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GEOLOGICAL SURVEY OF CANADA
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2014

Canada

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2014

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doi:10.4095/295628

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Recommended citation
Hatcher, S.V., Forbes, D.L., and Manson, G.K., 2014. Coastal geoscience field work near Iqaluit, Nunavut, 2009–2011; Geological Survey of Canada, Open File 7653, 65 p. doi:10.4095/295628

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Cover photo: Koojesse Inlet tidal flats, Iqaluit, Nunavut, looking toward Apex. Photo by S.V. Hatcher, 16 July 2010.

Abstract

This report describes data collected during five field trips to Koojesse Inlet, Nunavut, between 2009 and 2011. These trips have expedition numbers 2009306, 2010307, 2011303, and 2011307 (includes 2 trips). Koojesse Inlet is in the northwestern end of Frobisher Bay on Baffin Island. Data were collected primarily on foot within the intertidal, but there are some boat-based datasets associated with expedition 2011307. Data collected include: RTK-GPS transects, sidescan sonar lines, single beam sonar lines, tide and wave recorder deployments, current profiler deployments, surface and grab sediment samples, underwater drop camera lines, and shallow sub-bottom profile lines. Results show a complex intertidal zone characterized by a higher slope beachface and flank face at the edge of the low-slope tidal flat terrace, with varying concentrations of boulders. Sediment is a mixture of relict glaciomarine overlain by a shallow reworked sand/mud surficial layer. Sediment in the nearshore varies from fine silts to cobble/gravel deposits in the more exposed areas. This study was unable to resolve significant amounts of erosion on the tidal flat surface, but the geomorphological evidence is irrefutably indicative of an erosional landform.

Acknowledgements

This work was funded by the ArcticNet Network of Centres of Excellence, the C-Change International Community-University Research Alliance, and the Department of Geography at Memorial University of Newfoundland. Field work was supported by the Geological Survey of Canada (Natural Resources Canada) under the Climate Change Geoscience Program, based at the Atlantic Division of the Geological Survey of Canada (GSC-Atlantic) at the Bedford Institute of Oceanography. Additionally funding for field work was provided by the Northern Scientific Training Program, Aboriginal Affairs and Northern Development Canada (AANDC). The authors would like to acknowledge the help and support provided by the CNGO office in Iqaluit (in particular David Mate and Tommy Tremblay), by the Nunavut Research Institute (in particular Mary-Ellen Thomas, Rick Armstrong, Mosha Cote, Jamal Shirley, and Alex Flaherty), and by Michel Allard (lUniversit Laval) and Anne-Marie Leblanc (GSC-Northern) for their help in conducting fieldwork. Dominique St-Hilaire contributed to the tidal flat surveys in 2009. Alex Flaherty provided the rental vessel for marine surveying. We are grateful to Meagan Leach (Director of Engineering and Sustainability) and Robyn Campbell (Sustainability Coordinator) with the City of Iqaluit for their advice and support. Additionally, we would like to thank Dustin Whalen and Paul Fraser (GSC-Atlantic) for providing critical reviews of this manuscript.

Expedition Details

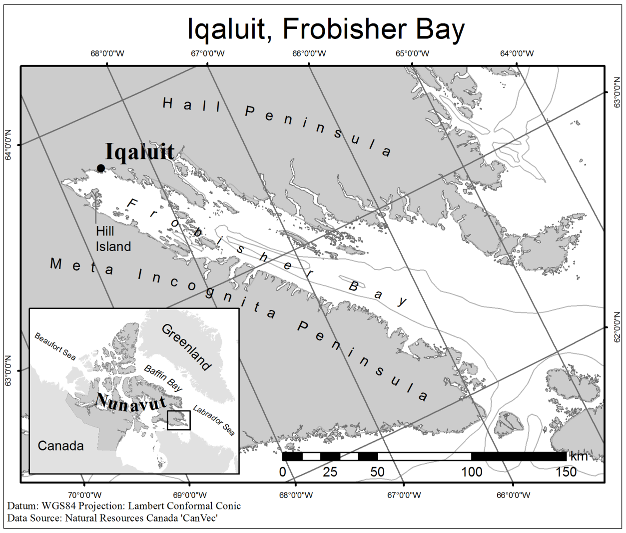
Dates	07/08/2009 - 09/08/2009 13/08/2010 - 26/08/2010 12/02/2011 - 16/02/2011 12/07/2011 - 05/08/2011 21/11/2011 - 28/11/2011
Area of Operations	Koojesse Inlet off the shores of Iqaluit, Nunavut
Operating from:	Iqaluit, NU.
GSC Personnel:	Donald Forbes (senior scientist) Gavin Manson (systems specialist) Scott Hatcher (MUN graduate student and NRCan volunteer)
Other personnel:	Dominique St-Hilaire (MUN graduate student, 2009 survey) Alex Flaherty (boat operator, 2011 survey)

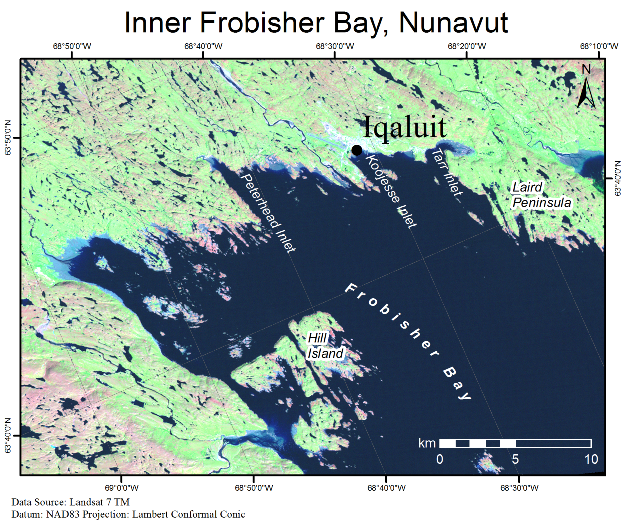
1 Introduction

This expedition report describes field operations in and around Koojesse Inlet during three field seasons in 2009 (2009306), 2010 (2010307), and 2011 (2011303 & 2011307). Koojesse Inlet sits on the northwest coast of Frobisher Bay on southern Baffin Island in Canada's Subarctic. It is macro-tidal with an 11.3 m spring tidal range. It spans 4 km at its mouth, and runs 4 km deep. It is located between Tarr Inlet and Laird Peninsula to the east and Peterhead Inlet the west.

1.1 Objectives

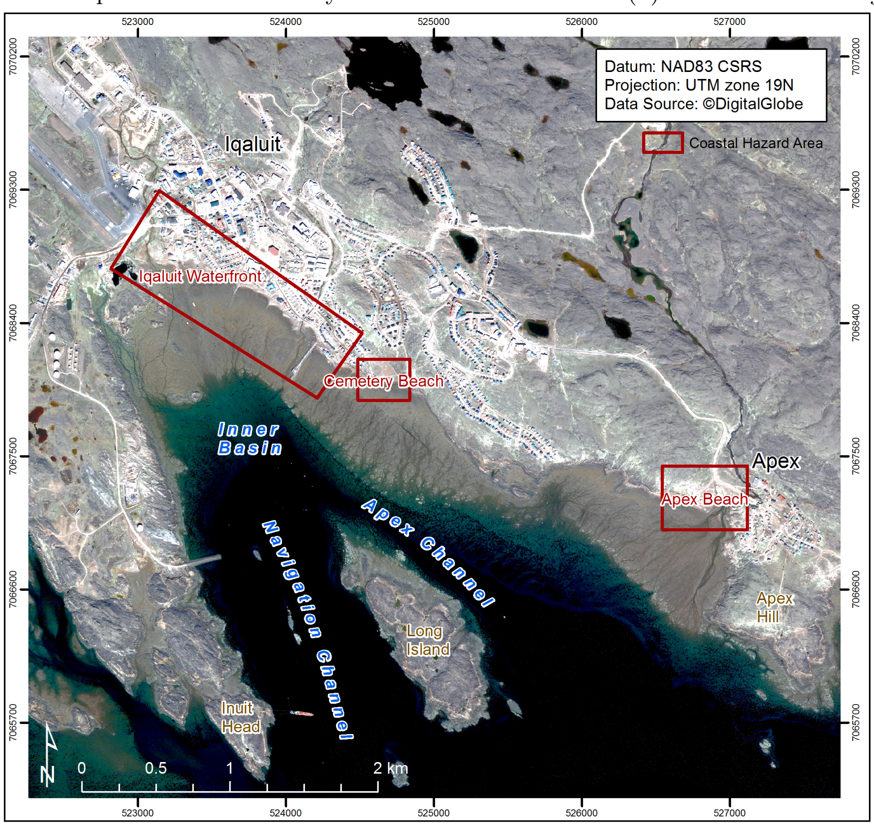
To collect evidence of erosional and depositional processes at work on and just beyond the extensive tidal flats in the bay, measure current and wave energy in the system, and map the offshore substrate and bedforms. The work was partially in support of Scott Hatcher's M.Sc. thesis aimed at understanding coastal hazards in the City of Iqaluit in the context of climate change. Lack of an adequate knowledge base necessitated the data acquisition described in this report in order to characterize the coastal environment and potential hazards to waterfront infrastructure in Nunavut's capital.





(a) Location of Iqaluit in Frobisher Bay

(b) Inner Frobisher Bay



(c) Overview of Koojesse Inlet, with Frobisher Bay to the south and the City of Iqaluit on the northern shore. The projection is NAD83 CSRS UTM zone 19.

Figure 1: Study area

2 Data Collected

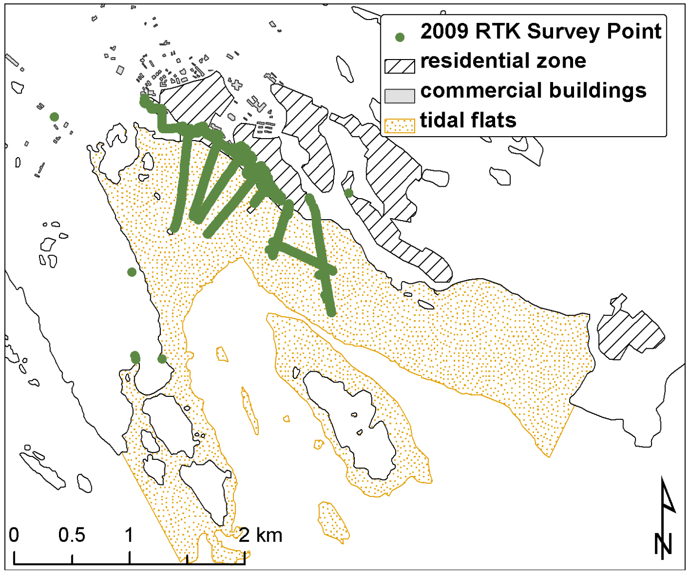
2.1 RTK Surveys

Real-time kinematic GPS surveys were conducted throughout the study area using an Ashtech Z-Extreme survey-grade receiver to collect high-precision coordinates at locations of interest in the bay (See Figure 3).

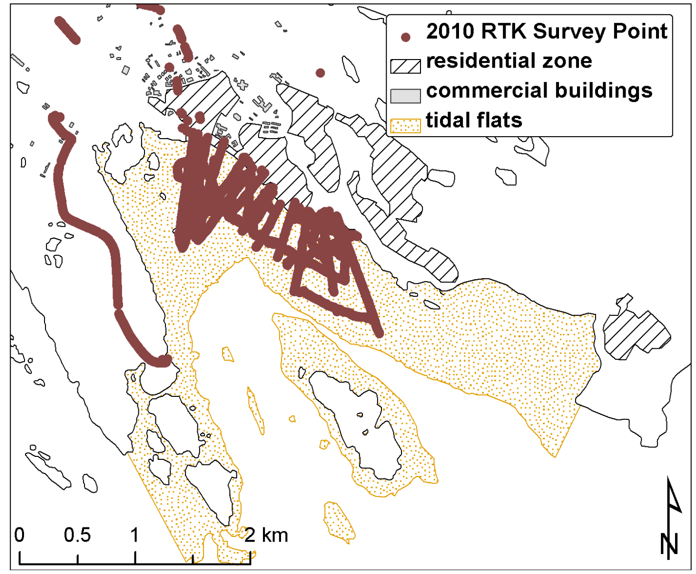
Survey control was provided by local Canadian Geodetic Survey monuments, and correction to tidal surfaces was done by surveying in the FB1968 CHS tidal benchmark. During both 2010 and 2011, benchmarks M009000 and CCM24 (Table 1) provided local control. A temporary benchmark (CAP) was established closer to the survey sites (Table 1), with check points on the east and west flukes of the anchor mounted at the Iqaluit cemetery (Table 1). All surveys were corrected to M009000, with listed horizontal and vertical root-mean-square errors averaging 0.013 m and 0.017 m respectively.

Table 1: Control positions used to correct RTK-GPS surveys in 2010 and 2011.

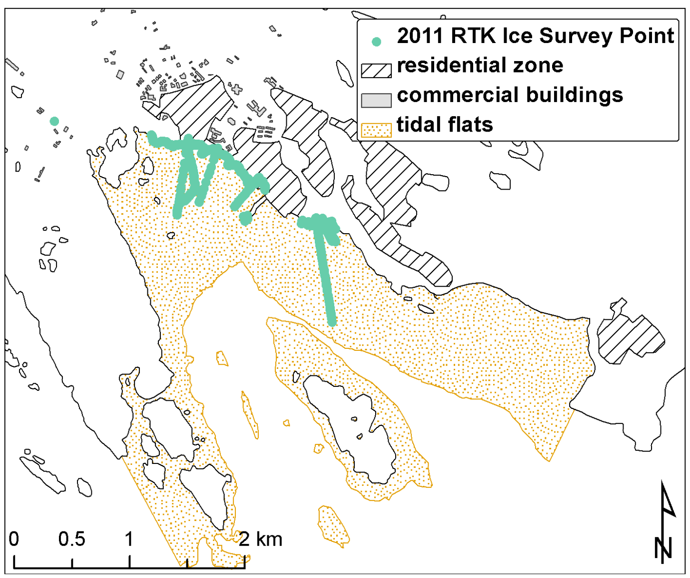
ID	Easting (m)	Northing (m)	Elevation (Ellipsoidal) (m)	Elevation (CGVD28) (m)
M009000	522372.23	7068886.14	22.34	32.51
CCM24	524629.62	7069268.50	118.23	128.40
CAP	524511.59	7068063.94	3.52	13.69



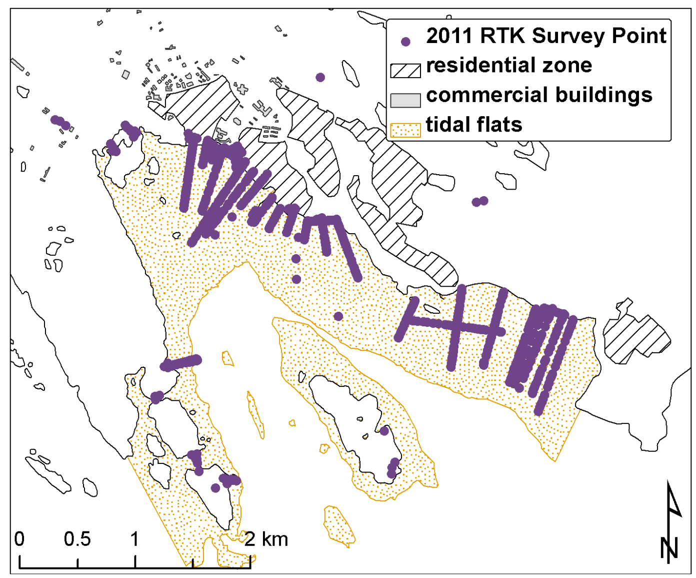
(a) 2009 RTK Field Surveys.



(b) 2010 RTK Field Surveys.



(c) 2011 RTK Field Surveys from February 2011.



(d) 2011 RTK Field Surveys from July/August 2011.

Figure 2: RTK-GPS survey points from 2009, 2010, and 2011 field seasons.

2.1.1 Tidal Flat Transects

Twenty shore-normal transects were surveyed along the flats, with two additional shore-parallel transects used to map shore-parallel sediment transport. The initial plan was to re-survey the transect lines drawn in the 2009 surveys conducted by Don Forbes and Dominic St-Hilaire. Once this was finished, further shore-normal transects were established in order to a) be re-surveyed in 2011, and b) provide a robust overview of shore-normal topography on the tidal flats in the absence of bathymetric information (see Appendix A). The transects were drawn approximately shore-normal using Quickbird satellite imagery of the area to create 'endpoints', which were then transferred to a handheld GPS for navigation during the kinematic GPS survey.

2.1.2 Tidal Flat Topography Kinematic Surveys

Kinematic surveys meant to 'fill in' topography on the flats in order to extend the DEM. These surveys used the RTK GPS system in kinematic mode sampling points every 1 m and running roughly transverse to the defined shore-normal transects.

2.1.3 Coastal Infrastructure

Surveys of foundation elevations of coastal infrastructure were conducted in order to provide information on inundation potential from sea-level rise and extreme water levels.

2.1.4 Ice surveys

In February of 2011, ice surveys were conducted on the winter sea ice. These included re-occupying three of the established shore-normal transects, as well as mapping the edge of the icefoot along Iqaluit beach (see "_ice" lines in Appendix A).

2.1.5 Other

- Water level elevations with time stamp to validate seabed instrumentation measurements of tide (using an RBR TWR 2050 recorder), as well as predicted water elevations.
- Recorded GPS points at high water debris lines on Long Island and around the sewage pond.
- Control point surveys used to establish local control, as well as tie the surveys into the CSRS network.
- Vegetation lines on the beach in order to measure shore-normal orientation.
- High water limit kinematic surveys to determine transect deviation from shore normal.

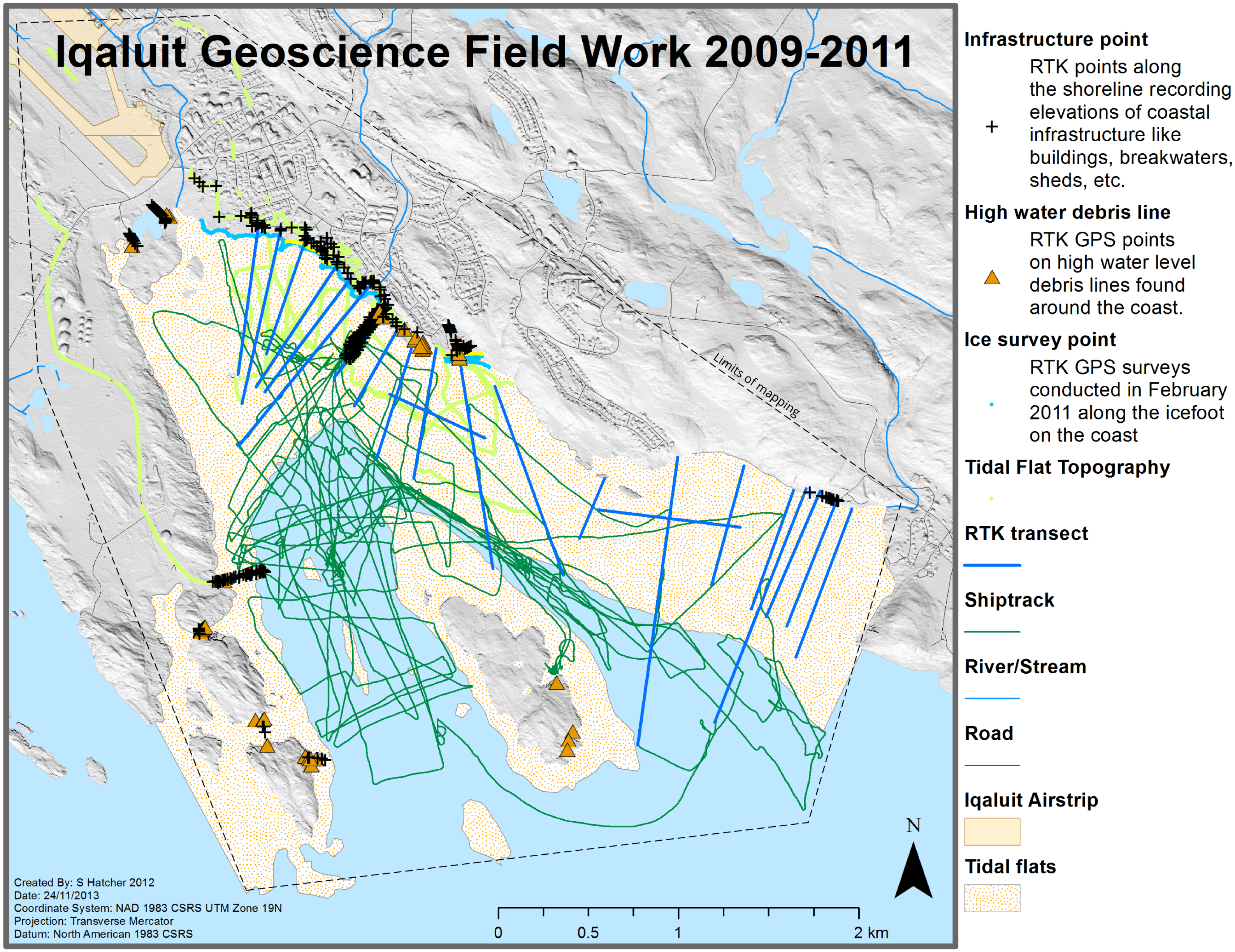
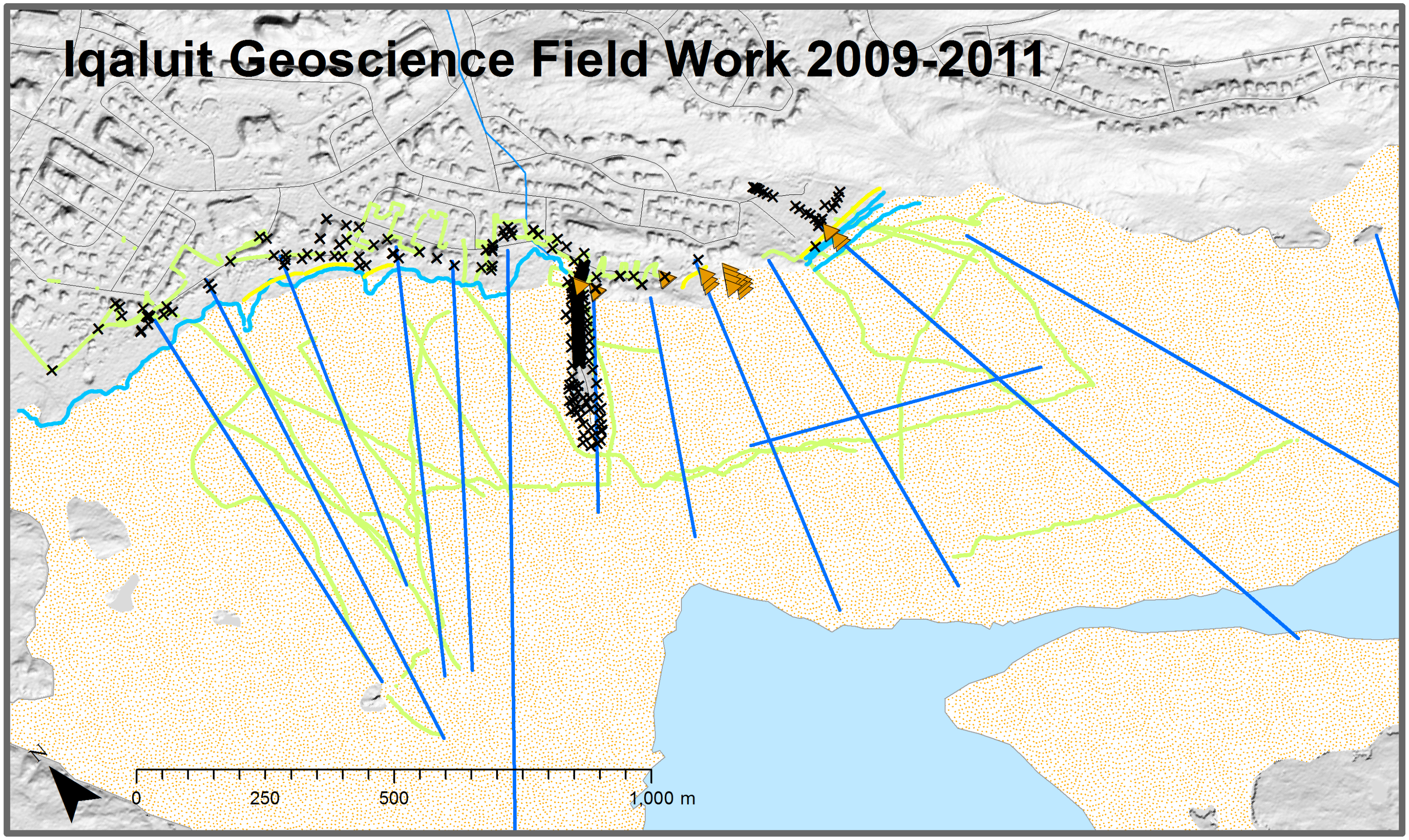


Figure 3: Map of surveys conducted during the 2009, 2010, and 2011 field seasons in Iqaluit, Nunavut.



Infrastructure point — + — RTK points along the shoreline recording elevations of coastal infrastructure like buildings, breakwaters, sheds, etc.

High water debris line — RTK GPS points on high water level debris lines found around the coast.

Ice survey point — RTK GPS surveys conducted in February 2011 along the icefoot on the coast

Tidal Flat Topography — Kinematic GPS survey points spaced 1 m apart.

