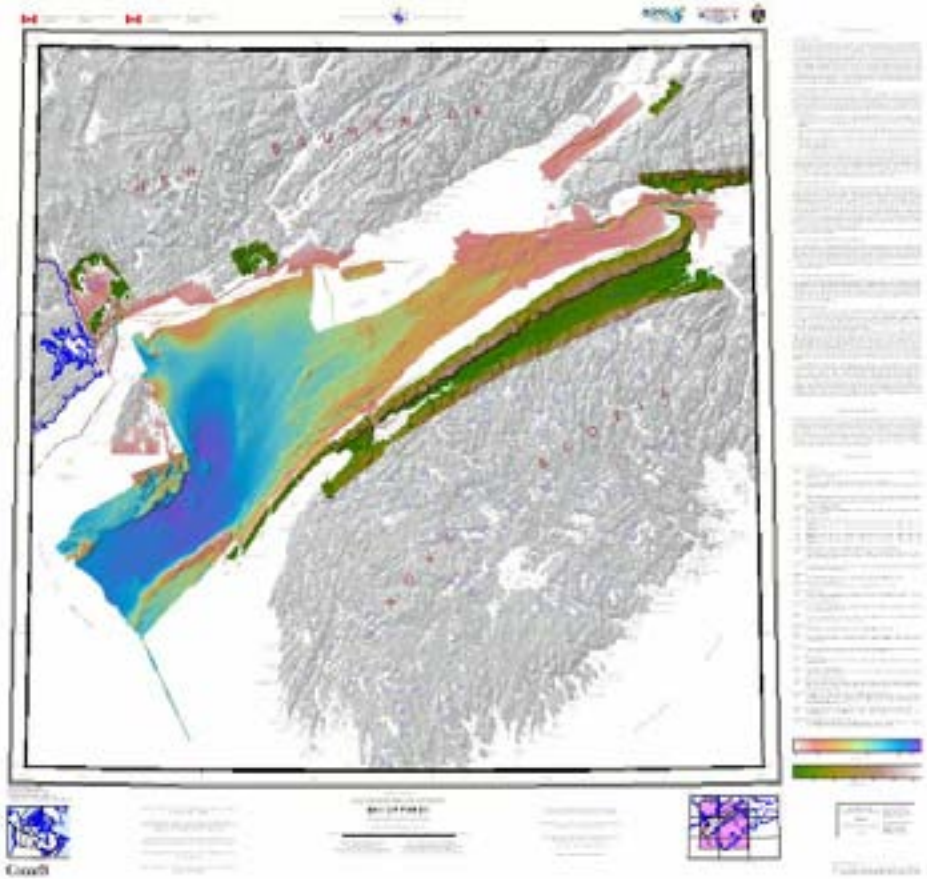
Integration of Multibeam Bathymetry and LiDAR Surveys of the Bay of Fundy, Canada



Partners

- **Geological Survey of Canada**
  - **Natural Resources Canada**
- **Canadian Hydrographic Service**
  - **– Fisheries and Oceans Canada**
- **Ocean Mapping Group**
  - **University of New Brunswick**
- **Applied Geomatics Research Group**
  - **– College of Geographical Sciences**

D. Russell Parrott[1], Brian J. Todd[1], John Shaw[1], John E. Hughes Clarke[2], Jonathan Griffin[3], Bruce MacGowan[3], Michael Lamplugh[3] and Tim Webster[4]

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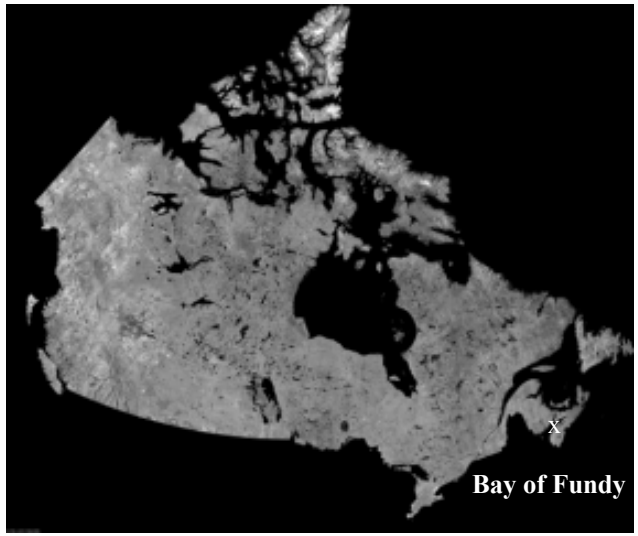
2 Ocean Mapping Group, Department of Geodesy and Geomatics Engineering, University of New Brunswick, Fredericton, NB. (jhc@omg.unb.ca)
3 Canadian Hydrographic Service, Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS. (GriffinJ@mar.dfo-mpo.gc.ca)
4 Applied Geomatics Research Group, College of Geographical Sciences, Middleton, NS (Tim.Webster@nscc.ca)

Canadian Hydrographic Conference
Victoria, BC
5-8 May 2008



Outline of Presentation

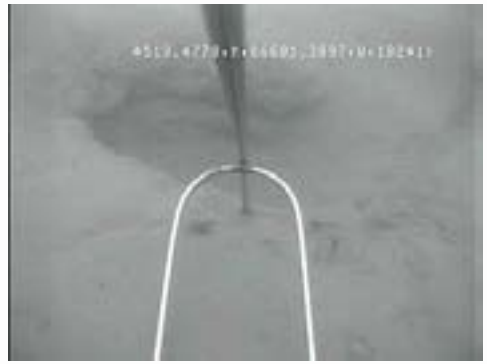
- Study Objectives
- Map Series
- Data Collected
  - 2006, 2007 multibeam bathymetry
  - previous multibeam bathymetry
  - LIDAR
  - existing geophysical data
  - maps
- Future Plans

Objectives

Geoscience for Ocean Mapping

Bay of Fundy Project

- This mapping is a national priority under the Canada Oceans Action Plan announced in the 2005 federal budget.
- The work is lead by the Geological Survey of Canada, Natural Resources Canada, in partnership with the Canadian Hydrographic Service and Canadian universities and colleges.
- Previous surveys in the Bay of Fundy have collected a variety of geophysical and multibeam bathymetry data, samples, and photographs. These regional scale data will be integrated with new multibeam bathymetry coverage from this survey to provide a better understanding of the nature and distribution of the surficial sediments and benthic habitat for the Bay.
- In selected coastal regions around the Bay, the marriage of airborne topographic LIDAR and bathymetric survey data with shipborne data will provide a seamless digital elevation model across the intertidal zone.
- The resulting 1:50 000 scale maps will be released as part of the new NRCan national marine map series and will include sheets of sea floor topography, backscatter strength, and surficial geology.
- The Bay of Fundy maps will be the crucial scientific underpinning for integrated ocean management.



GSC National Marine Map Series

First new offshore map series in 30 years

Established new standards for offshore maps

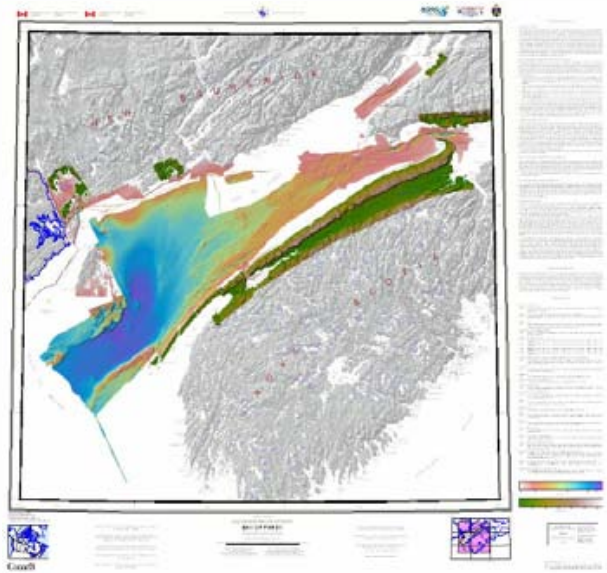
Three scales

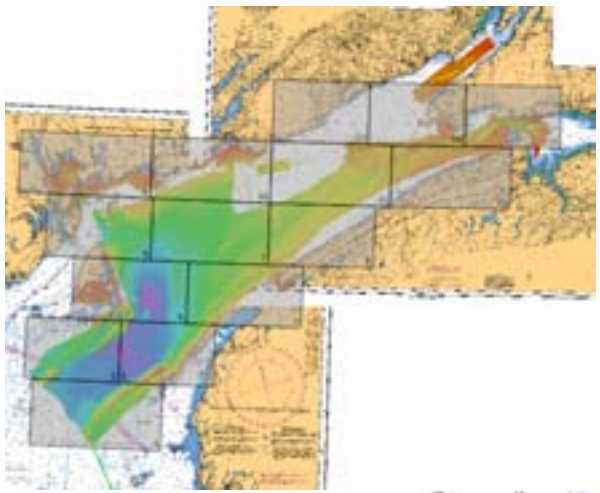
- **Regional (1:250,000)**
- **National multibeam series (1;50,000)**
- **Local multibeam based (1;10,000)**

