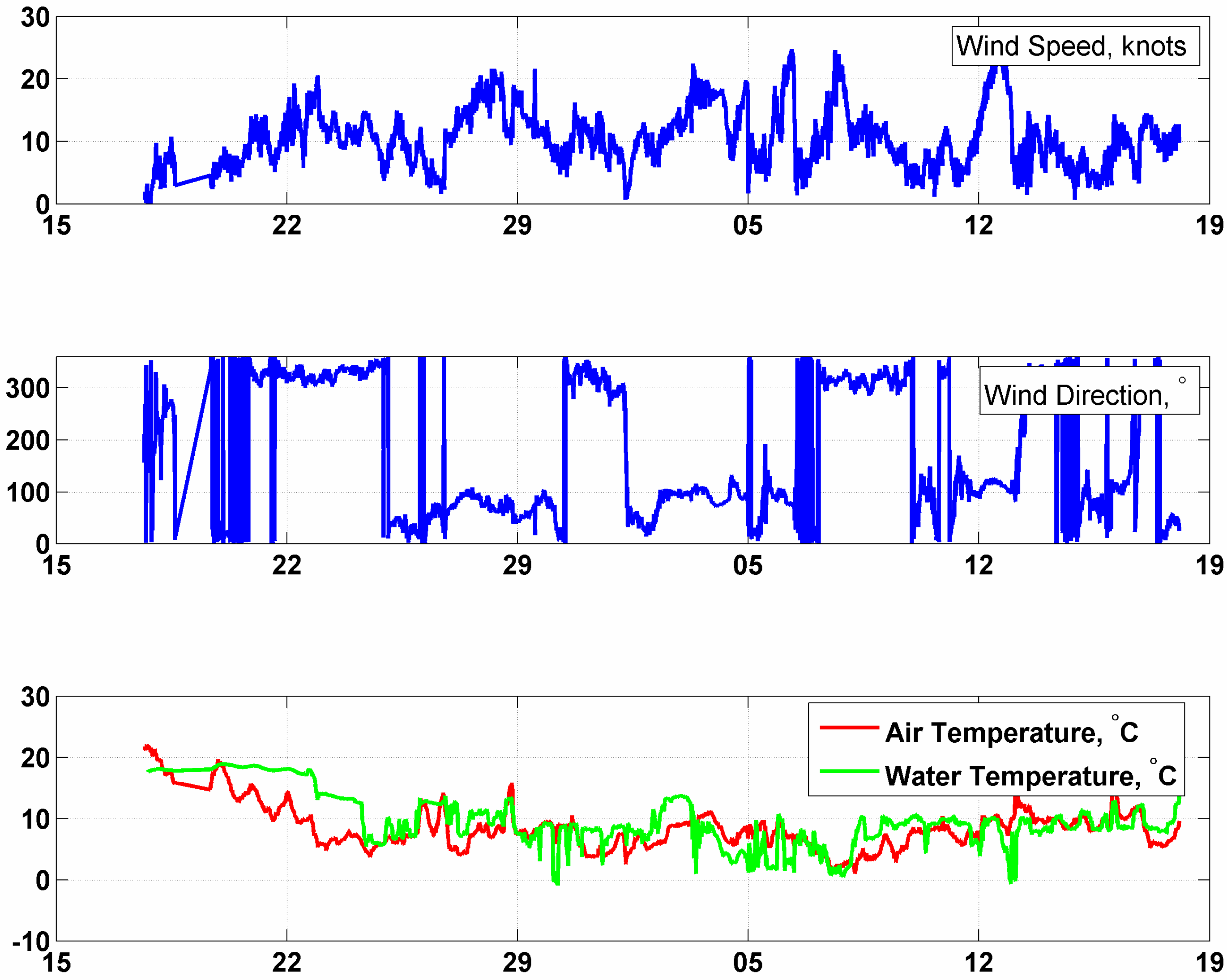



**Figure 5:** Meteorological data from the AVOS weather station on board the ship for the duration of the cruise.

# Physical Oceanography Program

## **Bill Williams,** DFO, Institute of Ocean Sciences.

The physical oceanography program now has three primary areas of interest for process oriented studies: the Mackenzie River plume, Mackenzie Trough and Cape Bathurst.

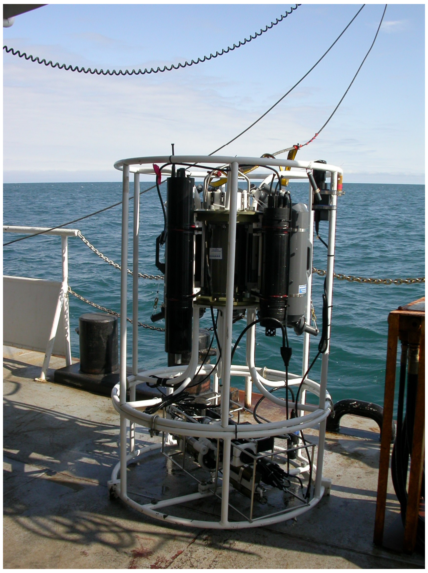
The Mackenzie River plume forms a large and irregular brackish surface water plume over the Canadian Beaufort Shelf. Satellite images suggest that the transition from river water (close to the Mackenzie delta) to oceanic water (offshore) might be comprised of a series of continually evolving fronts at which horizontal mixing and dispersal of riverine water occurs via eddy-like motions. In addition, the Mackenzie plume is also strongly forced by the wind and ice. A vertical profile through the Mackenzie plume generally shows a thin (~6m) surface layer of buoyant riverine water overlying more saline shelf water. Ekman transport from wind/ice surface stress is expected to be largely confined to this surface layer, causing considerable advection of the plume on/off-shore during down/up-welling events. Figure 4 is a visible satellite image taken on 26 July 2007. The wave-like edge to the plume north of the delta is suggestive of the growth of instabilities in the plume front following advection of the plume onshore by the winds.

Cape Bathurst is at the northeastern end of the Mackenzie Shelf and on the southwestern side of Amundsen Gulf. Hydrographic and satellite data indicate upwelling of the nutrient-rich, Pacific-origin water to the surface at the cape when surface-stress is upwelling-favourable for the shelf. The shelf abruptly ends at Amundsen Gulf and the steep bathymetry into the gulf coupled with the relatively flat Mackenzie Shelf creates strong isobath divergence near the cape. The enhanced upwelling is thought to be forced by the adjustment of the wind-driven along-shelf flow to the strong isobath divergence. Benthic samples near Cape Bathurst show high numbers and diversity of organisms which suggests that the nutrients brought to the surface by upwelling allow additional primary production in the region that ultimately feeds the benthos. This year, we were able to conduct a CTD and ADCP survey of Cape Bathurst immediately following a period of upwelling wind-stress. Figure 6 is a photograph of the upwelling front near the northern point of Baillie Island. Water on the coastal side of the front (to the right in the photo) is about 0 degrees C and water on the offshore side of the front is about 9 degrees C. Internal waves on the front are giving the surface water its stripy appearance. Figure 7 shows the CTD section from this survey that runs from Amundsen Gulf onto the continental shelf north of Cape Bathurst. The upwelling of Pacific origin water is clear.

Mackenzie Trough is also a site of large amplitude upwelling that occurs when the along-shelf component of either the wind or the ice motion is towards the west. Although upwelling within the trough is well documented, the location and flux of upwelled water onto the continental shelf is not. From numerical modeling of cross-shelf canyons, we expect that upwelling water crosses the shelf break either at the head of Mackenzie Trough or on its western side. However, Mackenzie Trough is unusual in that on the western side of the trough lie Herschel Island and a constriction in the bathymetry of the trough. The constriction in bathymetry causes the along-isobath flow to be much faster there which possibly amplifies the upwelling occurring in the trough. The presence of Herschel Island blocks upwelling onto the continental shelf at the constriction and so we expect the upwelling onto the shelf to be focused northwest of the island. CTD sections were taken this year during upwelling conditions that support this. We were unable to do a full CTD and ADCP survey of the upwelling in Mackenzie Trough this year as the ship time was needed by other parts of the Nahidik program.

There were 4 components to the physical oceanography sampling: CTD profiling, a shipboard ADCP and sea-surface water measurements and meteorological measurements.

**CTD:**



**The CTD/Rosette package on the aft deck of the Nahdik.**

A standard Seabird CTD/Rosette system was used this year with a conducting-cable winch, deck unit and data acquisition computer. This allowed us to record and view the data in real-time and to close Niskin bottles at prescribed depths or at interesting features in the water column. During a CTD cast, an acoustic altimeter, mounted on the CTD frame, gave the height above bottom of the CTD/Rosette. The CTD was lowered at about 0.5m/s until it was approaching the bottom and then slowed aiming, in calm conditions, to stop the CTD 1m above the bottom. If the CTD frame did touch the bottom, it typically came back on deck with mud on the lower ring of the frame but never any on the CTD. We were careful to wash the mud off the deck and CTD frame after each CTD cast to ensure that there could be no contamination of the data from mud on the frame washing into the CTD package. It also kept the deck less slippery. The deck unit and CTD acquisition computer was kept in the 5'x5'x5' blue container on the aft deck of the Nahidik. This was very close to the CTD and allowed good communication between the CTD operator and the deck crew. Thanks to Megan Foss for allowing us to share this space, which was provided for the bottom video camera equipment.

The components of the CTD/Rosette system were:

| Component | Make/Model | Serial number |
|---|---|---|
| CTD logger | Seabird SBE 25 | 0415 |
| Temperature sensor | Seabird SBE 3F | 4444 |
| Conductivity sensor | Seabird SBE 4C | 3209 |
| Pressure (strain gauge) 1000dbar | Seabird SBE 29 | 0693 |

| | | |
|---|---|---|
| Pressure (strain gauge) 350dbar | Seabird SBE 29 | 0530 |
| Dissolved Oxygen | Seabird SBE 43 | 1202 |
| Pump | Seabird SBE 5T | 4646 |
| Fluorometer | Seapoint | SCF2859 |
| Transmissometer | Wetlabs | CST-1047DR |
| Optical Backscatter | Seapoint | 11074 |
| PAR sensor | Biospherical, QSP200PD | 20273 |
| Altimeter, Benthos | Benthos PSA-916D | 41098 |
| Nitrate, ISUS | Satlantic | 121 |
| Nitrate, ISUS battery pack | Satlantic | 053 |
| Niskin Bottles, 5 litre | Seabird | |
| PDIM | Seabird | 0113 |
| Carousel | Seabird SBE 32 | 0591 |
| Deck unit | Seabird SBE 33 | 0132 |

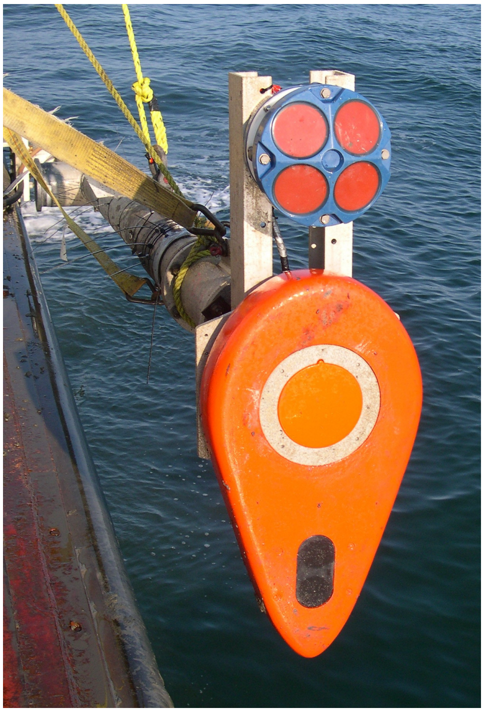
This is a new CTD system, and it has the new wet-pluggable connectors wherever possible. These connectors were very easy to use and we had no problems with them. One of the remaining Sea-Conn connectors attached the CTD/Rosette to the sea-cable. As the CTD winch was also used for vertical net tows, the CTD/Rosette was frequently unplugged from the sea cable. This unplugging and re-plugging eventually caused the connector to fail and a short to occur between the pins of the connector. At this point we replaced the Sea-Conn connector with a wet-pluggable one and had no further problems. The design of the wet pluggable connectors means that they wear less with frequent plugging and unplugging.

It is worth noting here that all available inputs to the SBE25 were in use, including the 2 differential inputs. The design of the SBE 25 is a little odd in that the differential inputs do not switch on until the pump switches on and if the pump switches on in while in air the current draw is so large it causes a loss of communication with the CTD. This makes it difficult to test the differential channels when the CTD is out of the water and can cause annoying loss of communication with the CTD.

The CTD winch did not have a wire out meter so instead we used a metered block, supplied by the winch shop at IOS. The meter is attached to the axle of the block and the readout is attached to the winch so that the operator can read it. A long flexible, coiled cable runs between the two.

Early in the cruise, some kinks were put in the end of the winch wire when tension was put on the wire before it was properly seated in the block. We were lucky that this did not damage the conductor in the wire and we did not have to cut off the damaged section and make a new termination. The problem was caused by the block twisting about a vertical axis when not in use and then needing to be reoriented before the wire could be reseated in the block. A rope tied to the block allowed us to reorient the block as needed.

**ADCP:**



**The ADCP mounted forward of the acoustic pod on the acoustic arm.**

A 600 kHz RD Instruments Workhorse Monitor Acoustic Doppler Current Profiler (serial number 8886) was mounted in front of the pod on the acoustic arm. The instrument appeared to work well. This year single ping data were collected at a rate of about 2Hz. Single ping data is noisy and averaging in time is necessary to increase the signal-to-noise ratio during post processing. The vertical bin size used ranged from 1-8 m, larger bin sizes being used in deeper water. The depth of the transducers of the ADCP was 2.8m and the orientation of the 4 beams of the ADCP relative to the ship as viewed from above was:

FORWARD
3 2
1 4
AFT

Although the ADCP nominally functions at 600 kHz, its bandwidth is broader than simple echo sounders so that there can be interference between the sounders and the ADCP. We had less problems with the 600 kHz ADCP than the 300 kHz ADCP we used last year, presumably because its frequency is further away from the frequency of the other acoustics. The engine noise on the Nahidik interferes with all sounders and becomes worse with higher engine revs. The solution for the ADCP was to run with both engines rather than just one, allowing lower revs for a given speed. We were able to move faster with acceptable noise levels on the ADCP by doing this.

To find the water velocity, the velocity of the ship needs to be accurately removed from the ADCP data. When using single ping data, this can be done by either using the bottom track velocity as ship's velocity or by using the ships velocity from the DGPS systems. If DGPS is used, the heading of the instrument (or equivalently the ship) is needed. Since the compass on the ADCP does not work well close to a steel hulled ship and in an area of weak horizontal magnetic field, a black box was installed to transmit the readout of the ship's gyro to the ADCP computer.

Unfortunately, this system did not work last year owing to a ground fault. It worked well this year.

**Sea surface measurements:** Sea surface temperature and salinity, fluorescence and transmission were 'continuously' recorded by using seawater pumped from the forward sea chest and into a tall bucket in the forward hold. This set up is described in Patricia Ramlal's write up of the Carbon Studies part of the cruise. It was affectionately called the 'bucket of doom' as we were pumping water into an open container that was inside and below the waterline of the ship. An externally powered and externally recording Seabird 19 CTD with a fluorometer and transmissometer attached was placed in the bucket. The serial numbers of the sensors were

| **Sensor** | **Serial number** |
|---|---|
| Seabird 19 CTD | 0904 |
| Temperature | 0904 |
| Conductivity | 0904 |
| Pressure (strain gauge) | 0904 |
| Fluorometer, Seapoint | SCF 2745 |
| Transmissometer, Seatech | |

Some good data was collected by the system used this year, but there were many problems:

1. The SBE19 sn0904 needed modification to be externally powered. This was discovered several days into the cruise after using up two sets of the D-cells that internally power the CTD. The RS232 input/output on the 0904 had 'optical isolation' that prevented the external power reaching the instrument. The CTD pressure case was opened and a 'jumper' installed across the optical isolation.
2. We eventually realized that when the internal memory on the 0904 became full data transmitted was bad. This occurred at several times and is the largest source of data loss for the sea-surface measurements.
3. Pumping water from the forward sea-chest has the advantage that the pump is below sea-level so there are none of the problems associated with sucking water several meters up a hose to the level of the deck. The flow of water was continuous. However, a fairly low flow rate was used so that the sump pump in the 'bucket of doom' would be less stressed and the chance of failure of this pump minimized. A high flow rate is best for sea-surface measurements to maximize horizontal resolution and minimize the temperature change from the water intake to the temperature sensor. In this case the flow rate was so low that air bubbles formed on surfaces inside the bucket. This included the optical windows for the transmissometer and fluorometer and so this data is suspect.