RTK transect

Road

River/Stream

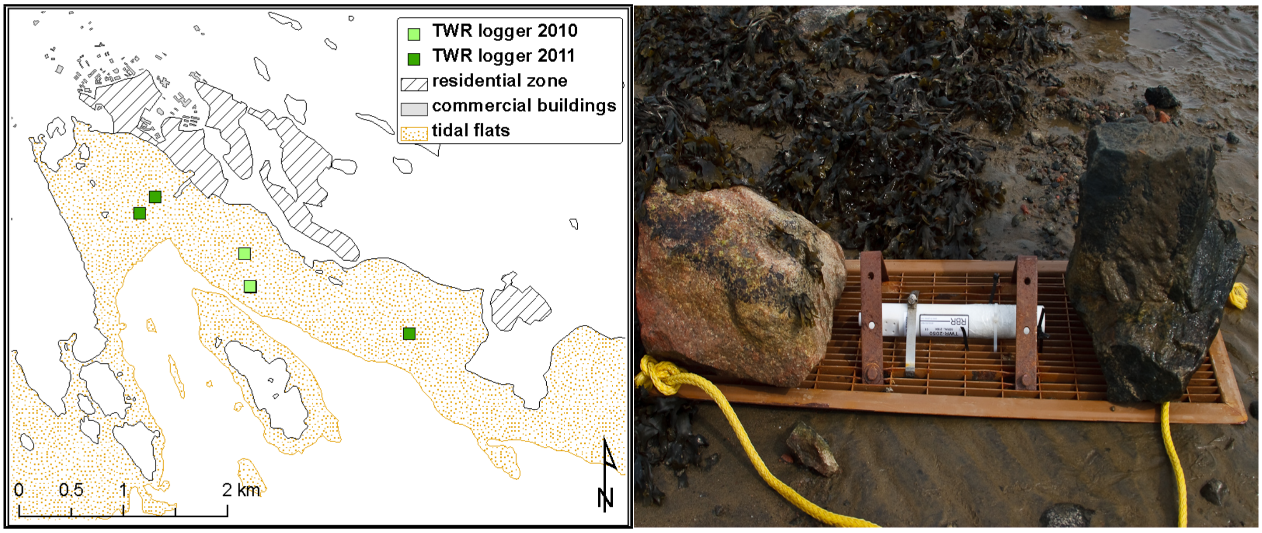
Tidal flats

Created By: S Hatcher 2012
Date: 24/11/2013
Coordinate System:
NAD 1983 CSRS UTM Zone 19N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

Figure 4: Map of surveys conducted along the Iqaluit shoreline during the 2009, 2010, and 2011 field seasons.

2.2 Seabed Instrumentation

RBR TWR-2050 pressure transducer tide and wave recorders were used to acquire water level and wave data in 2010 and 2011. There were six separate moorings, two in 2010 and four in 2011. These instruments have a published accuracy of 0.05% in the depth channel (± 5mm at 10 m depth) and ± 0.005 ℃ in the temperature channel (see Appendix B).



(a) Map showing location of tide and wave data loggers on the tidal flats in Koojesse Inlet.

(b) RBR moorings were made either from bolted strap ties, or from flooring grates.

Figure 5: RBR tide and wave recorders

2.2.1 Time Periods

Year	Period of Observation
2010	Aug 18 - Oct 19
2011	Jul 16 - Sep 18

Table 2: Schedule of RBR tide and wave recorder (TWR) deployments

2.2.2 Locations

In 2010, the TWR's were deployed on one surveyed transect line. They were placed on the flats at the farthest end of the transect (near Lower Low Water (LLW)) as well as approximately three-quarters of the way along the transect. This was done to allow comparison between the instruments in order to measure wave attenuation over the tidal flats. In 2011, the location of the deeper deployment from 2010 was used, as well as three new deployments. Two were used to mirror the study from 2010 (two points along a shore-normal transect), only on a line directly in front of the city (See Figure 5). The last deployment was off Apex, on the eastern part of the Koojesse Inlet flats.

2.2.3 Separation on 0 m depth points

The loggers were placed at roughly 2 m Chart Datum (CD) elevation on the flats to record waves over the flats. Because of this there was a period during low spring tides when the instruments were dry. All records were separated into 'wet' and 'dry' irregular time series in order to facilitate analysis.

2.2.4 Measured Parameters:

- Depth (m)
- Chart Datum water level through RTK GPS surveyed position
- Water temperature (℃)
- Air temperature on surface of flats after exposure (℃)
- Tidal slope (m/hr)
- Wave statistics
    - Average wave height (m)
    - Maximum wave height (m)
    - 1/10 wave height (m)
    - Significant wave height (m)
    - Wave energy (J/m^2)
    - Peak period (s)

2.3 ADCP Deployments

An acoustic doppler current profiler (ADCP) instrument was used to measure water velocity profiles at several locations. The first deployment (AD1) was set on the tidal flats near the low tide line. This was chosen to document current velocities on the flats, as a basis for estimating the potential for sediment entrainment by tidal currents.

AD 2 was deployed in the channel running between the Western side of Long island and Polaris reef. This is the deeper channel running into Koojesse inlet, and was a good place to measure the current velocities found in the deeper channel during a spring tidal cycle.

AD3 was deployed in the channel running between the tidal flats in between Apex and Iqaluit and Long Island's northern coast. This is a shallower channel, which was hypothesized to have a stronger current signature than AD2 due to constriction.

2.3.1 Time periods and locations

Deployment	Time Period
AD1	July 24 2011 11:40 - July 26 2011 13:28
AD2	July 26 2011 18:18 - July 29 2011 17:05
AD3	July 29 2011 17:25 - Aug 3 2011 15:40

Table 3: Schedule of Nortek Aquadopp Acoustic Doppler Current Profiler (ADCP) deployments

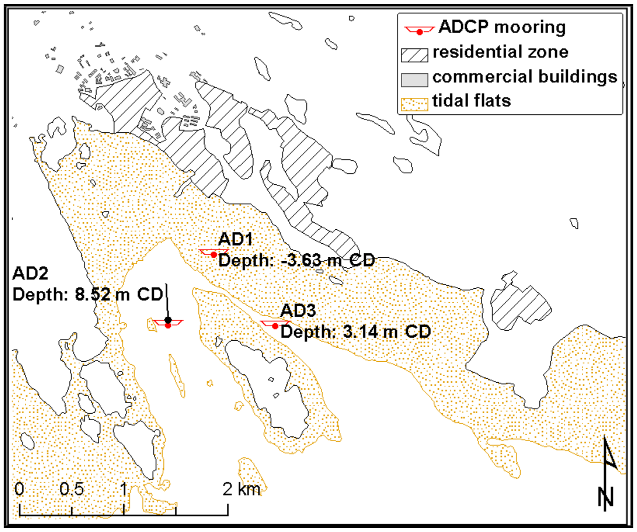


Figure 6: Map showing location of Acoustic Doppler Current Profilers (ADCP) on the tidal flats in Koojesse Inlet.

2.3.2 Separation on 0 m depth on AD1

AD1 was on the flats, and so was subject to periodic exposure. The record was split at these points of 0 depth to produce an irregular time series.

2.3.3 Measured Parameters

- Depth (m)
- Temperature (℃)
- Current velocity (m/s) and direction (up to surface in 50 cm cells)

2.4 Sediment Samples

Surface sampling consisted of trowel samples ranging in depth from 2–5 cm below the surface. Forty-six samples spread over tidal flats and upper beachface were taken. Marine grab sampling was done from in the offshore using an Ponar grab sampler, with penetration depths of 2–5 cm. Nine grab samples were taken from within Koojesse Inlet.

2.4.1 Surface Sediment Samples

46 samples spread over tidal flats and upper beachface. Depths ranging from 0–2 to 0-5 cm

2.4.2 Marine Grab Samples

9 grab samples from various locations within Koojesse Inlet. Depths of 0–4 cm

2.5 Boat Survey Logistics

The small vessel survey logistics were determined by the timing of the tides in Koojesse Inlet. The small 18 ft wooden freighter canoe (Figure 8b) was chosen as a survey vehicle with the macro-tides in mind. The “drying” of the tidal flats during spring low tides, however, made survey work

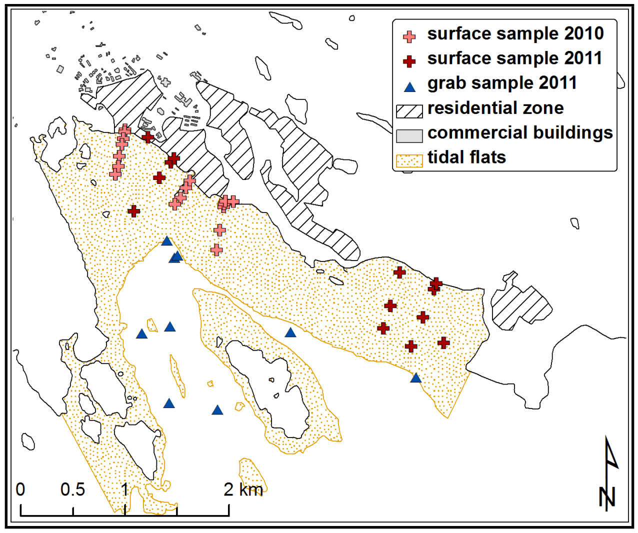


Figure 7: Map showing location of surface samples on the tidal flats in Koojesse Inlet and offshore grab samples in the bay.

impossible at these times. Therefore, boat-work was conducted at mid to high tide at whatever hours of the day that was. Because of this, as well as the multiple sensors being used for surveying, the mount had to be removable at the end of each working day.

The boat was set up to accommodate the sensor mount and three or four crew. The crew included Scott Hatcher, Gavin Mansion, Alex Flaherty, and occasionally one deckhand. The sensor mount was made-fast across the gunnels, and had a right angle steel pipe mount reaching down to ˜50 cm depth below surface (Figure 8a). This system provided a safe way to conduct shallow water surveys, but had inherent problems with systematic boat-motion induced noise. It also severely limited the travel speed of the boat while surveying was underway — a cost in ground covered for the benefit of shallow water capability.

2.6 Boat Survey Planning

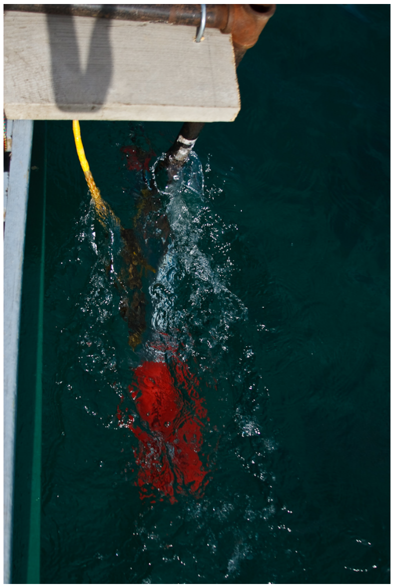
Navigation was provided by two basic map grade GPS receivers on-board. Survey route navigation was done using a handheld Garmin® GPS-Map 76. Uploaded waypoints from the projects GIS provided bearings for continuing coastal transects surveying, and collected waypoints established position information for instrument moorings and samples. An integrated GPS antenna and receiver in the Lowrance® single beam echosounder provided position information to the depth surveys. This echosounder was used as a live depth monitor as well as a depth data logger for all boat-work.

There were a number of goals for the ship surveys, which included:

1. Extending GPS transect lines over the tidal flat edge and into the deeper bathymetry of the harbour.

2. Providing preliminary single beam echosounding lines in a roughly spaced grid throughout the inlet.

3. Sampling seabed substrate in areas of interest to aid in the understanding of the morphology of the overall area.



(a) Sensor mount setup with the Sidescan Sonar

(b) View from the stern of the 18 ft wooden freighter canoe

Figure 8: Photographs showing the layout of the survey boat

4. Providing underwater video tows that would further show morphological differences in substrate make up within and around the inlet.

2.7 Sidescan Sonar

The sidescan survey system employed was an Imagenex dual frequency SportScan© digital sonar transducer array. The two transducers operate at 330/800 kHz with beam widths of 1.8°×60°(330 kHz) and 0.7°×30°(800 kHz). This results in relative range resolutions of 0.06 m (15 m “shallow” mode), 0.12 m (30 m “medium” mode), and 0.24 m (60 m “deep” mode). The system was hard-mounted to the boat by a fastened pole mounted arm running down the starboard gunnel, which put it at a depth of 0.5 m. This translates into a swath width of 160 m in 30 m depths, and 110 m in shallow coastal waters (like on the flats).

2.8 Strata Box Sub bottom profiler

The sub-bottom profiler used was a SyQwest StrataBox© low frequency sound profiler. The unit operates at 10 kHz, which provides a vertical resolution of 0.06 m with 40 m bottom penetration. It was mounted on the same arm as the sidescan system, and so was hard mounted at 0.5 m depth. Lines were run over the flats, as well as off the edge of the flats. Also, a line over the Apex flats was done for comparison, and another in the Apex channel toward Long Island. The abundance of boulders and outcrops of coarse material made it hard to resolve sub-bottom stratigraphy on the flats. The only place that gave data was over the “sealift” road; the road on the flats cleared annually to allow barge unloading at low tide.

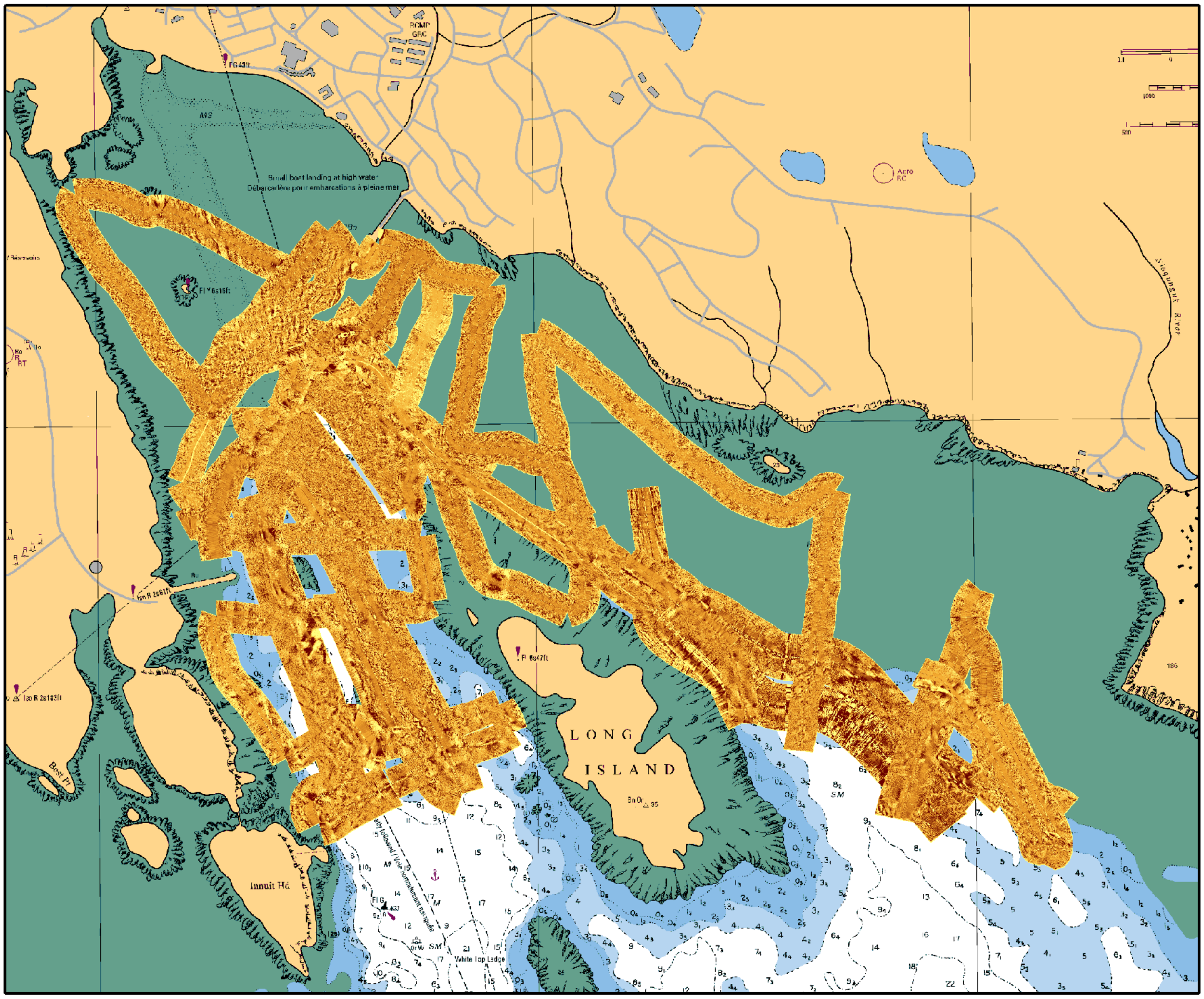


Figure 9: Sidescan sonograph mosaic within Koojesse Inlet.

2.9 Marine drop video camera

Transect file	Start time
DVR010101_0005_001.avi	July 26 2011 21:02 UTC
DVR010101_0022_001.avi	July 26 2011 21:18 UTC
DVR010104_1830_001.avi	July 30 2011 15:26 UTC
DVR010101_1906_001.avi	Aug 1 2011 16:03 UTC
DVR010106_2142_001.avi	Aug 1 2011 18:38 UTC
DVR010106_2226_001.avi	Aug 1 2011 19:22 UTC

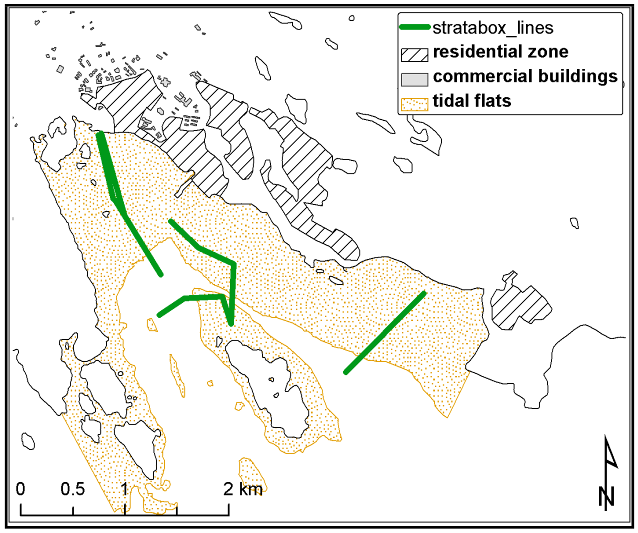


Figure 10: Map showing sub-bottom profile lines in Koojesse Inlet.

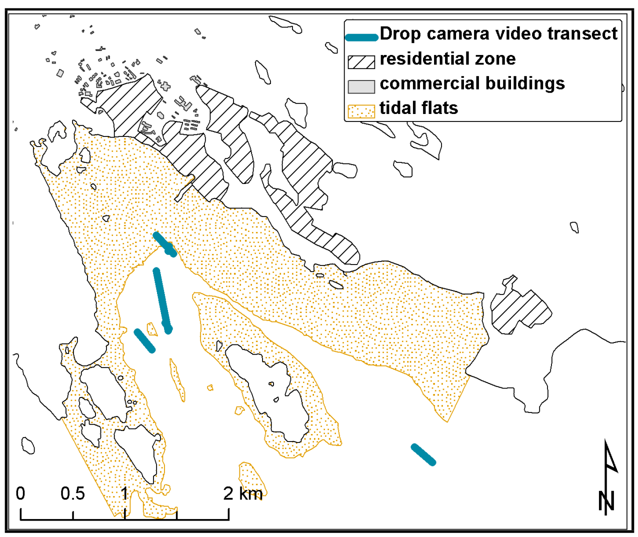


Figure 11: Map showing location of drop camera underwater video transects in Koojesse Inlet.

3 Scientific Summary

3.1 Study Area and Related Work

The study area is Koojesse Inlet, a small inlet located at the head of Frobisher Bay on the south-eastern end of Baffin Island in the Canadian subarctic. Koojesse borders the City of Iqaluit, the capital of the territory of Nunavut and home to 6,700 people (Statistics Canada 2012). The inlet is east of the Sylvia Grinnell River, between Tarr Inlet and Peterhead Inlet (See Figure 1ab). Surrounding bedrock is Precambrian gneiss with outcrops of Paleozoic sediments (Hodgson 2005).

Tidal flats are quite common on most of the coast in Frobisher Bay, due mainly to the large tides found in the bay. Semi-diurnal tides here have a spring range of 11.3 m and a neap range of 7.8 m (Dale *et al.* 2002) In Koojesse Inlet specifically, it appears that the flats were formed proglacially at the end of the last glaciation, the base layer deposited in brackish coastal waters at the edge of the "Iqaluit" river delta formed on a paleotributary of the Sylvia Grinnel River (Hodgson 2005, McCann *et al.* 1981, McCann and Dale 1986)

Field seasons conducted in 1981 and 1982 in and around Koojesse Inlet by McCann, Dale, and Hale from McMaster University established the current geomorphological understanding of the tidal flats near Iqaluit. Their work focused on sedimentary zonation and processes on the low-slope flats, as well as the process and dynamics of the break-up and freeze-up of the annual sea ice cover on the flats (McCann *et al.* 1981). Aerial surveys of these ice processes revealed their importance in both the transportation of sediment on the flats through rafting and entrainment, but also the importance of offshore drift ice in containing the fractured ice, and its entrained sediment, on the flats (McCann and Dale 1986). This cycling of sediment is an important part of the sediment budget on the flats, and is a key aspect in looking at how things might change in a different sea ice climate.

Measurement of boulder movement on the flats, along with a theoretical treatment in Drake and McCann (1982) of boulder movement, came out of studies on the Iqaluit tidal flats. In some cases boulders with a diameter of 0.5 m were moved more than 30 m over a single ice season (McCann and Dale 1986). The lack of a coherent boulder barricade on the Iqaluit tidal flats, as is found in other analogous environments (McCann *et al.* 1981), remains unclear. It appears, however, that given the extent of the Koojesse Inlet flats, small quasi-barricades have formed intermittently along the lower flats. Why they have not been connected over time by ice processes is unknown.

The process of sea ice freeze up and break up, as said earlier, formed a substantial aspect of previous work on the flats. The ice surveys conducted in 2010 and 2011, in conjunction with the summer time surveys, will be able to provide a better measurement of mean thicknesses found over the flats, as well as describe the motion of the ice over the flats with the daily tide floating and resting a large amount of ice.

3.2 Morphology of Koojesse Inlet

3.2.1 Tidal flat topography

Within Koojesse Inlet the tidal flats cover an area of 6.4 km ^{2} delineated shoreward by the lower beachface and seaward by the slope leading into the deeper channels of the inlet (Figure 12). The flats are characterized by a low slope gradient with extensive boulder cover and fine silt surface material with discontinuous exposures of sandy pebble gravel in the ebb tide channels. Tidal flat width varies considerably throughout the inlet, with the greatest widths on the eastern side (˜1100 m) and the smallest widths on the western side (˜150 m). Within the inlet, the flats run 4.6 km on the eastern side and 3.7 km on the western side. Two main channels flow offshore of the flats; a narrow shallower channel running between Long Island and the Apex trail running east of Iqaluit, and a deeper channel running between Long Island and Inuit Head named the Navigation channel, which is divided by a rock reef (Figure 12).

The inlet has two channels leading in and out. One leads between Long Island and the shoreline east of the city, and the others lead out between Long Island and Inuit head. The Apex channel is narrower and shallower than the Navigation channel (See Figure 12). The Apex channel has a minimum depth of 1 m CD, and on the western side of Long Island the Navigation channel has a minimum of 2.6 m CD east of the rock reef and 7.6 m CD west of the rock reef. The deeper part, however, appears to have been dredged in the past.

Given the high tidal range of the inlet, and the limited channels leading into it, there was an initial hypothesis that currents would be strong in the channels, and that the bottom would be current scoured. The findings from the ADCP's did not confirm this, instead showing current

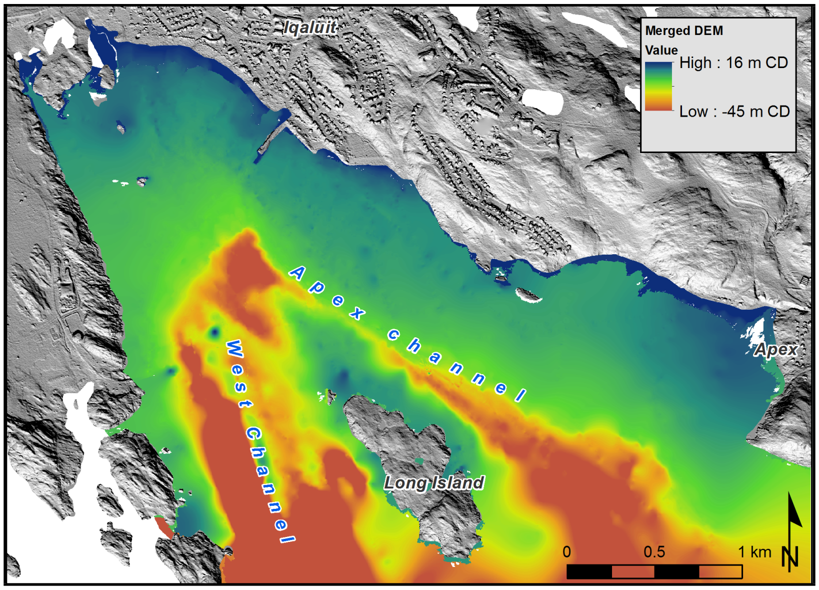


Figure 12: Digital elevation model for Koojesse Inlet constructed from RTK GPS points in the intertidal zone and single beam echo soundings in the offshore channels. A constrained spline interpolation was used to create the model from elevation points of differing densities throughout the region.

speeds no greater than 1 m/s at the surface, decreasing with depth. Because of this, the bottom substrate found within the inlet was of very fine silt composition with little evidence of sediment transport found in the drop-camera transects.