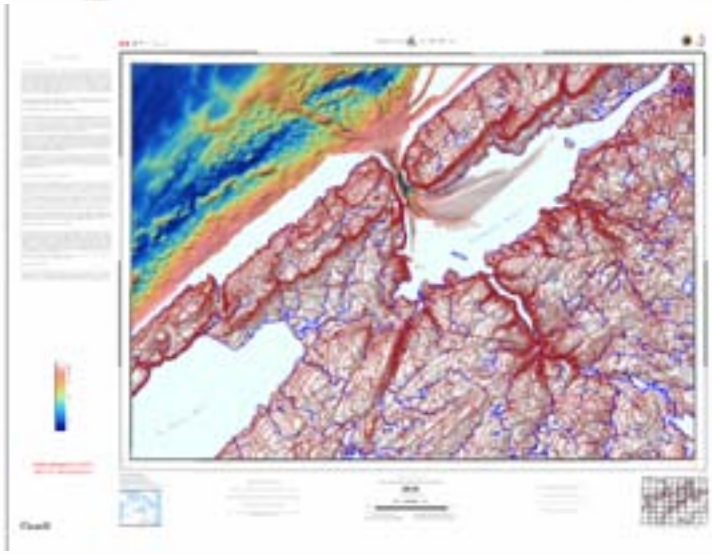
Four sheets per mapped area,

bathymetry **backscatter,**
geology **benthic habitat**

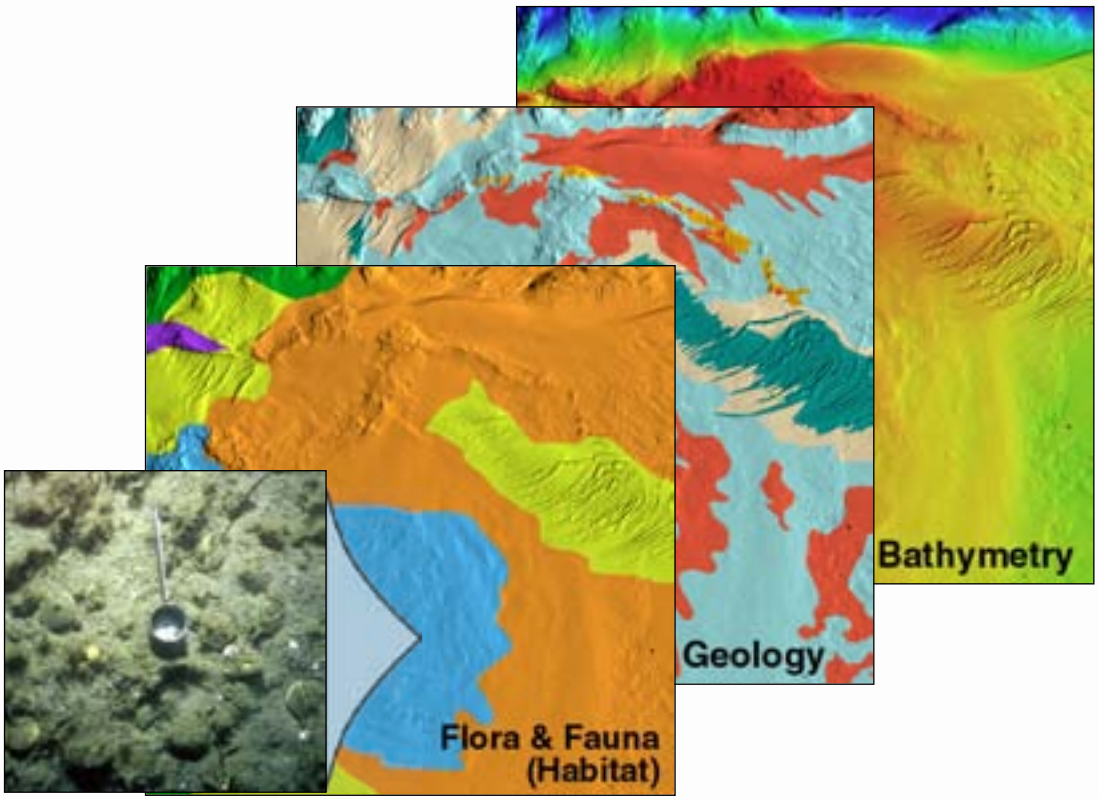
>100 map sheets planned





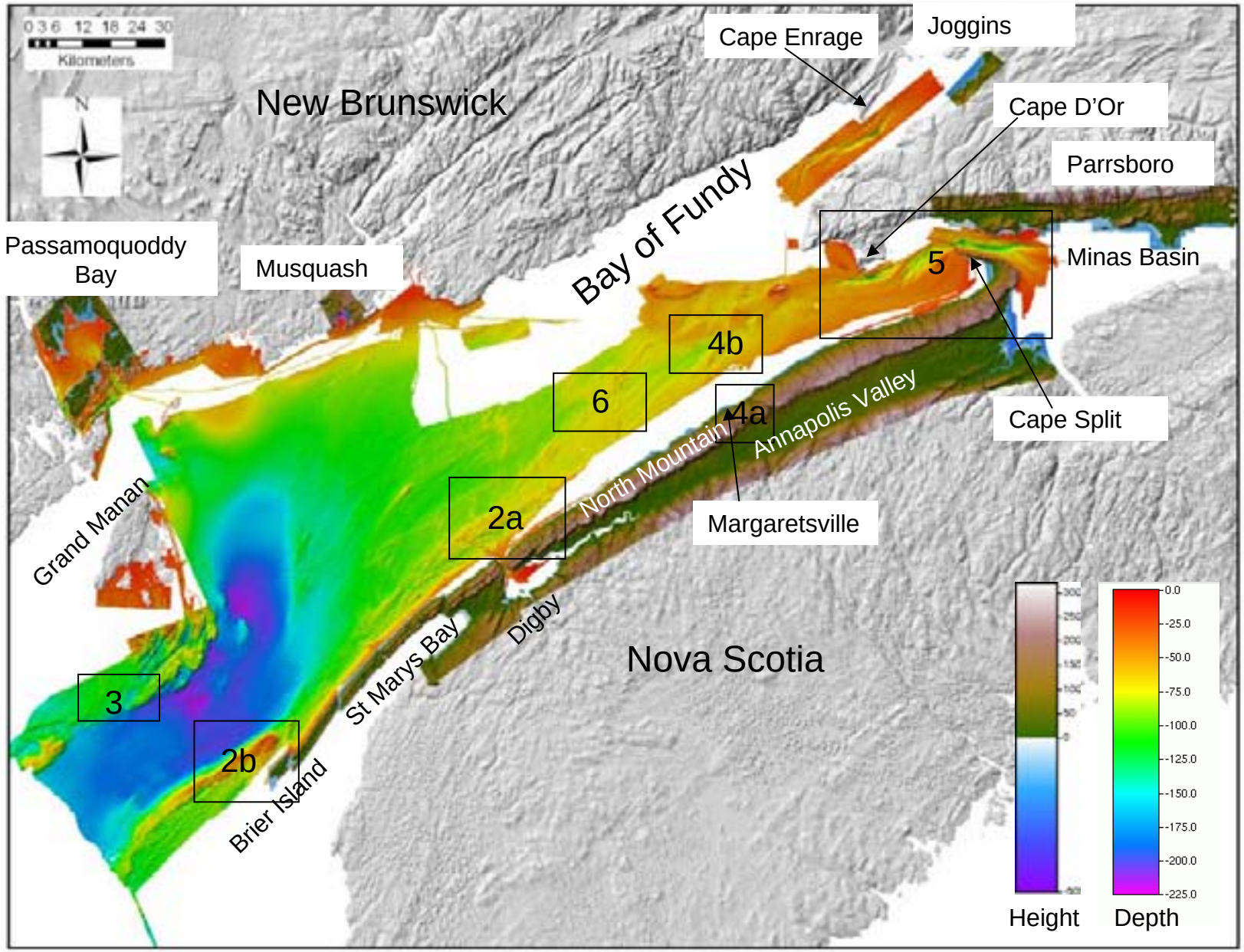


Integrated Seafloor Mapping, A Tool to Deliver Integrated Ocean Management



- **Multibeam bathymetry: color shaded, sun illuminated relief image**
- **Geology: color coded sediment type, draped over bathymetry, derived from traditional geoscience ground truth surveys**
- **Habitat: color coded community structure, statistically derived draped over bathymetry**
- **Bottom photography: benthic habitat**

"Foundation maps and data sets to deliver Integrated Ocean Management"


0 3 6 12 18 24 30
Kilometers
N
New Brunswick
Cape Enrage
Joggins
Cape D'Or
Parrsboro
Passamoquoddy Bay
Musquash
Bay of Fundy
5
Minas Basin
4b
6
4a
Annapolis Valley
Cape Split
North Mountain
Margaretsville
2a
Grand Manan
3
2b
Brier Island
St Marys Bay
Digby
Nova Scotia
Height
Depth
0.0
-25.0
-50.0
-75.0
-100.0
-125.0
-150.0
-175.0
-200.0
-225.0

Data Integration to provide a better understanding of the geological history of an area