The solution for next year are is to pump a large volume of water from the forward sea chest straight up using a 1" internal-diameter pipe through the forward deck. The vortex de-bubbler and a SBE 21 thermosalinograph would then be placed outside on the forward deck, somewhere near the Petrel and the outflow would go over the side after passing though a bucket with the fluorometer and tubidity sensor in it. A T-junction in the pipe with a tap in it would allow a small amount of water to go into the 'bucket of doom' in the forward hold for Patricia's use. The low flow rate needed by Patricia would make the 'bucket of doom' far less worrisome.

**Meteorological measurements.** Environment Canada installed and AVOS weather station on the Nahidik this year. Thankyou. Some of the data from this station is plotted in Figure 5 and shows the prolonged periods of wind from the east that we experienced this year. In addition to the AVOS weather station we installed a surface PAR (Photosythetically Active Radiation) sensor to complement the PAR sensor on the CTD/Rosette.

**Wish list for the Physical Oceanography program.**

**MVP ($150K+)**
This is the Moving Vessel Profiler. It automatically does CTD casts as the ship is moving and can do many CTD casts in a short amount of time. CHS has an MVP30 on the Petrel that was newly installed last year and may have become operational this year. I hope to have a look at the data that was collected. It may be very good for showing the structure of the Mackenzie Plume. It costs over $150K.
**ADCP ($22-30K).** A 600 kHz ADCP was used this year. We were unable to borrow Svein Vagle's 300 kHz ADCP. A 600 kHz ADCP has finer resolution and shorter range than a 300 kHz and is suited to measuring the Mackenzie Plume. Ideally we would like to combine the 600 kHz ADCP with a lower frequency unit for measuring deeper flows in Mackenzie Trough and around Cape Bathurst. A 150 kHz unit could be ideal.
**Optical Back-Scatter sensor (2K).** The transmissometer used for sea-surface measurements this year appeared to be faulty. Next year I propose to use a turbidity (optical back-scatter) sensor instead. These sensors are better suited to the very turbid Mackenzie plume and are also very small and so much easier to handle than a transmissometer. This turbidity sensor is the same kind as the one on the CTD/Rosette system.
**Freshwater hose.** A freshwater hose needs to be installed for the aft deck. The CTD/Rosette system needs to be washed down after each use.
**4 Laptop computers (8K?).** It would also be much easier to use laptop rather than desktop computers while at sea as data loggers. They are smaller, lighter and easier to set up and take down. Shipping costs would be much less too as we would ship one less pallet of equipment north.
**Surface seawater pipe (?K).** See sea-surface measurements section.

**Figure 6:** An upwelling front near the northern point of Baillie Island.

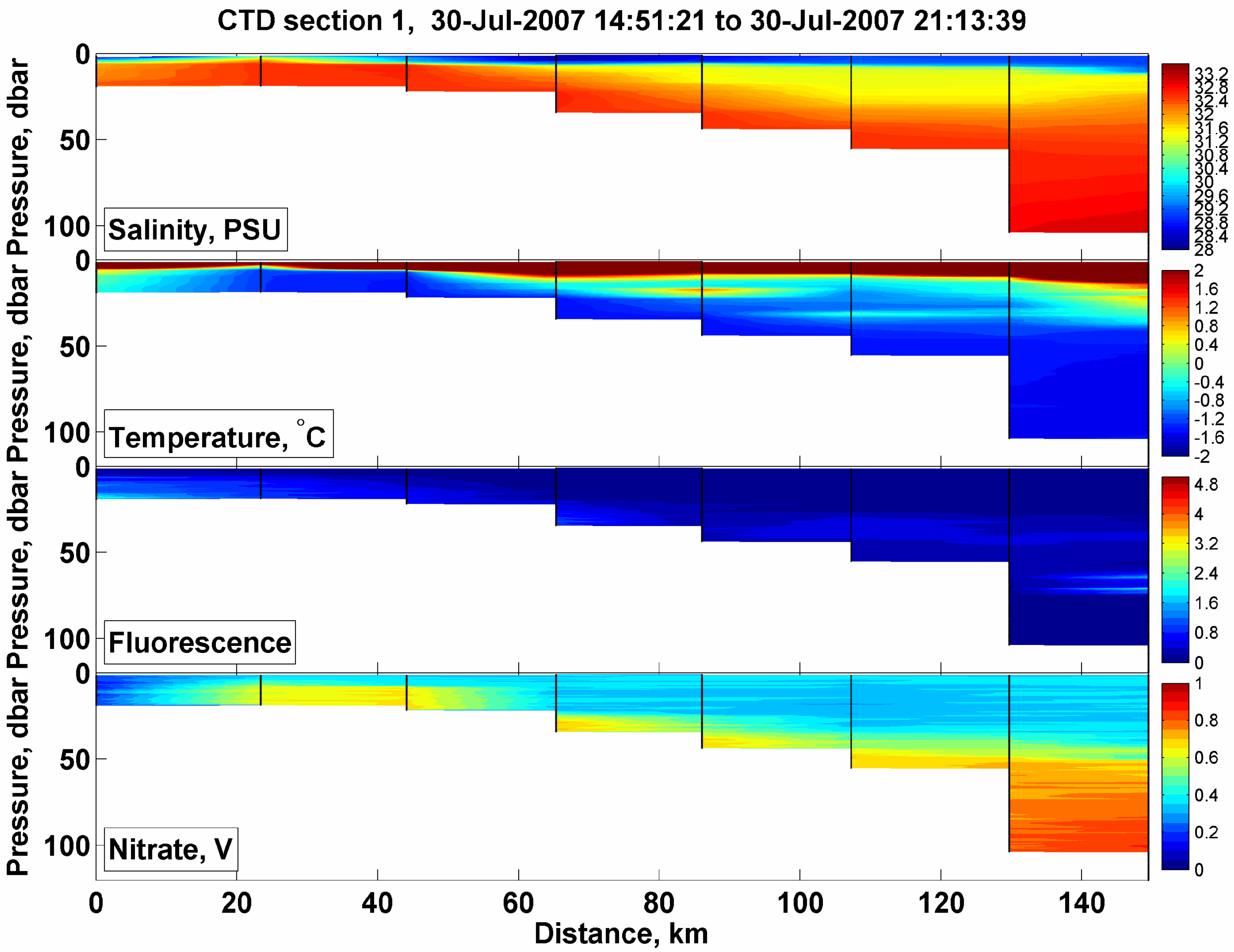



**Figure 7:** A CTD section from Amundsen Gulf onto the Canadian Beaufort Shelf north of Cape Bathurst.

**Carbon Studies in the Beaufort Sea**

Patricia Ramlal
Fisheries & Oceans Canada
Freshwater Institute, Winnipeg

**Objective:**

The objective of the 2006 Nahidik cruise was to gather further data to develop a model of the food web of the lower trophic levels of the nearshore area of the Beaufort Sea. This year the cruise plan included: (1) plume front studies in the water column; (2) exploratory samples around Cape Bathurst; (3) a 24 hour stay at a station in Mackenzie Bay to look at diurnal processes at a single site; and (4) water column sampling along a series of transect lines west and east of Herschel Island. In order to provide the data need for the food web modeling the following methods were used: (1) measurement of surface water carbon dioxide ($CO_2$) and oxygen ($O_2$) concentrations to provide an estimate of the mixed layer primary production. The instrument used in these measurements also detects methane ($CH_4$) at concentrations between 0 and 500 ppm and may prove useful in identifying the possible location of thermal gas vents; (2) water, sediment and biotic samples were collected for chemical analyses, biomass estimates, some species identification and stable isotope measurements. In 2007 a fluoroprobe, the Algae Online Analyzer (AOA) was also installed, continuously recording the chlorophyll *a* concentration of four major algal groups and the dissolved organic carbon. The fluoroprobe outputs of total chlorophyll biomass and separate chlorophyll biomasses of four major taxa: bacillariophytes, cyanophytes, cryptophytes and chlorophytes. This information will then be used to establish the components of the lower trophic levels that support the food web in the Beaufort Sea. This work will complement other work being done on the higher trophic levels including fish studies (Jim Reist and Andy Majewski), ichthyoplankton (Joclyn Sareault and Sally Wong), and zooplankton (Polish Institute of Oceanology). Sampling was done from of the CCGS Nahidik during July and August of 2007.

**Samples:**

1. **Gas Measurements:** Measurement of carbon dioxide ($CO_2$) and oxygen ($O_2$), and, methane ($CH_4$) fluxes to/from surface waters of the Beaufort Sea was done using a continuous flow of surface water through a gas equilibrator that splits the gas flow between an oxygen sensor, methane sensor and a LiCor GasHound infrared $CO_2$ analyzer. When surface water was being pumped measurements of surface water dissolved gases was done at hourly intervals for a period of 22 minutes.10 minute intervals
2. **Whole water samples** were taken, filtered and preserved. Chemical analyses will be made of dissolved organic carbon, nitrogen and phosphorus and particulate nitrogen, carbon, phosphorus, silica, and chlorophyll *a*. Bacteria, and phytoplankton samples were taken and

preserved. Additionally stable isotopes, $\delta^{13}C$ and $\delta^{15}N$, of the particulate organic matter will be analysed.

3. Using a **phytoplankton** net (10 µnet; Table 1), net hauls were taken from the surface to meters above the bottom. This should provide sufficient material for measurement of stable isotopes. Some of this material was also preserved for phytoplankton taxonomic identification. Material was collected from the **zooplankton** tows (153 µnet; Table 1)
4. **Sediment analyses**: Subsamples were taken from a 0.25 $m^2$ box core using small core tubes (3.5 cm diameter). All cores, except those taken for benthic bacteria biomass were sliced in one cm sections up to 5 cm and one 5 to10 cm section. The cores to be used for bacterial biomass estimates were sliced in one cm sections up to 2 cm. Sediments were preserved with formalin for taxonomic and biomass estimates or frozen for stable isotope measurements. The following parameters will be considered.
    a. Sediment structure
    b. Meiofauna (smaller than 1mm, larger than 40 µm) (preserved to 10% formalin).
    c. Benthic bacteria biomass (preserved to 2% formalin)
    d. Possible benthic algae identification to genus
    e. Carbon, nitrogen and phosphorus measurement
    f. $\delta^{13}C$ and $\delta^{15}N$ measurement

    Sediment from each location was frozen for stable isotope measurements and preserved with 10% formalin for possible meiofaunal identification and bacterial biomass estimates.

Plume Front Studies:

During the first series of plume front studies the station names were not consistent among the various groups. The table below indicates the station names and locations used by the ichthyoplankton sampling team and the current project:

| Date | Stn | Icthyo. Stn | Latitude | Longitude |
|---|---|---|---|---|
| 24-Jul-07 | P6 | P1 | 70.08422 | 133.73757 |
| 24-Jul-07 | P4 | P2 | 69.91234 | 133.59241 |
| 24-Jul-07 | P1 | P3 | 69.65452 | 133.37467 |
| 24-Jul-07 | PF | P4 | 69.78062 | 133.37882 |
| 25-Jul-07 | P12 | P5 | 69.90066 | 134.22253 |
| 25-Jul-07 | PF2 | P6 | 69.92909 | 134.24466 |
| 26-Jul-07 | P16.5 | P8 | 69.74025 | 134.7527 |
| 27-Jul-07 | P26 | P9 | 69.89635 | 134.88859 |
| 27-Jul-07 | P30 | P10 | 70.10355 | 135.06555 |
| 27-Jul-07 | P33 | P11 | 70.25864 | 135.20556 |

During the second series of plume front studies, the station names were consistent among all groups.

Water chemistry and phytoplankton net hauls (10um) were taken from all stations, and a subsample of the zooplankton tow (153 um) was also frozen for stable isotope analyses.

| Date (2007) | Station | Depths Sampled (m) |
|---|---|---|
| 24 July | P6 | 2, 10, 32 |
| 24 July | P4 | 2, 8, 14 |
| 24 July | P1 | 2 |
| 24 July | PF | 2, 8 |
| 25 July | P12 | 2, 8 |
| 25 July | PF2 | 2, 10 |
| 26 July | P16.5 | 2, 10, 31 |
| 27 July | P26 | 2, 11 |
| 27 July | P30 | 2, 10, 38 |
| 27 July | P33 | 2, 10, 51 |
| 16 August | P30-R | 2, 36 |
| 16 August | P26-R | 2, 10 |
| 16 August | P24-R | 2, 6 |
| 17 August | P6-R | 2, 31 |
| 17 August | P1.5-R | 0.5, 5 |
| 17 August | P0.5-R | 0.5, 3 |

Box Coring Studies:

At many of the sites where box cores were attempted, the sediments were too rocky or sandy to allow proper sub-sampling for meiofauna. A full set of cores, i.e. chemistry, bacteria, and meiofauna were taken at the Kugmallit gas vents and the reference site, and a few stations on the transects to the east of Herschel Island. During the box core transect in Cape Bathurst on 30 July, where appropriate. A single small sub-sample (0 to 10 cm) was taken for chemical analyses:

| Station Name | Core No. | MacKillop No. | Latitude (deg) | Longitude (deg) |
|---|---|---|---|---|
| CB4.1_10m | None | 16 | 70.9222 | 127.72412 |
| CB4.2_25m | 1 | 17 | 70.50862 | 127.65919 |
| CB4.3_40m | 2 | 18 | 70.52653 | 127.58449 |
| CB4.3_60m | 3 | 20 | 70.53293 | 127.55000 |
| CB4.4_75m | 4 | 21 | 70.54141 | 127.54116 |
| CB4.4_96m | 5 | 22 | 70.54448 | 127.53103 |
| CB4.4_120m | 6 | 23 | 70.54642 | 127.51572 |

Diurnal Study:

On 3 August, a sampling station was established on Mackenzie Bay to investigate the diurnal cycle of photosynthesis and other microbial processes in the surface water. A full set of water samples for chemical analyses were taken at the beginning and the end of the ~ 24-hour period. Every 4 hours chlorophyll *a*, suspended silica, TDN, TDP, DOC, and a net phytoplankton tow were taken in addition to a sample from the AOA to be able to confirm the taxonomic identification of algal groups. A concurrent study of the 24-hour cycle of the zooplankton was done and at each sampling time, a sub-sample was taken for stable isotope analyses. At the end of the study, water chemistry was sampled from 2, 8, and 37 m. A box core was also taken and single 10 cm core taken and sliced for future chemistry and stable isotope analyses.