3.2.2 Surficial sediments

The surficial material found on the flats ranges from boulders to fine silty sediments. The sediments found in the surface veneer of the flats are a mixture of fine silty sand with coarser sand and pebble clasts intermixed within ebb tide channels and areas of ice scour and deposition (Leech 1998). Multiple studies of the sedimentology of the flats have shown no fining-landward trend (Leech 1998, McCann *et al.* 1981, Dale *et al.* 2002), a common characteristic of temperate tidal flats (Dionne 1992, Dionne and Poitras 1998). Boulders are plentiful on the flats, and are arranged in varying densities and groupings. They seem to be concentrated more on the eastern end of the flats, perhaps because of the typical circulation of ice during freezeup. There exist only discontinuous and faint boulder barricades on the outer flats at levels corresponding roughly to LLWLT, although they are far less defined than in other parts of the region (McCann *et al.* 1981).

The substrate materials found off the flats in the harbour channels vary widely as well. Drop camera transects have shown the existence of boulders similar to those found on the flats, although they were very rare and were found amongst angular clasts near the western breakwater and so likely a product of human construction. Elsewhere there exists very fine draped silt substrate which seems to be affected very little by the tidal currents found in the inlet. This description, however, holds only for the inner inlet. Off Apex, east of Long Island, the substrate was found to be an arrangement of cobbles with a silt matrix. These were found at roughly the same depths as the inner channel fine materials, and could be due to increased exposure to southerly swell or increased tidal current influence. Sidescan imagery indicates a similar seabed just west of the rock reef in the Navigation channel, but this could not be verified with the drop-camera.

The sidescan sonar imagery revealed significant iceberg scour marks at the mouth of the inlet on both sides of Long Island in about 30 - 40 m depth. Residents describe seeing icebergs at about that location, usually in mid summer.

Sub-bottom profiling carried out in this field study has corroborated previous interpretations of the tidal flats' origins. Previous studies have sampled the underlying dense clay sediments of the flats (McCann *et al.* 1981, Dale *et al.* 2002). These are interpreted to be of glacio-marine origin (Hodgson 2005), deposited during the last postglacial high stand roughly 6500 BP about 45 m above current sea level. Sub-bottom profiles collected in 2011 show draping of this sediment underlying the flats. Irregularities in this configuration could be due to boulder placement or underlying geology. The proliferation of boulders and cobble clasts on the substrate of the flats made it hard to collect meaningful sub-bottom data, and so this interpretation is based on only a single profile acquired over an area where boulders are annually cleared to allow barge unloading.

3.2.3 Backshore

Within Koojesse Inlet the backshore comprises bedrock outcrop and sandy beaches. Both the Iqaluit beach and the Apex beach are products of postglacial deltaic deposition (Hodgson 2005). Iqaluit is built primarily on this deltaic plain, terminated seaward by the poorly sorted modern sand beach. The beach is shorter and steeper at Apex than in Iqaluit, and is backed in part by rock cliffs.

3.3 Erosion

Simple differencing of repetitive yearly transects between 2009 and 2011 over the flats did not reveal any significant erosion or deposition, assuming a combined error estimate of ± 20 cm. Previous studies have shown that a significant amount of sediment is entrained by basal adfreezing to sea ice on the flats, but McCann and Dale (1986) described a process by which offshore ice contains the sediment laden pack ice during breakup. The net result is significant sediment recycling over the flats, and the interpretation that erosional depositional bedforms on the flats are largely a product of reworking by ice (in winter) and currents (in summer) during high tide. Historical aerial photos support this interpretation, showing little shoreline change, except in areas of human intervention. Observations, along with ADCP measurements of currents on the flats and scatterometer TSS profiles in the channels, show very little suspended sediment in the water column on both flood and ebb spring tides. No measurements were taken during high wind events, however, which could significantly alter the suspension load. Furthermore, the widespread presence of asymmetrical ripples over the flats at low tide attest to substantial bedload transport on the ebb.

3.4 Significant Findings

- Currents recorded during spring tidal cycles showed low velocities, and concentration of velocity in the top 2 m of the water column. Consequently, scatterometer profiles showed little suspended sediment in the channels due to tidal currents, with only local reworking in shallow water on the flats themselves.
- The seaward edge of the flats was found to correspond closely with the LLWLT water level, and thus represents the lower limit of subaerial tidal exposure.
- The substrate found off the tidal flats varies depending on depth and position in the inlet. More sheltered areas on the inner inlet show very fine draped silt material, with sporadic cobble.

- Sub-bottom profiles seemed to support the earlier interpretation of a glacio-marine origin of the sub-flat marine clay material, showing draped stratigraphy up to a depth of ~4 m.
- Transect differencing on the flats showed no resolvable erosion during the three year study period. Nevertheless, small-scale bedforms attest to significant bedload sediment transport seaward as the flats drain on the ebb tide.

4 Summary of Operations

* Note: Acronyms used in the summary of operations. SS (Sidescan Sonar), ES (Single Beam sounding), SV (drop-camera video), RBR (tide and wave recorder), S (start time of station), E (end time of station.

2009

Expedition BIO 2009306

Day **219** (Aug 7 2009)

- Commercial flight Pond Inlet - Iqaluit. Some bags including GPS rover antenna rod left behind.
- Iqaluit - improvised 2x2 pole, $h_v = 1.839$ m
- RTK Survey - profiles on tidal flats.
- Set up on CBN, h_a 0.091 m, M009000
- CSRS coords: (entered in BASE setup) 19N N 7068886.14 m, E 522372.23 m, ellipsoidal elevation 22.34 m, 63°44' 48.7025" N 68°32' 48.1112" W, geoid sep (HTv2.0) -10.166 m.
- PPP coords: N 7068886.146 m (±0.002 m), E 522372.269 m (±0.009 m), ellips elevation 22.498 m (±0.009 m), 63°44' 48.7025" N 68°32' 48.1082" W.
- Phase centre offsets for Magellan antennas: MAG111406 78.3 - 68.5 (relative), MAG990596 101.8 - 86.2 (relative).

Day **221** (Aug 9 2010)

- Autonomous setup on ridge behind house 2408.
- PPP position: N 7068226.054 m (±0.003 m), E 524925.973 m (±0.006 m), Zone 19N, ellips elevation 54.283 m (±0.007 m), CGVD28 64.314 m, 63°44' 26.7585" N, 68°29' 42.2231" W.
- 68T9000 = 1968-FIB (CHS)
- CSRS coords (NAD83 CSRS): 63°43' 40.6192" N, 68°31' 41.2418" W, h_E = -4.73 ±0.007 m, geoid sep = -10.180 m, N 7066785.485 m, E 523304.519 m.

2010

Expedition BIO 2010307

Day **230** (Aug 18 2010)

- Set up base on M009000 Pillar (near EC climate station).
- Surveyed tidal bm 'FB-1968' (20:23).
- Kinematic survey on road leading out to the dump in order to validate DEM in this area.
- Tagged temporary bm near M009000 (bm_7966) at 21:38

Day **231** (Aug 19 2010)

- Iqaluit Control:
- CORRECT CAP COORDINATES
- 524511.5914 E 7068063.9359 N 3.524 Z (WGS84 Ellips)
- ptnum 232–236, kinetic on waterline off by 0.25 m due to ant. height error.
- Set up base (CAP)
- Got TR-6 (tn11) and TR-5 (tn9) from 2009 surveys (going from deep to shallow).
- Did deep part of tr-6 (tn11) then whole of tr-5 (tn9) then back to finish tr-6 (tn11).
- Points along small breakwater.
- Kinematic waterline survey
- Wander around cemetery with GPS gear

Day **232** (Aug 20 2010)

- Set up BASE at CAP (near cemetery). Corrected to known points from Aug 19 survey.
- Surveyed spot elevations at base of main breakwater, then followed outline of breakwater road.
- Took 4 surface sediment samples along the east side of the main breakwater.
- Due to timing, we surveyed the outer sections of tn6, tn4, tn3, and tn1. In between lines we ran kinematic topo.
- Later in the day we returned and surveyed the inner parts of tn6, tn4, tn3, and tn1. There was a gap in the middle of the lines that needed to be filled.
- Surveyed culvert elevations near 2nd pumping station.

Day **233** (Aug 21 2010)

- Set up BASE on CAP using corrected coords from Aug 19.
- Surveyed Geophysics line with sampling along the line (smpl 5–11).
- Ran midpoints of tn1, followed by extending tn1 on the outer end.
- Ran midpoints of tn3, tn4, and tn6.
- Ran tn10 off cemetery, with samples 12–16.
- Took sample 17 on cemetery beach (14:16)
- Ran inner points of tn7 and tn8.
- Got foundation heights (RTK) on Fisheries building and the Museum.

Day **234** (Aug 22 2010)

- Set up BASE at CAP using Aug 19 survey.
- Took photos of sample sites (smpl 1–17)
- Finished tn7 and tn8
- Surveyed identified features from the Quickbird imagery
- Surveyed Coast Guard Station fence line, as well as pumping station 1.
- Surveyed water line
- Tagged cemetery anchor fluke for control.

Day **235** (Aug 23 2010)

- Set up BASE at pillar M009000
- Topo survey on the airstrip curtain.
- Surveyed tn2 and tn5
- Surveyed shallow RBR (12540) position.
- Tagged CAP and cemetery anchor fluke for survey control.

Day **236** (Aug 24 2010)

- Downloaded RBR's (12539, 12540)
- Ran tn12 and end of tn10.

2011

Expedition BIO 2011303

Day **43** (Feb 13 2011)

- Set up BASE at autonomous point on cemetery beach (to be post-processed).
- Surveyed tn11 on top of the ice.

- Ran shore-parallel surveys of a) icefoot hinge line, b) upper extent of chunk ice line, and c) the uppermost water level line (slush line).
- Surveyed small portions of tn10 and tn12.
- Captured two shore-normal linear features in the ice.
- Sunny, 5 knot SE wind, -28 °C.

Day **44** (Feb 14 2011)

- Set up base at temp rock on the end of the main breakwater. Provided control by tagging pillar M009000, then surveying the cemetery anchor fluke and the base station from feb 13 2011.
- Surveyed ice pile up on the western side of the end of the main breakwater.
- Surveyed ice sitting above tn6, tn3, and tn1.
- Topo kinematic on top of ice near tn1.
- Surveyed the pile-up line running the entire length of the city shoreline.

Day **196** (July 16 2011)

- Deployed RBR's (21504, 21503). 21503: WP004, 18:00, 21504: WP005, 18:55

Day **197** (July 17 2011)

- Set up BASE over pillar M009000.
- Tagged bm_7966 near pillar.
- Surveyed in RBR 21504 and 21503 elevations.
- Spot elevations on the corners of the end of the main breakwater.
- Surveyed tidal benchmark FB_1968.
- Established second temporary benchmark (CAP2) near cemetery.
- Surveyed in CCM24 on top of the hill for control.
- Tagged bm_7966 again.

Day **199** (July 19 2011)

- Set up base on CCM29 on top of the hill by the francophone school. BASE point was autonomous with tie in at M009000.
- Tagged M009000
- Ran Apex transects tn13, tn14, tn16, tn18, tn19, and tn20.

Day **200** (July 20 2011)

- Set up BASE on CCM29 on top of the hill. Used horizontal coordinates from July 19 survey, and vertical coordinates from CSRS database.
- Ran tn22 (shore-parallel).
- Ran tn15, took samples 003–006
- Ran tn17, took samples 007–011
- Surveyed base heights of the monument sitting on the beach.
- Tagged bm_7966 for control.

Day **201** (July 21 2011)

- Set up BASE on M009000
- Tied in to bm_7966

- Collected infrastructure elevations along shore: Navaid base, seacans, seashacks, manhole near pumping station.
- Surveyed tn1
- Surveyed tn3, took smpl 0012
- Collected infrastructure: seacans, courthous, and water booster station.
- Small temp transect off eastern side of minor breakwater.
- Ran tn4
- Ran tn5 with smpl 013–016
- Surveyed sewage pond containment causeway elevations and storm debris lines near causeways.

Day **202** (July 22 2011)

- Deployed two additional RBR's (21560, 21561). 21560: off Apex, 21561: off Breakwater, deployed 22:13.

Day **203** (July 23 2011)

- Set up BASE on CCM29.
- Captured smpl003 site, as well as the two RBR locations from July 22.
- Tied in to bm_7966, as well as M009000.

Day **204** (July 24 2011)

- Set up BASE at CAP2 near cemetery.
- Deployed AD1 on tidal flats off cemetery.
- Tied in to cemetery anchor fluke, and M009000.

Day **205** (July 25 2011)

- Set up BASE at M009000
- Tied in to bm_7966
- Captured elevation on pumping station 2
- Ran inner part of tn2
- ran inner part of temp line 2
- Ran two kinematic surveys along the seaweed line on the beachface in front of the city in order to orient transect distance to shore-normal.
- Ran inner part of tn6
- Tied in to bm_7966

Day **206** (July 26 2011)

- Boat work
- Lowrance transducer depth: 0.3 m
- AD2 deployed 18:18, 14m dut. WP: 'AD2 actual'
- SV1 - S:21:10, 14–16 m dut.
- SV2 - E:21:17.
- Grab sample. 16 m dut. WP: 'wp0022'
- ES lines running off main breakwater towards causeway. Then causeway to long island, then on to Inuit head.
- ES lines across tn from cemetery to Long island.

Day **207** (July 27 2011)

- Boat work
- ES + SS line across flats at ln1 - 230 deg true bearing.
- CTD 0024 - S:20:20, E:20:23 FAILED
- CTD 0025 - S:20:38, E:20:41. FAILED
- Grab sample 20:45. WP: "G0026". 19 m dut.
- ES line on 270 deg bearing. S:21:02.
- ES line on 90 deg bearing. S:21:10.
- ES line on 240 deg bearing. S:21:15.

Day **208** (July 28 2011)

- Sidescan and Echosounder line to fill in hole of flats.
- Line 1 at 310 deg True, 1435h.

Day **209** (July 29 2011)

- Echosounder and Sidescan lines on 3 cross channel transects, then 3 parrallel to channel
- CTD cast at AD2, stn 0027. S:15:05:13 E:15:06:19
- AD3 deployed off Apex. S:17:25. E:15:40 Aug 3 2011
- CTD cast off AD3 stn 0029, S:17:27:40, E:17:28:05, 4.6 m depth.
- CTD cast off AD3 stn 0030, S:17:30:30, E:17:31:20

Day **210** (July 30 2011)

- Launched from breakwater on a falling spring tide. Went to AD3 site to do a drop camera and make sure it was sitting upright.
- Grab sample 0031 off AD3
- Grab sample 0032 at WP"HOLE"
- CTD cast WP"HOLE" stn0033, S:15:36, E:15:36:30
- Ran Stratabox lines parrallel with ln10 then ln5 onto the flats. (Echosounder as well)
- Stratabox lines up both channels East of Long Island.
- Called it a day due to poor weather.

Day **211** (July 31 2011)

- Set up Basestation on CAP2 near cemetary. Used coords from July 19th survey.
- Tied in to cemetary anchor fluke.
- Surveyed: ln13, ln6, ln8, beach kinematic on pocket beach near cemetary, beach kinematic on cemetary beach.
- Tied into to cemetary anchor fluke

Day **212** (Aug 1 2011)

- Sidescan and Echosounder for ln4-ln6
- Echosounder deployed at 13:30
- reboot, new file: 15:04
- Drop camera stn0035 off Apex.
- CTD stn0036
- Grab sample stn0037
- CTD cast in inner stn0038

- Grab sample 0039
- CTD cast off west channel stn0040
- Drop camera through West channel stn0041
- Grab sample West channel stn0042
- CTD cast West channel stn0043, S:19:00:30, E:19:01:30, 16 m depth
- Grab sample stn0044
- Drop camera stn0045 off edge of flats near ln9

Day **213** (Aug 2 2011)

- CTD cast in WP"HOLE" stn0046, 15 m depth, rising spring tide.
- CTD cast off Inuit head stn0047 & stn0048, 35 m depth.
- CTD cast stn0049, further north in channel than stn0048, shallower water.
- Set up basestation at M009000, surveyed out Inuit Head, control on BM7966.

Expedition BIO 2011307

Day **325** (Nov 22 2011)

- Survey RBR's for recovery
- Rod height = 1.219 m
- Recovered RBR 21561 "rbrapex"
- GPS session 1001 static, S:15:07, E:15:14
- RBR recording in EDT?
- Recovered RBR 21560 "rbrnew2"
- session 1002 static, S:16:03:30, E:16:15
- GPS session 9000 at M009000, S:17:08, E:17:14

Day **326** (Nov 23 2011)

- 15:00 - walked out over ice to recover RBR 21504 "rbrdeep" off of cemetary
- E:15:35 - recovered RBR21504 from an ice cover ~3 cm thick.
- GPS session 2001
- 16:00 - Went out off west side of breakwater to recover RBR 21503 "rbrnew".
- Thick ice chunks inshore with thin (~5cm) veneer of floating puck ice on the windward side of the breakwater.
- Once past this line there was very little ice, only frozen veneer over sediment and boulders.
- 16:20 - recovered RBR21503
- GPS session 2002
- 18:15 - GPS session on pillar M009000 (site: 9000)
- 19:50 - Static survey on beach near monument (Apex).
- GPS session 2003, SW corner of monument.

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Appendices

Appendix A RTK-GPS data

Shown here are graphs of all the RTK-GPS coastal transect data plotted with elevation on the vertical axis and distance cross-shore in the horizontal axis. The legend shows the year the surveyed line was collected, with additions showing “ext” (boat mounted single beam sonar extension of the line) and “ice” (on-ice survey directly over transect line during the February 2011 field visit). Figure 2 shows the location of transect surveys by year. Figure 13 shows the numbering system used to name transects. Figure 3 shows locations of supplementary surveys. All orthometric heights are corrected to CGVD28 m (approximate mean sea level).

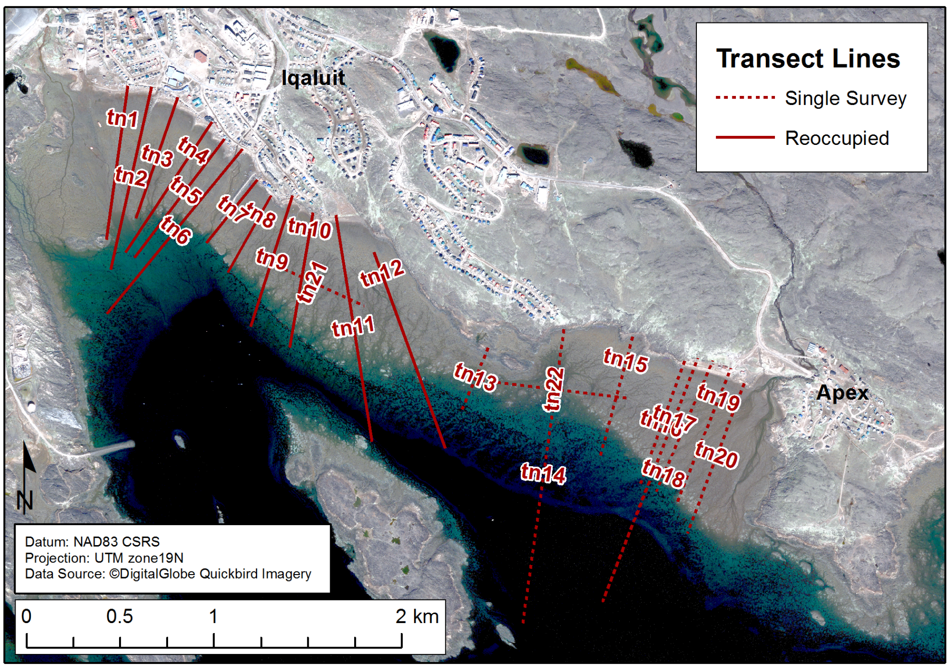
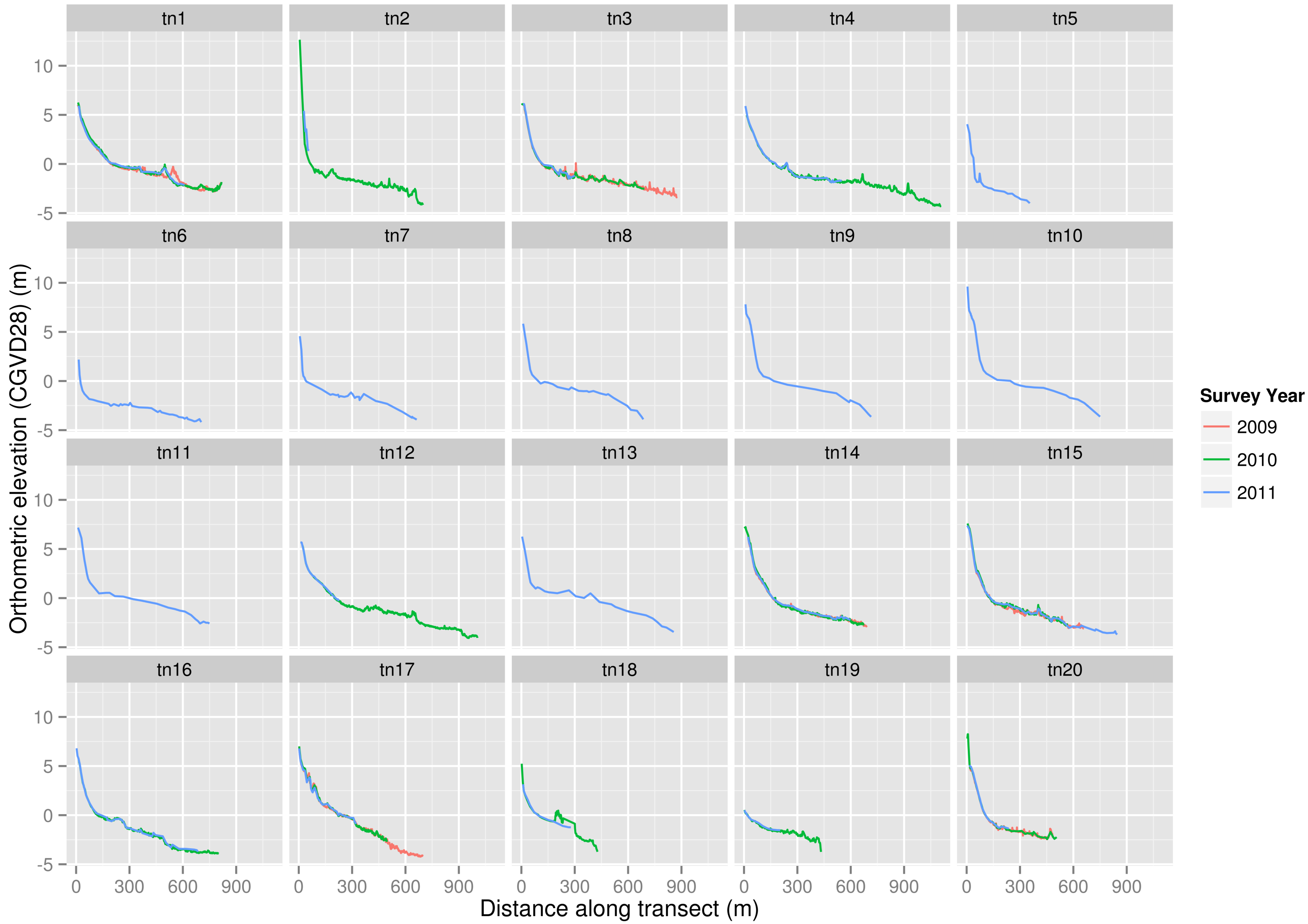
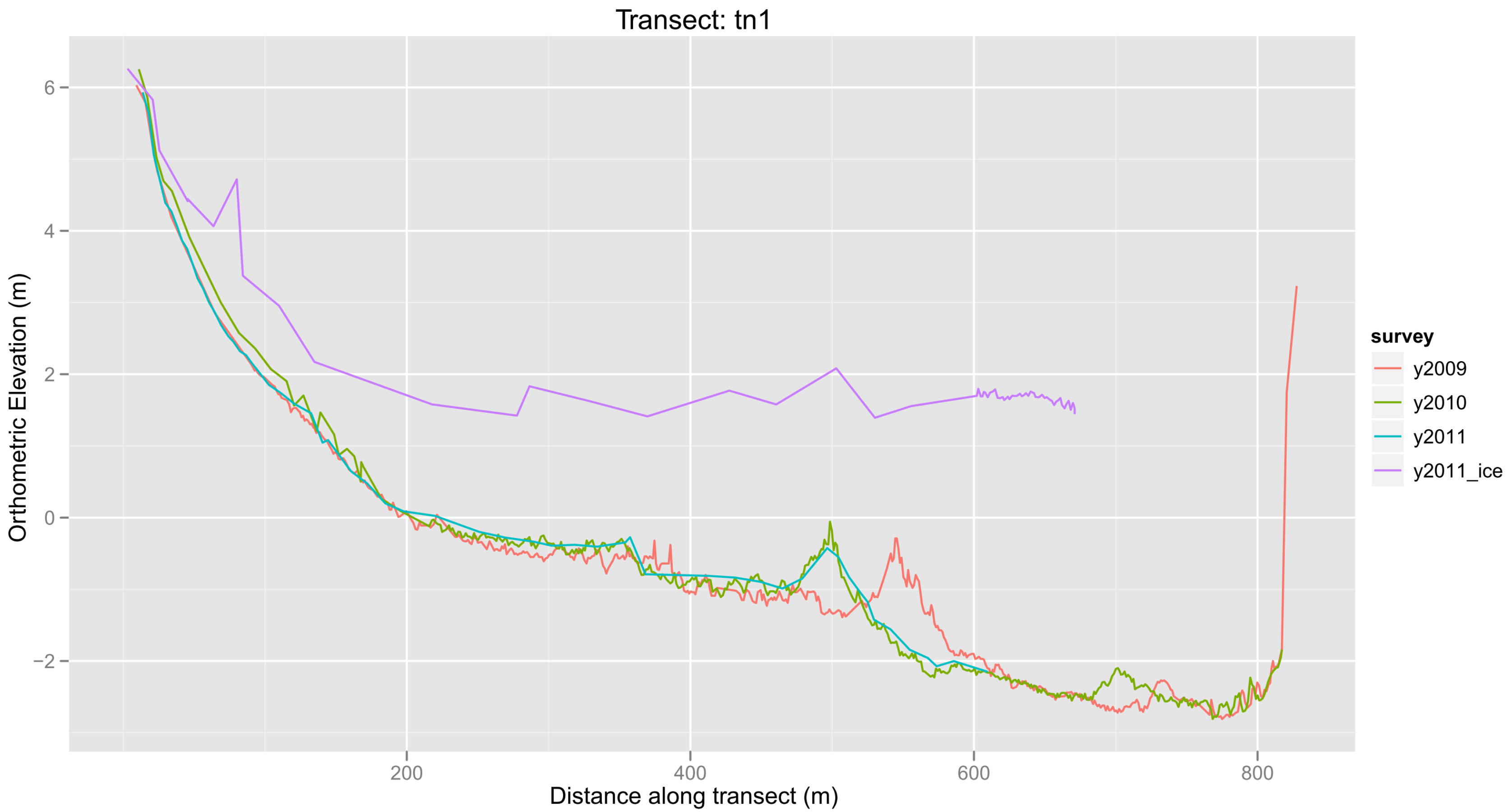