Information from charts

Multibeam bathymetry –

2-5 m resolution 10000 km^2 to date

Single beam bathymetry –

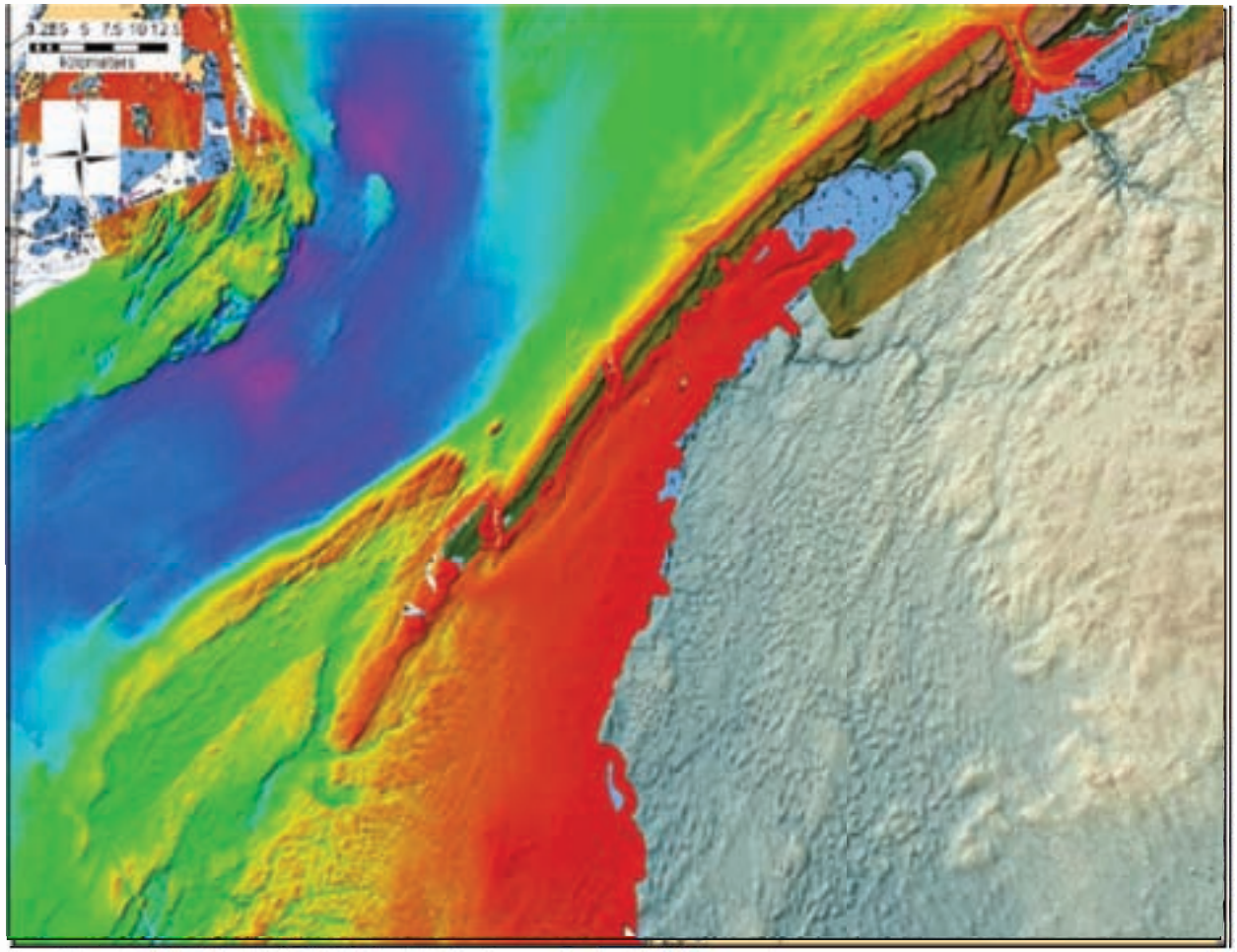
Olex system – 30-200 m resolution

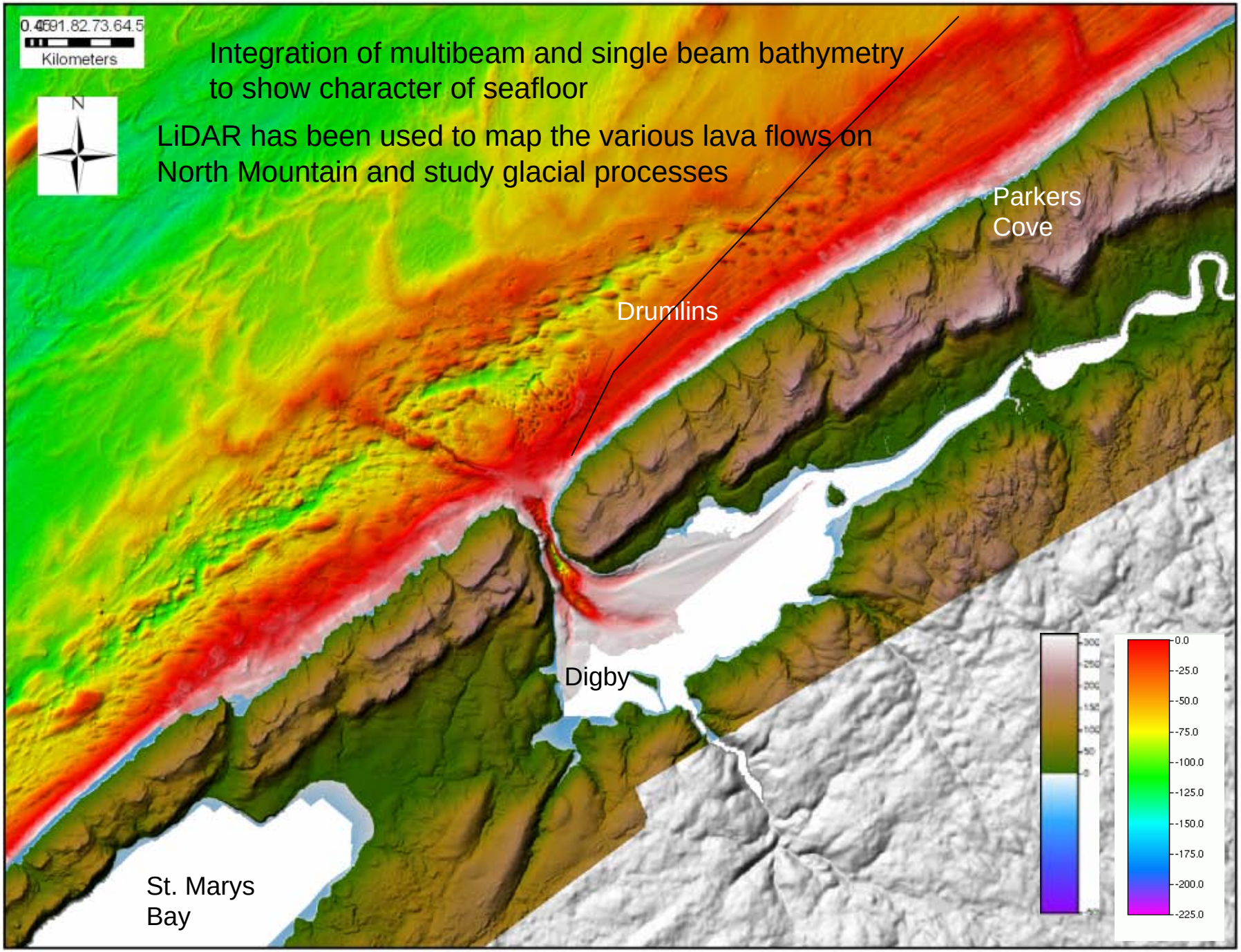
Topographic data

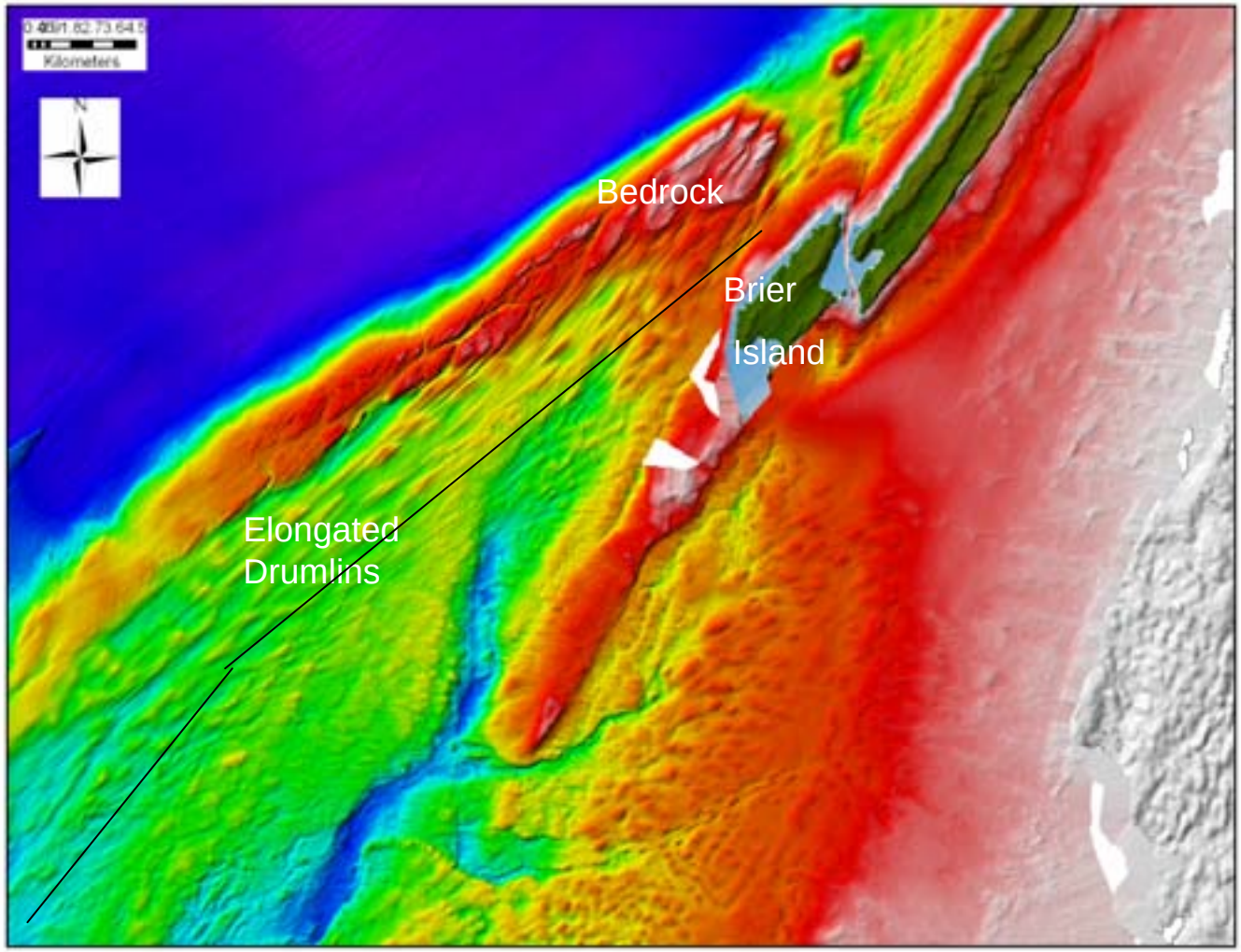
– SRTM 30 m grid

LiDAR

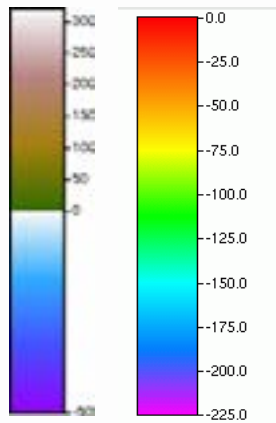
2-5 m resolution 4000 km^2 to date

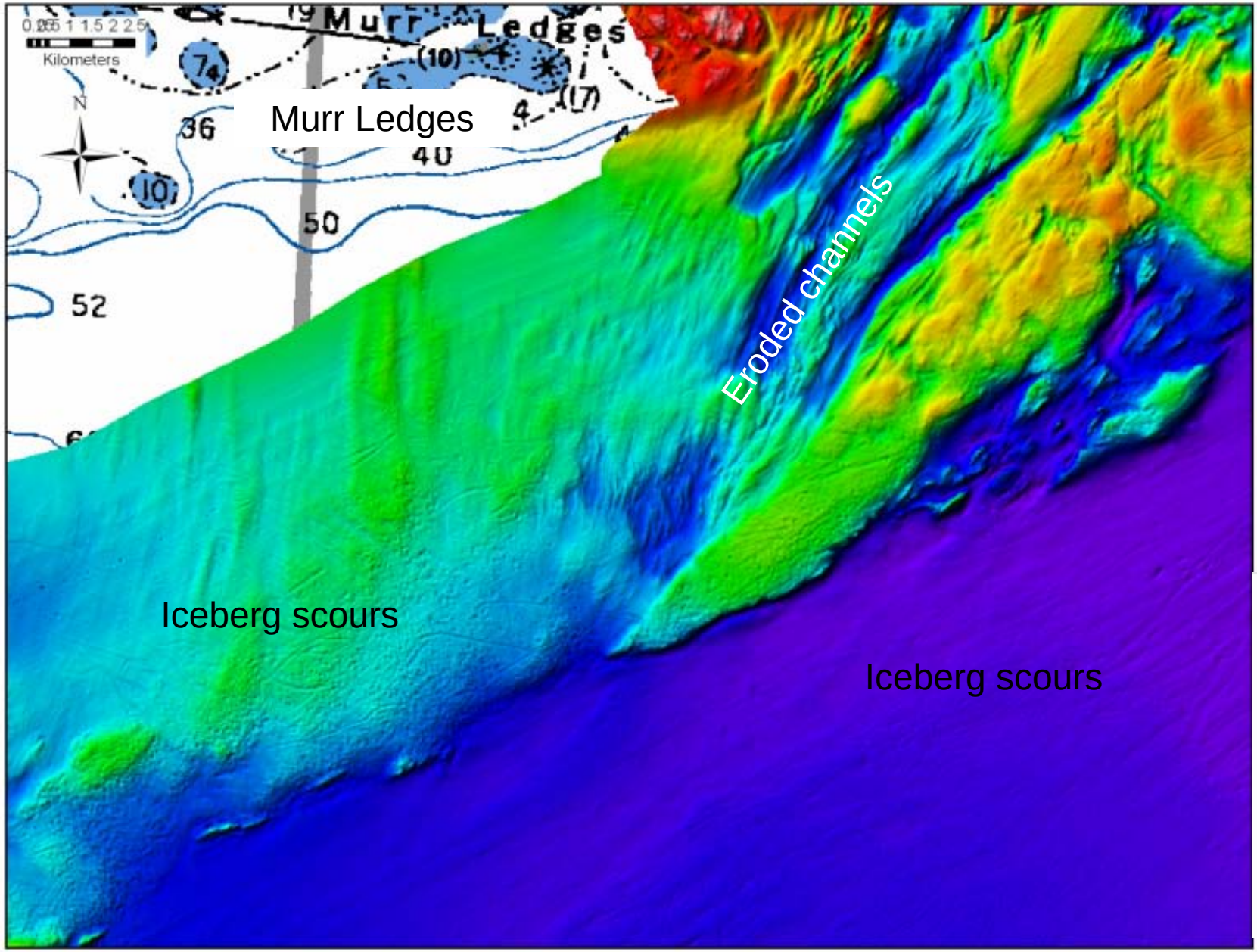


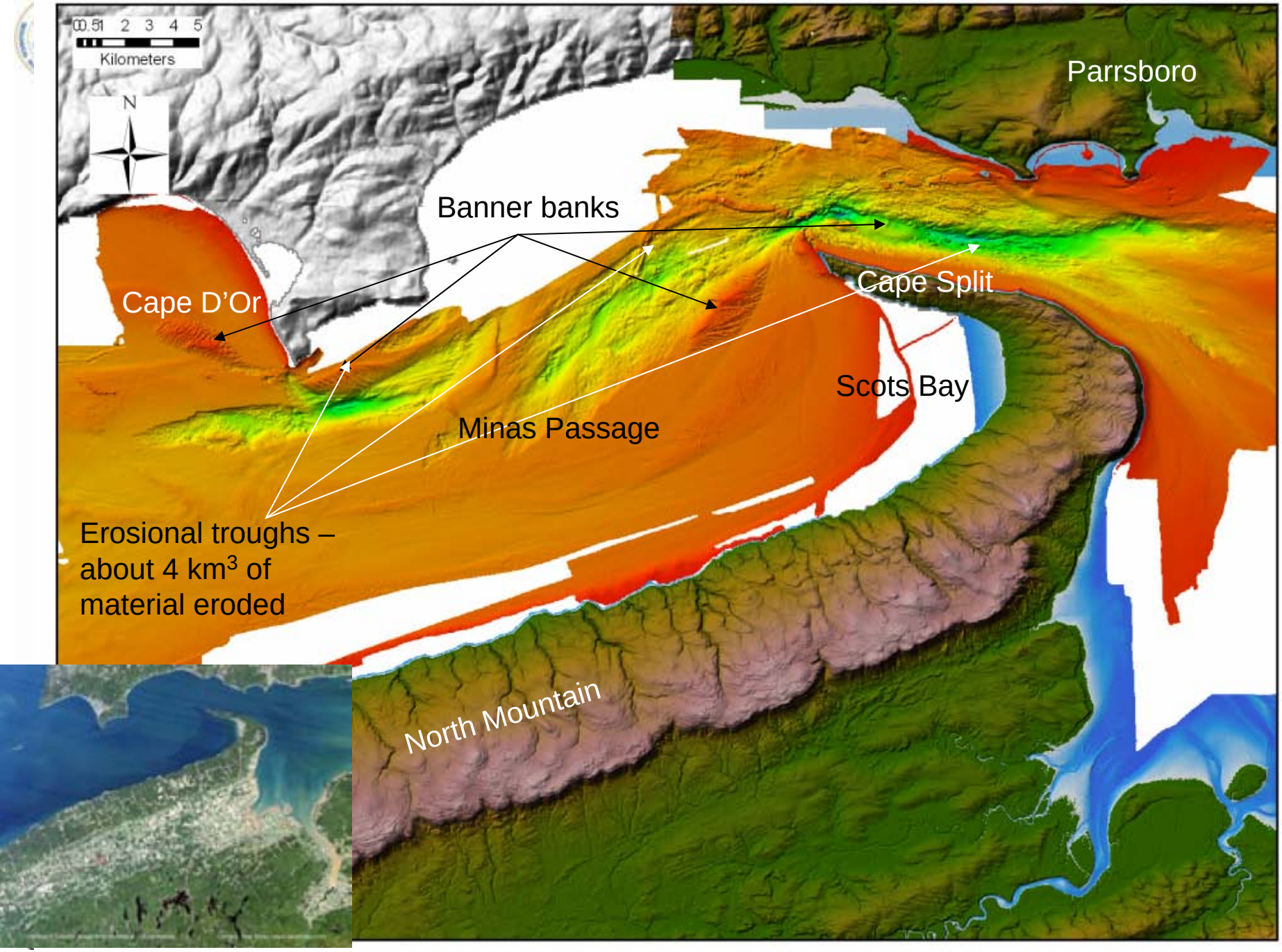