Cape Bathurst (CB) and transects run near Herschel Island:

Water chemistry and phytoplankton net hauls (10um) were taken from all stations listed below, and a subsample of the zooplankton tow (153 um) was also frozen for stable isotope analyses.

| Date (2007) | Station | Depths Sampled (m) |
|---|---|---|
| 31 July | CB1.2 | 2, 18 |
| 31 July | CB1.6 | 2, 53 |
| 2 August | E6 | 2, 34, 114 |
| 5 August | C2 | 2, 12 |
| 5 August | C6 | 2, 12 |
| 5 August | C10 | 2, 8, 13 |
| 6 August | B3 | 2, 28 |

| | | |
|---|---|---|
| 6 August | B8 | 2, 10, 51 |
| 6 August | B13 | 2, 15 |
| 7 August | A6 | 2, 9 |
| 8 August | D6 | 2, 4, 49 |
| 9 August | H3.3 | 2, 36 |
| 10 August | H3.5 | 2, 58 |
| 10 August | H3.6 | 2, 150 |
| 11 August | H7.3 | 2, 58 |
| 11 August | H7.1 | 2, 36 |
| 12 August | H7.7 | 2, 64 |
| 12 August | H7.5 | 2, 46 |

A Note on the Algae Online Analyzer:

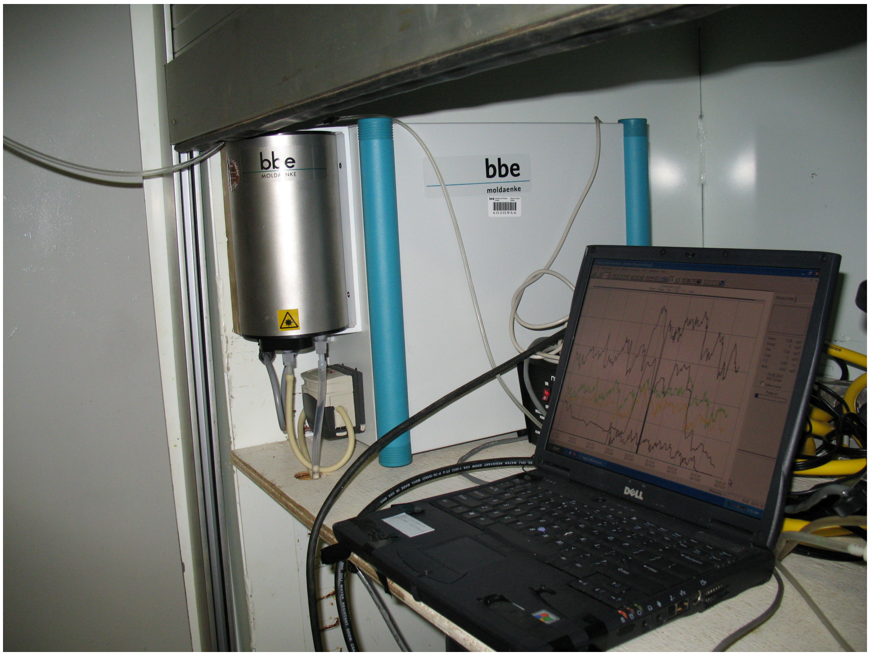
This year we were able to take advantage of the fresh seawater intake that was added to the ship before the 2006 field season.  This allowed us to set up the AOA as well as the "gas box" in the forward hold instead of on deck.  The AOA is not an instrument that can be set up on deck unless it is in a protected enclosure. The efforts of the engineers on the CCGS Nahidik greatly facilitated the use of this instrument.

Figure 1:  Intake from Sea-chest

Figure 2:  De-bubbler

Figure 3:  Sea-water reservoir, aka, "the bucket of doom" showing sump pump.

Figure 4:  Arrangement of the AOA in the forward hold of the CCGS Nahidik




**Comments and recommendations**

This was the third field season for this program and the cruise plan, as it was followed for this year, allowed me to sample from a range of depths at many locations.  Unfortunately, the nature of the sediments precluded sub-sampling at a number of sites.  It was worthwhile to have coordinated sampling programs with other projects that will be useful in looking at the overall picture of the food web dynamics in the shallow region of the Beaufort near the Mackenzie River outflow.  It was very valuable to have the assistance of Dave Tobio from CHS in troubleshooting equipment problems and others from CHS in keeping the activity log for the cruise.  On the whole I felt this was a successful field trip for my program.  I would also like to comment on the exceptional help and professionalism of the Captain Cloutier and his crew who contributed in large measure to the success of this leg of the cruise.

As was stated last year, for future cruises of a similar nature I would recommend that the plans for the cruise direction (scientific and geographic) be discussed as soon as can be reasonably expected for the upcoming field season.  To that end it may be more practical to arrange shorter legs of more specific sampling programs. The ship would also benefit from additional lab space.  During the current cruise there were 6 researchers trying to use the same space, frequently at the same time.

Although it may not be always practical, it would also be beneficial to spread the sampling program to accommodate all of the researchers to be sure that all of the programs accomplish some, if not all, of their sampling requirements.

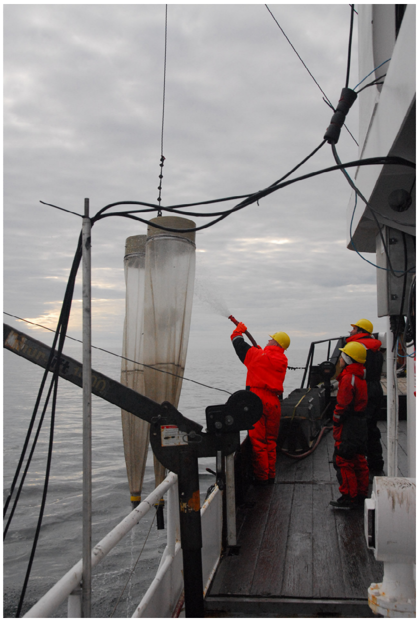
**Beaufort Sea Research Project: Ichthyoplankton and Zooplankton Program – Nahidik 2007 Cruise Report.**

Graduate Student: Sally Wong
Research Scientist: Dr. Wojciech Walkusz
Research Scientist/Supervisor: Dr. Michael Papst

## Objectives:

Assessment of the ichthyoplankton and zooplankton distribution:
- across the plume front (Kugmallit Bay)
- across the depth gradients of the Herschel Basin
- in the region of upwelling (Cape Bathurst, West of Herschel Island)
- short term changes in zooplankton community in the Mackenzie Bay

## Introduction:



The sampling of ichthyoplankton and zooplankton were conducted on July 24th to August 17th at various localities of the Beaufort Sea Shelf. The major emphasis of this year's study was on the Mackenzie Plume front and the Herschel Basin, hence they are key interest areas in Sally Wong's thesis. Additional sampling also contributed valuable information towards the science knowledge gap that existed for the Beaufort Sea.

The Mackenzie Plume front was intensively studied during the beginning of leg one and it was the first time that our group took a closer look at the front to examine their ecological role. The plume waters originating from the Mackenzie River are known for discharging large amount of nutrients and sediments during the arctic summer. The plume waters dominate the Beaufort Sea shelf in accordance to the wind directions and are important drivers of the local hydrological and ecological phenomena. This study will analyse the role it plays in the ecology of the arctic fish larvae and zooplankton.

Our second priority site was the Herschel Basin where we were sampling in order to understand its ecological importance based on the topography of the basin. It has not been intensively studied before; therefore, the results bring a better understanding and assessment of the larvae and zooplankton ecology in the area.

Two students from the Fisheries Joint Management Committee jointed us onboard this year - Jayneta Pascal and Gerald Nosksana with their supervisor, Andrea Hoyt. Their role was to give us a hand with the plume front study. Jayneta and Gerald were also involved in a mini video project, video-taping footage of science work done on the ship.

**Sampling Areas**

For the Mackenzie Plume front study, five transects were selected across the plume front with stations established in the shore side of the plume, at the plume front (where oceanic and riverine waters meet) and at the open sea away from the plume influence. In the Herschel Basin, nine stations were conducted to cover depth gradient from the inner shore of the basin towards the open sea of the shelf breaks.

Exploratory works were done for the Cape Bathurst, Mackenzie Bay and west of Herschel Island. The sampling done at the Cape Bathurst upwelling area composed of two stations -- one at the relatively shallow water ~20m and the other one at ~50m depth. There was one station established in the Mackenzie Bay where 24h continuous sampling was performed to figure out the short-term variability of the zooplankton. As for the area west of Herschel Island two transects were established in order to get estimation of diversity in the area.

**Equipments/ Sampling Results**

The bongo and vertical nets were used in the investigation of ichthyoplankton and zooplankton. A Bongo net equipped with 500µm mesh was towed obliquely from the surface to the bottom at each station. Two replicate tows were always taken at each station. In addition to two tows, target tows were done at particular layers if there was a strong signal received from the echosounder.

After the sampling, one sample was preserved in 5% formaldehyde solution in sea water, while the second sample was splitted into two halves: one part was frozen for calorific content study while the other one was preserved in formalin for taxonomic work. Seventy-nine oblique Bongo tows (158 samples) were conducted during the entire cruise.

The second type of sampling tool was the vertical net, equipped with 153µm mesh. It was towed vertically from the bottom to the surface to collect small fraction of zooplankton. At each station three replicates were taken. Two of them were done for zooplankton and fish larvae analyses, while the third one was collected for stable isotopes determination (coordinated with Patricia Ramlal). All samples collected from the vertical net were preserved in 5% formaldehyde solution in sea water. The total number of vertical tows was 88.

All zooplankton and fish samples will be processed back in Winnipeg.

**Preliminary Ichthyoplankton Results**


Altogether a total of 33 stations were sampled during this year's expedition. As the usual protocol after each sampling tow, fish larvae are picked and stored separately with 5% formaldehyde. For the preliminary results, in total 1211 fish were collected which includes the diversity of: Arctic cod (*Boreogadus saida*), snailfish (Family Liparidae), alligator fish (*Ulcina olrikii*) and herring (*Clupea* sp.). They will be subjected to examination in the lab for further identification. For the Mackenzie Plume study the result demonstrated predominance of Arctic cod in the area of deep marine water while pacific herring seems to predominate freshwater. Alligator fish was more abundant in comparison to the past few years that we have been sampling. Furthermore, no conclusions can be drawn at this point; further investigations will give more clues to the catch.

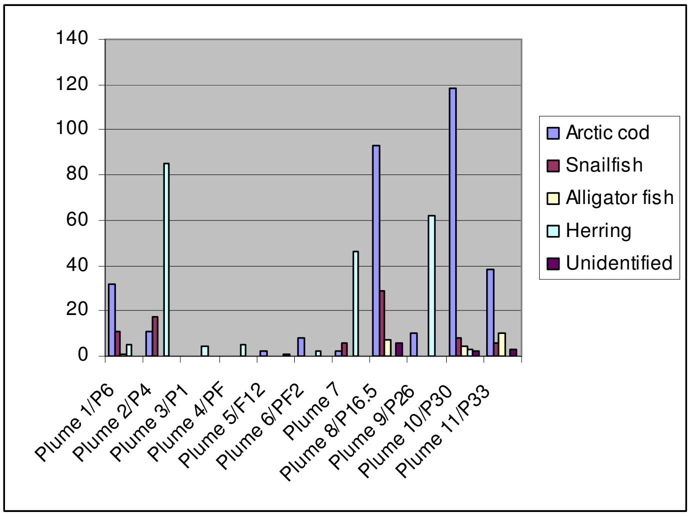
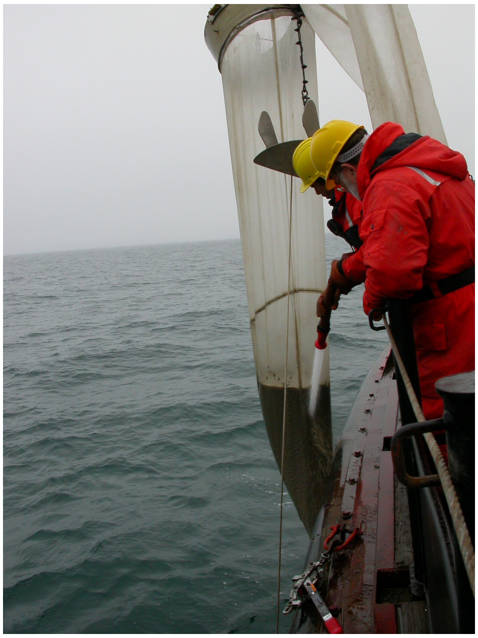



Figure 1. Preliminary results for the larval and early juvenile fish catch for the Mackenzie Plume front study.

**Comments:**

First, we would like to give a big "THANKS" to our CCGS *Nahidik* crew for their constant assistance and service during our sampling and to our colleagues for helping us along the way. With the good teamwork and good weather conditions -- our expedition is regarded as a very successful one. We were able to collect more than the expected amount of fish and zooplankton samples. It's time for lab work!!



**There are a few things that we would like to see improvements on for future expeditions. It is essential to place a wire counter on the main winch for next year. It has been a desire for us to have it on over the past few years to make our work more efficient and precise. This year we encountered the same problem of having repeated samplings due to nets hitting the bottom of the ocean floor. Running into such problems are mainly due to not having the ability to accurately determine the actual release of the wire in a timely matter. We would like to request a wire counter to be in placed for next year's cruise.

# CCGS NAHIDIK 2007, Leg 1 – Summary of Fishing Activities

**Bradley J. Park, Mark K. Lowdon, and Andrew R. Majewski**

Fishing efforts were conducted at 26 locations along five transects southeast of Herschel Island, and at 4 stations northwest of Herschel Island, YK between August 2nd and August 12th, 2007. Sampling was also conducted at one station near Cape Bathurst on July 31st 2007. This beam trawl survey was conducted with the objective of investigating fish species composition and distribution as they relate to various habitat types, and to collect baseline data for impact assessments of industrial use of the region southeast of Herschel Island.

Gill netting was conducted on August 12th 2007 at one location on the north shoreline of Herschel Island. The objective for gill netting was to investigate the northern Herschel Island coastline as a potential alternate migratory route for anadromous species commonly found using the Yukon mainland coast corridor.

### *Beam Trawl*

A 3m benthic beam trawl was deployed 41 times at stations along the five transects southeast of Herschel Island (figure 1), four stations northwest of Herschel Island and one station near Cape Bathurst (Table 1). The beam trawl was deployed from the CCGS *Nahidik* using the boom and winch cable located on the main deck of the ship.

At the stations southeast of Herschel Island, the beam trawl was deployed 26 times for a total of 520 minutes with set depths ranging from nine to 120m. At the stations northwest of Herschel Island the beam trawl was deployed 12 times with set durations of 20 minutes and a total sampling effort of 240 minutes. The beam trawl was also deployed near Cape Bathurst for three 20 minute trawls.

The mouth of the beam trawl measured 3m x 3m, and the net was 9.4m in length. The main body of the net was composed of 3.75cm stretched mesh, with a 1.25cm stretched mesh liner on the inside of the bottom panel. The cod-end was lined on the outside with 0.3cm square mesh.

The beam trawl proved effective at catching a wide range of size classes and fish species. Size classes ranged from 2.0 to 25.4 cm total length. A total of 1163 fish, representing seven families were captured in the beam trawl across 39 stations where deployment was successful.

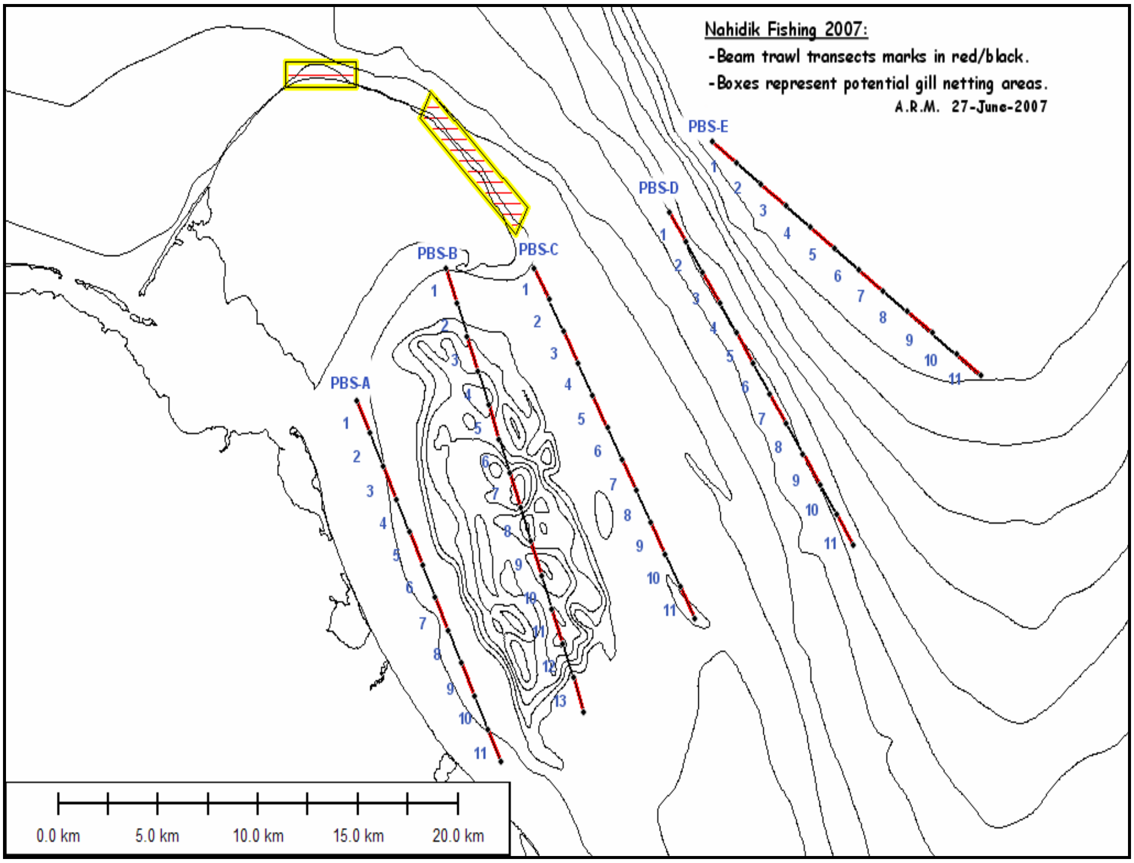



Figure 1. Location of southeast beam trawl transects, and potential gill net sets, at Herschel Island during Leg 1 of the 2007 CCGS Nahidik scientific cruise.