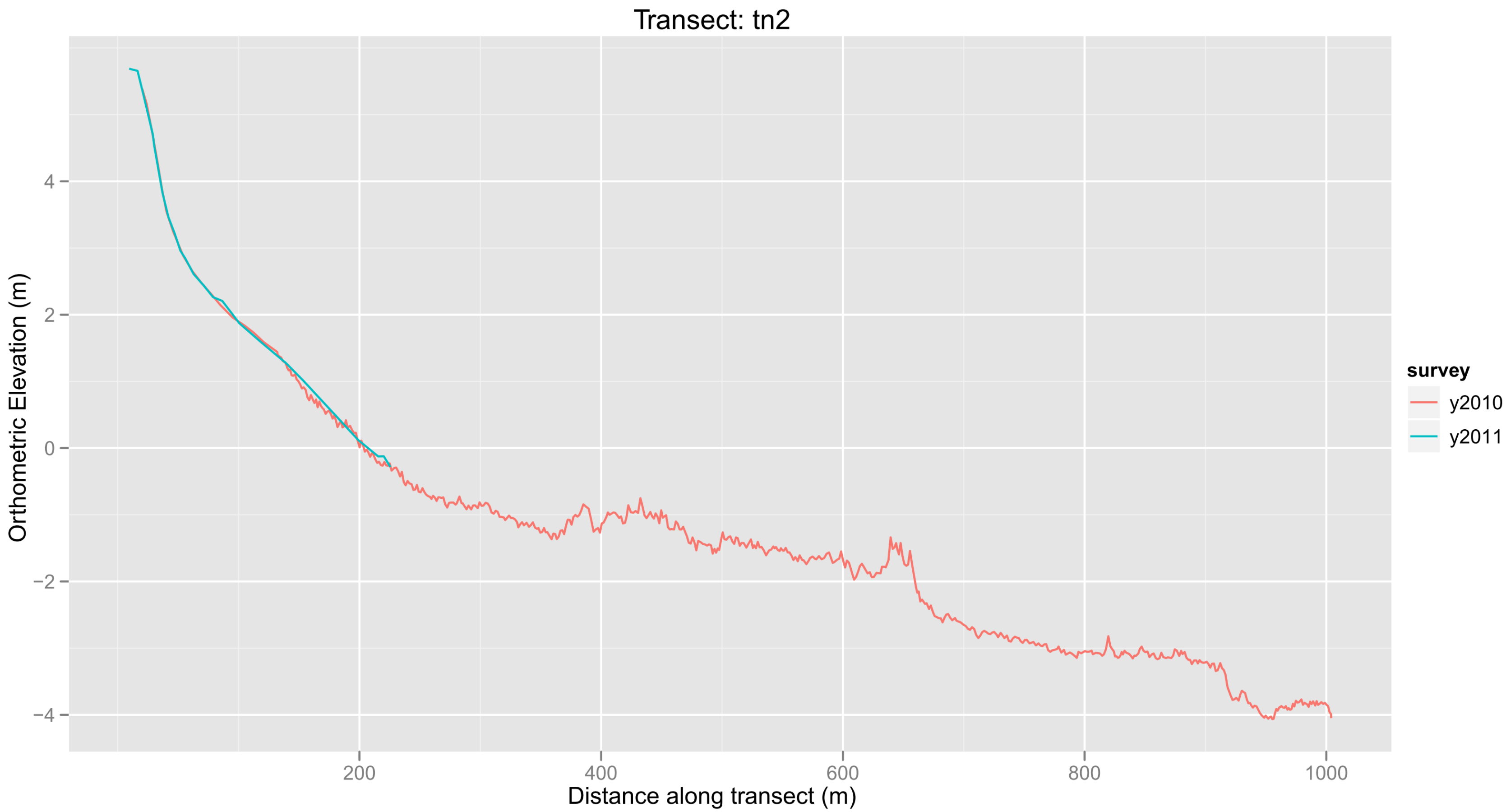
Figure 13: Location and numbering system for all collected transects presented in the appendix

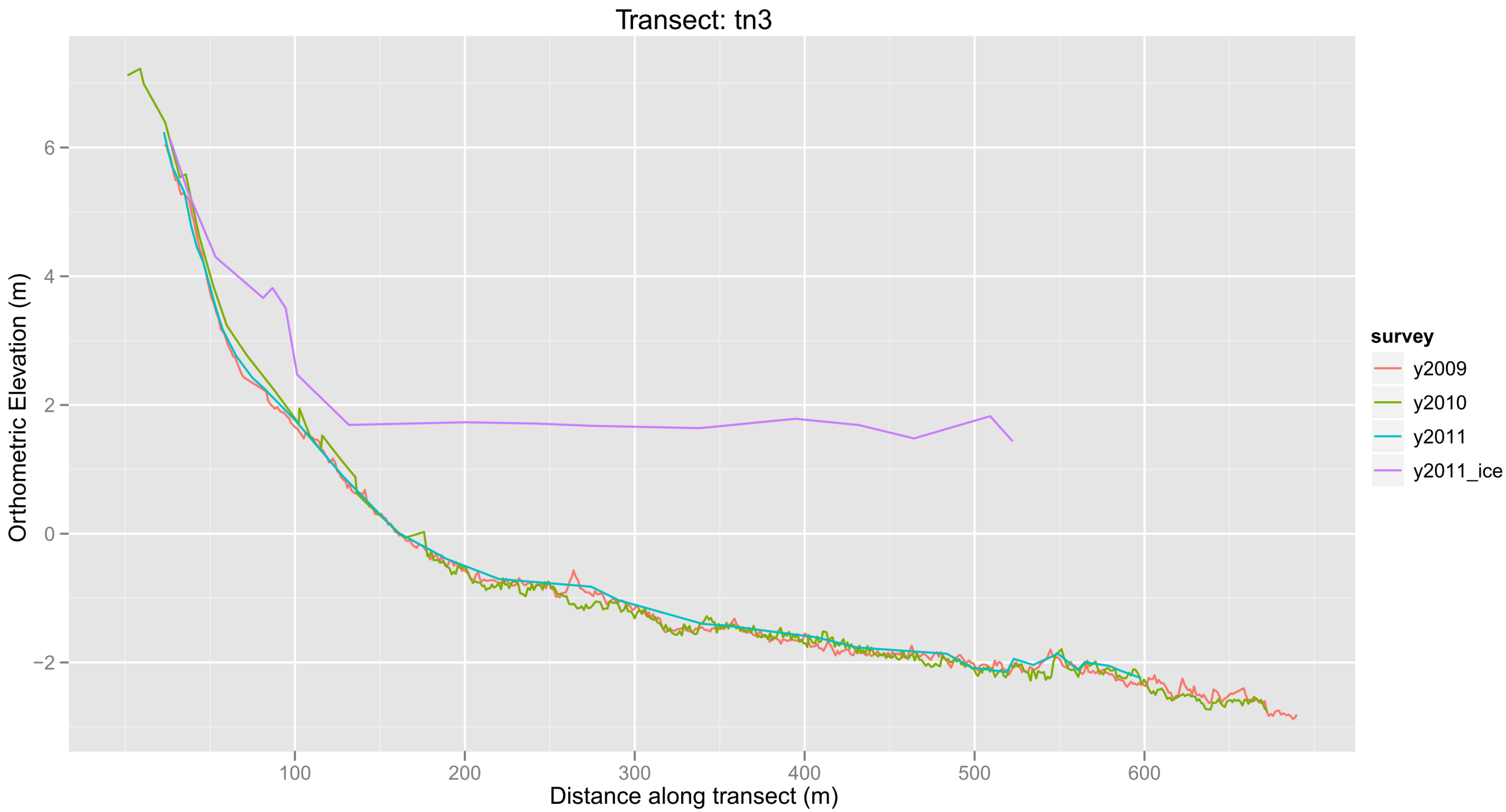


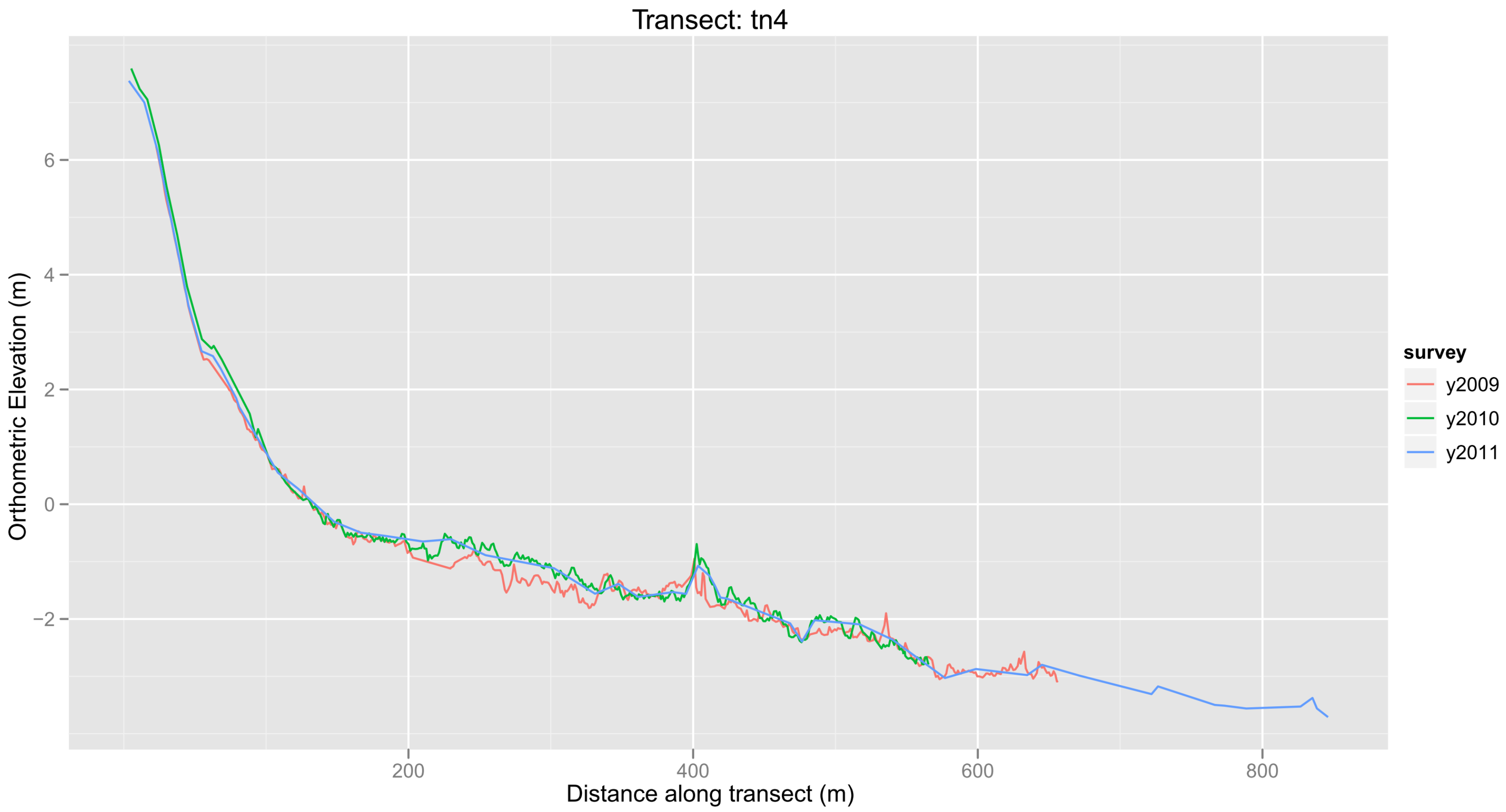
tn1
tn2
tn3
tn4
tn5
tn6
tn7
tn8
tn9
tn10
tn11
tn12
tn13
tn14
tn15
tn16
tn17
tn18
tn19
tn20
Orthometric elevation (CGVD28) (m)
10
5
0
-5
0
300
600
900
Distance along transect (m)
Survey Year
2009
2010
2011

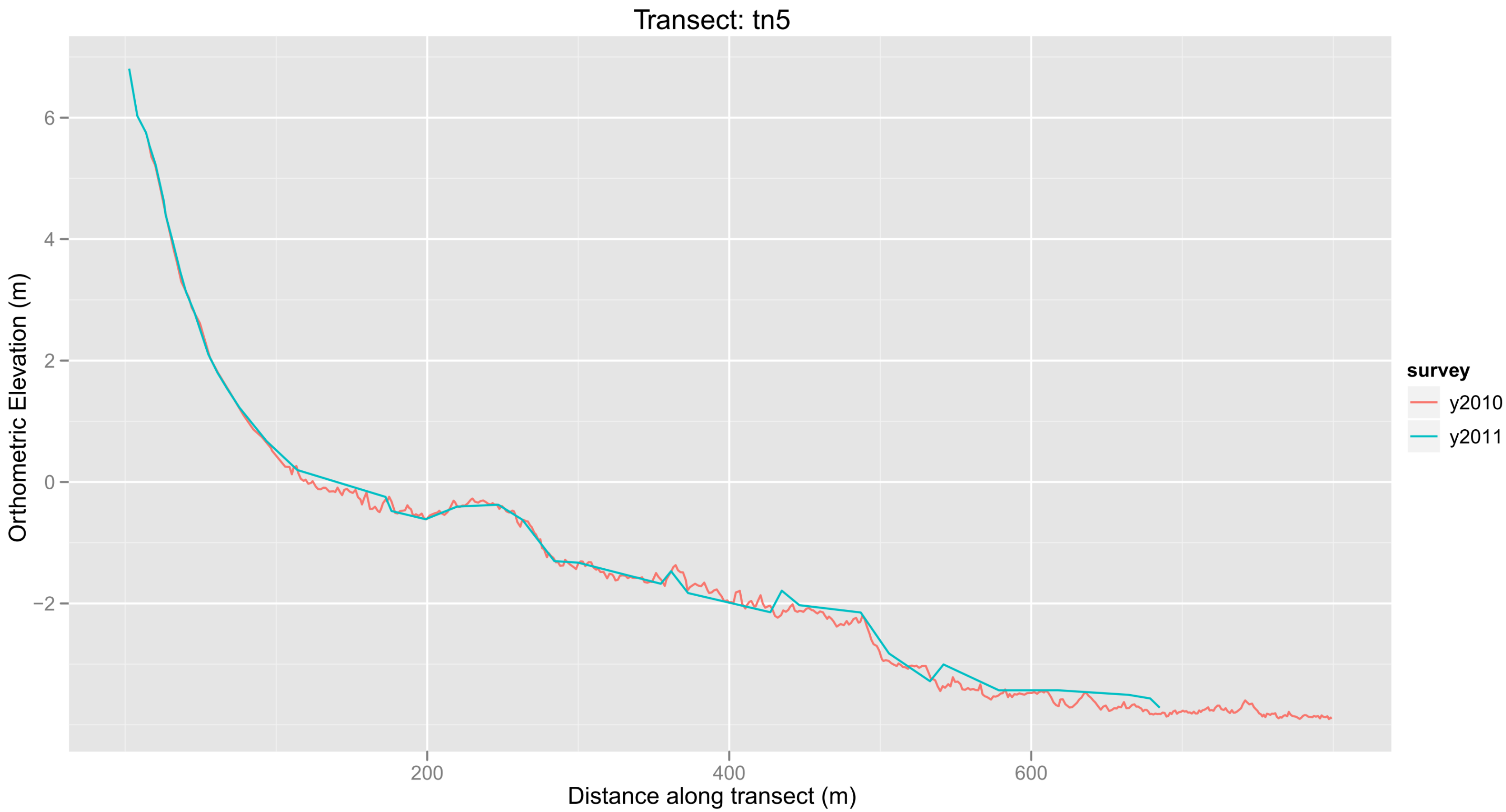


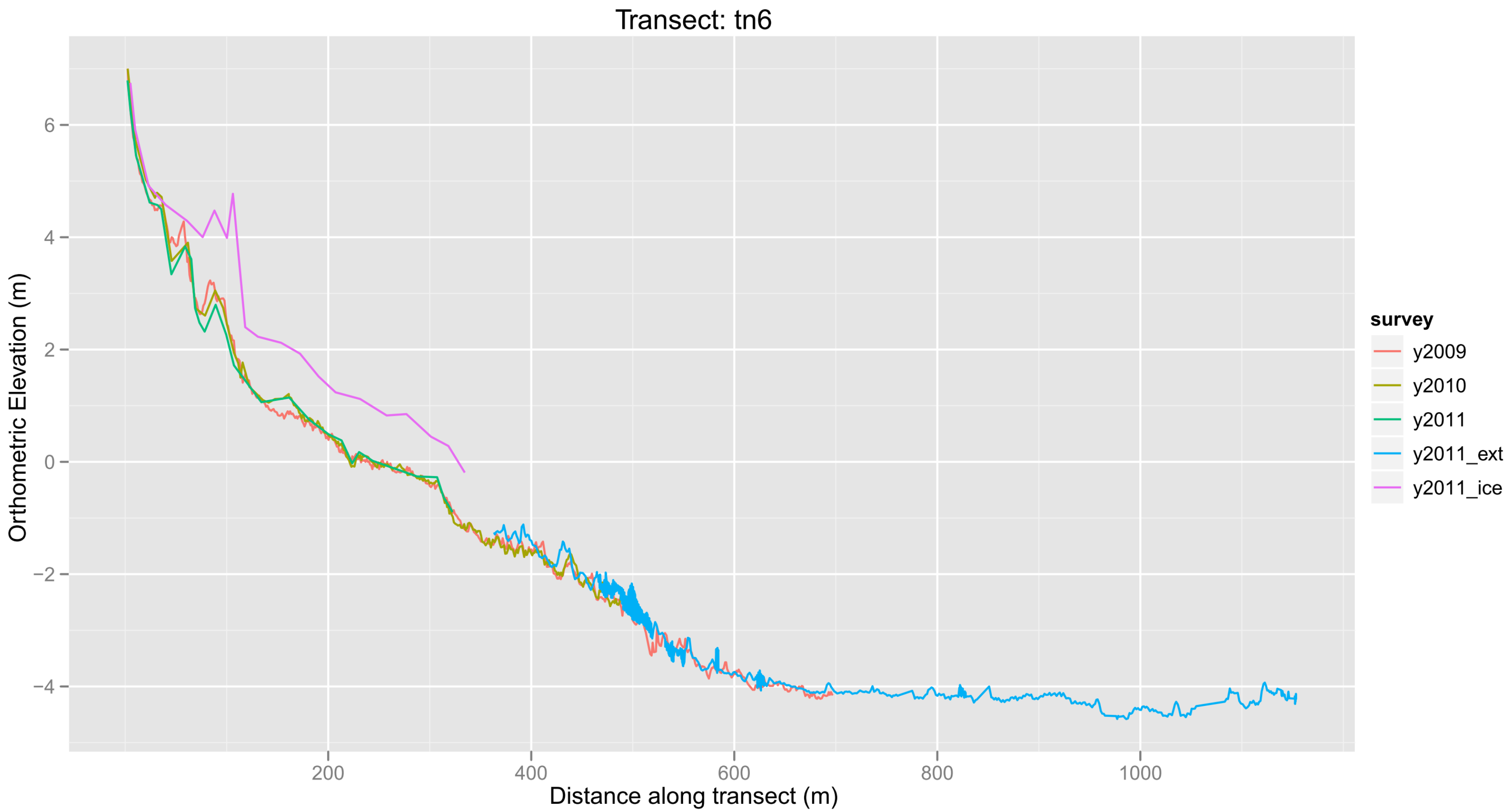
Transect: tn1
Orthometric Elevation (m)
Distance along transect (m)
6
4
2
0
−2
200
400
600
800
survey
y2009
y2010
y2011
y2011_ice


Transect: tn2
Orthometric Elevation (m)
4
2
0
−2
−4
200
400
600
800
1000
Distance along transect (m)
survey
y2010
y2011

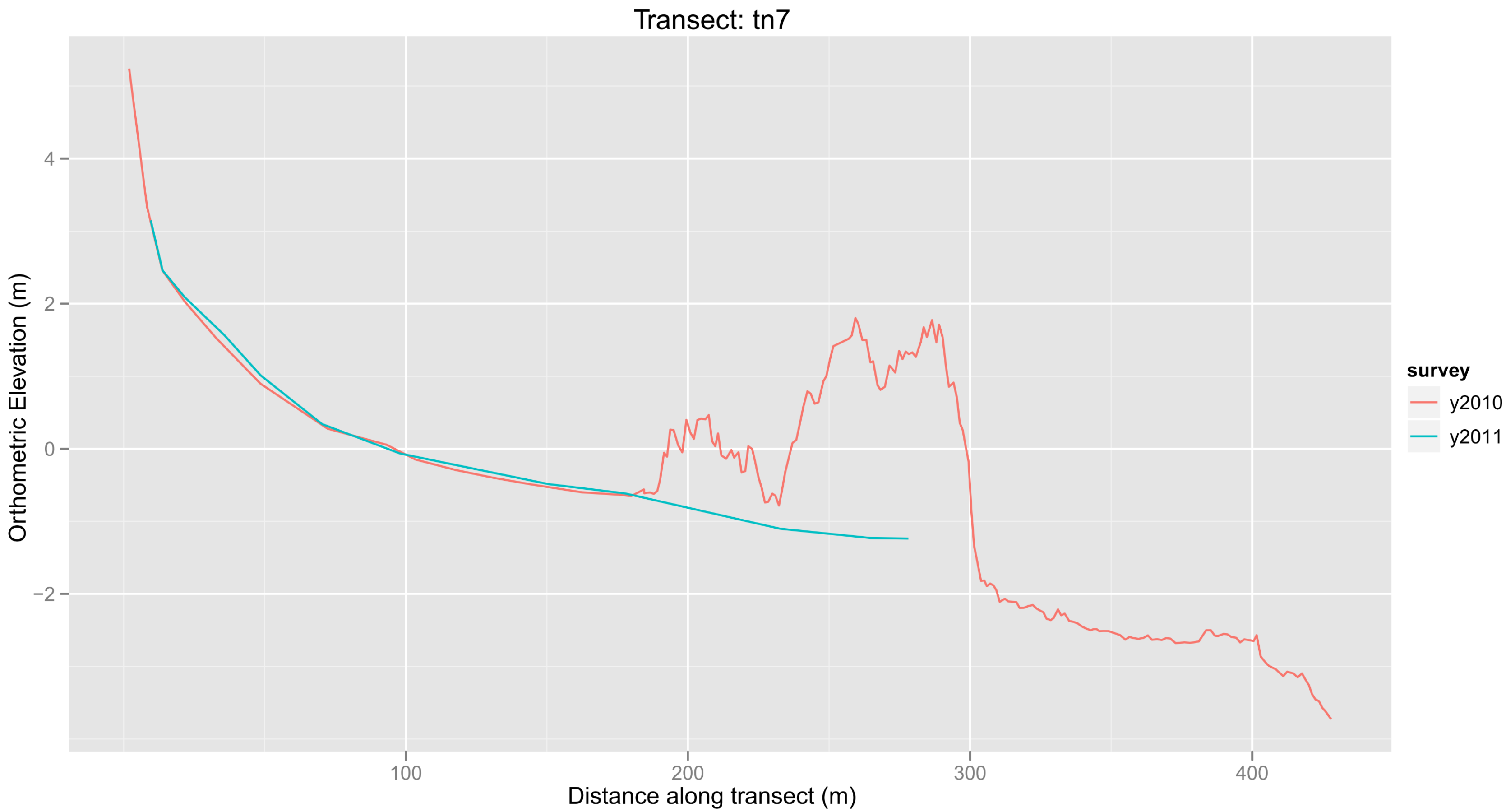

Transect: tn3
Orthometric Elevation (m)
6
4
2
0
−2
100
200
300
400
500
600
Distance along transect (m)
survey
y2009
y2010
y2011
y2011_ice