0.4591.82.73.64.5
Kilometers
N
Integration of multibeam and single beam bathymetry to show character of seafloor
LiDAR has been used to map the various lava flows on North Mountain and study glacial processes
Parkers Cove
Drumlins
Digby
St. Marys Bay
0.0
-25.0
-50.0
-75.0
-100.0
-125.0
-150.0
-175.0
-200.0
-225.0



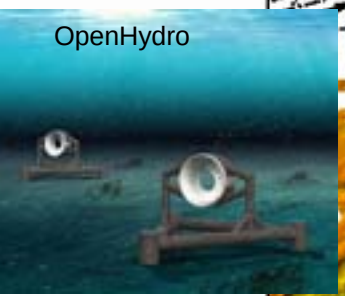
Integration of multibeam and single beam bathymetry to show character of seafloor




Murr Ledges
Murr Ledges
Eroded channels
Iceberg scours
Iceberg scours
Kilometers
36
40
50
52

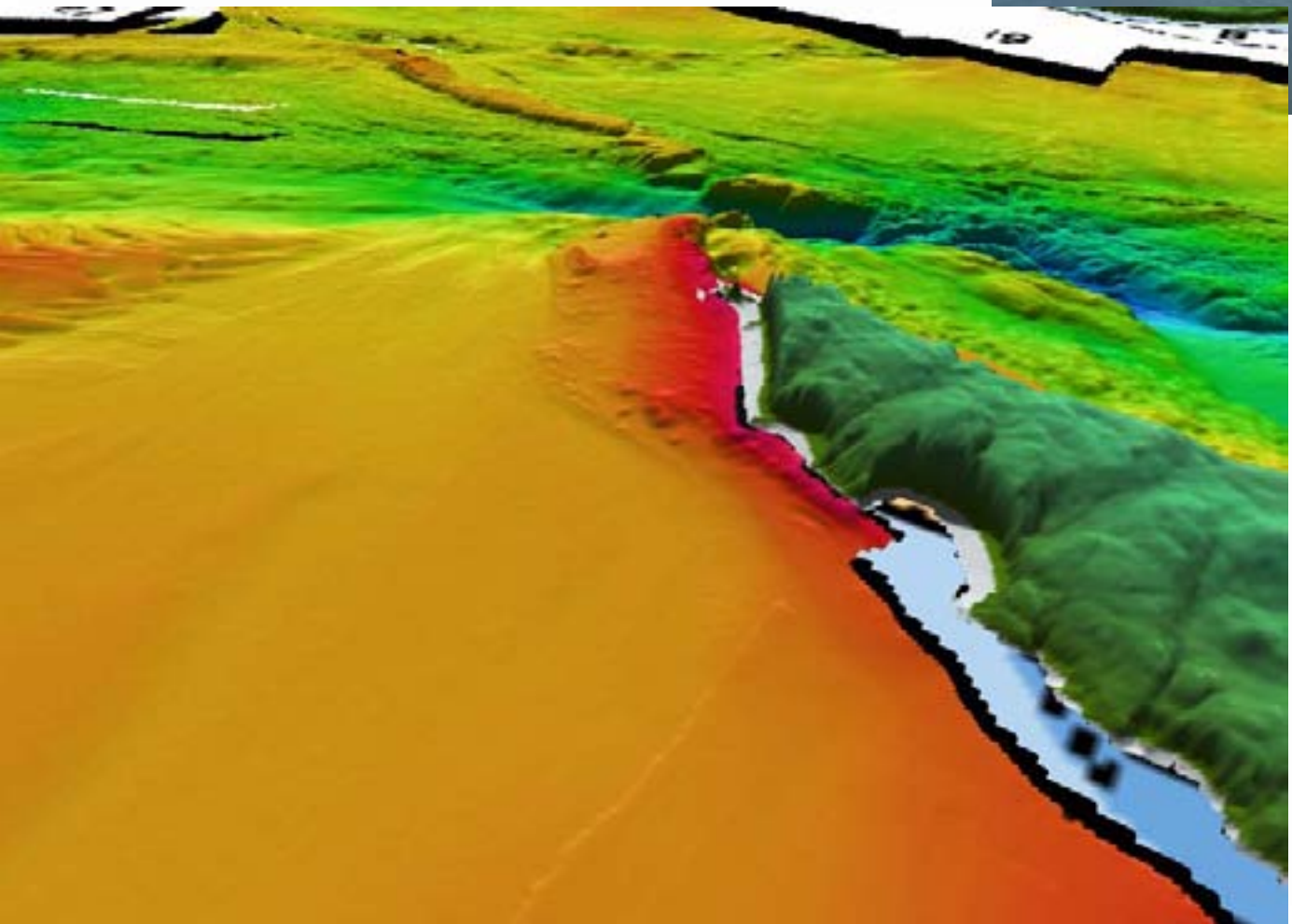

0 0.51 2 3 4 5
Kilometers
N
Parrsboro
Banner banks
Cape D'Or
Cape Split
Scots Bay
Minas Passage
Erosional troughs – about 4 km3 of material eroded
North Mountain

Bay of Fundy Mapping Project –multibeam bathymetry and LiDAR data collection 2006 and 2007



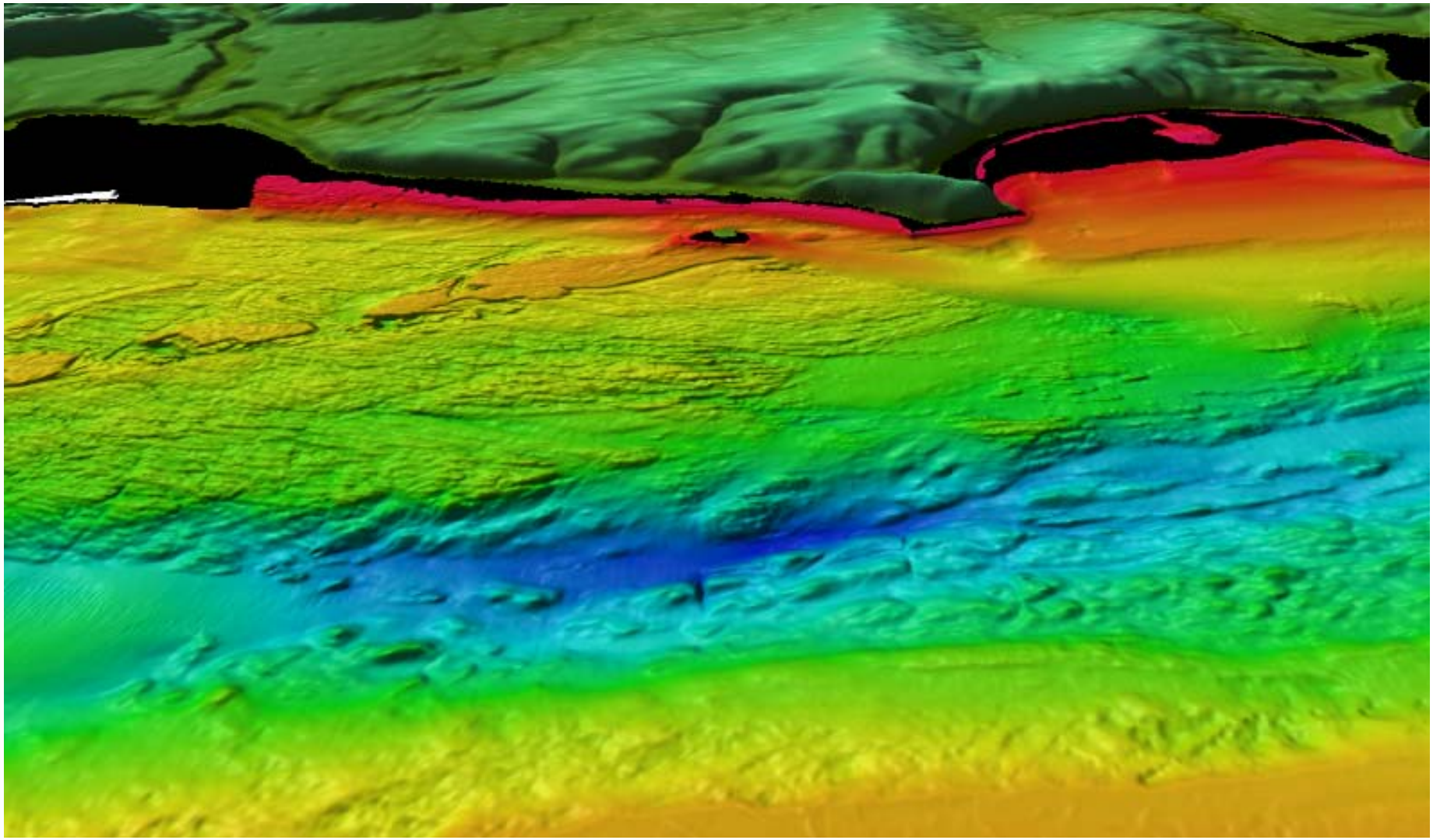
Minas Passage data coverage

Cape Split – ever wonder about the currents in the area ?