A CTD (**C**onductivity, **T**emperature, **D**epth) logger was attached along the top panel, near the mouth, of the trawl during each deployment. Also, a depth transmitter was attached along side the CTD which sent depth information to a small omni-directional hydrophone attached to the ship's acoustic arm. A receiver stationed on the main deck provided real-time depth data, allowing us to monitor trawl depth as ship speed and trawling path varied.

Table 1. Beam Trawl information as part of fishing efforts during leg 1 of the 2007 CCGS *Nahidik* cruise.

| Date | Station | Trawl name | Depth (m) | Latitude | Longitude |
|---|---|---|---|---|---|
| 31-Jul-07 | CB1.2 | BT-07-01 | 23.5 | 09 W 0505912 | 7843499 |
| 31-Jul-07 | CB1.2 | BT-07-02 | 22.5 | 09 W 0505838 | 7842808 |
| 31-Jul-07 | CB1.2 | BT-07-03 | 22.5 | 09 W 0505720 | 7842745 |
| 2-Aug-07 | PBS-E-2 | BT-07-04 | 115 | 07 W 0594315 | 7724820 |
| 2-Aug-07 | PBS-E-4 | BT-07-05 | 120 | 07 W 0596876 | 7723278 |
| 2-Aug-07 | PBS-E-6 | BT-07-06 | 119 | 07 W 0599741 | 7721679 |
| 2-Aug-07 | PBS-E-8 | BT-07-07 | 115 | 07 W 0602429 | 7720159 |

| | | | | | |
|---|---|---|---|---|---|
| 2-Aug-07 | PBS-E-10 | BT-07-08 | 110 | 07 W 0604850 | 7718807 |
| 4-Aug-07 | PBS-D-2*** | BT-07-09a | 66 | 07 W 0592283 | 7721350 |
| 4-Aug-07 | PBS-C-2 | BT-07-09 | 13 | 07 W 0585632 | 7718352 |
| 4-Aug-07 | PBS-C-4 | BT-07-10 | 15.5 | 07 W 0587535 | 7715847 |
| 4-Aug-07 | PBS-C-6 | BT-07-11 | 16 | 07 W 0589195 | 7713161 |
| 4-Aug-07 | PBS-C-8 | BT-07-12 | 16 | 07 W 0590742 | 7710803 |
| 4-Aug-07 | PBS-C-10 | BT-07-13 | 15 | 07 W 0592476 | 7708159 |
| 5-Aug-07 | PBS-A-2 | BT-07-14 | 9 | 07 W 0577510 | 7711504 |
| 5-Aug-07 | PBS-A-4 | BT-07-15 | 10.6 | 07 W 0578736 | 7709393 |
| 5-Aug-07 | PBS-A-6 | BT-07-16 | 12 | 07 W 0580303 | 7706873 |
| 5-Aug-07 | PBS-A-8 | BT-07-17 | 10 | 07 W 0582036 | 7704269 |
| 5-Aug-07 | PBS-A-10 | BT-07-18 | 10 | 07 W 0583594 | 7701676 |
| 5-Aug-07 | PBS-B-13 | BT-07-19 | 22.5-19 | 07 W 0588424 | 7702600 |
| 6-Aug-07 | PBS-B-7 | BT-07-20 | 66 | 7 W 584484 | 7710161 |
| 6-Aug-07 | PBS-B-8 | BT-07-21 | 23-70 | 7 W 585156 | 7709201 |
| 6-Aug-07 | PBS-B-5 | BT-07-22 | 54 to 38 | 7 W 583166 | 7713395 |
| 6-Aug-07 | PBS-B-3 | BT-07-23 | 30 | 7 W 581854 | 7716118 |
| 6-Aug-07 | PBS-B-1 | BT-07-24 | 9.2 | 7 W 580407 | 7718923 |
| 8-Aug-07 | PBS-D-2 | BT-07-25 | 50-55-64 | 7 W 592712 | 7720416 |
| 8-Aug-07 | PBS-D-4 | BT-07-26 | 57 | 7 W 594209 | 7718777 |
| 8-Aug-07 | PBS-D-6 | BT-07-27 | 51 | 7 W 596116 | 7716587 |
| 8-Aug-07 | PBS-D-8 | BT-07-28 | 52 | 7 W 597977 | 7714442 |
| 8-Aug-07 | PBS-D-10 | BT-07-29 | 53 | 7 W 599755 | 7712134 |
| 9-Aug-07 | H 3.3 | BT-07-30 | 38 | 7 W 570329 | 7733995 |
| 9-Aug-07 | H 3.3 | BT-07-31 | 38 | 7 W 570073 | 7733955 |
| 9-Aug-07 | H 3.3 | BT-07-32 | 39 | 7 W 571523 | 7733886 |
| 10-Aug-07 | H 3.5 | BT-07-33 | 61 | 7 W 578198 | 7740587 |
| 10-Aug-07 | H 3.5 | BT-07-34 | 61 | 7 W 577443 | 7741542 |
| 10-Aug-07 | H 3.5 | BT-07-35 | 59 | 7 W 576673 | 7742592 |
| 11-Aug-07 | H 7.3 | BT-07-36 | 60 | 7 W 540771 | 7765741 |
| 11-Aug-07 | H 7.3 | BT-07-37 | 60 | 7 W 540362 | 7764781 |
| 11-Aug-07 | H 7.3 | BT-07-38 | 58 | 7 W 540184 | 7763784 |
| 11-Aug-07 | H 7.1 | BT-07-39 | 38 | 7 W 534901 | 7753251 |
| 11-Aug-07 | H 7.1 | BT-07-40 | 38 | 7 W 536947 | 7752833 |
| 11-Aug-07 | H 7.1 | BT-07-41 | 36 | 7 W 538221 | 7752437 |

*Latitudes and longitudes represent the starting point of each 20m trawl.

**Beam trawl deployed, but contact with the seabed was not achieved.

### *Gill nets*

Two 120m multi-mesh gill nets were deployed on the north-west side of Herschel Island on August 12, 2007. The nets were composed of six panels (2m x 20m). Mesh sizes were 2.5cm, 3.75cm, 6.25cm, 8.75cm, 11.25cm, and 13.75cm stretched. Nets were set perpendicular to shore with small mesh panels nearest to shore. Set depths ranged from 0 to 4.0m. Soak time was two hours per net.

Preliminary identifications for the gill net catch consisted of seven Arctic cisco (*Coregonus autumnalis*), four Pacific herring (*Clupea pallasii*), and one fourhorn sculpin (*Myoxocephalus quadricornis*).

## *Catch Overview*

Arctic cod (*Boreogadus saida*) was captured at 26 of the 41 stations the beam trawl was deployed and comprised 1.0% of the total catch (Figure 2). Fish from the families Agonidae and Cottidae were the most common, and comprised 49% and 22% of total catches respectively. The relative abundance of each species captured at a given station is presented in Figures 2 and 3.

The tolerance ranges of individual species to the physical and chemical parameters of their environment will be investigated using data collected from the CTD loggers and from a portable CTD unit deployed from the ship at each station.

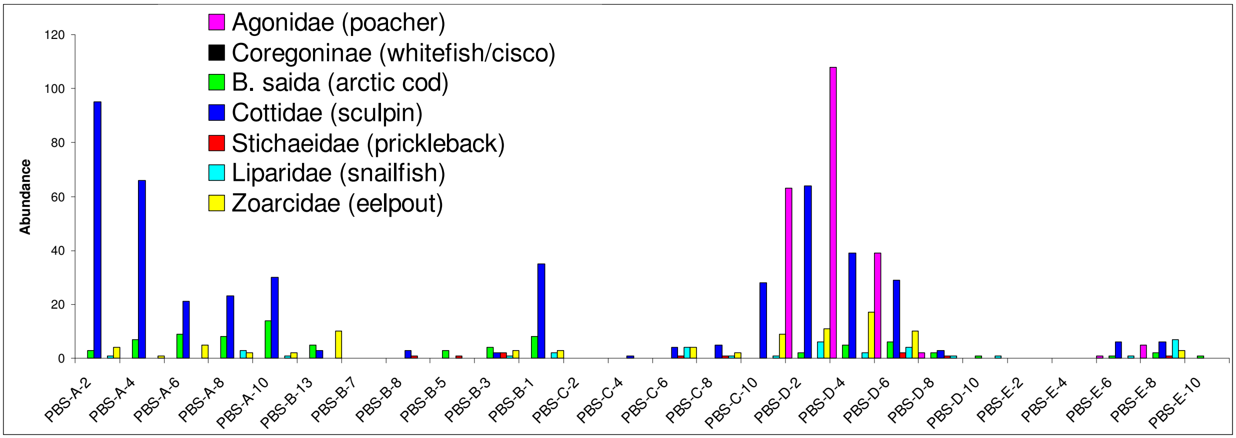



Figure 2. Species abundance of beam trawl catches along Ptarmigan Bay and Herschel Island stations during Leg 1 of the 2007 CCGS *Nahidik* cruise.

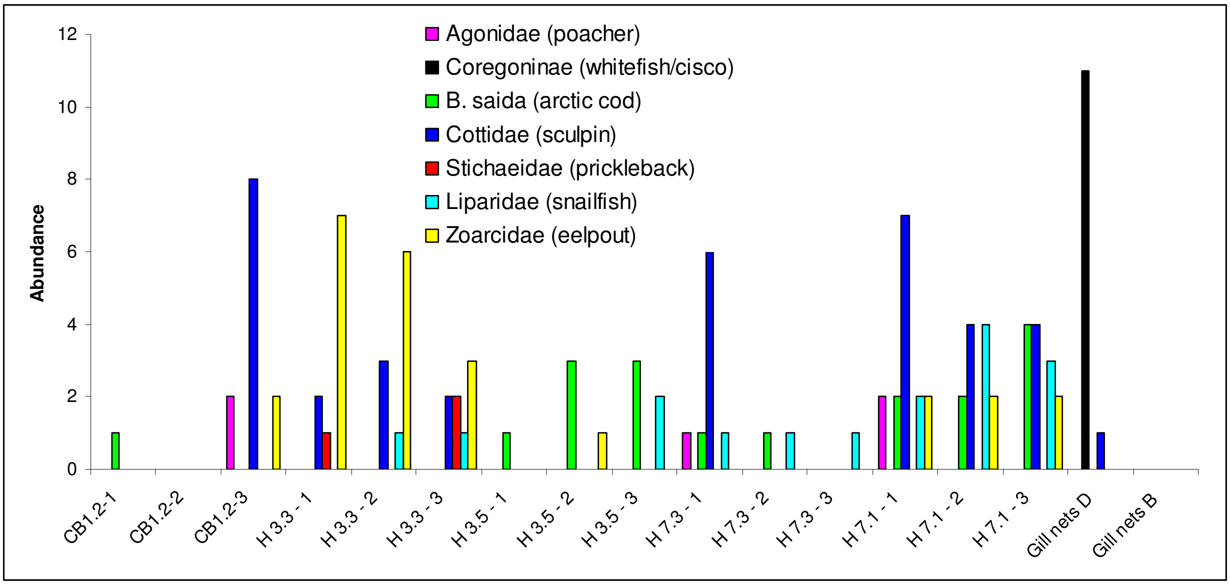


Figure 3. Species abundance of beam trawl catches along stations north-west of Herschel Island and near Cape Bathurst during Leg 1 of the 2007 CCGS *Nahidik* cruise.

Final species identification and biometrics will be performed at the Freshwater Institute in Winnipeg, MB during the winter of 2007/2008. The data generated from these fish will contribute to the general biological and ecological information on offshore fish populations in the Beaufort Sea. Tissue samples will contribute to an ongoing study of the trophic structure of the Beaufort Sea, as well as ongoing genetic and contaminant studies.

Invertebrate by-catch comprised the majority of biomass collected during beam trawl deployments. Sub-samples of invertebrates were collected and frozen from each station to contribute the aforementioned trophic structure study. Photos of representative specimens were also taken of less common species.

### *Fishing Program Overview*

Relative to the combination of gill netting and mid-water trawling used in 2004 and 2005, the beam trawl provided a more reliable and efficient method of catching fish across a broad range of sampling conditions, including moderately rough seas. The trade-off in solely using the beam trawl is the lack of pelagic marine species such as Pacific herring, and adult anadromous species such as rainbow smelt (*Osmerus mordax*), least cisco (*Coregonus sardinella*), and Arctic cisco. In past years, these fish were generally collected in gill nets in water depths of less than 30m.

However, the beam trawl was more effective at catching juvenile and adult benthic fish species across all depth ranges, averaging approximately 83 fish per hour of sampling effort in 2007. Many of the species captured in the beam trawl, including Arctic cod, have body profiles that don't lend well to capture by gill nets. Also, many of the benthic fish species captured are not highly mobile, making them difficult to capture using short gill net sets.

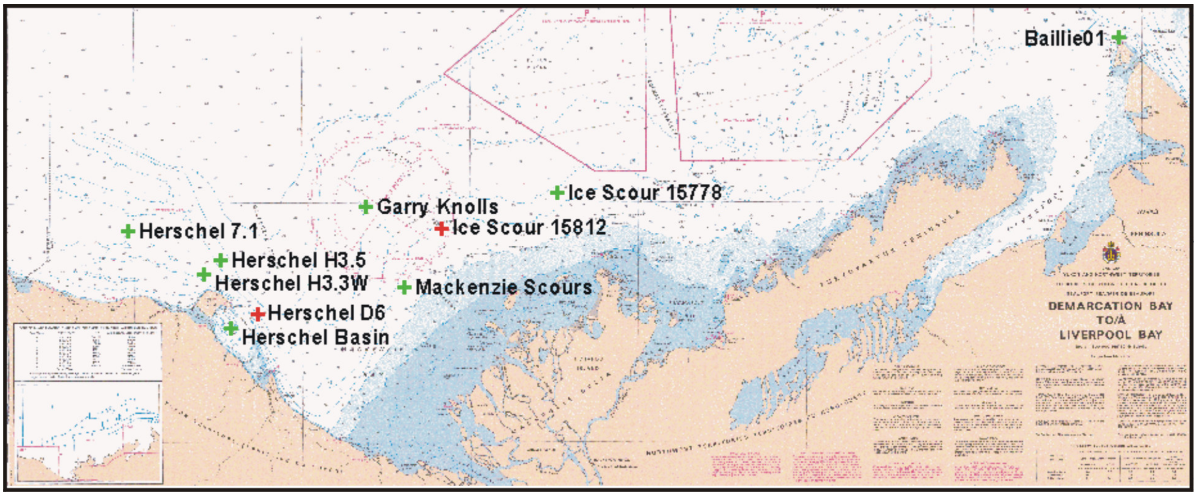
Thanks to good weather, ice free conditions, and the support of the CCG crew, this was a successful year for the CCGS *Nahidik* fishing program. The fishing crew would like to thank the entire staff of the CCGS *Nahidik* for their hard work and enthusiasm while supporting our efforts.

**Cruise Report**

Acoustics Project
Beaufort 2007, Leg 1

The acoustics project is responsible for collecting acoustics data to provide pelagic biology distribution information and seabed classification to the program. The amount of biota in the water column is measured using two Simrad split-beam echosounders, one on the *Nahidik* and the other on the survey launch *Widgeon.* The seabed is acoustically classified using a dedicated Quester Tangent acoustic system on the *Nahidik* and can also be classified by post-processing the Simrad data. The acoustic systems on the *Nahidik* collect data 24-hours per day along the ship's path, except for brief periods (~30 min.) a few times a week when data are downloaded for storage or when the acoustic arm has to be raised for fast travel or because of shallow water. The survey launch *Widgeon* is used to conduct high resolution surveys in a grid pattern around specific study stations as determined through consultation with other researchers.

The 2007 Acoustic program participated in research on 2 main study sites; Baillie Islands/Cape Bathurst, and Herschel Island, as well as a number of sites defined by specific features. The following map indicates 2007 high resolution grid sites surveyed from the *Widgeon*.