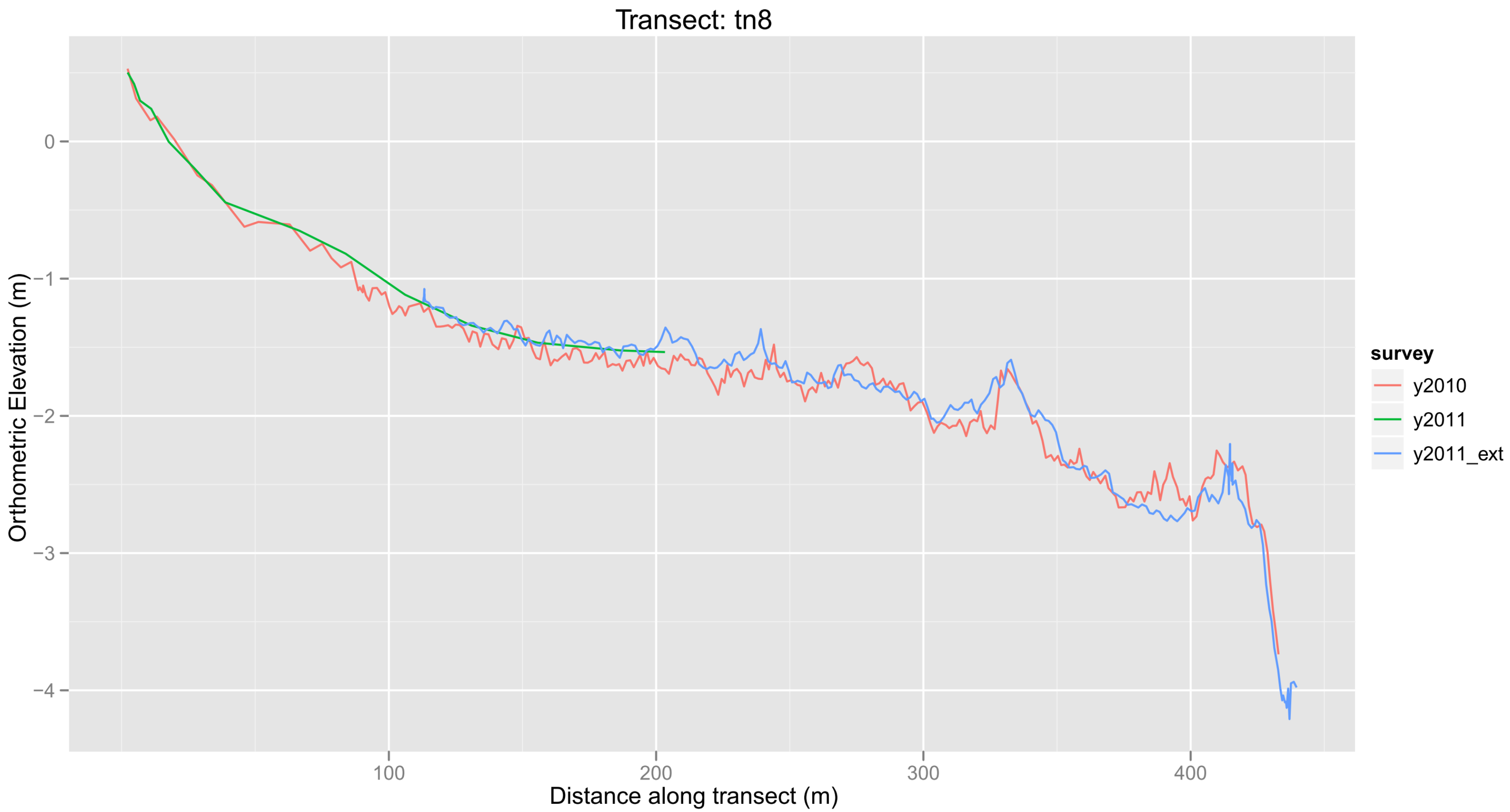

Transect: tn4
Orthometric Elevation (m)
6
4
2
0
−2
200
400
600
800
Distance along transect (m)
survey
y2009
y2010
y2011

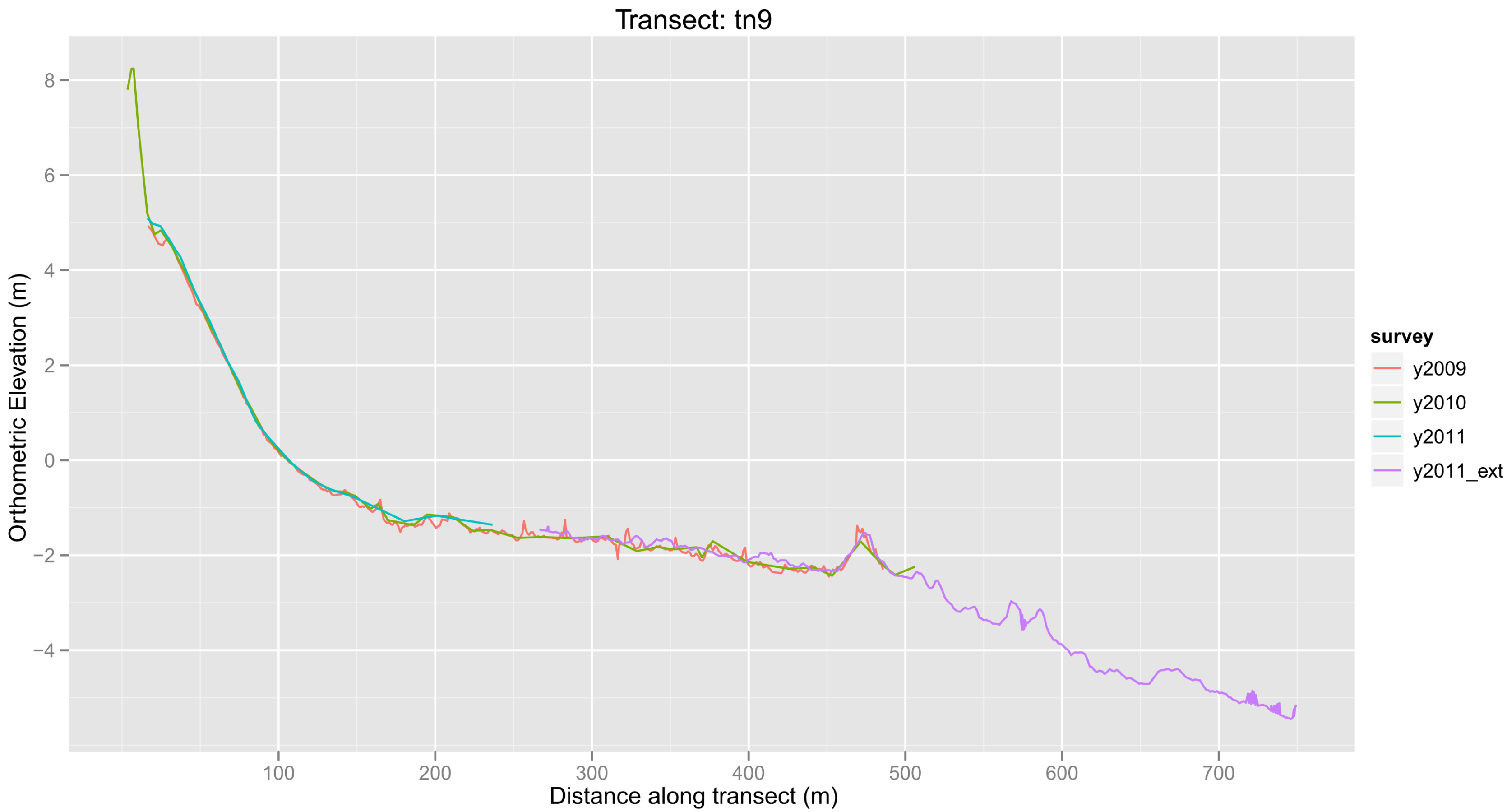

Transect: tn5
Orthometric Elevation (m)
6
4
2
0
−2
200
400
600
Distance along transect (m)
survey
y2010
y2011

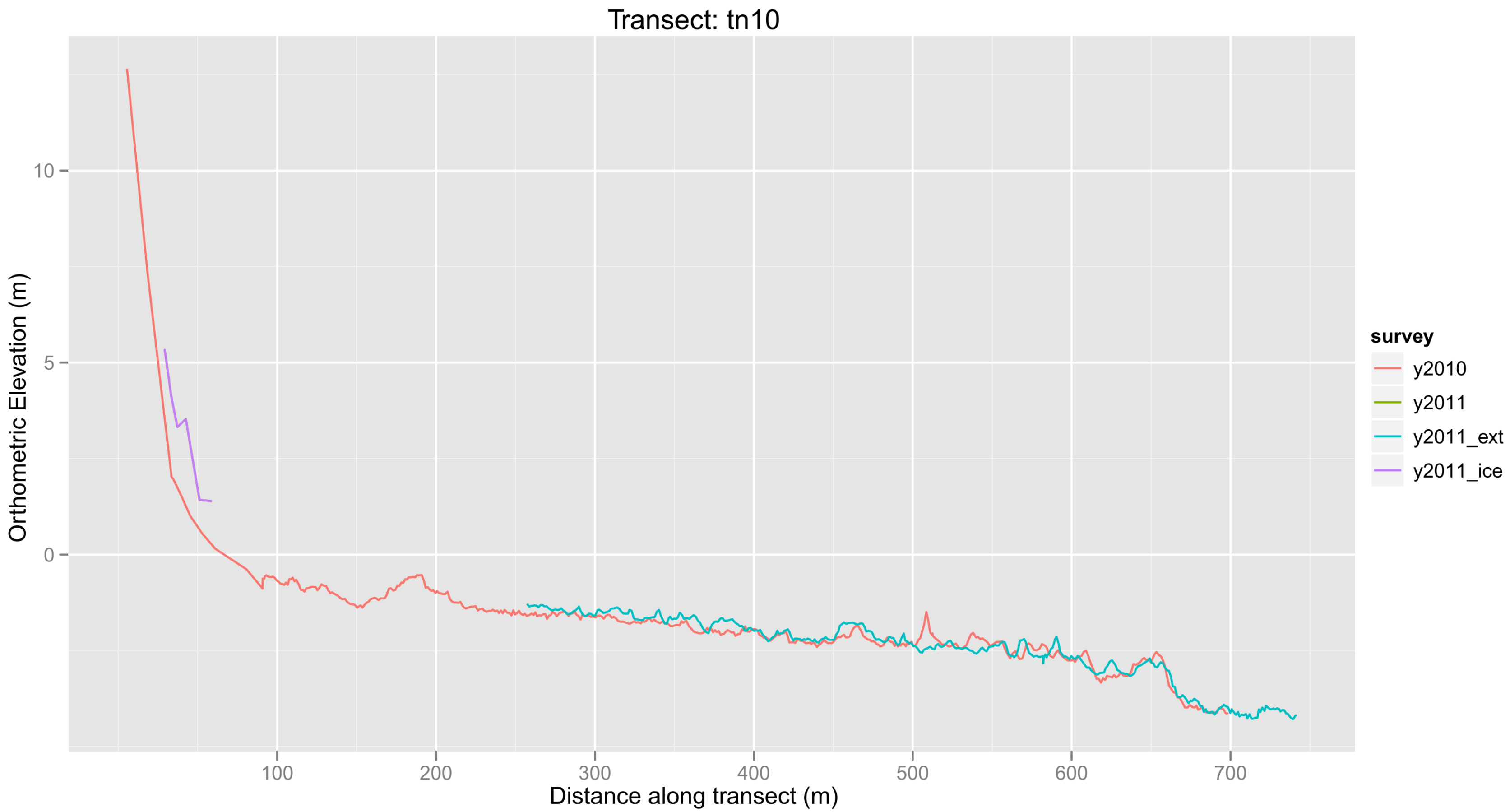


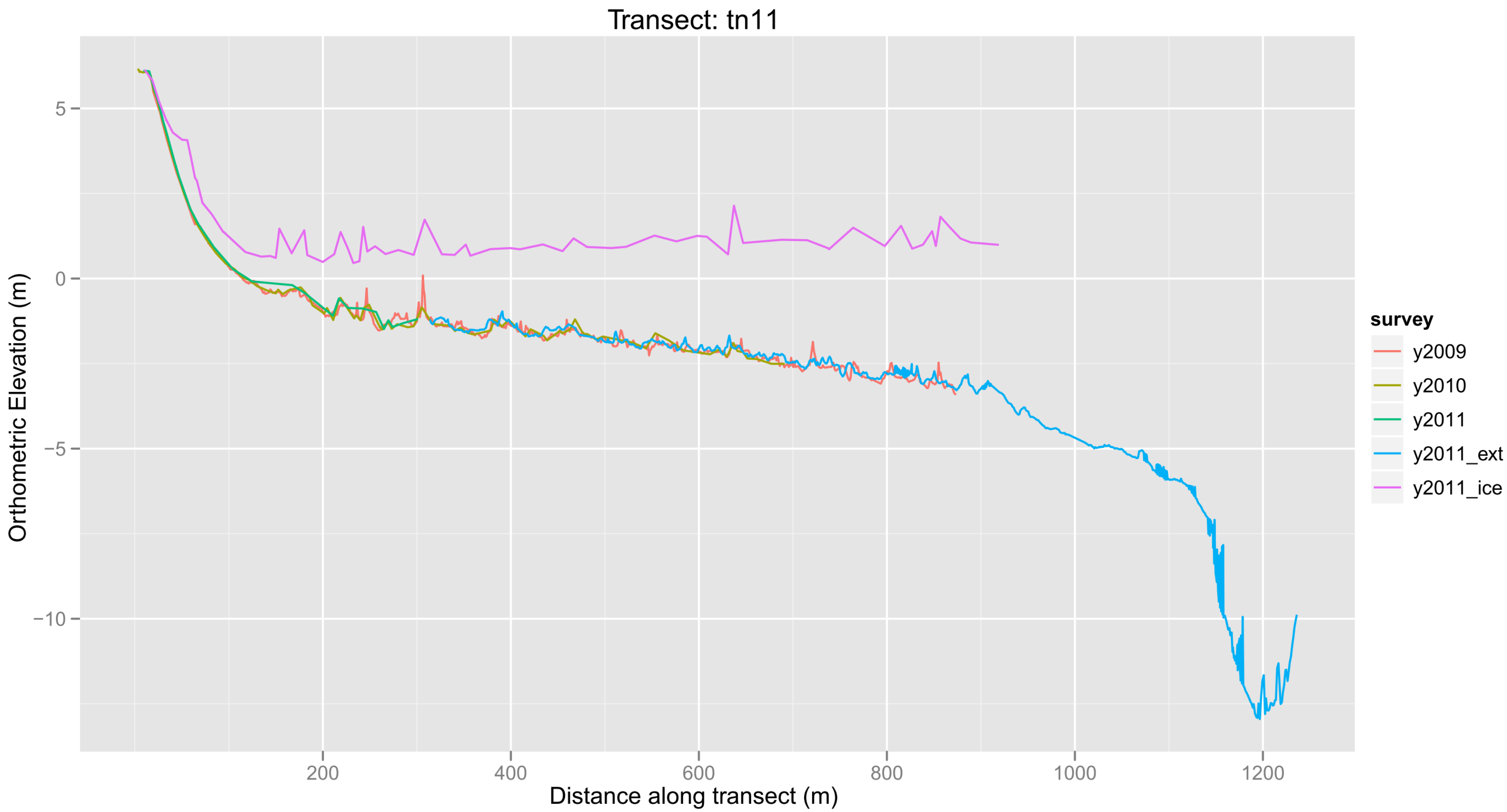
Transect: tn6
Orthometric Elevation (m)
Distance along transect (m)
6
4
2
0
−2
−4
200
400
600
800
1000
survey
y2009
y2010
y2011
y2011_ext
y2011_ice

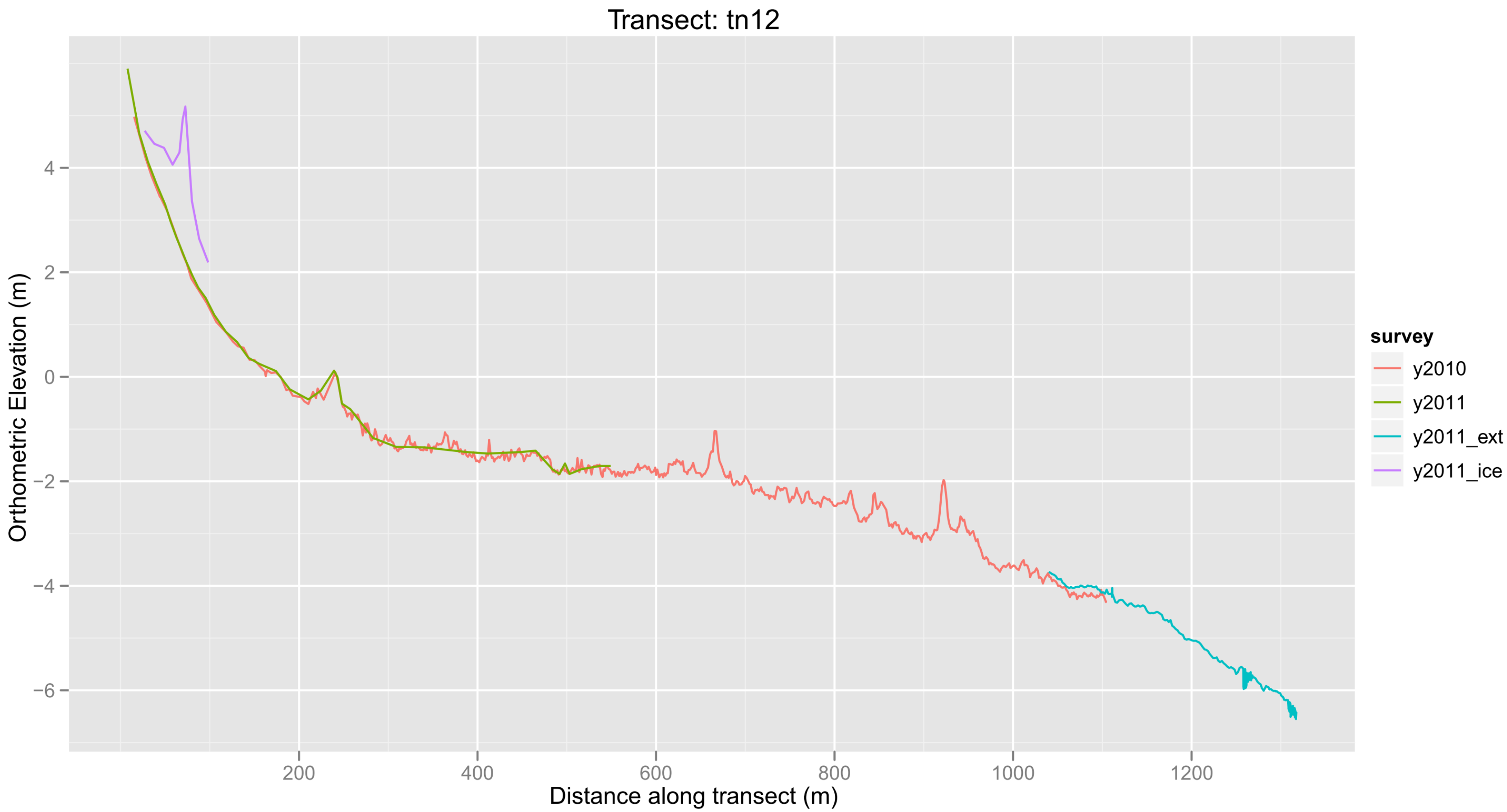

Transect: tn7
Orthometric Elevation (m)
4
2
0
−2
100
200
300
400
Distance along transect (m)
survey
y2010
y2011

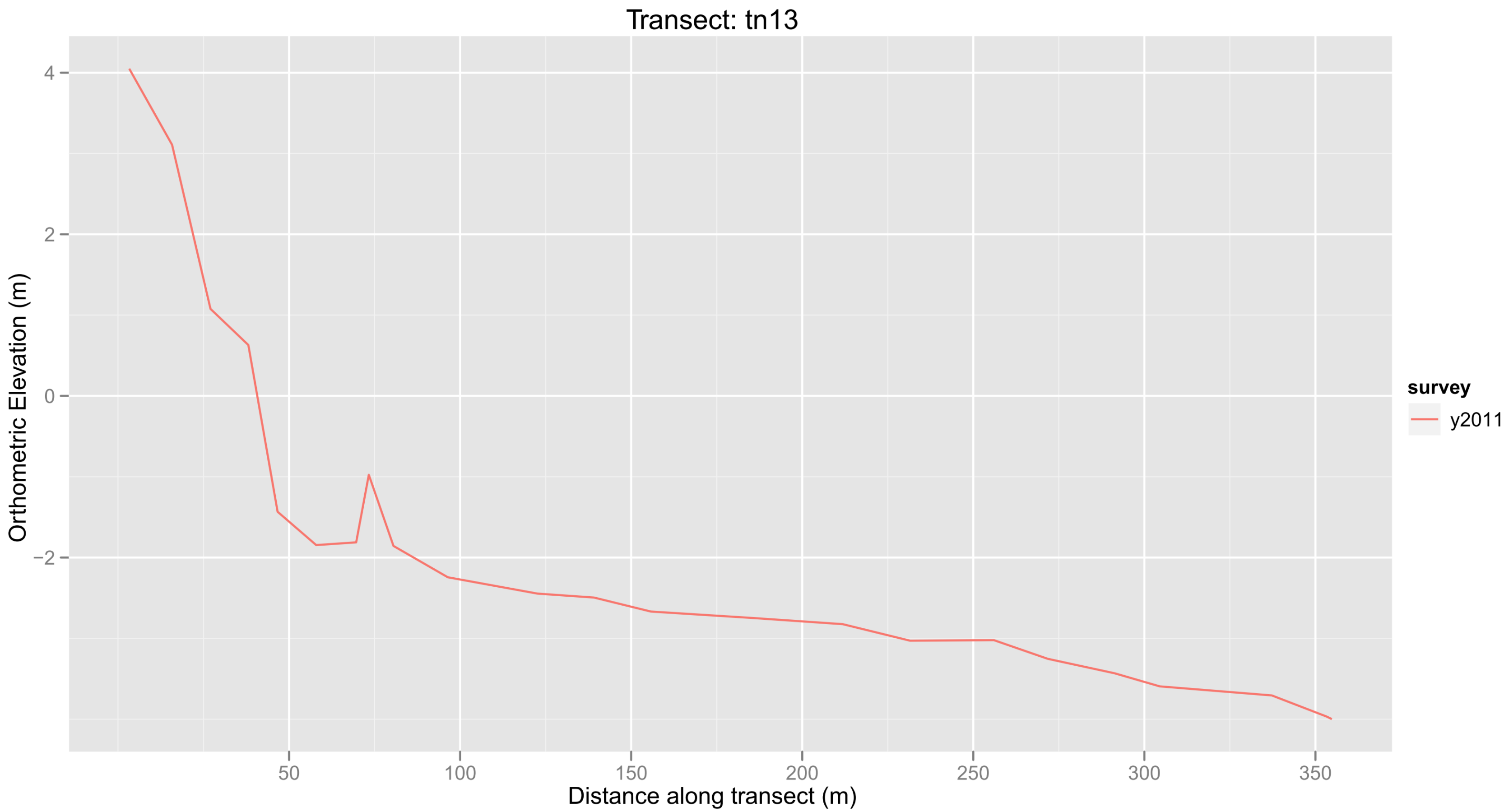

Transect: tn8
Orthometric Elevation (m)
Distance along transect (m)
0
−1
−2
−3
−4
100
200
300
400
survey
y2010
y2011
y2011_ext


Transect: tn9
Orthometric Elevation (m)
8
6
4
2
0
−2
−4
100
200
300
400
500
600
700
Distance along transect (m)
survey
y2009
y2010
y2011
y2011_ext