Natural Resources Canada | Ressources naturelles Canada

Parrsboro LiDAR and Multibeam Bathymetry



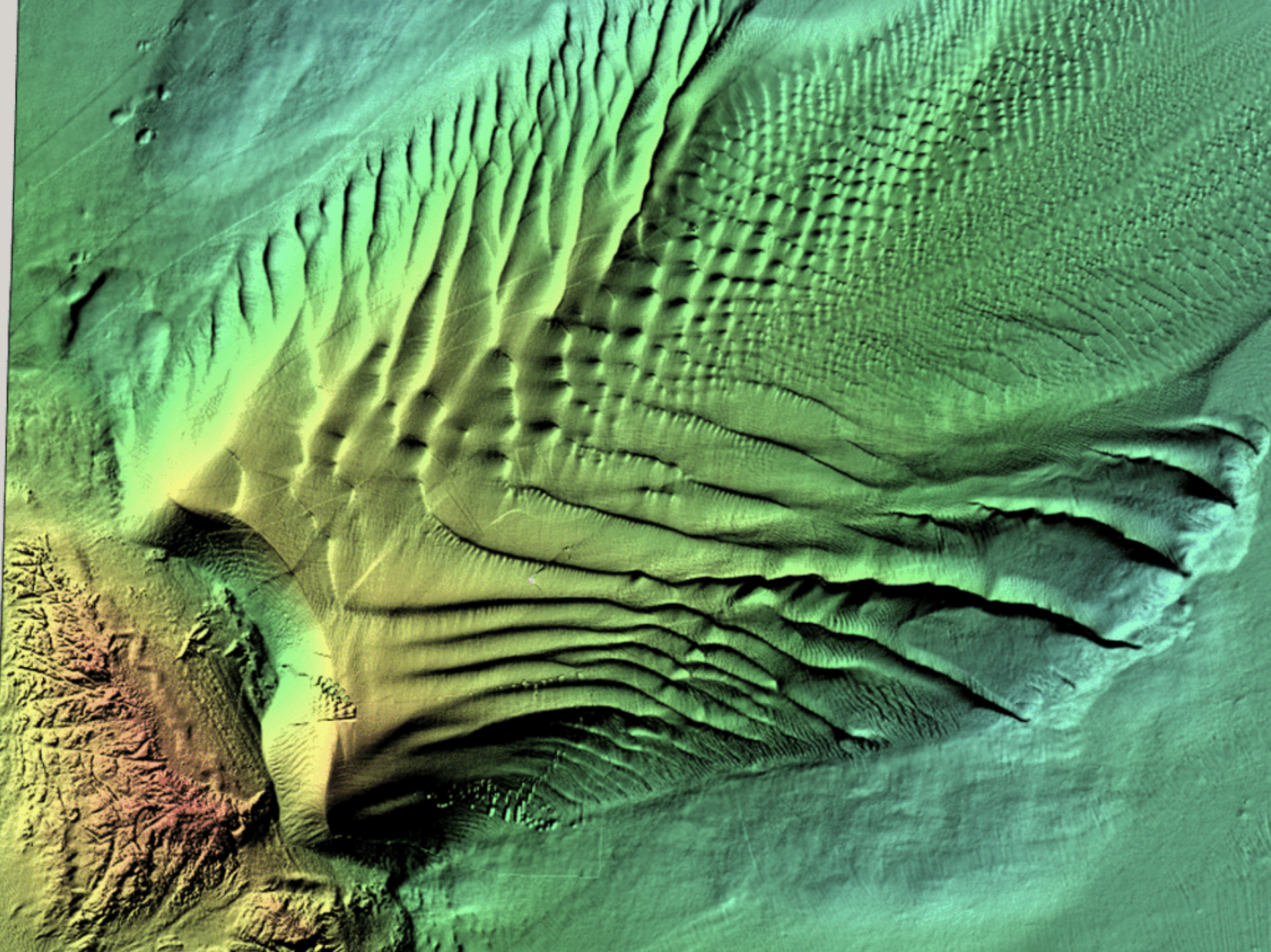
Bay of Fundy Mapping Project –multibeam bathymetry data collection 2006 and 2007

Quaco Ledge, in the middle of the Bay of Fundy data

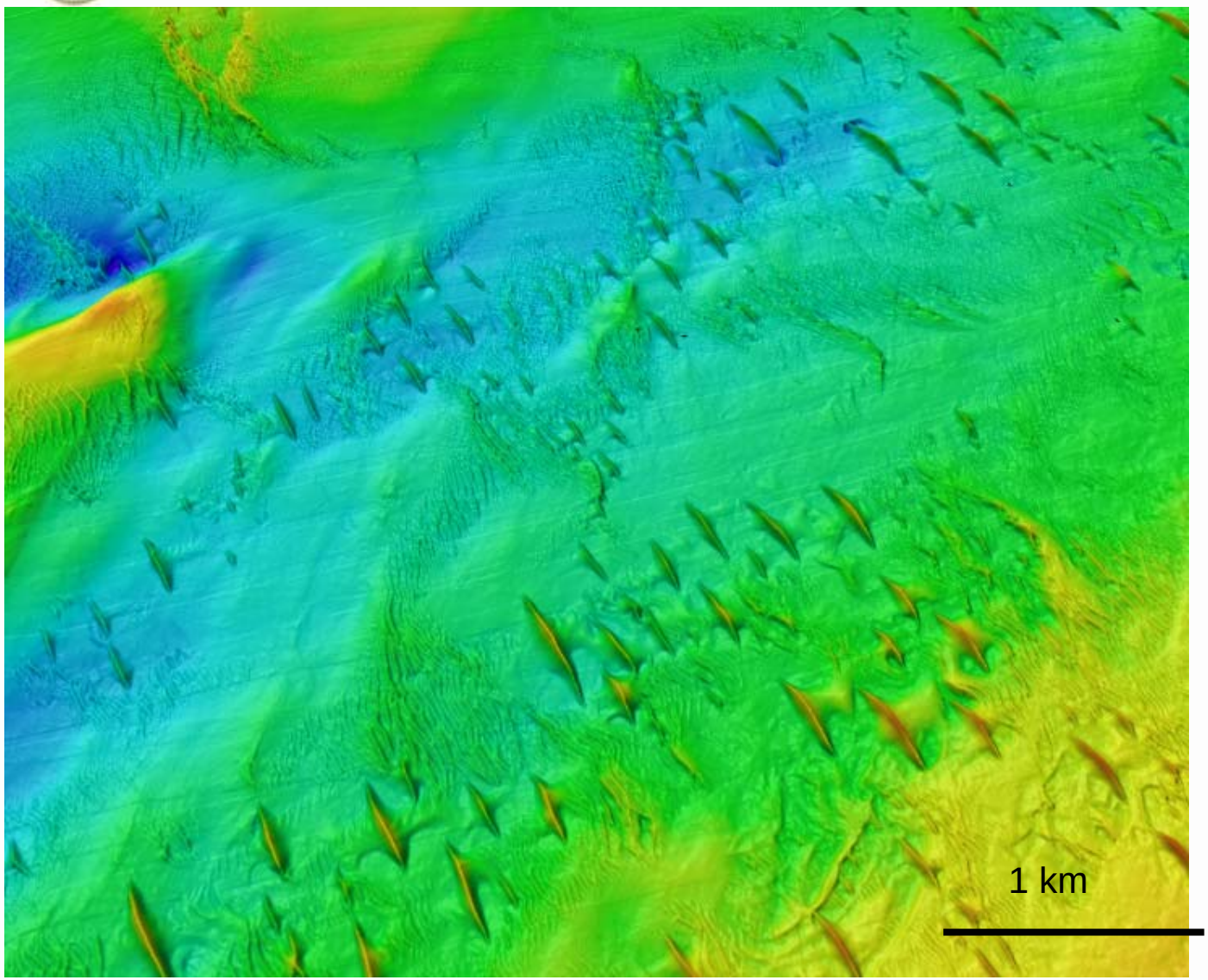
Note the interference patterns between the sand wave fields on either side of the ledge, and the erosion taking place northeast of the ledge. The sandwave field shows strong sediment transport on the flood tide, into the Bay of Fundy.

The bathymetry data will be made available to DFO to enable refinements in current and tidal models. Data from several tide gauges deployed by CHS will also be available.