Operational procedures as well as weather dictated how often launch surveys could be conducted. Surveys from the acoustic launch are probably more sensitive to rough seas than any other project, the planing hull of the *Widgeon* being unstable in anything worse than moderate winds (limits are wind speeds <15 knots, no whitecaps). Not only is it rough on personnel, but data quality deteriorates greatly. In addition, safety protocols require that the Nahidik be within 15 nautical miles of the launch survey site. Multiple stations per day were often sampled by the *Nahidik*, and if they were more than 15 nautical miles apart, we were unable to survey from the *Widgeon*. These constraints resulted in some sites being only partially surveyed (those marked with +).

Overall, the concentrations of biomass seen in 2006's survey of the Mackenzie Trough weren't observed this year. While scattering layers from 4 to 10m were fairly common, probably corresponding to the thermo/halocline, there was only one instance of a midwater concentration (see figure below). The following is a qualitative summary of what was seen at each station. Bottom classification doesn't become apparent until post-processing, which has not yet been done.

**Baillie01 –** very few scatterers, rare concentrations at 2-4m.

**Herschel Basin -** concentrated bands of scatterers from 2-7m, occasional midwater concentrations in leg NE_SW01.

**Herschel D6 -** very few scatterers, no layers.

**Herschel H3.3 –** very few midwater scatterers, concentrated bands of scatterers from 2-7m.

**Herschel H3.5 -** very few scatterers, occasional diffuse layer with a few strong scatterers at 4-9m, rare concentrated layer at 4m.

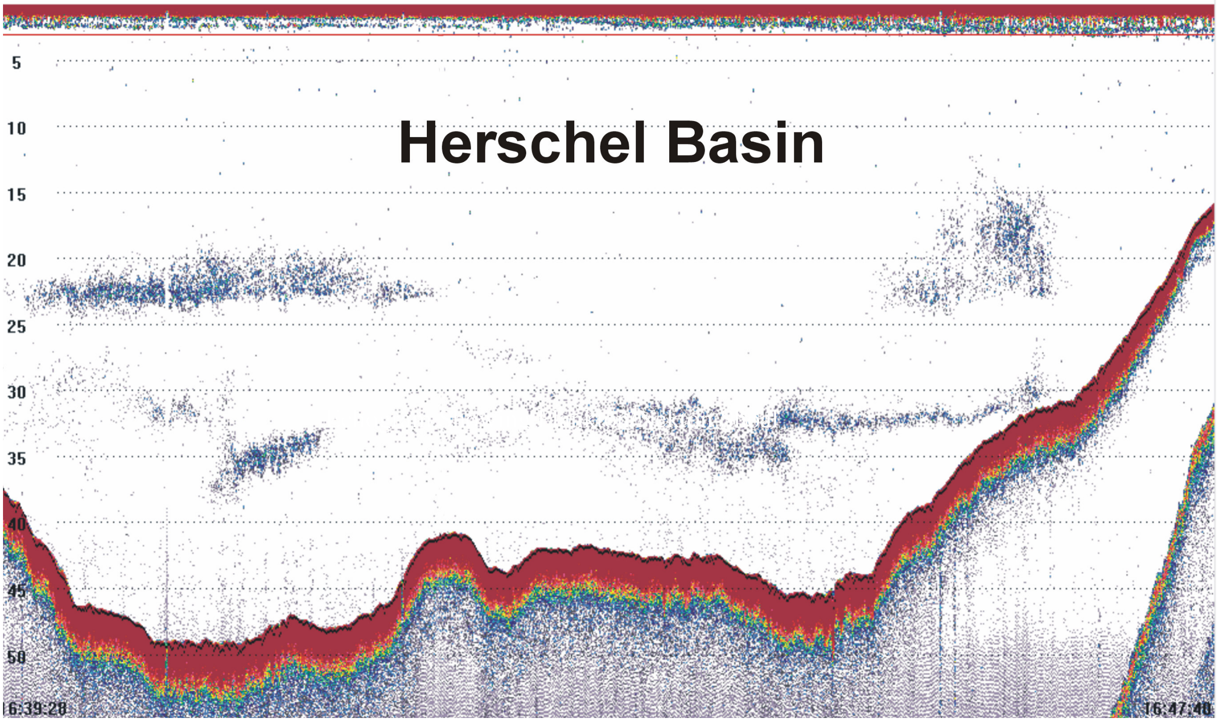
**Herschel H7.1 –** very few scatterers, occasional diffuse layer with weak scatterers at 4-9m.

**Mackenzie Scours –** concentrated layer of weak scatterers at 4m, occasional diffuse layer of weak scatterers at 7-10m.

**Garry Knolls -** diffuse layer at 5-10m, some strong scatterers.

**Ice Scour 15812 -** diffuse layer at 6-8m, some strong scatterers.

**Ice Scour 15778 -** diffuse layer at 6-12m, weak scatterers.




The *Widgeon* is the replacement launch for the *Wood* which was used from 2003-05. Generally, the launch worked well, with the exception of an unresolved discharge from the 12 volt electrical system battery. This was circumvented by isolating the battery through a switch which was set to off when the launch wasn't in use. A valuable addition to the Widgeon's navigation system would be an autopilot with gyroscopic compass to allow more precise steering, especially when visibility becomes poor and landmarks aren't available. Integration of such a system may further impact the 12 volt electrical system, however, and the selection and installation of such a system should be done by technicians familiar with the launch's electronics. As recommended in previous years, the launch should be turned around on the *Nahidik's* foredeck so that the bow faces outward. This configuration would make for safer and easier launching. Although the *Nahidik* crew has greatly improved the way the *Widgeon* is launched and recovered, the addition of a safety cage for the main winch means the *Widgeon* must now be raised much higher above the deck in order to turn her around and is difficult to control in rough seas. Although its operation was without problems, the *Widgeon's* functionality as a platform for hydroacoustics surveys remains an issue. Noise becomes obvious at depths greater than 30m., becoming worse as depth increases. This is readily apparent when compared to data collected by an identical system on the *Nahidik* bridge, which is virtually noise-free to depths greater than 200m. Probably little can be done to remedy this as it seems to be a function of the vessel design, specifically its hull and possibly electrical system and engine. A vessel of the Nelson class, such as the CHS multibeam survey vessel *Petrel*, remains the best choice for acoustic surveys. This would also allow data collection in rougher seas, as the Nelson class hull design, displacement as opposed to planing on the *Widgeon*, is more stable in waves. A diesel fuelling station on the fore deck of the *Nahidik* was requested during the refit. This would have made it much easier to refuel both the Widgeon and Petrel. This was not done but should be strongly considered as a future improvement.

The acoustic arm was rebuilt during the winter of 2006. The new arm is stronger and has less vibration than the previous version. Consequently, the acoustic data seems to be of a higher quality. Nonetheless, the arm must still be manually raised whenever the *Nahidik* is in shallow water or when there is debris or ice in the water. This task is not easy and requires several staff to complete. The arm is also close to the area where most of the box coring and trawling is done. There is a constant threat of entangling the gear in the arm. As well, the arm is close to the docking area for the *Widgeon*, which can be a concern in rough seas. Ultimately, the solution to this problem is to engineer and install an acoustic keel similar to those used on the *Amudsen* and *Martha Black*. This would be a major refit item but acoustics is likely to be a major component of the *Nahidik's* program for the foreseeable future and is therefore worth considering.

The Simrad EY500 previously used on the bridge of the Nahidik was replaced this year with a Simrad EK60 identical to that being used on the Widgeon. This system is more reliable and will allow more direct comparisons between the data collected on the *Nahidik* and *Widgeon*. In addition, it is much more user friendly and will allow other staff on the bridge to make any necessary adjustments to system settings while hydroacoustic staff are surveying on board the *Widgeon*.

The ship's computer network system should be developed to enable science staff to access common data from their cabins. Science staff can presently access this data from a common computer on the bridge and make copies to move to their own computers but this made for congestion on the bridge and was inefficient. A network would allow more data to be stored and accessed while at sea. The system should be designed so that email/internet access can be added to the system.

# Videocamera Program
# Beaufort 2007

The underwater videocamera system was returned to the vendor after the 2006 field season to have numerous problems addressed. These were attended to and a dedicated slip-ring winch and laptop computer were integrated into the system. This now consists of the following:

- Winch
- 1000' of winch-to-camera-end cable
- digital wire meter
- underwater video camera
- lights x2
- laser rangefinders x2
- depth sensor
- camera/light/depth sensor/laser rangefinder frame
- winch-to-deck-unit cable
- deck unit with controls, GPS input, and backup Digital Video and VHS recording
- DVD recorder for primary data storage
- dedicated laptop computer for coordination of data inputs, annotation, and display.

In previous years, GPS input was from a portable unit that delivered uncorrected position information. This year we were able to input differentially corrected GPS readings directly from the ship's GPS, coordinating videocamera positional information with other data collection activities. While absolute position data is more accurate, a correction factor needs to be calculated between the *Nahidik's* positioning antennae and the location of the videocamera deployment.

Details of the videocamera survey are covered in the Videocamera project trip report.

**<u>Macrobenthic Diversity and Abundance on the Beaufort Sea shelf and shelf break.</u>**

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## Introduction:

The objective of this year's cruise was to collect underwater video images to add to previous years data for the creation of a broad, regional map of the diversity and abundance of benthic macrofauna. Video images were taken along selected transects across depth contours between 10m and 250m, depending on the area and time frame available for work. The stations along each transect were usually at depth intervals of approximately 20m when possible. Priorities were to look at unique habitats, the shelf break around Mackenzie trough, Cape Bathurst and Hershel Island areas. Images were also taken (still photographs) of fauna from bottom trawls in the areas of video sampling to compare species identifications and diversity.

## Methods:

The camera was a SeaView SV-DSP2002 high resolution digital signal processor underwater colour video camera (811 x 508 picture elements, horizontal resolution 450 TV lines, min. illumination 2 Lux, maximum operational depth

1000 ft) with two external lights mounted on a tripod frame. Scaling lasers (optical wavelength 650 nm, min. spot size <60 μm at <10" distance, with bore sight accuracy of <2.5 mm/m, wavelength 400-690 nm, peak power 5-100 MW) are attached to frame on either side of the camera. Distance between the two laser spots measured 17.78 cm on deck. The camera tripod was designed and built by the Freshwater Institute (DFO, Winnipeg). See Figure 1 for camera set up. The video images were recorded using a LG DVD/HDD recorder. A Shark Marine Technologies SM Rocky laptop (RT 786EX) was used to produce an overlay (Shark video overlay version 1.3.2) on the video recording of GPS coordinates, depth and temperature (from depth transducer attached to camera frame), along with date and time (UTC). Text was also possible to overlay on the video recording, used to record station information and special features. In addition, the laptop recorded a log of the overlay with details of locations and date and time. New this year, Shark Marine built a heavy-duty reel with hydraulic drive winch that held the cable attached to the camera and accessories (i.e.: depth transducer, lasers, lights) (Figure 2). The winch measures 96.5 x 71 x 76 cm, empty weight of 136 kg and hydraulic pressure maximum rating of 2500 psi. An encoder for the line out on the cable was used, and the cable was fed from winch to camera through the specifically designed cable feed wheel which attached to the small port aft crane (Figure 3). The camera cable ran from the winch outlet and attached to a SV-SC98 surface camera control console (Figure 4), which was used for viewing the video as it was recorded and to be able to adjust the cable (via winch) to maximize visibility of the seafloor. The frame tripod legs were stabilized at the base with weights.

The camera was set at 35cm above the tripod base, which resulted in 45x32cm wide view field when camera legs were on the seabed. A new housing was built (5'x5'x5') to hold the recording equipment and viewing console and computer. The housing was also shared with other researchers (CTD related equipment) (Figure 5).

The camera and related equipment including the housing were operated off the aft port deck.

Station numbers were given an NRCan station label, followed station numbers onboard for benthic samples (2007-801-Stn#), and given a descriptive label specific to the camera work on the overlay. The duration of video filming at each station was adjusted according to operating conditions and visibility, and varied from 5 to 20 minutes per station, though most stations had a recording time of 20 minutes. Additional information recorded for each station included substratum characteristics, visibility, dominating fauna and any other distinguishing features for each site. A total of 80 stations were recorded on the DVD/HDD, and full quantitative analysis of abundances of epibenthic macrofauna and species richness for each station will be carried out subsequently. The camera was also used to preview the substratum for boxcore work (checking for rocks) in certain depths and areas – there was no recording for this.

**Preliminary Observations:**

From viewing during video collection, the fauna differed according to depth, location and substrate. There was a difference in species found at stations near Hershel Island (west Mackenzie trough) from those near the east side of the trough. Rocky areas consistently had a different variety of species, which could be due to the rocks providing attachment sites for certain species. This was apparent at a station on a Knoll, where a change of fauna was clear as substrate became rockier on top of the Knoll. The ice scours showed little fauna within the scours compared to other areas of similar depths and undisturbed substrate. Along Hershel Island transects, shallower sites (~30 – 60 m) had rocky substrate, which caused some difficulty with the camera drift. At some of the shallow sites it was not possible to continue with camera work due to murkiness of the water (usually at 10 – 30 m water depth). Two sites of Knolls, two Ice Scours and a whale maw mark site were video sampled for interest and collaboration with other benthic researchers. Reference areas before and after the special interest areas were taken for comparison of diversity and abundance. There will be future analysis of the video collections to determine abundances and diversity for each station as well as biomass calculations.

See Figure 6 and 7 for maps of stations sampled, and Table 1 for the list of stations and information on each station.

**Reflections and considerations:**

I was able to sample almost double the amount of stations compared to the previous two years, covering areas all around the Mackenzie trough, and also sampled the Cape Bathurst area where upwelling was monitored by other researchers. Time in the night allowed CTD data to be collected along with camera work, sometimes at the same stations though camera work focused more by depths than the CTD (used more evenly spaced stations). Time was however limited and it was decided that time would be better spent on covering more areas than to have replicates for depths in similar areas (replicates could be focused on for future study). The mapping of the Mackenzie trough area east and west is more complete now, with transects running all around the area – east, west and south (Figure 6). Cape Bathurst area sites are found in Figure 7.

Sampling depth was limited to 300m or less due to length of cable (1000ft). The deepest station sampled was 250m. Using the winch made the lowering and lifting of the camera much easier, and convenient, though it needed a few adjustments along the way.

Having two crew on in the night also helped with operations of equipment, allowing me to focus on the observation and communications with winch operator and bridge. It would be beneficial to have crew given an overview of the purpose of projects before cruise begins along with test runs of the equipment to see how it handles. Having the outline plan for stations was very useful to plan accordingly and I found it valuable to coordinate with researchers of similar projects and/or of similar work times.

It may be useful to have zoom on the camera, along with brighter lights to be able to be further away from the sea floor and maintain better visibility by keeping clear of the bottom.  A camera that was remotely operated with grabs would be ideal of course, in order to be able to control viewing certain areas and species along with collecting samples in a non-invasive manner.  The text overlay on the screen tends to blocks a lot of viewing area, which is more an issue for analysis, though it is useful to have to continually monitor depth and time.  It could be possible to have equipment that would allow display of the distance from bottom (altimeter), although it may not really help in keeping the camera clear of the bottom as it would not likely provide the information quickly enough to adjust the cable.

A big thanks to Kevin MacKillop and Bill Williams for all their assistance, and for help with mapping and station locations.  Thanks so much to all the crew for their patience and help with daily work and general ship life.  Thanks also to John Jorgenson for all his assistance with the equipment set up and maintenance.