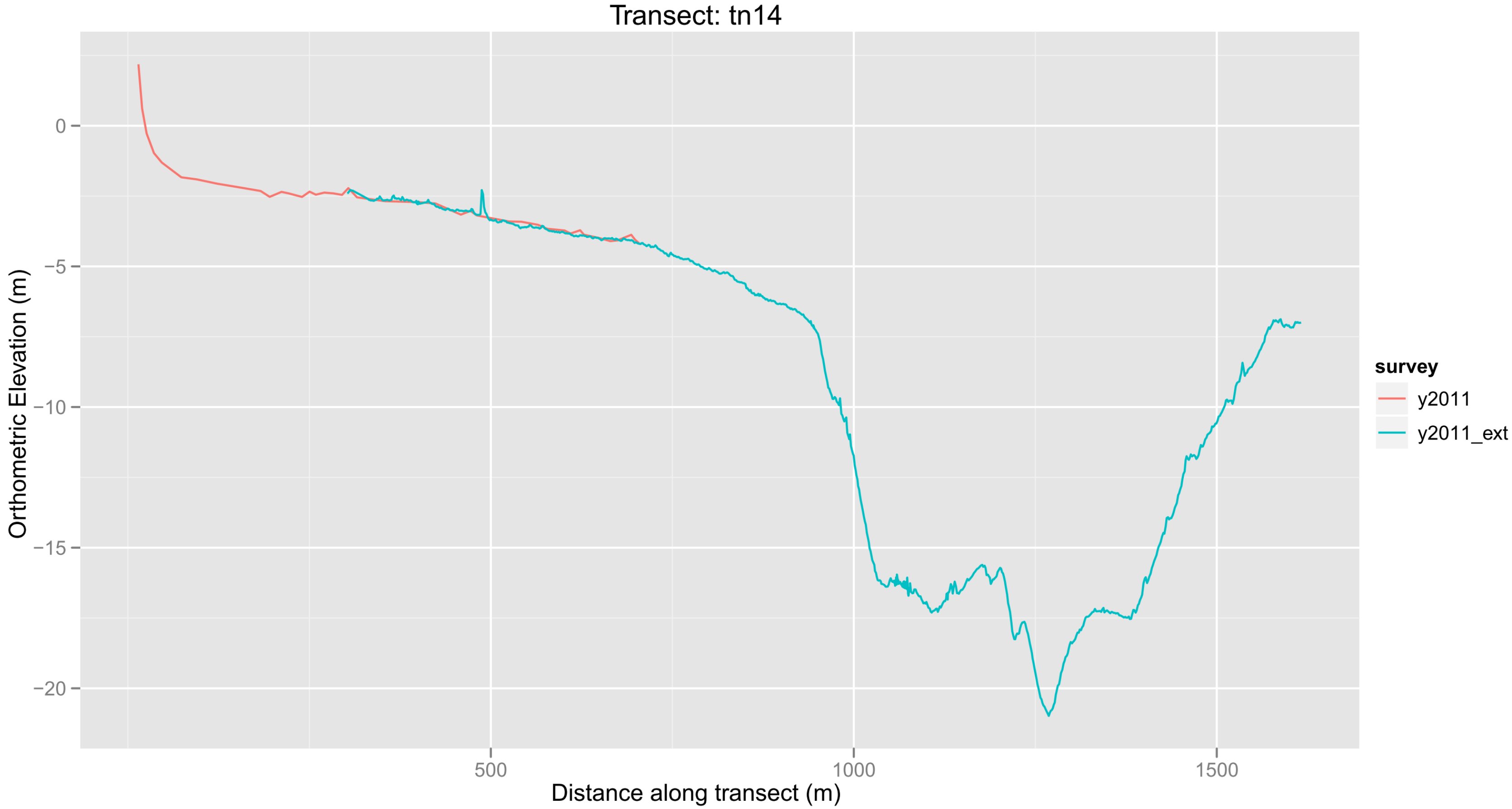

Transect: tn10
Orthometric Elevation (m)
10
5
0
100
200
300
400
500
600
700
Distance along transect (m)
survey
y2010
y2011
y2011_ext
y2011_ice

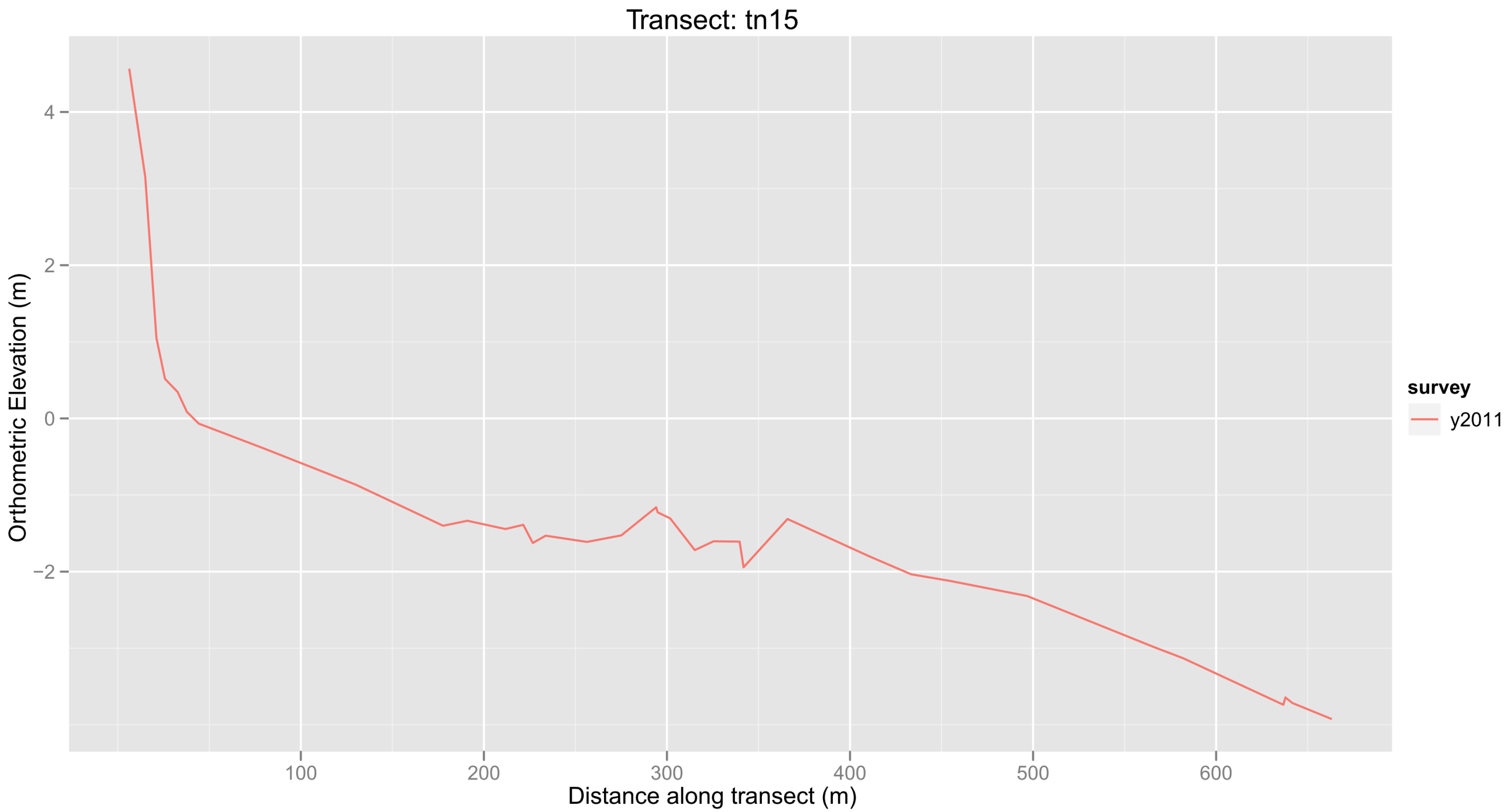

Transect: tn11
Orthometric Elevation (m)
Distance along transect (m)
5
0
−5
−10
200
400
600
800
1000
1200
survey
y2009
y2010
y2011
y2011_ext
y2011_ice

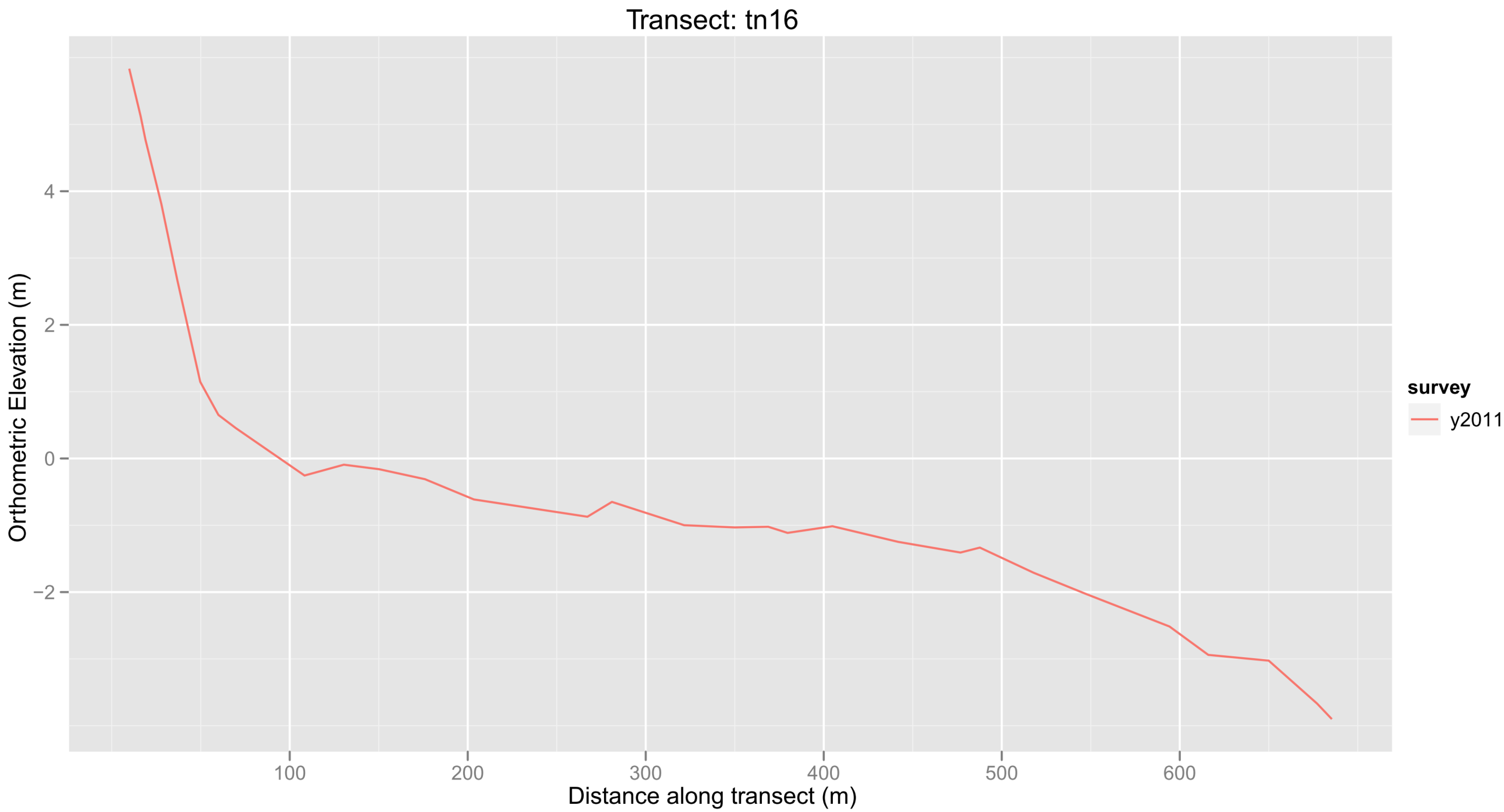

Transect: tn12
Orthometric Elevation (m)
4
2
0
−2
−4
−6
200
400
600
800
1000
1200
Distance along transect (m)
survey
y2010
y2011
y2011_ext
y2011_ice

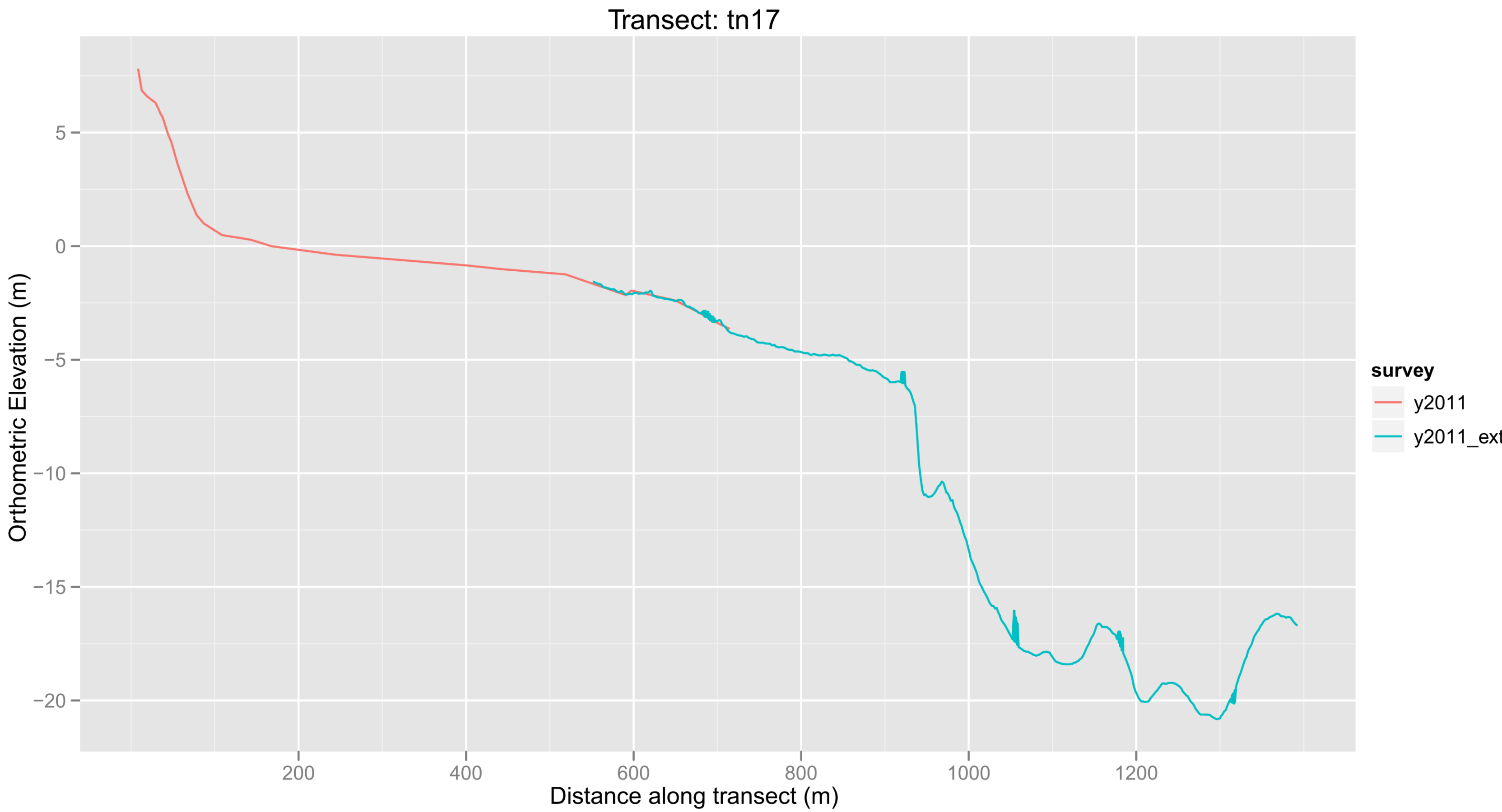


Transect: tn13
Orthometric Elevation (m)
4
2
0
−2
50
100
150
200
250
300
350
Distance along transect (m)
survey
y2011

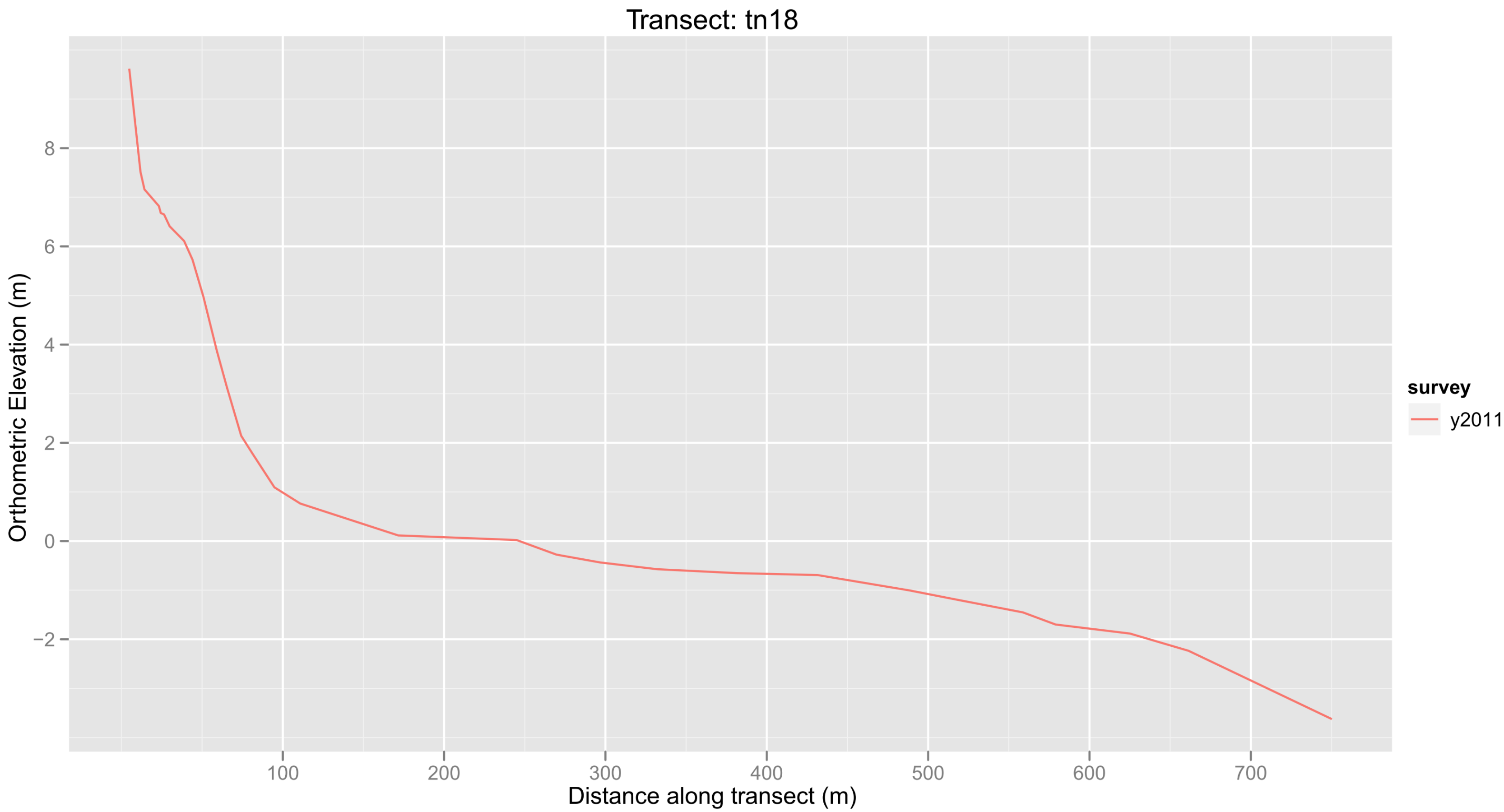

Transect: tn14
Orthometric Elevation (m)
0
−5
−10
−15
−20
500
1000
1500
Distance along transect (m)
survey
y2011
y2011_ext

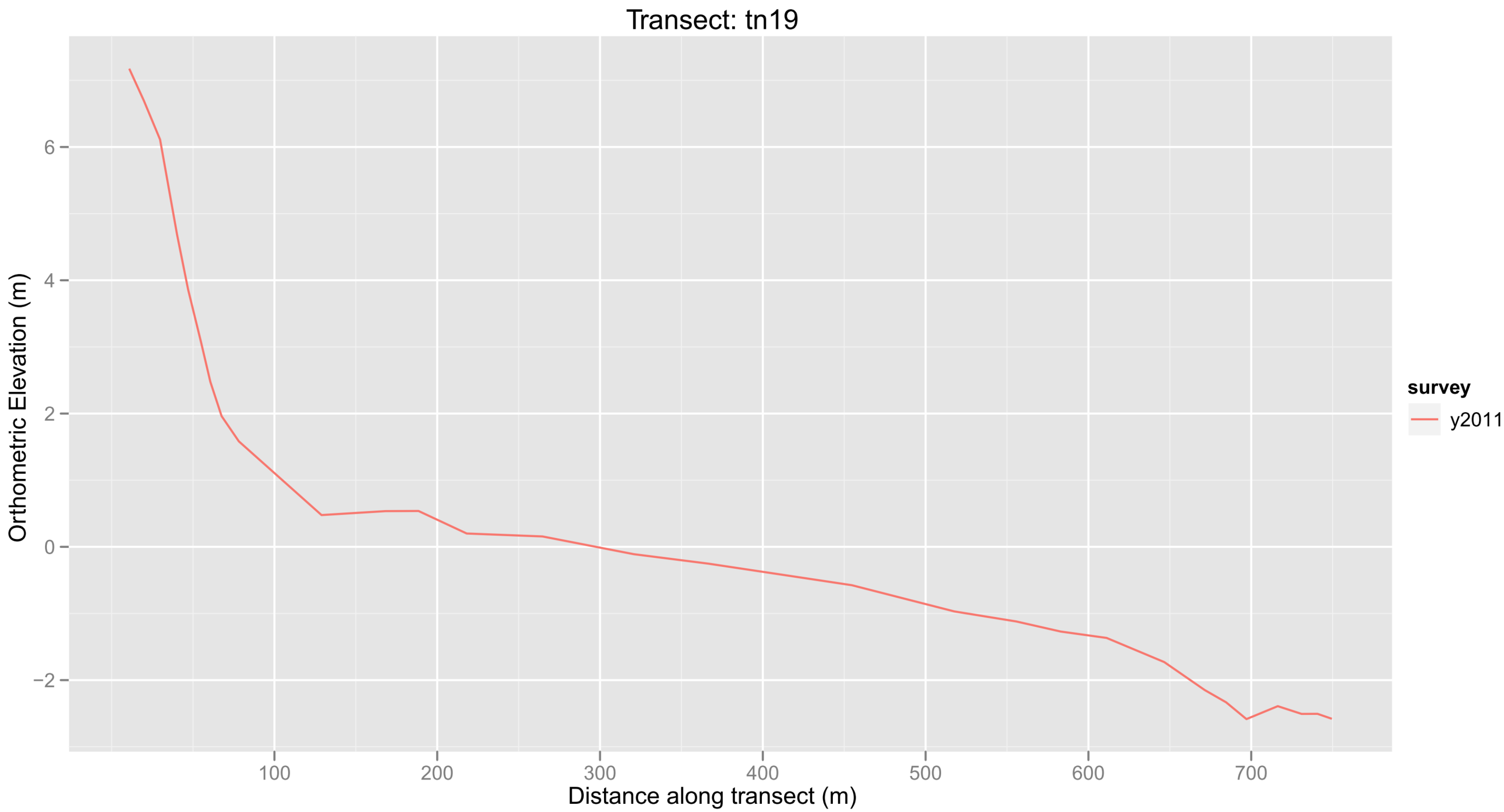

Transect: tn15
Orthometric Elevation (m)
4
2
0
−2
100
200
300
400
500
600
Distance along transect (m)
survey
y2011

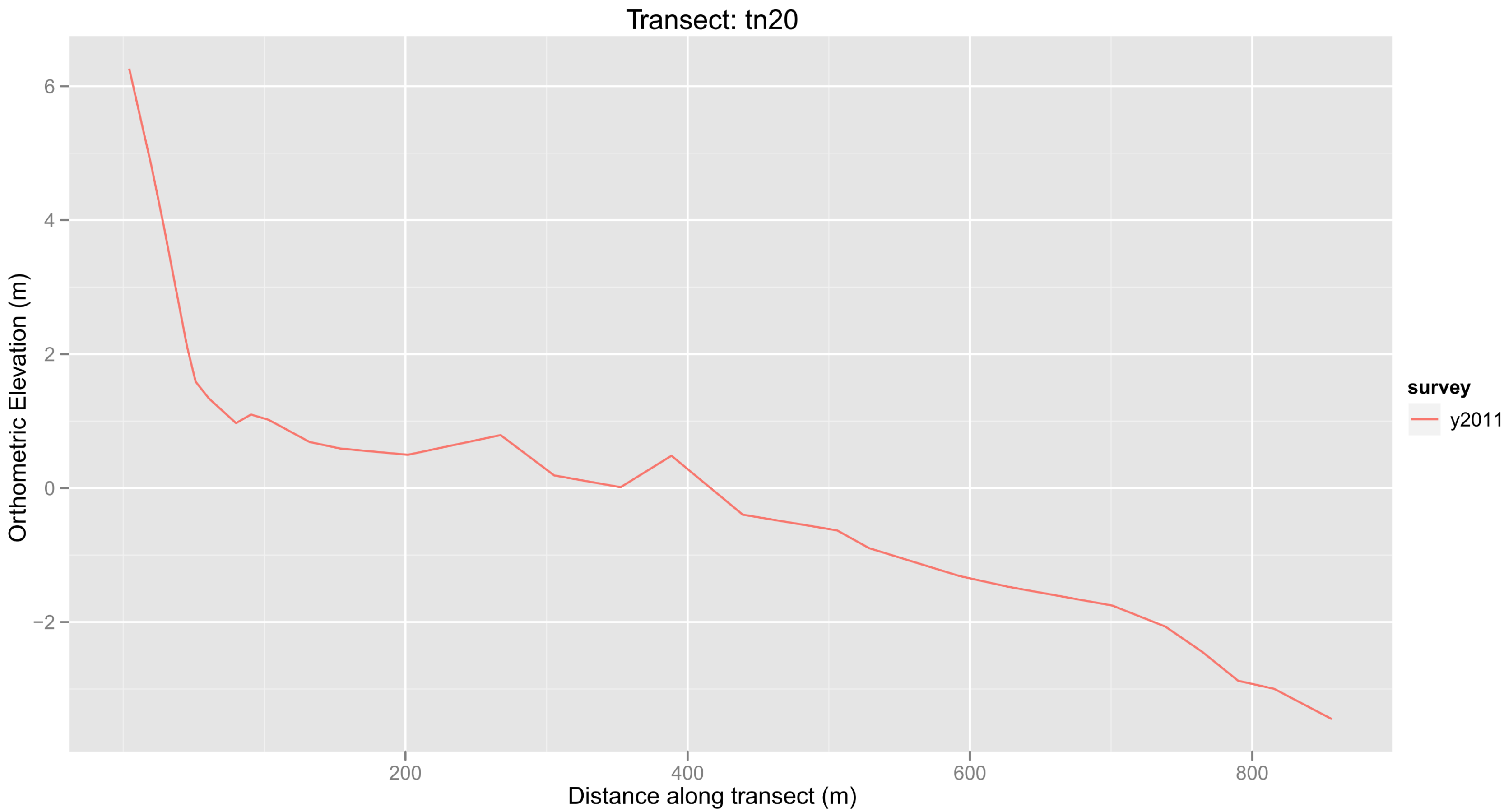

Transect: tn16
Orthometric Elevation (m)
4
2
0
−2
100
200
300
400
500
600
Distance along transect (m)
survey
y2011