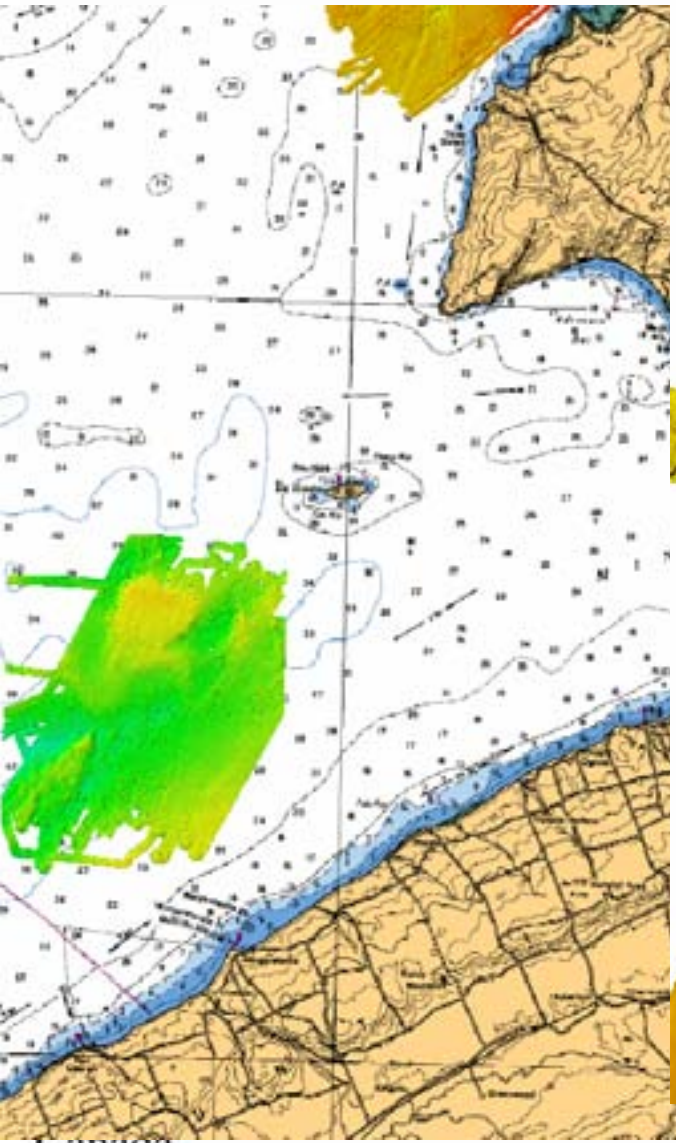
The level of detail available in the multibeam bathymetry data is shown in the next slide.

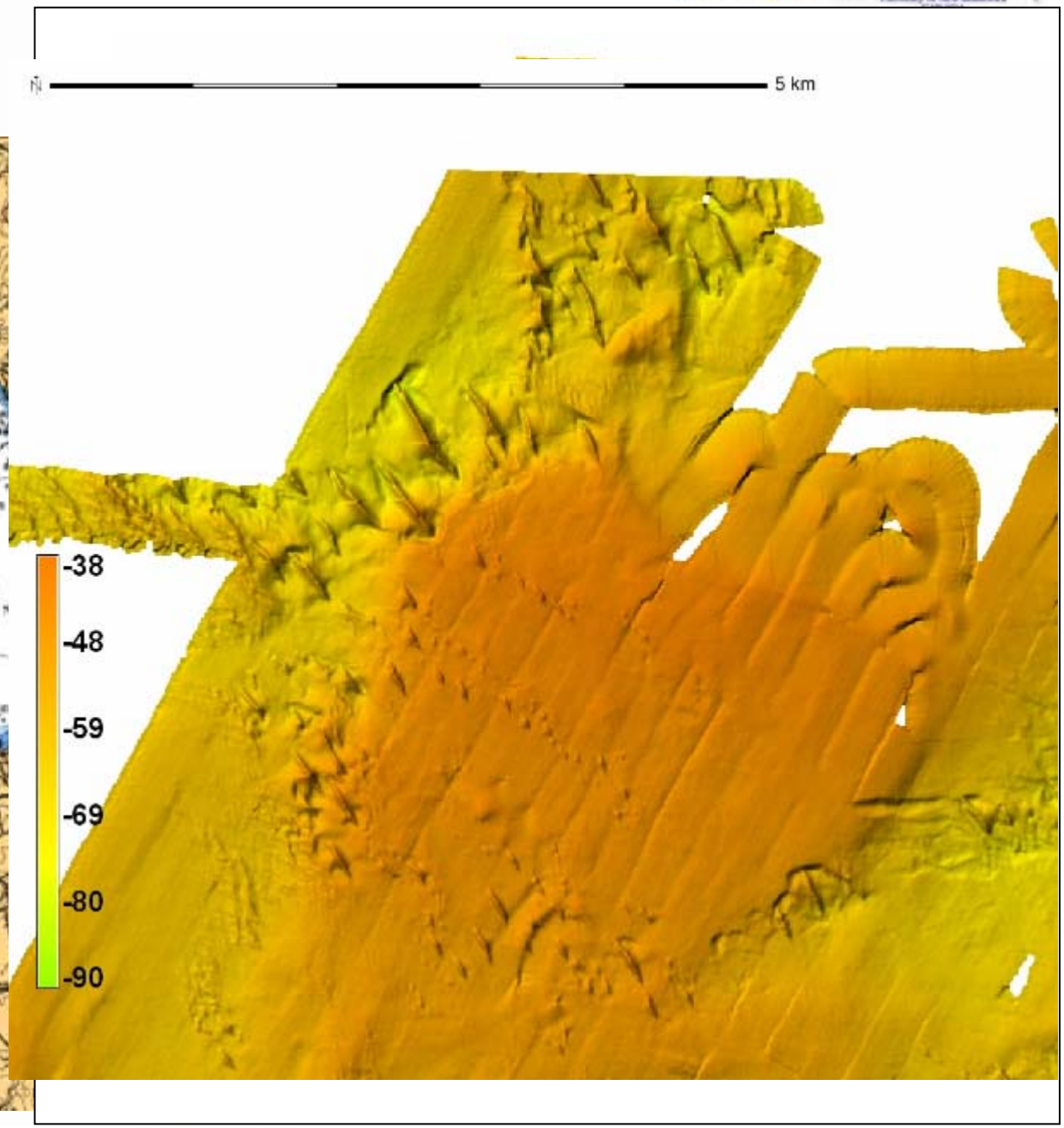


Margaretesville sand dune field



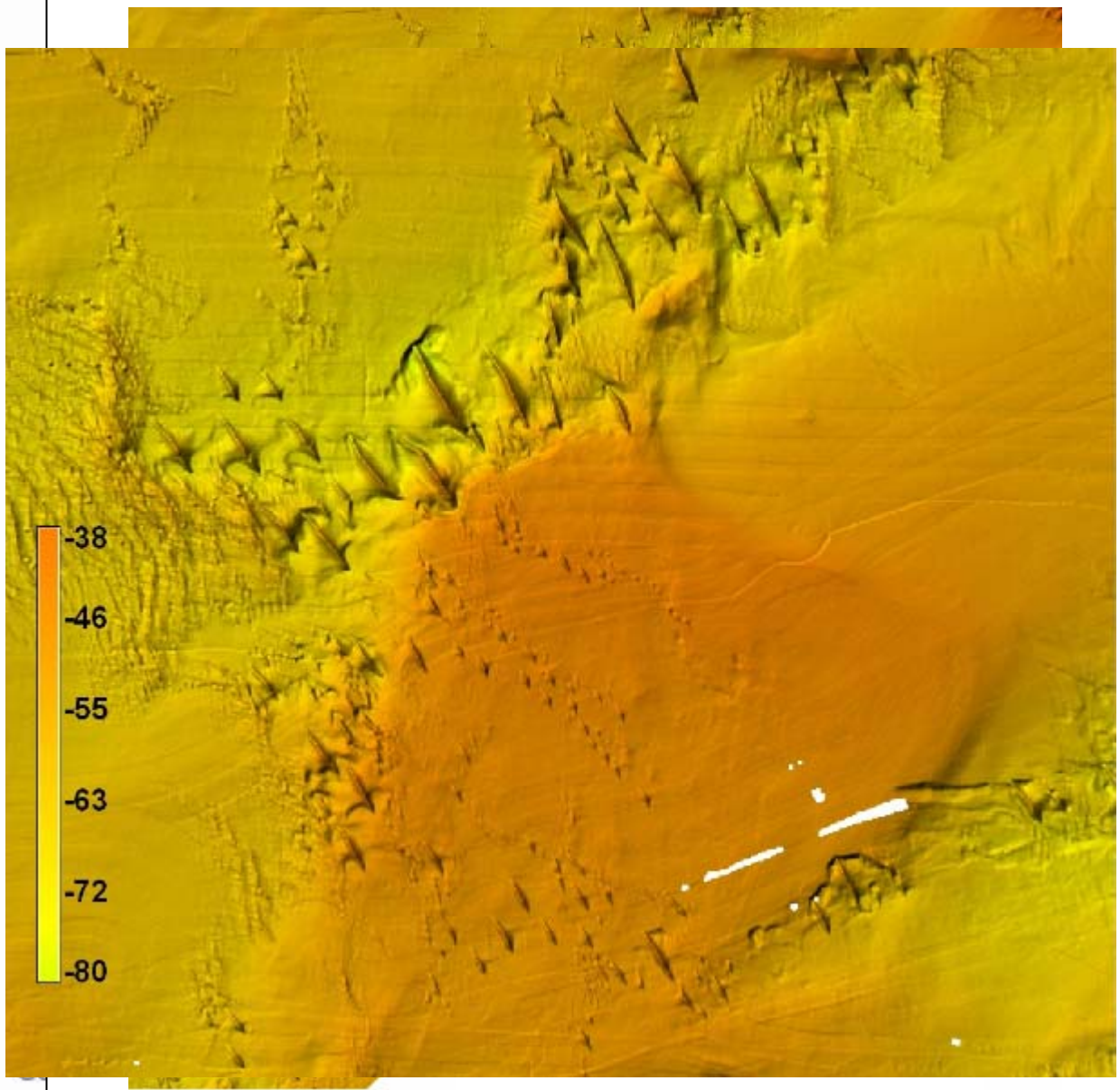
Repetitive survey studies 1993-2007





Canada

Differences in data from 1993 and 2007 will be studied to determine the stability of the large sand dunes (some of which are 21 m above the seafloor) and smaller sand waves, megaripples etc.