**Figure 1.** Camera, lasers, lights and depth transducer attached to tripod frame with weights.

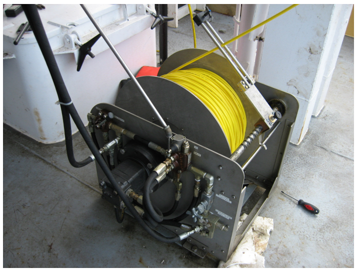

**Figure 2**. Winch with cable on aft port deck.

**Figure 3**. Camera with cable running through cable feed wheel (attached to encoder for line out)

**Figure 4**. Camera console/viewing area, laptop and recording unit within housing unit.

**Figure 5**. Housing for video console and laptop and other equipment on aft port deck.

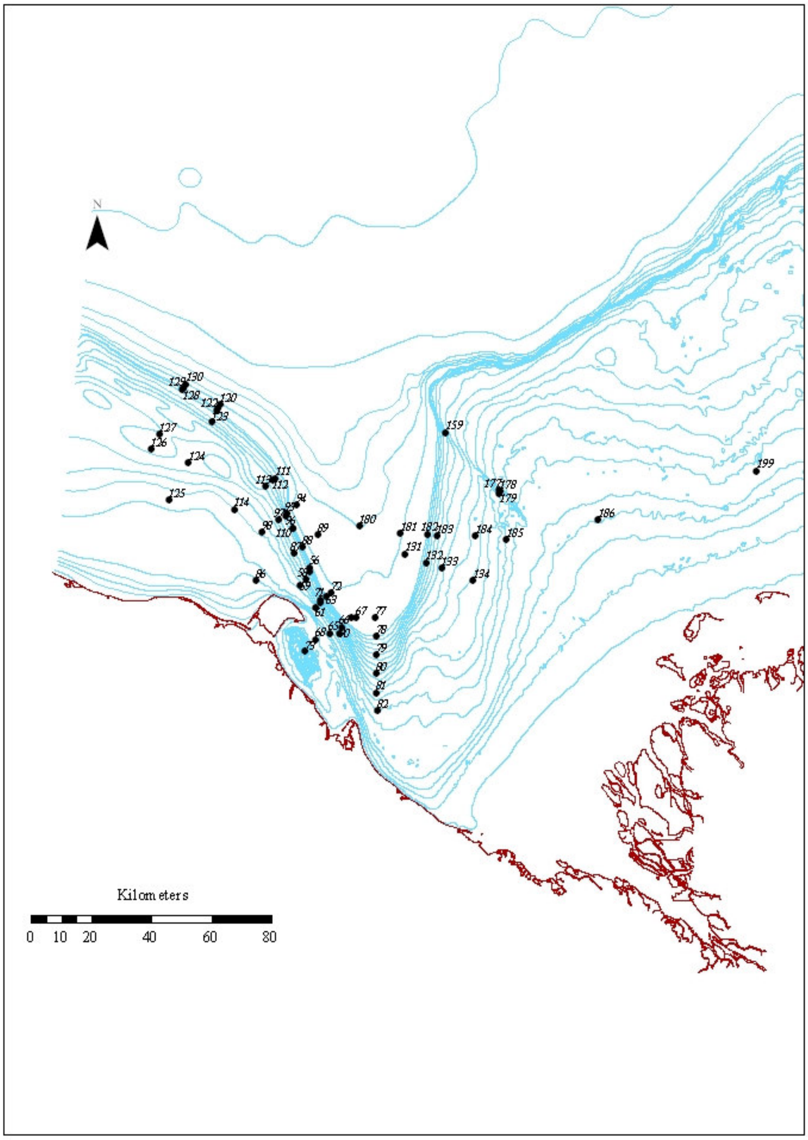


**Figure 6**.  Camera Stations 2007 Mackenzie Trough, Hershel Island areas.

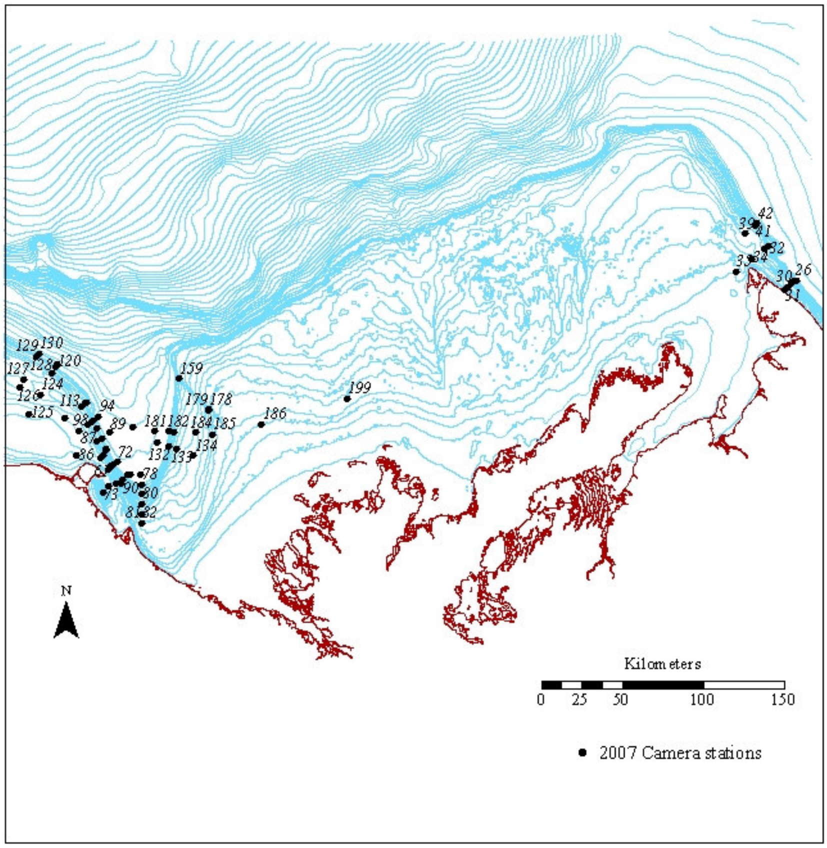


**Figure 7.** All Camera Stations 2007 (Mackenzie trough, Hershel Island, Cape Bathurst stations).

**Table 1**. Camera Stations 2007.

| Benthic Station | Date (UTC) | Depth (m) | Latitude | Longitude | Substrate | rec. time (min) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | 07/30/07 | 24.18 | 70.508676 | -127.659372 | | |
| 2007-801-stn25 | 07/31/07 | 113.62 | 70.539757 | -127.506693 | mud | 20 |
| 2007-801-stn26 | 07/31/07 | 95.15 | 70.543973 | -127.532849 | mud | 20 |
| 2007-801-stn27 | 07/31/07 | 80.62 | 70.542652 | -127.542644 | mud | 20 |
| 2007-801-stn28 | 07/31/07 | 67.59 | 70.540467 | -127.550358 | mud | 20 |
| 2007-801-stn29 | 07/31/07 | 41.31 | 70.528315 | -127.588140 | mud | 20 |
| 2007-801-stn30 | 07/31/07 | 23.51 | 70.511161 | -127.663761 | rocky, uneven, lumpy | 20 |
| 2007-801-stn31 | 07/31/07 | 15.72 | 70.495082 | -127.718120 | rocky, uneven, lumpy | 20 |
| 2007-801-stn32 | 07/31/07 | 77.65 | 70.746967 | -127.895923 | mud | 20 |
| 2007-801-stn33 | 07/31/07 | 50.86 | 70.736218 | -127.969483 | mud/rocks | 21 |
| 2007-801-stn34 | 07/31/07 | 28.63 | 70.690113 | -128.198168 | mud | 21 |
| 2007-801-stn35 | 07/31/07 | 17.30 | 70.627942 | -128.494504 | mud | 20 |
| 2007-801-stn39 | 07/31/07 | 45.20 | 70.829862 | -128.265131 | mud, pebbles, rocks | 20 |
| 2007-801-stn41 | 08/01/07 | 55.96 | 70.869105 | -128.084847 | mud, pebbles, rocks | 21 |
| 2007-801-stn42 | 08/01/07 | 77.75 | 70.879853 | -128.050209 | mud | 22 |
| 2007-801-stn52 | 08/02/07 | 120.26 | 69.589176 | -138.440505 | mud | 25 |
| 2007-801-stn56 | | 98.41 | 69.722569 | -138.819139 | mud | 20 |
| 2007-801-stn57 | 08/03/07 | 88.00 | 69.713071 | -138.817640 | mud, lumpy | 20 |
| 2007-801-stn58 | 08/03/07 | 59.28 | 69.688224 | -138.847848 | mud, lumpy | 20 |
| 2007-801-stn59 | 08/03/07 | 54.20 | 69.672462 | -138.893365 | mud, lumpy, rocks | 22 |
| 2007-801-stn60 | too murky | | | | | too murky |
| 2007-801-stn61 | 08/03/07 | 39.91 | 69.610839 | -138.752952 | mud, lumpy, rocks | 21 |
| 2007-801-stn62 | 08/03/07 | 57.19 | 69.626154 | -138.713791 | mud, lumpy, rocks | 20 |
| 2007-801-stn63 | 08/03/07 | 99.00 | 69.643527 | -138.670727 | mud | 24 |
| 2007-801-stn65 | 08/05/07 | 32.57 | 69.539631 | -138.614629 | mud | 21 |
| 2007-801-stn66 | 08/05/07 | 79.10 | 69.559350 | -138.517229 | mud | 21 |
| 2007-801-stn67 | 08/05/07 | 122.62 | 69.588185 | -138.402551 | mud | 20 |
| 2007-801-stn68 | 08/05/07 | 15.32 | 69.518054 | -138.732477 | rocky, sand | 20 |
| 2007-801-stn71 | 08/06/07 | 66.58 | 69.633788 | -138.710237 | mud, lumpy, sml rocks | 15 |
| 2007-801-stn72 | 08/06/07 | 136.52 | 69.654215 | -138.627468 | mud | 20 |
| 2007-801-stn73 | 08/06/07 | 69.41 | 69.483442 | -138.816558 | mud | 21 |
| 2007-801-stn77 | 08/07/07 | 121.31 | 69.590010 | -138.237893 | mud | 20 |
| 2007-801-stn78 | 08/07/07 | 101.20 | 69.538045 | -138.223280 | mud | 20 |
| 2007-801-stn79 | 08/07/07 | 81.91 | 69.484580 | -138.214655 | mud | 20 |
| 2007-801-stn80 | 08/07/07 | 65.40 | 69.430828 | -138.203782 | mud, lumpy | 20 |
| 2007-801-stn81 | 08/07/07 | 51.30 | 69.376644 | -138.192048 | mud | 20 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2007-801-stn82 | 08/07/07 | 42.20 | 69.324675 | -138.181908 | mud | 20 |
| 2007-801-stn83 | 08/07/07 | 12.01 | 69.458871 | -138.948669 | | cancelled - too murky |
| 2007-801-stn86 | 08/08/07 | 32.36 | 69.676378 | -139.272537 | mud, lumpy,uneven | 20 |
| 2007-801-stn87 | 08/08/07 | 62.14 | 69.760361 | -138.968738 | rocks, mud, uneven | 21 |
| 2007-801-stn88 | 08/08/07 | n/a | 69.781098 | -138.896091 | mud | 21 |
| 2007-801-stn89 | 08/08/07 | n/a | 69.818132 | -138.773137 | mud | 20 |
| 2007-801-stn90 | 08/08/07 | 50.22 | 69.538626 | -138.535090 | mud | 21 |
| 2007-801-stn94 | 08/09/07 | 180.64 | 69.899546 | -138.966156 | mud | 20 |
| 2007-801-stn95 | 08/09/07 | n/a | 69.873569 | -139.043748 | mud | 20 |
| 2007-801-stn96 | 08/09/07 | 79.48 | 69.867842 | -139.058195 | mud, lumpy | 20 |
| 2007-801-stn97 | 08/09/07 | 61.53 | 69.854776 | -139.117117 | mud, sml rocks, lumpy | 20 |
| 2007-801-stn98 | 08/09/07 | 42.84 | 69.814355 | -139.254435 | mud, rocky | 20 |
| 2007-801-stn109 | 08/10/07 | 101.20 | 69.832686 | -138.987763 | mud/rocks | 11 |
| 2007-801-stn110 | 08/10/07 | 103.09 | 69.833063 | -138.988168 | mud/rocks | 15 |
| 2007-801-stn111 | 08/10/07 | 138.67 | 69.972091 | -139.171013 | mud | 20 |
| 2007-801-stn112 | 08/10/07 | 108.77 | 69.968838 | -139.188579 | mud, sml rocks, lumpy | 20 |
| 2007-801-stn113 | 08/10/07 | 59.95 | 69.946724 | -139.248719 | mud/rocks | 21 |
| 2007-801-stn114 | 08/10/07 | 40.69 | 69.875055 | -139.502709 | rocky, mud | 20 |
| 2007-801-stn120 | 08/11/07 | 244.27 | 70.171176 | -139.693053 | mud | 20 |
| 2007-801-stn121 | 08/11/07 | 146.39 | 70.159477 | -139.707628 | mud | 20 |
| 2007-801-stn122 | 08/11/07 | 77.68 | 70.154285 | -139.718169 | mud, sml rocks | 20 |
| 2007-801-stn123 | 08/11/07 | 58.62 | 70.121003 | -139.758811 | mud, rocks, pebbles | 20 |
| 2007-801-stn124 | 08/11/07 | 59.60 | 69.996588 | -139.932371 | rocky, mud | 20 |
| 2007-801-stn125 | 08/11/07 | 39.57 | 69.886767 | -140.075856 | mud, some rocks | 20 |
| 2007-801-stn126 | 08/12/07 | 57.88 | 70.026905 | -140.268959 | mud, lumpy, few rocks | 21 |
| 2007-801-stn127 | 08/12/07 | 41.10 | 70.072443 | -140.205942 | mud, sml rocks | 20 |
| 2007-801-stn128 | 08/12/07 | 76.48 | 70.204478 | -140.034358 | mud, some rocks, pebbles | 20 |
| 2007-801-stn129 | 08/12/07 | 110.33 | 70.208035 | -140.029975 | mud | 20 |
| 2007-801-stn130 | 08/12/07 | 211.00 | 70.221866 | -140.008601 | mud | 20 |
| 2007-801-stn131 | 08/13/07 | 136.69 | 69.778238 | -138.004995 | mud | 20 |
| 2007-801-stn132 | 08/13/07 | 90.18 | 69.756898 | -137.821276 | mud | 21 |
| 2007-801-stn133 | 08/13/07 | 70.10 | 69.741812 | -137.687109 | mud | 20 |
| 2007-801-stn134 | 08/13/07 | 57.52 | 69.710435 | -137.411752 | mud | 20 |
| 2007-801-stn159 | 08/14/07 | 82.46 | 70.131781 | -137.701445 | mud | ? |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2007-801-stn177 | 08/14/07 | 53.45 | 69.973751 | -137.213911 | mud | 10 |
| 2007-801-stn178 | 08/14/07 | 56.17 | 69.969230 | -137.207986 | mud | 13 |
| 2007-801-stn179 | 08/15/07 | 54.99 | 69.965283 | -137.212769 | mud | 15 |
| 2007-801-stn180 | 08/15/07 | 202.36 | 69.850715 | -138.412945 | mud | 20 |
| 2007-801-stn181 | 08/15/07 | 153.51 | 69.836464 | -138.054091 | mud | 20 |
| 2007-801-stn182 | 08/15/07 | 99.25 | 69.838310 | -137.826195 | mud | 20 |
| 2007-801-stn183 | 08/15/07 | 79.23 | 69.834193 | -137.736559 | mud | 20 |
| 2007-801-stn184 | 08/15/07 | 60.64 | 69.838335 | -137.405131 | mud | 20 |
| 2007-801-stn185 | 08/15/07 | 42.49 | 69.831834 | -137.136794 | mud | 20 |
| 2007-801-stn186 | 08/15/07 | 23.77 | 69.897091 | -136.344114 | mud, lumpy, | |
| 2007-801-stn199 | 08/15/07 | 30.81 | 70.041593 | -134.969612 | mud, lumpy, | |

## Benthic Sampling

Nahidik 2007, Leg 1
Participants: Alec Aitken (University of Saskatchewan, Geography)
Christine McClelland (Canadian Museum of Nature)

**Introduction:**

The objective of this cruise's benthic component was to continue the sampling of seafloor features from the past four field seasons. Particular focus was placed on the ice scours, abandoned drilling platforms and submerged pingo-like features. In addition to sampling these features, samples were also collected to develop a better understanding of the benthic faunal compositions in areas of known upwelling. Samples are analysed with respect to diversity and abundance of the animals living within and on the sea floor.

A secondary purpose of this cruise for the benthic team was to collect samples for lipid content analyses from Cape Bathurst and Herschel Island to determine the food web of benthic macrofauna at these upwelling areas.

**Method:**

Samples were collected using a 0.5m x 0.5m boxcore. When present, surface water was sieved off to collect animals disturbed in the collection process. As in previous years, grain size samples and 70% of the top 15 cm of sediment from the box core were collected. Animals were removed from the sediment through an elutriation process and collected with a 0.4mm sieve. Samples were relaxed with menthol crystals and preserved in a buffered 10% formalin solution.