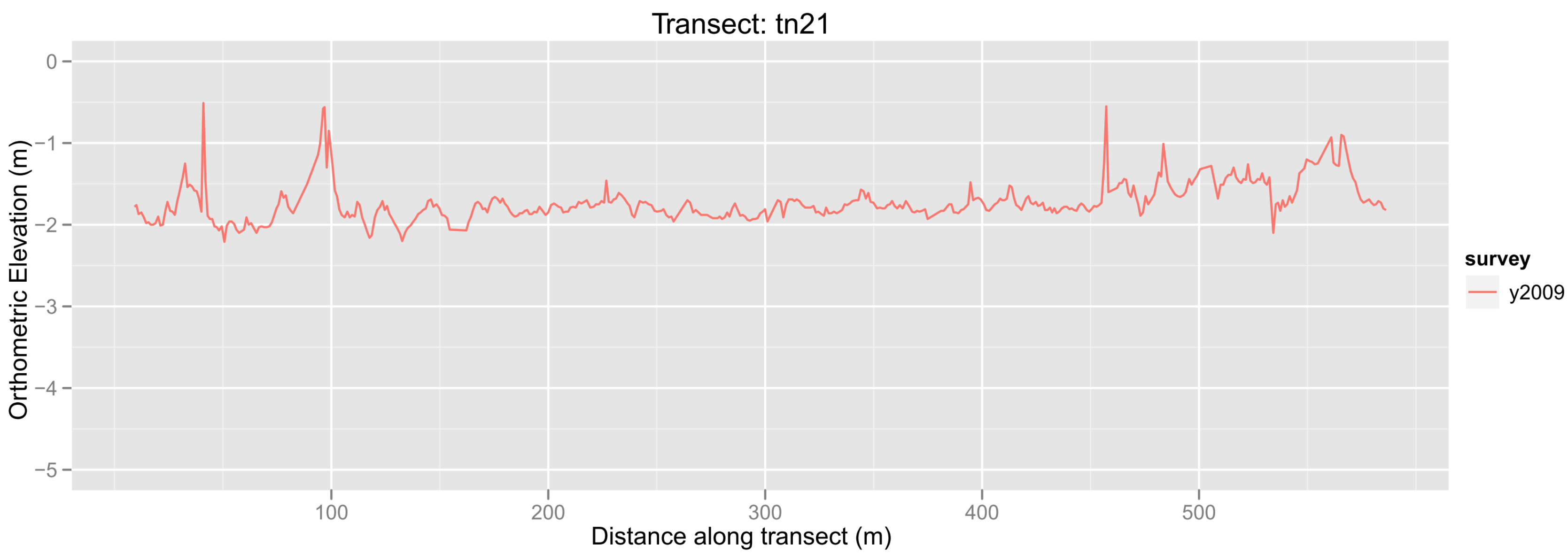


Transect: tn17
Orthometric Elevation (m)
5
0
−5
−10
−15
−20
200
400
600
800
1000
1200
Distance along transect (m)
survey
y2011
y2011_ext


Transect: tn18
Orthometric Elevation (m)
8
6
4
2
0
−2
100
200
300
400
500
600
700
Distance along transect (m)
survey
y2011


Transect: tn19
Orthometric Elevation (m)
6
4
2
0
−2
100
200
300
400
500
600
700
Distance along transect (m)
survey
y2011


Transect: tn20
Orthometric Elevation (m)
6
4
2
0
−2
200
400
600
800
Distance along transect (m)
survey
y2011


Transect: tn21
Orthometric Elevation (m)
0
−1
−2
−3
−4
−5
100
200
300
400
500
Distance along transect (m)
survey
y2009


Transect: tn22
0
−1
−2
−3
−4
−5
Orthometric Elevation (m)
200
400
600
Distance along transect (m)
survey
y2011

Appendix B RBR tide and wave recorder data

- RBR TWR-2050 Tide and Wave recorders
- Sampling period: 00:15:00
- Averaging period: 00:01:00
- Wave sampling period: 00:30:00
- Wave burst rate: 2 hz
- * Note: Depths are given as height of water above instrument in m. The scale is inverted, therefore high tide comes at the time of greatest depth (lowest point in the graph).

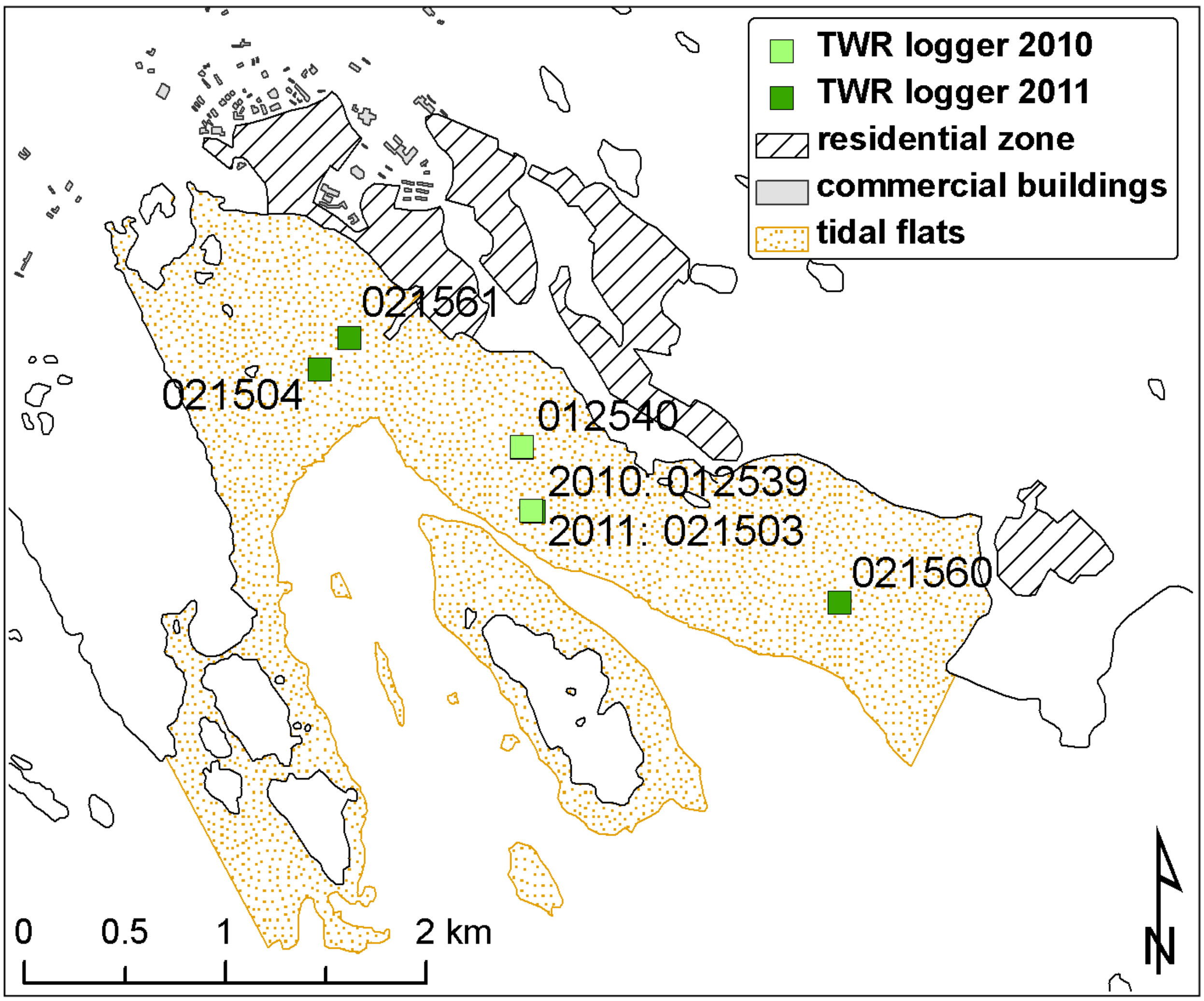
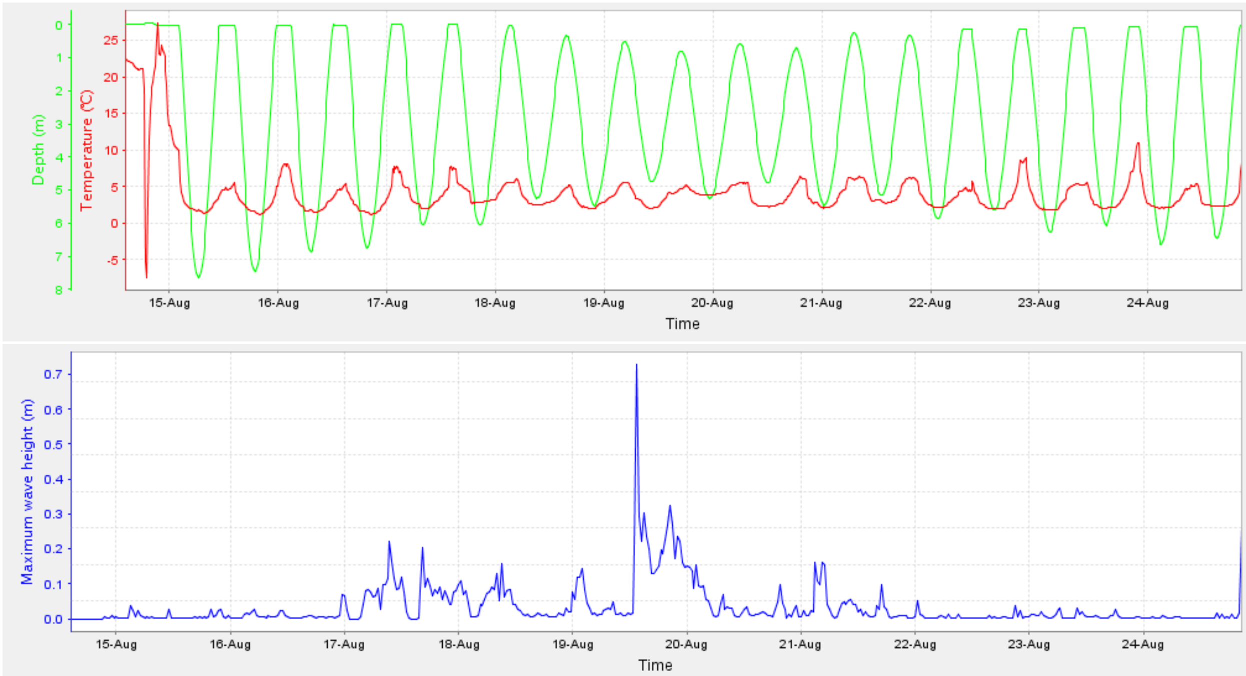


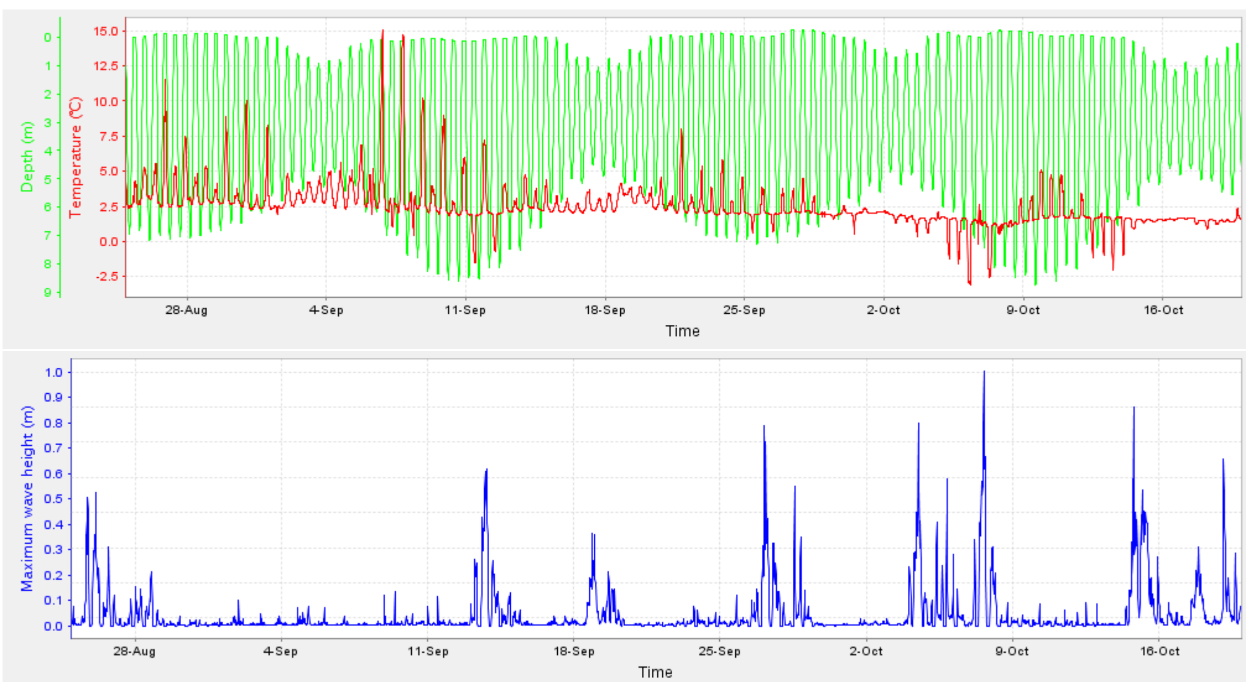
Figure 14: Location of the RBR TWR-2050 tide and wave recorder instruments on the Iqaluit tidal flats. All instruments were deployed on foot, and so were dry for part of the tidal cycle.

B.1 TWR 012539

Deployment 1 - Start: 2010-08-14 12:00:00 End: 2010-08-24 19:30:00

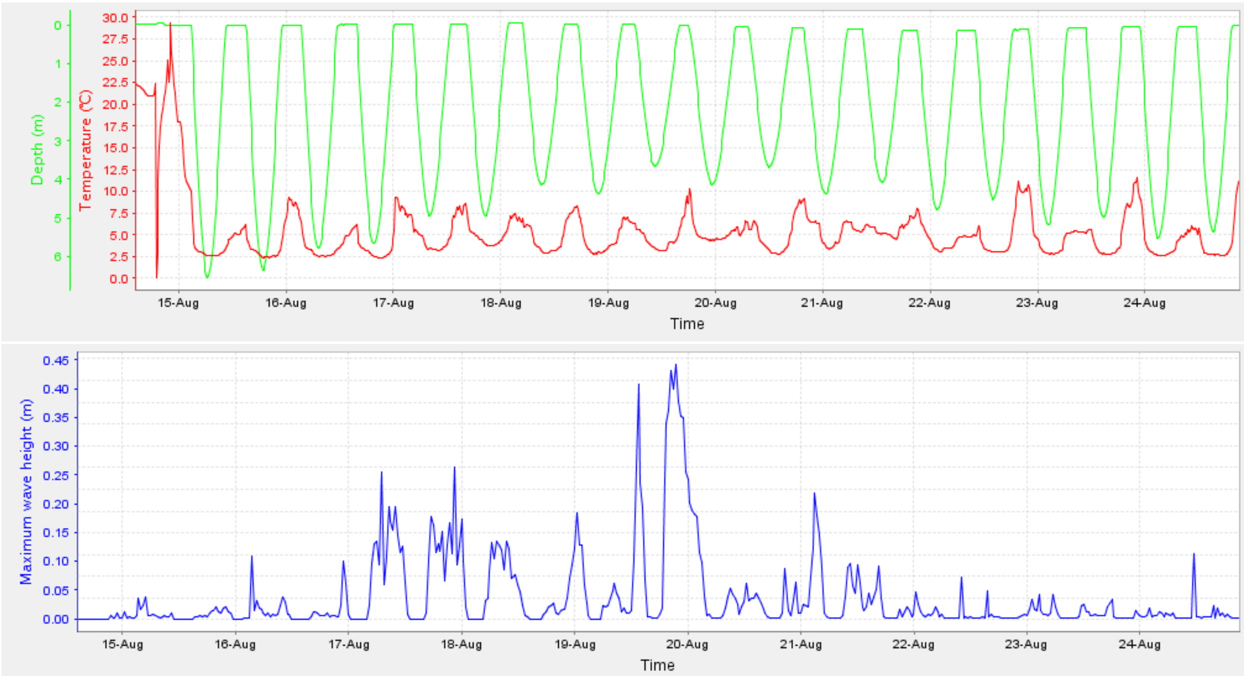


Deployment 2 - Start: 2010-08-24 20:00:00 End: 2010-10-19 20:00:00

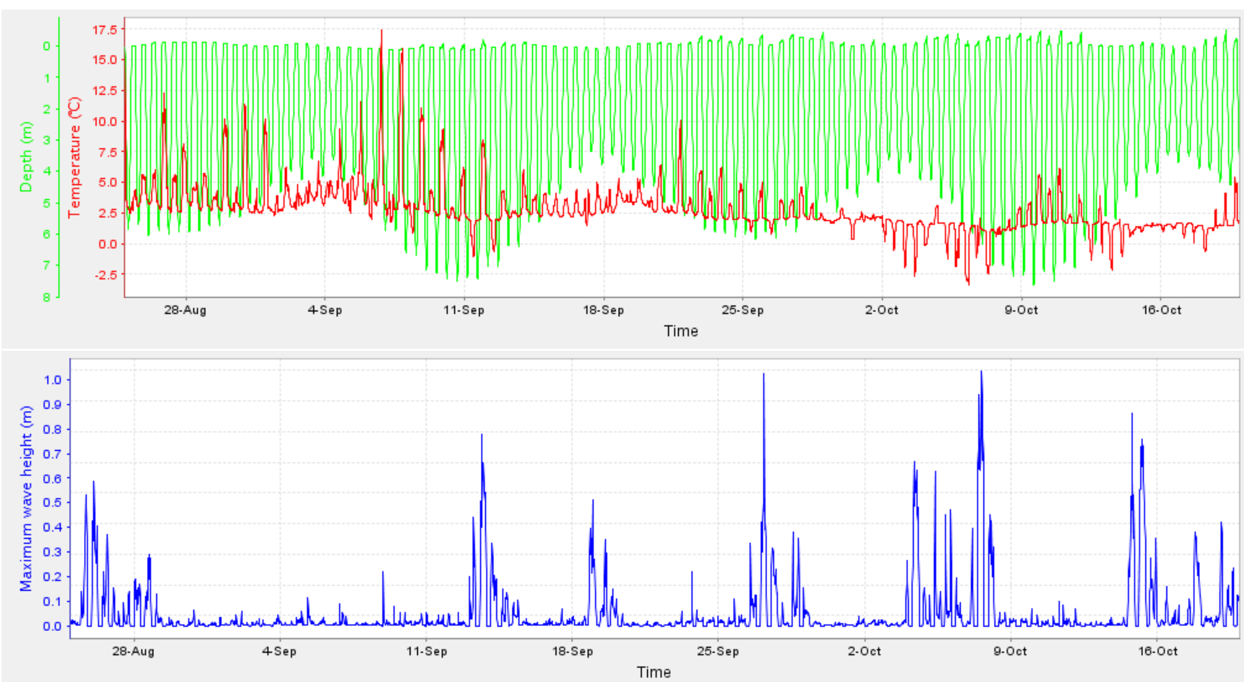


B.2 TWR 012540

Deployment 1 - Start: 2010-08-14 12:00:00 End: 2010-08-24 19:30:00

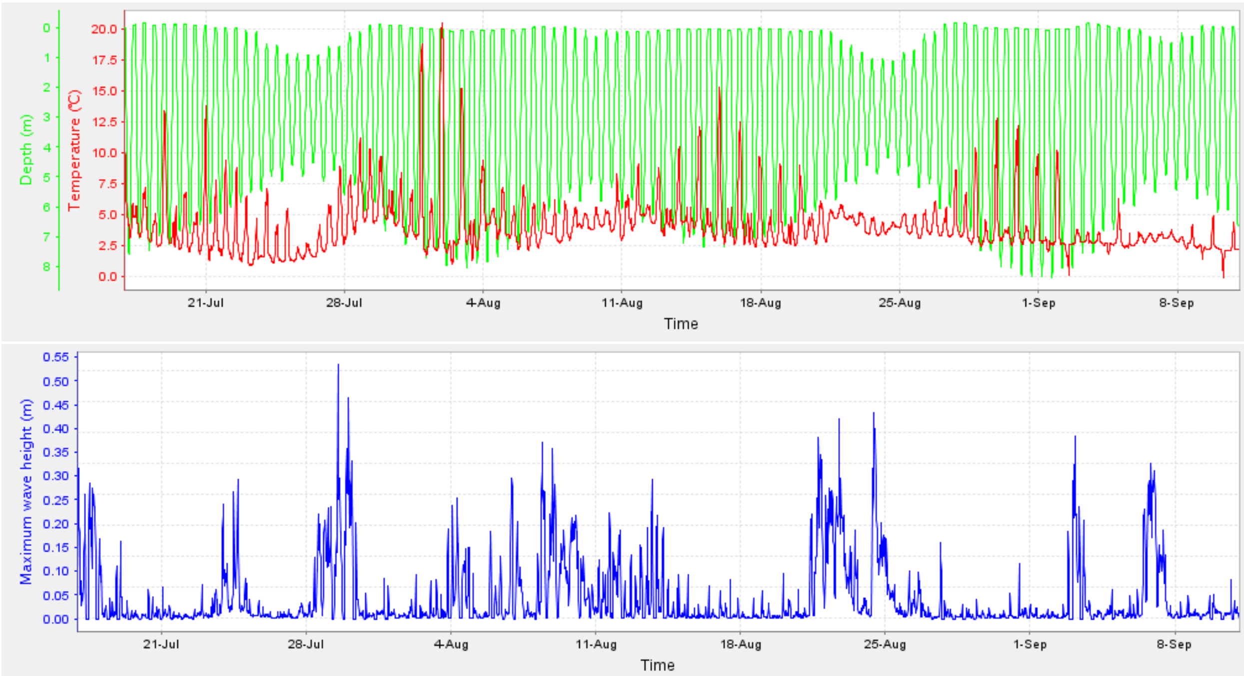


Deployment 2 - Start: 2010-08-24 20:00:00 End: 2010-10-19 20:00:00



B.3 TWR 021503

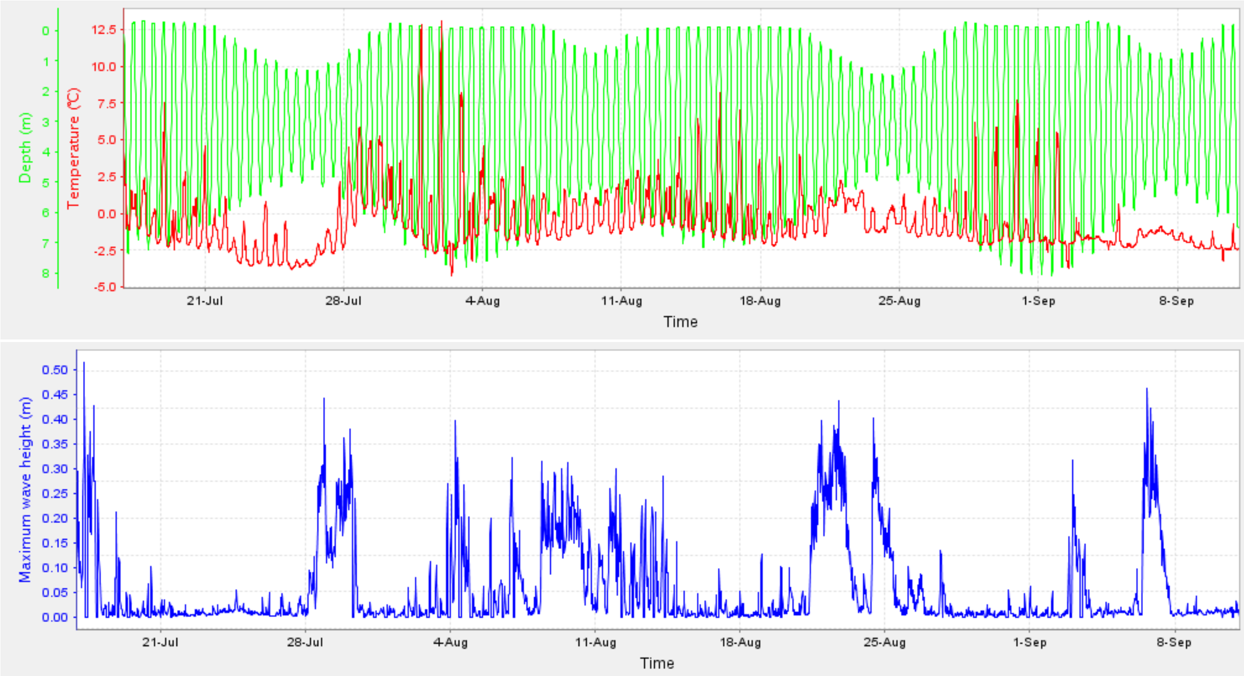
Deployment 1 - Start: 2011-07-16 20:00:00 End: 2011-09-11 00:00:00