For the food web study, samples were collected with the bottom trawl and box core. When possible, a set of seven replicates for each species or functional group were kept. Animals were allowed to depurate for an average of 24 hours after which they were photographed, placed in aluminium weigh boats and frozen at -80ºC under a nitrogen gas atmosphere.

**Table 1. Boxcore samples collected for benthic fauna abundance and diversity analyses.**

| Station | Date | Depth (m) | Latitude | Longitude | Interest |
|---|---|---|---|---|---|
| Issungnak Top of Island 1 | 07/25/07 | 6.03 | 70.015821 | -134.321150 | Abandoned drilling platform |
| Issungnak Top of Island 2 | 07/25/07 | 5.98 | 70.015827 | -134.321161 | Abandoned drilling platform |
| Issungnak Top of Island 3 | 07/25/07 | 6.02 | 70.015905 | -134.321063 | Abandoned drilling platform |
| Issungnak Reference 1 | 07/26/07 | 19.35 | 70.022290 | -134.350664 | Abandoned drilling platform |
| Issungnak Reference 2 | 07/26/07 | 19.66 | 70.022305 | -134.350627 | Abandoned drilling platform |
| Issungnak Reference 3 | 07/26/07 | 19.34 | 70.022342 | -134.350611 | Abandoned drilling platform |
| Issungnak Wide Borrow Pit 1 | 07/27/07 | 36.59 | 70.017811 | -134.300307 | Abandoned drilling platform |
| Issungnak Wide Borrow Pit 2 | 07/27/07 | 36.66 | 70.017812 | -134.300280 | Abandoned drilling platform |
| Issungnak Wide Borrow Pit 3 | 07/27/07 | 35.31 | 70.017892 | -134.300072 | Abandoned drilling platform |
| Kug Gas Vents Reference 1 | 07/29/07 | 8.95 | 69.750108 | -133.378350 | Gas Vents |
| Kug Gas Vents Reference 2 | 07/29/07 | 9.01 | 69.750096 | -133.378392 | Gas Vents |
| Kug Gas Vents Reference 3 | 07/29/07 | 8.98 | 69.750103 | -133.378530 | Gas Vents |
| Kug Gas Vents Inside 1 | 07/29/07 | 12.89 | 69.749637 | -133.363013 | Gas Vents |
| Kug Gas Vents Inside 2 | 07/29/07 | 12.25 | 69.749588 | -133.362960 | Gas Vents |
| Kug Gas Vents Inside 3 | 07/29/07 | 12.50 | 69.749602 | -133.362946 | Gas Vents |
| CBT4-1 | 07/30/07 | 12.06 | 70.492223 | -127.724117 | Upwelling Area |
| CBT4-2 | 07/30/07 | 23.60 | 70.508622 | -127.659188 | Upwelling Area |
| CBT4-3/CBT4-4 | 07/31/07 | 41.38 | 70.526526 | -127.584494 | Upwelling Area |
| CBT4-5 | 07/31/07 | 65.58 | 70.539226 | -127.549999 | Upwelling Area |

| | | | | | |
|---|---|---|---|---|---|
| CBT4-6 | 07/31/07 | 80.48 | 70.541406 | -127.541159 | Upwelling Area |
| CBT4-7 | 07/31/07 | 98.78 | 70.544476 | -127.531030 | Upwelling Area |
| CBT4-8 | 07/31/07 | 119.21 | 70.546416 | -127.515718 | Upwelling Area |
| CB1-2 | 07/31/07 | 21.65 | 70.686077 | -128.838685 | Upwelling Area |
| CB1-5 | 07/31/07 | 44.56 | 70.828018 | -128.276888 | Upwelling Area |
| CB1-5 | 07/31/07 | 45.86 | 70.830500 | -128.273766 | Upwelling Area |
| CB1-6 | 07/31/07 | 55.18 | 70.870200 | -128.089378 | Upwelling Area |
| Scour 6854/6870 Reference 1 | 08/01/07 | 19.12 | 70.318032 | -130.954421 | Ice Scour |
| Scour 6854/6870 Reference 2 | 08/01/07 | 19.13 | 70.318047 | -130.954466 | Ice Scour |
| Scour 6854/6870 Reference 3 | 08/01/07 | 19.10 | 70.318046 | -130.954515 | Ice Scour |
| Scour 6870 Inside 1 | 08/01/07 | 18.36 | 70.305316 | -130.958924 | Ice Scour |
| Scour 6870 Inside 2 | 08/01/07 | 18.11 | 70.305320 | -130.958806 | Ice Scour |
| Scour 6870 Inside 3 | 08/01/07 | 18.23 | 70.305313 | -130.958865 | Ice Scour |
| Scour 6854 Inside 1 | 08/01/07 | 17.26 | 70.300729 | -130.960655 | Ice Scour |
| Scour 6854 Inside 2 | 08/01/07 | 16.91 | 70.300730 | -130.960782 | Ice Scour |
| Scour 6854 Inside 3 | 08/01/07 | 16.77 | 70.300723 | -130.960783 | Ice Scour |
| HTE-6 | 08/03/07 | 117.83 | 69.585257 | -138.444872 | Upwelling Area |
| HTE-6 | 08/03/07 | 117.90 | 69.585207 | -138.444836 | Upwelling Area |
| HTE-6 | 08/03/07 | 117.73 | 69.585232 | -138.444646 | Upwelling Area |
| MB24-6 | 08/04/07 | 40.15 | 69.322183 | -138.187758 | Compliment 24 hour study |
| HTB-8 | 08/06/07 | 54.70 | 69.481493 | -138.824072 | Upwelling Area |
| HTD-6 | 08/08/07 | 51.03 | 69.540712 | -138.537255 | Upwelling Area |
| Herschel Knolls 1 1 | 08/09/07 | 107.98 | 69.879584 | -139.053946 | Pingo-like feature |
| Herschel Knolls 1 2 | 08/09/07 | 108.39 | 69.879599 | -139.054206 | Pingo-like feature |
| Herschel Knolls 1 3 | 08/09/07 | 108.17 | 69.879593 | -139.054238 | Pingo-like feature |
| Herschel Knolls 5 1 | 08/09/07 | 96.19 | 69.832419 | -138.987265 | Pingo-like feature |
| Herschel Knolls 5 2 | 08/10/07 | 98.07 | 69.832406 | -138.987336 | Pingo-like feature |
| Herschel Knolls 5 3 | 08/10/07 | 97.27 | 69.832368 | -138.987400 | Pingo-like feature |
| H3-6 | 08/10/07 | 152.17 | 69.792177 | -138.874728 | Upwelling Area |
| Herschel Transect Line 3, 100 m | 08/11/07 | 106.00 | 69.781873 | -138.899256 | Upwelling Area |
| Herschel Transect Line 3, 75 m | 08/11/07 | 75.29 | 69.774106 | -138.918287 | Upwelling Area |
| Scour 6200 Reference 1 | 08/13/07 | 19.09 | 69.648635 | -136.760980 | Ice Scour |
| Scour 6200 Reference 2 | 08/13/07 | 19.59 | 69.648630 | -136.760909 | Ice Scour |
| Scour 6200 Reference 3 | 08/13/07 | 19.17 | 69.648621 | -136.760903 | Ice Scour |
| Scour 6200 Inside 1 | 08/13/07 | 18.28 | 69.649351 | -136.762598 | Ice Scour |
| Scour 6200 Inside 2 | 08/13/07 | 18.55 | 69.649337 | -136.762507 | Ice Scour |
| Scour 6200 Inside 3 | 08/13/07 | 18.89 | 69.649362 | -136.762516 | Ice Scour |
| Whale Maw Marks 1 | 08/14/07 | 80.52 | 70.130723 | -137.701758 | Whale Maw Marks |
| Whale Maw Marks 2 | 08/14/07 | 80.35 | 70.130733 | -137.701796 | Whale Maw Marks |
| Whale Maw Marks 3 | 08/14/07 | 80.39 | 70.130724 | -137.701760 | Whale Maw Marks |
| Gary Knolls Active 1 1 | 08/14/07 | 46.88 | 69.998968 | -137.284929 | Pingo-like feature |
| Gary Knolls Active 1 2 | 08/14/07 | 46.77 | 69.998971 | -137.284915 | Pingo-like feature |
| Gary Knolls Active 1 3 | 08/14/07 | 47.00 | 69.998973 | -137.284954 | Pingo-like feature |
| Gary Knolls Inactive 1 1 | 08/14/07 | 47.43 | 69.997823 | -137.296780 | Pingo-like feature |
| Gary Knolls Inactive 1 2 | 08/14/07 | 47.28 | 69.997811 | -137.296793 | Pingo-like feature |
| Gary Knolls Inactive 1 3 | 08/14/07 | 47.28 | 69.997808 | -137.296798 | Pingo-like feature |
| Gary Knolls Inactive 2 1 | 08/14/07 | 46.50 | 69.972558 | -137.212520 | Pingo-like feature |
| Gary Knolls Inactive 2 2 | 08/14/07 | 43.16 | 69.972543 | -137.212645 | Pingo-like feature |

| | | | | | |
|---|---|---|---|---|---|
| Gary Knolls Inactive 2 3 | 08/14/07 | 43.86 | 69.972493 | -137.212607 | Pingo-like feature |
| Gary Knolls Active 2 1 | 08/14/07 | 45.09 | 69.967743 | -137.207364 | Pingo-like feature |
| Gary Knolls Active 2 2 | 08/14/07 | 44.46 | 69.967716 | -137.207426 | Pingo-like feature |
| Gary Knolls Active 2 3 | 08/14/07 | 41.23 | 69.967711 | -137.207336 | Pingo-like feature |
| Scour 15812 Inside 1 | 08/15/07 | 24.10 | 69.898086 | -136.343560 | Ice Scour |
| Scour 15812 Inside 2 | 08/15/07 | 25.14 | 69.898068 | -136.343593 | Ice Scour |
| Scour 15812 Inside 3 | 08/15/07 | 23.20 | 69.898100 | -136.343483 | Ice Scour |
| Scour 15812 Reference 1 | 08/15/07 | 23.74 | 69.897015 | -136.344173 | Ice Scour |
| Scour 15812 Reference 2 | 08/15/07 | 23.70 | 69.897010 | -136.344138 | Ice Scour |
| Scour 15812 Reference 3 | 08/15/07 | 23.72 | 69.897005 | -136.344203 | Ice Scour |
| Kaubvik Island 1 | 08/15/07 | 8.30 | 69.875922 | -135.423508 | Abandoned drilling platform |
| Kaubvik Island 2 | 08/15/07 | 8.39 | 69.875819 | -135.423999 | Abandoned drilling platform |
| Kaubvik Island 3 | 08/15/07 | 8.56 | 69.875814 | -135.423962 | Abandoned drilling platform |
| Kaubvik Reference 1 | 08/15/07 | 18.47 | 69.873874 | -135.429834 | Abandoned drilling platform |
| Kaubvik Reference 2 | 08/15/07 | 18.43 | 69.873805 | -135.429687 | Abandoned drilling platform |
| Kaubvik Reference 3 | 08/15/07 | 18.45 | 69.873992 | -135.429512 | Abandoned drilling platform |
| Scour 15778 Inside 1 | 08/15/07 | 30.20 | 70.042779 | -134.964968 | Ice Scour |
| Scour 15778 Inside 2 | 08/15/07 | 30.12 | 70.042809 | -134.964931 | Ice Scour |
| Scour 15778 Inside 3 | 08/15/07 | 30.40 | 70.042805 | -134.964972 | Ice Scour |
| Scour 15778 Reference 1 | 08/15/07 | 30.66 | 70.041712 | -134.969122 | Ice Scour |
| Scour 15778 Reference 2 | 08/15/07 | 30.71 | 70.041737 | -134.969247 | Ice Scour |
| Scour 15778 Reference 3 | 08/15/07 | 30.87 | 70.041738 | -134.969194 | Ice Scour |

**Table 2. Samples collected for lipid analyses (note for the locations of bottom trawl, $t_s$ indicates the start of the trawl and $t_f$ indicates the finish of the trawl)**

| Sampling method | Station | Date | Depth (m) | Latitude ($t_s$) | Longitude ($t_s$) | Latitude ($t_f$) | Longitude ($t_f$) |
|---|---|---|---|---|---|---|---|
| Box core | Cape Bathurst Line 4, stn 3 | 07/31/07 | 41.38 | 70.526526 | -127.584494 | | |
| Bottom trawl | Cape Bathurst Trawl Net 1 | 07/31/07 | 23.05 | 70.695880 | -128.839667 | 70.707728 | -128.839893 |
| Bottom trawl | Cape Bathurst Trawl Net 2 | 07/31/07 | 22.31 | 70.689643 | -128.841767 | 70.700806 | -128.836752 |
| Bottom trawl | Cape Bathurst Trawl Net 3 | 07/31/07 | 22.66 | 70.689062 | -128.844926 | 70.699795 | -128.838294 |
| Bottom trawl | Herschel Trawl Net PBS-E2 | 08/02/07 | 116.13 | 69.615121 | -138.574018 | 69.609851 | -138.551121 |
| Bottom trawl | Herschel Trawl Net PBS-E4 | 08/02/07 | 118.94 | 69.600517 | -138.510226 | 69.594640 | -138.483006 |

**Sample Analyses:**

The diversity and abundance samples will be shipped to the Canadian Museum of Nature where they will be transferred into 70% ethanol, sorted and identified to the lowest taxa possible.

The lipid analyses for the food web study will be performed using a High Performance Liquid Chromatography system at Memorial University in Newfoundland.

**Summary:**

This cruise was a particularly successful one for the benthic team. We were able to collect samples from all of our top three priority sites as well as sample the upwelling areas of Cape Bathurst and Herschel Island with good special coverage. The effort by the officers, the deck crew and Jim Weedon allowed our project to collect samples of the highest precision and quality. We are very thankful to them as well as Kevin MacKillop and Bill Williams. We also greatly appreciate the team effort we benefited from in the final week of the cruise – we would not have been able to collect so many interesting samples were it not for the many helpers we had on the aft deck. Many thanks for a great cruise.

## Geotechnical Sampling

### Introduction

Installations of engineering structures including artificial islands, drilling caissons and pipelines to support oil and gas development must contend with the serve Artic climate, ice conditions and extensive iceberg scouring of the seabed. A regional understanding of the geology and engineering properties of the surficial sediments is essential to ensure safe development and transport of oil and gas. These sediments have unique engineering properties resulting from their geological history (constantly remolded by ice scouring), which affect the geotechnicial properties and thus their response under load.

### Objectives

The primary objective of the geotechnicial sea bed sampling was to acquire sediment samples to characterize the physical and engineering properties of the seabed sediments, in particular marine clays and enhance our understanding of the ice scouring process and its effect on geotechnicial properties. Secondary objectives include using the geotechnicial properties to help understand the benthic ecosystems and to ground truth multi beam data for seabed classification.

### Methods

Sediment samples were retrieved with box and gravity corers. The box corer (Fig 1) consists of a 50 by 50cm box and provides relatively undisturbed samples of the seafloor. Push cores (Fig 2) using a 10.0 cm diameter ABS plastic core liner were taken using a vacuum backpressure technique to prevent sample compression. The gravity corer consists of a 1.5 meter core barrel with plastic liner insert and core head (Fig 3). The corer head contained 125kg of lead weights.

Onboard sediment constant volume index property samples and undrained torvane shear strength measurements were taken at the top and base of each push and gravity core. Undrained shear strength measurements were made using a field hand vane tester (Fig 4) at sites associated with ice scouring. The measurements were made at 5 cm intervals (Fig 4) in the box corer prior to benthic and push core subsampling of the box core.

### Results

Geotechnical measurements and samples were collected at 39 sites (Fig 5) that included 15 sites associated with 5 ice scour events. The ice scour events were the MacScour, the east scours numbered 6854 and 6870 and one year old scours numbered 15778 and 5812 (Table 1).

The MacScour is an extreme scour event that has been mutli-beamed for over 10 km in water depths from 15 to 24 meters. The scour is up to 11 m wide and 3 meters deep. Five locations were sampled along the scour including 3 reference sites and 5 in scour sites.

The objective of the MacScour sampling was to enhance our understanding of the ice scouring process. The east scours consist of 1 older (14 years) and one newer scour (8 years). The objective of the east scour sampling is to provide a time series for benthic sampling. Scours 15778 and 5812 are 1-year-old scours located north of Richards Island and are 25 kms apart. Scour 15778 is 45 m wide and 2 meters deep while scour 15812 is 85 m wide and 2.4 m deep. The recent scours were sampled for benthic and geotechnicial. The objective of the recent scour sampling was to determine the degree of variability in soils properties across the width of a scour.

The undrained peak shear strength values for the scour sites are shown in Figures 6 and 7. The shear strength values are average values of measurements taken from 3 box cores from the same site. The incsour shear strengths at MacScour are consistently higher than the reference sites. This is not the case at Scour 15812 where there is little difference between the inscour and reference shear strength values. The shear strength values can be variable from box core to box core at the same site. This is evident at MacScour Site 2700. The shear strength values are less than 5.0 kPa in one box core but range from 7.0 to 15.0 kPa in a second box core (Fig 8). The two box cores are approximately 1 meter apart.

**Figure 1 Launching and retrieval of the box corer.**


**Figure 2 Push core taken in box core**

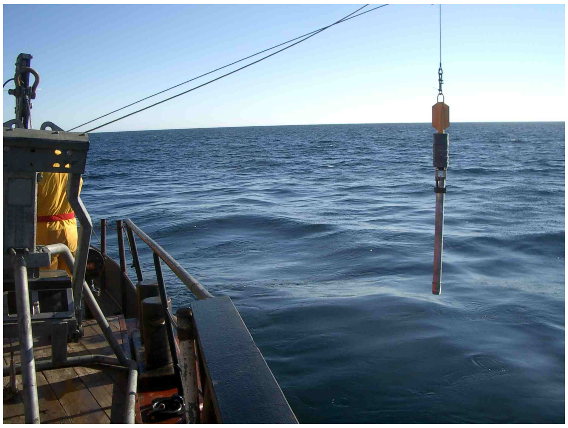

**Figure 3 Launching of the gravity corer.**

**Figure 4 Field hand vane undrained shear strength measurements on sediments retrieved with the box corer.**

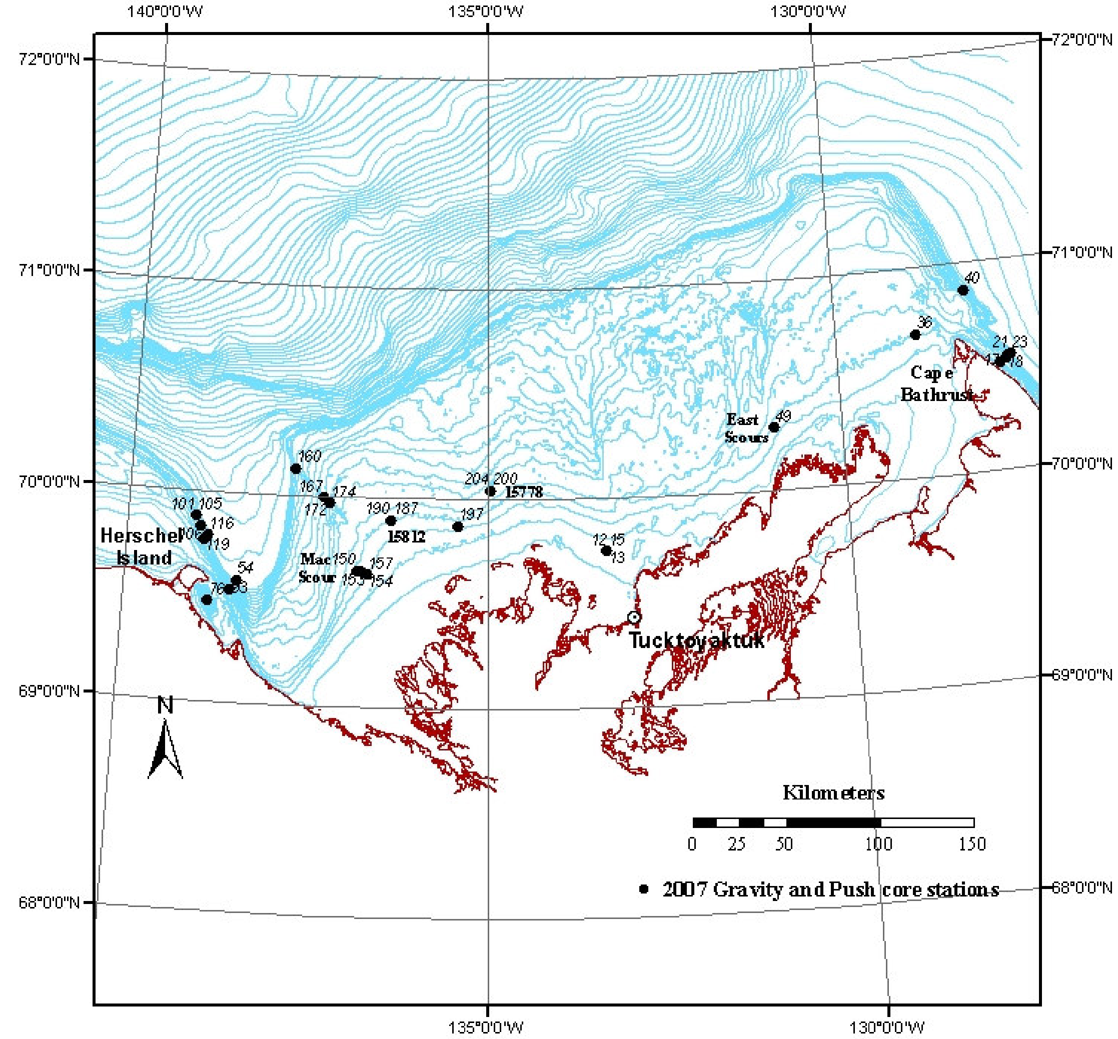


**Figure 5 Geotechnical sample locations.**

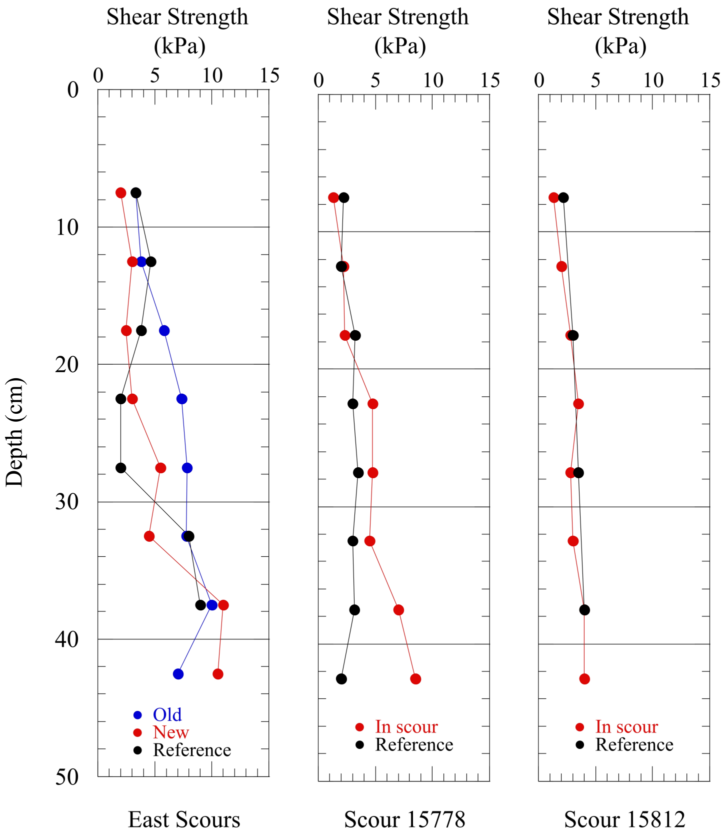


**Figure 6 Average field hand vane peak shear strength measurements taken in box cores from 3 scour sites.**

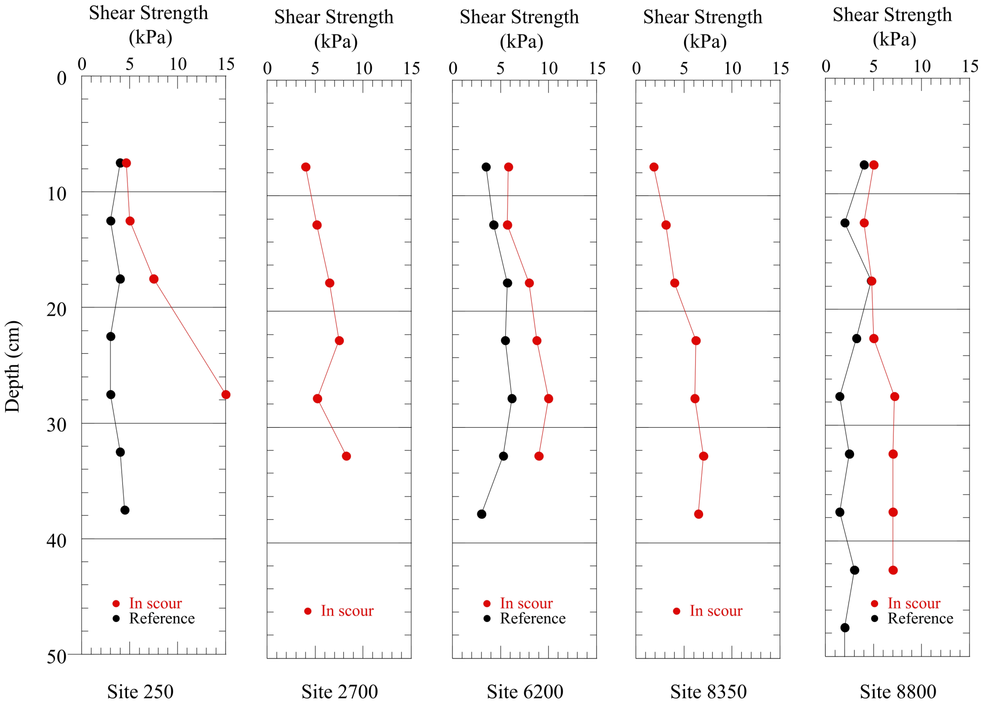


**Figure 7 Average field hand vane peak shear strength measurements taken in box cores from 5 sites along the MacScour.**

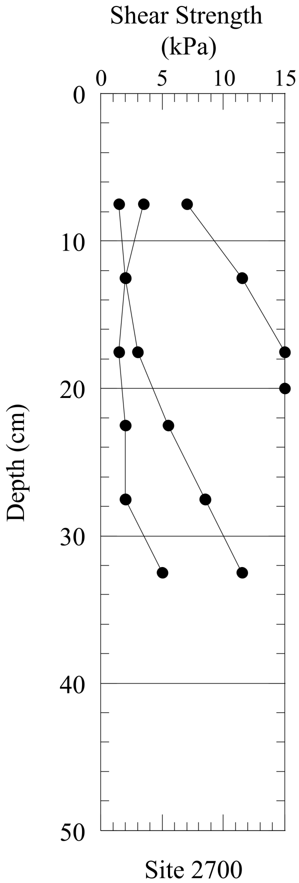

**Figure 8 Field hand vane peak shear strength measurements taken from 3 box cores at MacSCour Site 2700.**

**Table1 Geotechnical sample summary.**

| Station | Area | Site | Core Type | Water Depth (m) | Core Length (cm) | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 2007801 012 | Kugmallit Gas Vents | Reference | Push A | 8.98 | 34 | 69.750103 | -133.378530 |
| 2007801 013 | Kugmallit Gas Vents | Gas Vents | Push A | 12.89 | 43 | 69.749637 | -133.363013 |
| 2007801 015 | Kugmallit Gas Vents | Gas Vents | Push A | 12.50 | 54 | 69.749602 | -133.362946 |
| 2007801 017 | Cape Bathurst | CB4.2_25m | Push A | 23.60 | 31 | 70.508622 | -127.659188 |
| 2007801 018 | Cape Bathurst | CB4.3_40m | Push A | 41.38 | 34 | 70.526526 | -127.584494 |
| 2007801 021 | Cape Bathurst | CB4.4_75m | Push A | 80.48 | 42 | 70.541406 | -127.541159 |
| 2007801 023 | Cape Bathurst | CB4.4_120m | Push A | 119.21 | 44 | 70.546416 | -127.515718 |
| 2007801 036 | Cape Bathurst | CB2_15m | Push A | 21.65 | 40 | 70.686077 | -128.838685 |
| 2007801 040 | Cape Bathurst | CB1.6 | Push A | 55.18 | 36 | 70.870200 | -128.089378 |
| 2007801 049 | Scour 6854 | In Scour | Push A | 17.26 | 39 | 70.300729 | -130.960655 |
| 2007801 054 | Herschel Island | PBS-E6 | Push A | 117.90 | 38 | 69.585207 | -138.444836 |
| 2007801 076 | Herschel Island | PBS-B8 | Push A | 53.73 | 47 | 69.481438 | -138.823966 |
| 2007801 093 | Herschel Island | PBS-D6 | Push A | 51.00 | 34 | 69.540702 | -138.537273 |
| 2007801 101 | Herschel Knolls | HK1 | Push A | 107.98 | 35 | 69.879584 | -139.053946 |
| 2007801 105 | Herschel Knolls | HK1 | Gravity | 107.88 | 63 | 69.879576 | -139.054047 |
| 2007801 106 | Herschel Knolls | HK5 | Push A | 96.19 | 22 | 69.832419 | -138.987265 |
| 2007801 116 | Herschel Island | H3.6 | Push A | 152.19 | 37 | 69.792034 | -138.874380 |
| 2007801 118 | Herschel Island | H3.6_100m | Push A | 106.00 | 34 | 69.781873 | -138.899256 |
| 2007801 119 | Herschel Island | H3.6_75m | Push A | 75.29 | 17 | 69.774106 | -138.918287 |
| 2007801 135 | Mac Scour | 6200 Reference | Push A&B | 19.09 | 25 | 69.648635 | -136.760980 |
| 2007801 138 | Mac Scour | 6200 In Scour | Push A&B | 18.28 | 25 | 69.649351 | -136.762598 |
| 2007801 141 | Mac Scour | 8350 In Scour | Push A&B | 20.76 | 39 | 69.652852 | -136.805457 |
| 2007801 145 | Mac Scour | 8800 Reference | Push A | 21.03 | 54 | 69.651622 | -136.811956 |
| 2007801 147 | Mac Scour | 8800 Reference | Gravity | 21.93 | 54 | 69.651670 | -136.811958 |
| 2007801 149 | Mac Scour | 8800 In Scour | Push A | 21.40 | 41 | 69.651830 | -136.809909 |
| 2007801 150 | Mac Scour | 8800 In Scour | Push A | 21.26 | 27.5 | 69.651848 | -136.809769 |
| 2007801 152 | Mac Scour | 2700 In Scour | Push A | 19.16 | 36.5 | 69.645080 | -136.716312 |
| 2007801 153 | Mac Scour | 2700 In Scour | Push A | 18.90 | 24 | 69.645098 | -136.716339 |
| 2007801 154 | Mac Scour | 250 In Scour | Push A&B | 16.22 | 34.5 | 69.633239 | -136.663357 |
| 2007801 157 | Mac Scour | 250 Reference | Push A | 16.13 | 34.5 | 69.634073 | -136.664624 |
| 2007801 160 | MacKenzie Trough | WMM | Push A | 80.52 | 41 | 70.130723 | -137.701758 |
| 2007801 164 | Garry Knolls | Knoll C | Push A | 46.77 | 38.5 | 69.998971 | -137.284915 |
| 2007801 167 | Garry Knolls | Knoll D | Push A | 47.28 | 41 | 69.997811 | -137.296793 |
| 2007801 170 | Garry Knolls | Knoll E | Push A | 43.16 | 25 | 69.972543 | -137.212645 |
| 2007801 172 | Garry Knolls | Knoll E | Gravity | 42.62 | 45 | 69.972494 | -137.212591 |
| 2007801 174 | Garry Knolls | Knoll F | Push A | 44.46 | 29 | 69.967716 | -137.207426 |
| 2007801 187 | Scour 15812 | In Scour | Push A | 24.10 | 39 | 69.898086 | -136.343560 |
| 2007801 190 | Scour 15812 | Reference | Push A | 23.74 | 40 | 69.897015 | -136.344173 |
| 2007801 197 | Kaubvik Island | Reference | Push A | 18.43 | 38 | 69.873805 | -135.429687 |
| 2007801 200 | Scour 15778 | In Scour | Push A | 30.20 | 47 | 70.042779 | -134.964968 |
| 2007801 204 | Scour 15778 | Reference | Push A | 30.71 | 46 | 70.041737 | -134.969247 |