Deployment 2 - Start: 2011-09-28 12:44:42 End: 2011-11-23 15:44:29

B.4 TWR 021504

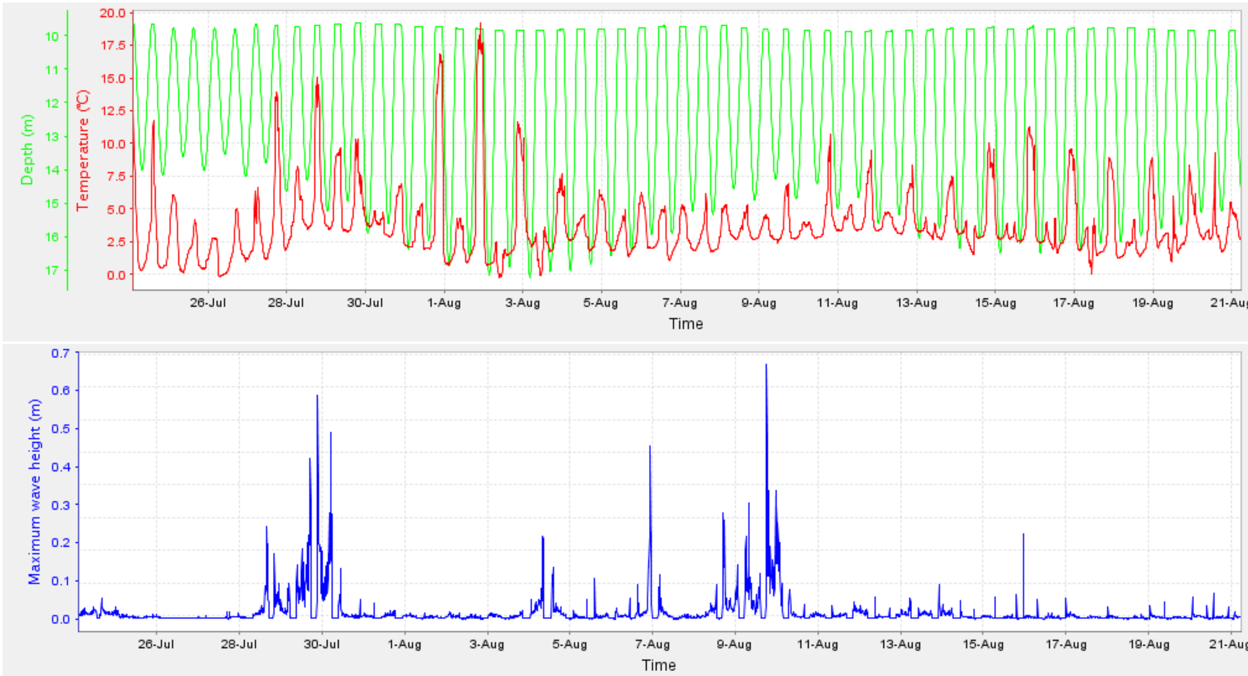
Deployment 1 - Start: 2011-07-16 20:00:00 End: 2011-09-11 00:00:00



Deployment 2 - Start: 2011-09-28 12:40:00 End: 2011-11-23 15:39:09

B.5 TWR 021560

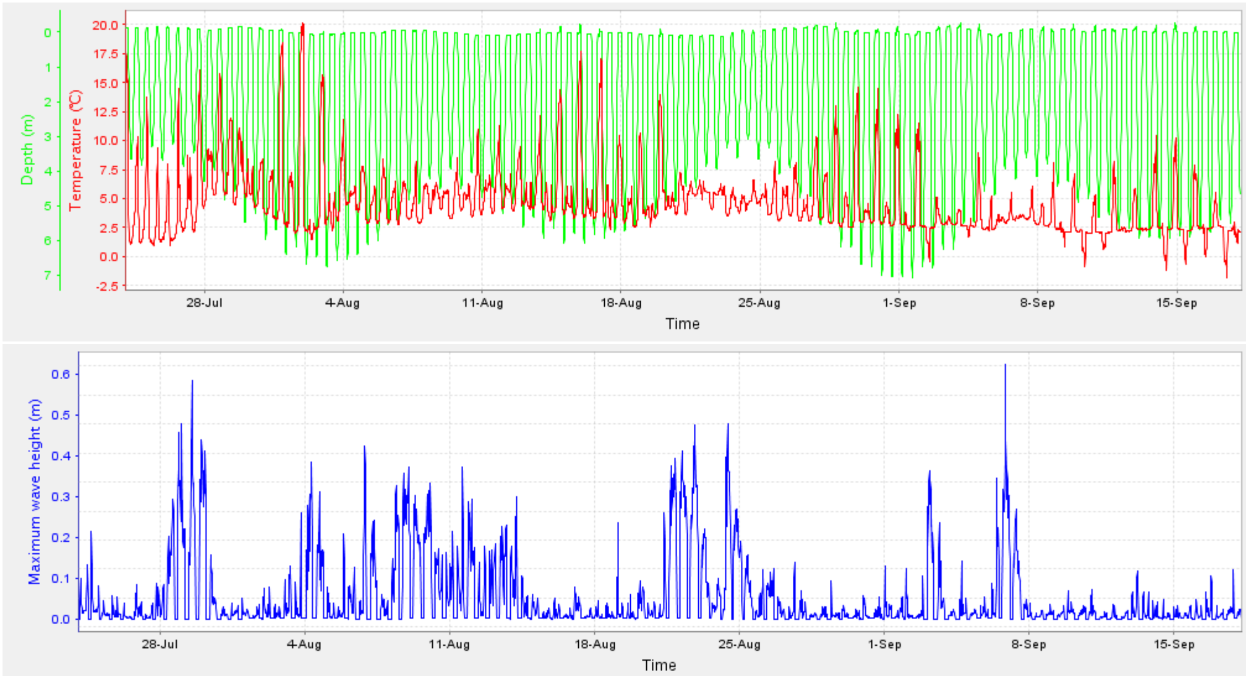
Deployment 1 - Start: 2011-07-24 00:00:00 End: 2011-08-21 03:15:00



Deployment 2 - Start: 2011-09-28 12:42:50 End: 2011-11-23 15:42:33

B.6 TWR 021561

Deployment 1 - Start: 2011-07-23 23:00:00 End: 2011-09-18 03:00:00



Appendix C CTD and turbidity casts

The CTD profiler used was an RBR XR-620 CTD and turbidity profiler. Casts were taken during rising and falling tides during spring tides on July 29/30 2011 and Aug 02 2011. Table 4 shows the tidal stage and spring/neap conditions for each profile.

CTD Profile	Time (UTC)	Tidal stage	Tidal cycle
1	2011-07-29 15:05	Late-falling	Mid-spring
2	2011-07-29 17:27	Early-rising	Mid-spring
3	2011-07-29 17:30	Early-rising	Mid-spring
4	2011-07-30 15:36	Late-falling	Mid-spring
5	2011-08-02 12:55	Late-rising	Spring
6	2011-08-02 15:12	Mid-falling	Spring
7	2011-08-02 15:21	Mid-falling	Spring
8	2011-08-02 15:40	Mid-falling	Spring

Table 4: Table showing the times and tides for each CTD profile.

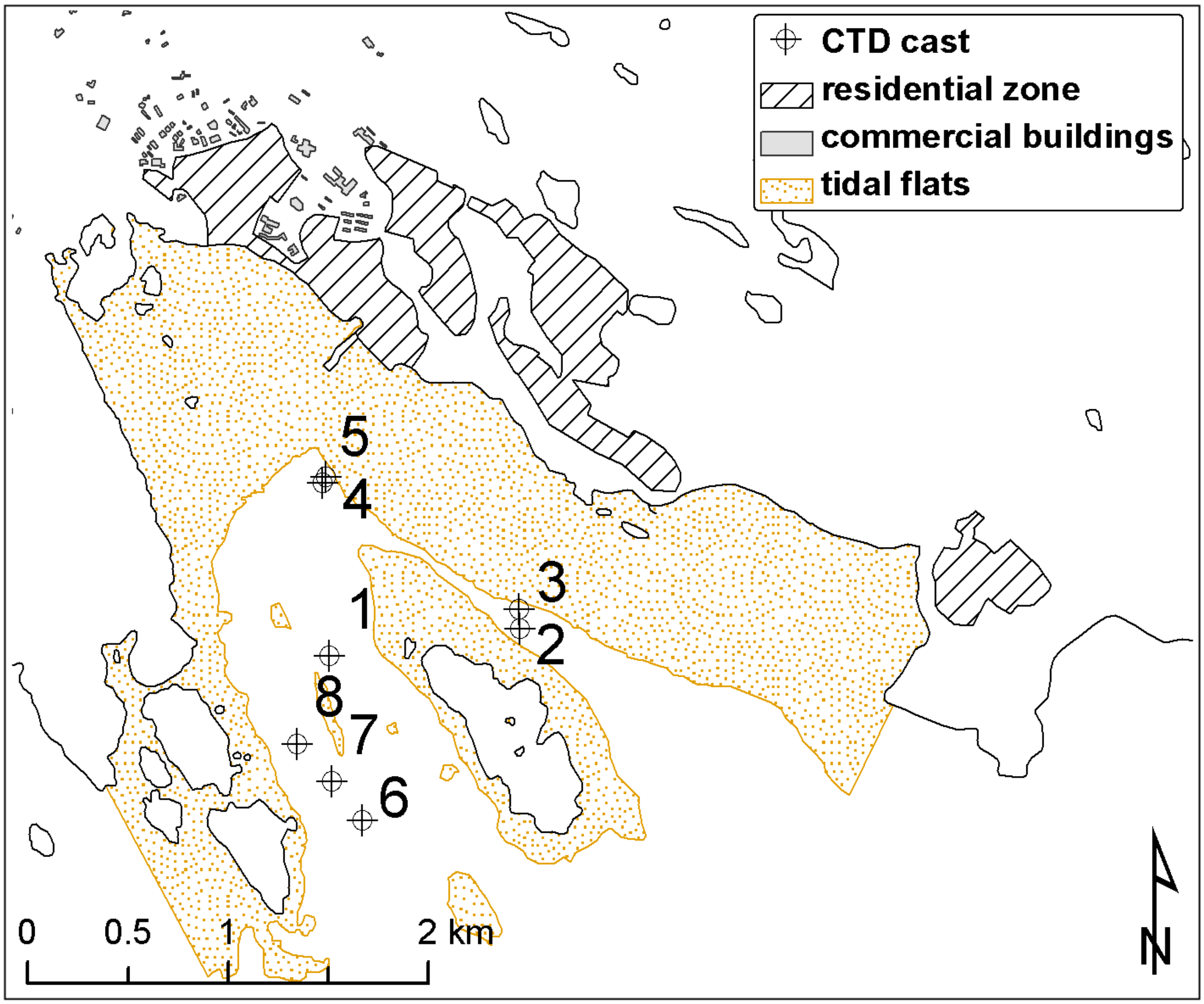


Figure 15: Map showing location of CTD profile casts in Koojesse Inlet.

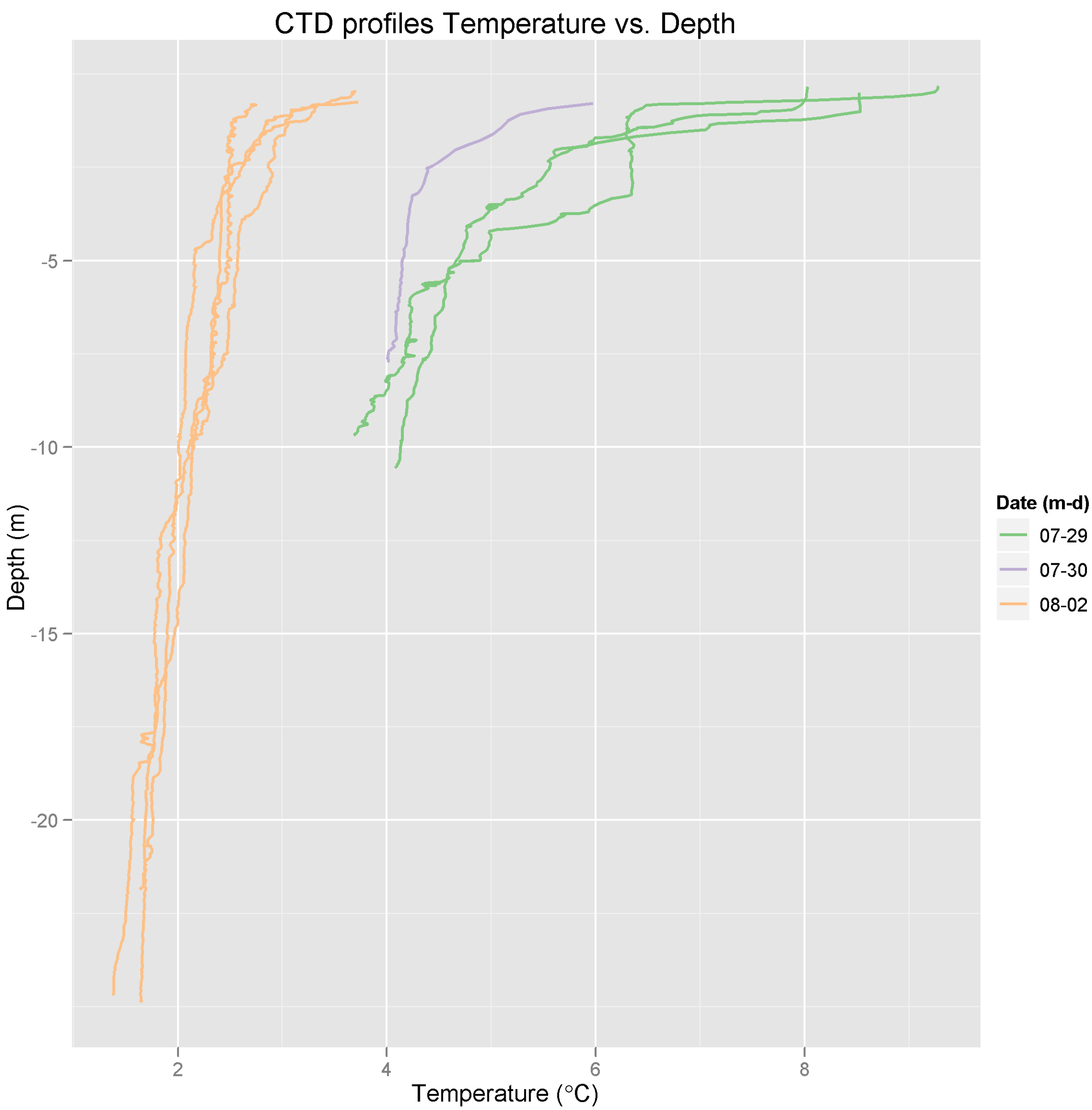


Figure 16: Plot of temperature with depth grouped by the three sampling days.

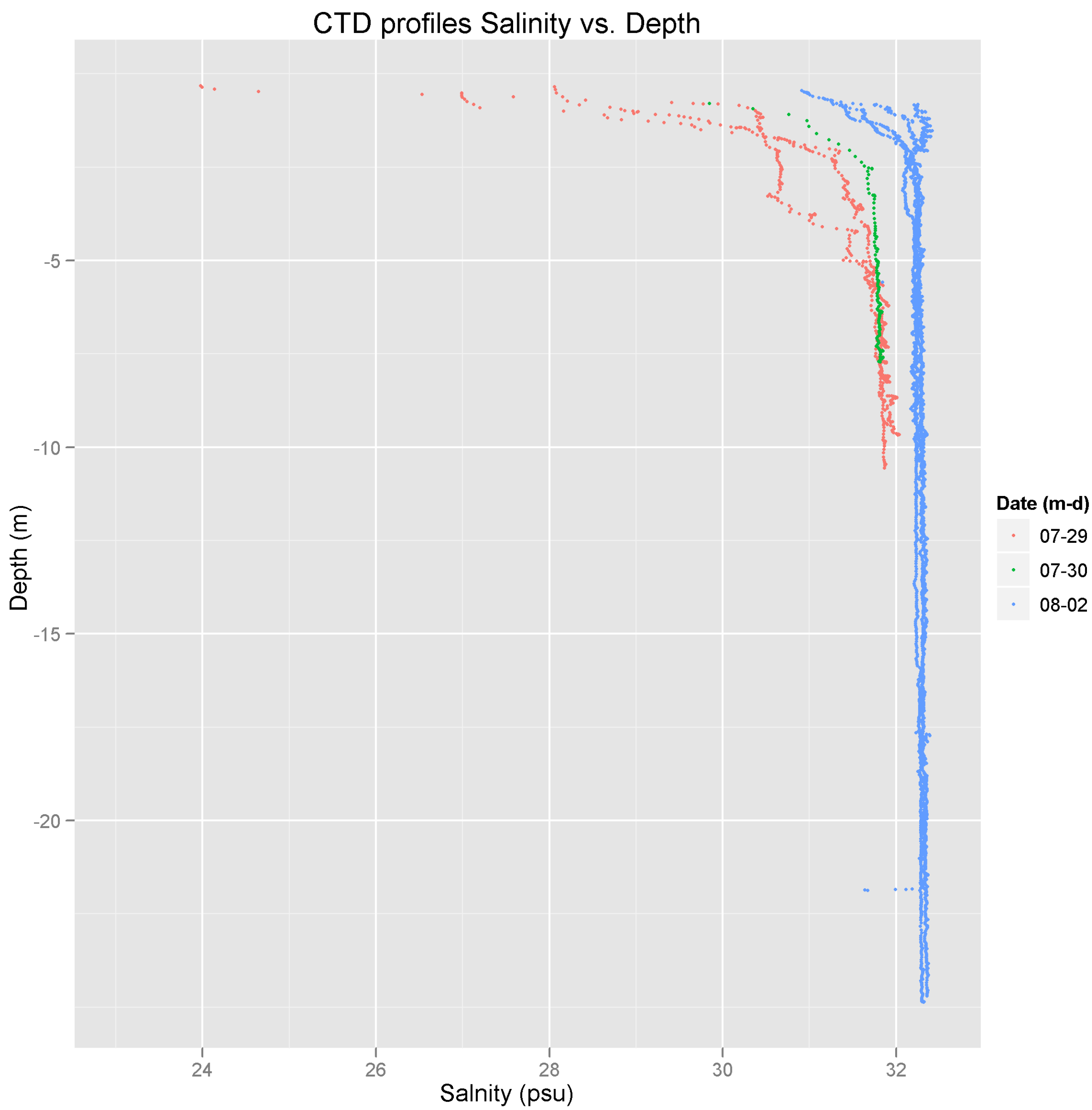


Figure 17: Plot of salinity with depth grouped by the three sampling days.

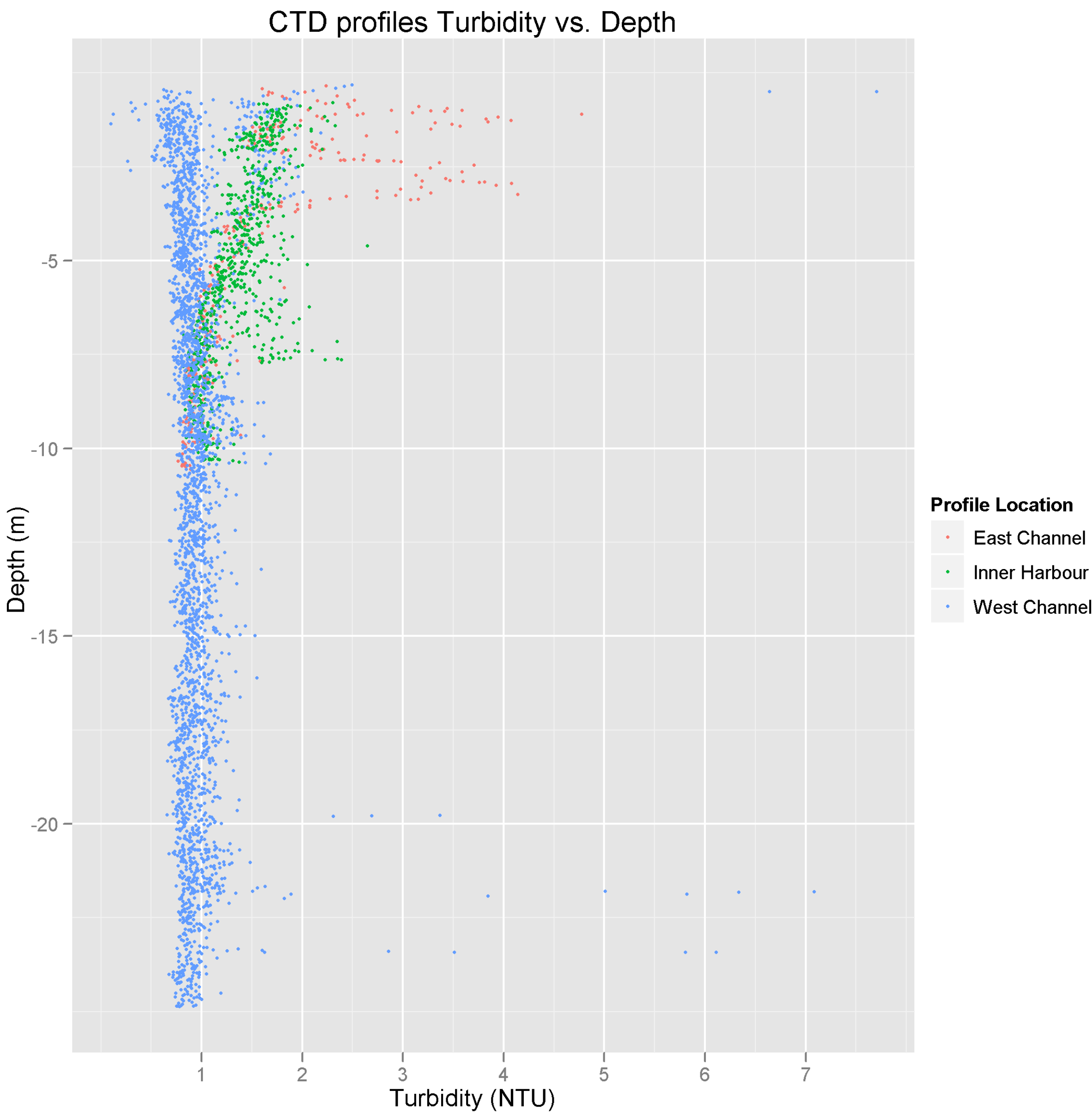


Figure 18: Plot showing turbidity with depth grouped by the position in Koojesse Inlet of the profile. The water is generally extremely clear during the sampling times (all <10 NTU), but there seems to be a slight increase in turbidity in the eastern channel during both rising and falling tides. This could be due to the nearby river input off Apex, or the bathymetry of the narrow channel.

Appendix D data directory structure

```
/
├── video
│   └── underwater_video ............ *.dvi files of drag camera deployments
├── marine
│   ├── ADCP
│   │   ├── AD1 ...................... raw Nortek aquadopp ADCP files
│   │   └── AD2+3
│   ├── CTD
│   │   ├── profiles ................. csv profile files
│   │   └── raw ...................... *.hex files. Need RBR Ruskin software
│   └── TWR .......................... *.hex files. Need RBR Ruskin software
├── surveys
│   ├── RTK_GPS
│   │   ├── 2009 ..................... csv files. 2009 surveys
│   │   ├── 2010
│   │   │   ├── processed ............ csv files
│   │   │   └── raw .................. receiver raw files
│   │   │       ├── base
│   │   │       └── rover
│   │   └── 2011
│   │       ├── summer
│   │       │   ├── processed ........ csv files
│   │       │   └── raw .............. receiver raw files
│   │       │       └── receiver
│   │       │           ├── base
│   │       │           └── rover
│   │       └── winter
│   │           ├── Processed ........ csv files
│   │           └── Raw .............. receiver raw files
│   ├── shiptrack
│   │   ├── garmin_gps ............... ESRI shapefiles
│   │   └── sounder
│   │       ├── processed ............ csv files
│   │       └── raw .................. raw echosounder files
│   └── sidescan_sonar
│       ├── CSF ...................... *.csf files of all lines
│       ├── mosaic ................... geoTiff mosaic of all lines
│       ├── nav ...................... ASCII navigation files
│       └── XTF ...................... *.xtf files for all lines
└── sub_bottom ....................... *.sgy files for all lines
```

Appendix E Geodatabase structure

The geodatabase serves as a GIS data repository for the layers creted from raw data collected during this project. The benefit of housing all the data in a shared geodatabase is a common reference coordinate system shared between all GIS layers, as well as ease of access and security in future editing.

All data layers share the NAD83 CSRS reference datum and are projected into UTM coordinates in zone 19.

```
Iqaluit.gdb
├── Survey_Other
│   ├── ADCP_moorings_2011
│   ├── bkwtr ........................ RTK-GPS point elevation data on the main breakwater
│   ├── bldgs ..................... RTK-GPS survey points coastal infrastructure foundations
│   ├── camera_transects_2011_line ...................... underwater drop camera transects
│   ├── ctd_2011 ................................................ CTD profile locations
│   ├── RBR .................................. location of TWR recorders 2010 deployments
│   ├── RBR_2011 ............................. location of TWR recorders 2011 deployments
│   ├── smpl .................................... location of 2010 sediment sampling sites
│   ├── smpl_2011 ............................... location of 2011 sediment sampling sites
│   ├── smpl_grab2011 ................................ location of 2011 grab sampling sites
│   └── stratabox_lines .............................. location of sub-bottom profile lines
├── Surveys_Raw ............................. RTK-GPS surveys for each day of surveying
├── Transects_2009 ........................................ RTK-GPS transect lines 2009
├── Transects_2010 ........................................ RTK-GPS transect lines 2010
├── Transects_2011 ........................................ RTK-GPS transect lines 2011
│   ├── *_ext .................................... transect extensions offshore using sounder
│   └── *_ice .......................................... transect lines on ice February 2011
└── iqaluit_ss_mosaic .......................... Sidescan mosaic in Iqaluit harbour, 2011
```