Preliminary Results Difference 1993 to 2007

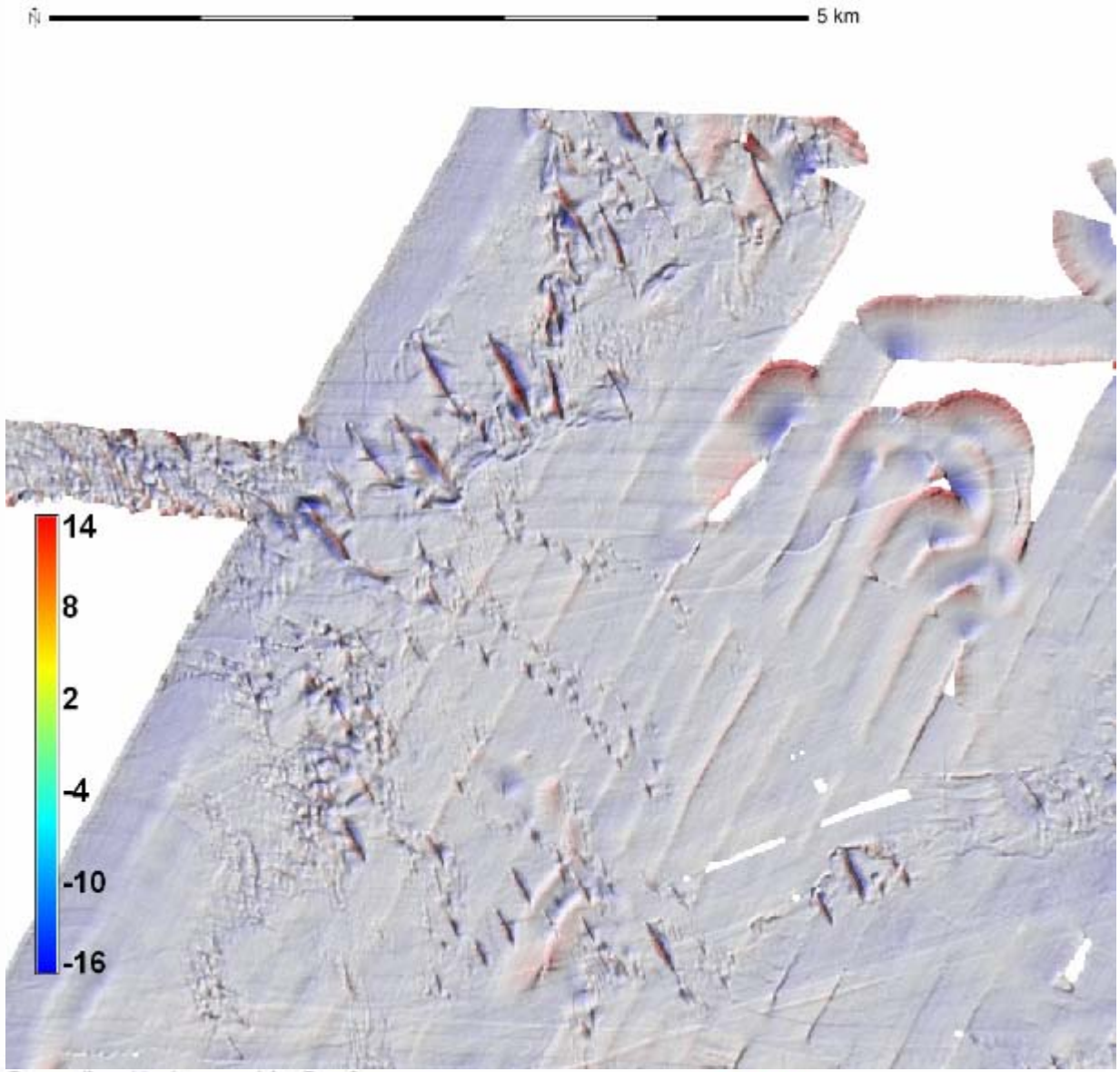
Margaretsville Dune Field

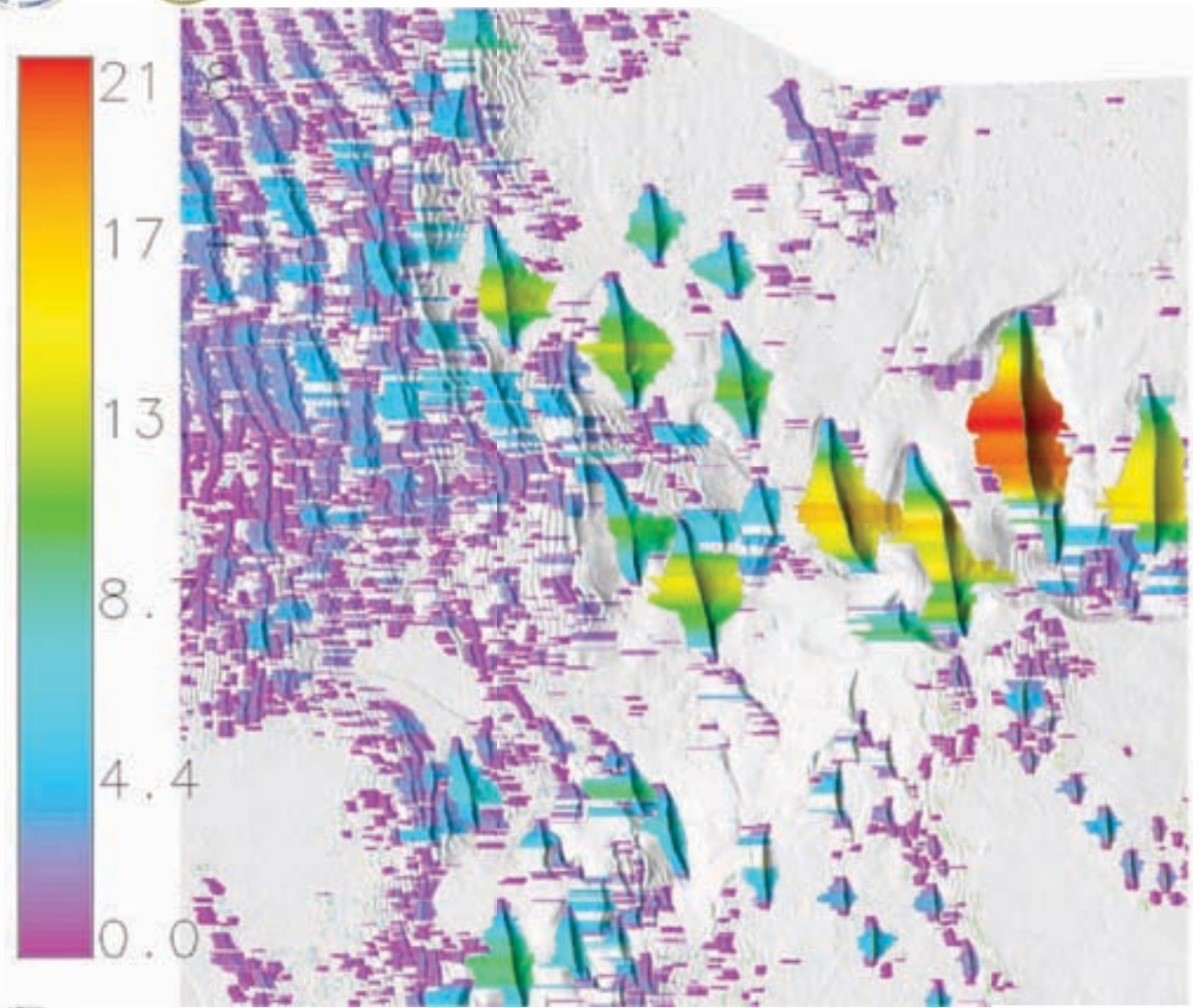
Dune crests offsets are on the order of ~35-45m in some areas.

The data still require analysis for systematic errors in navigation etc. before any real confidence can be place on the results.

RALPH will be deployed near this area to look at the seafloor character and change during late winter.

Transects will be run through the area in 2008 to investigate some of the larger features





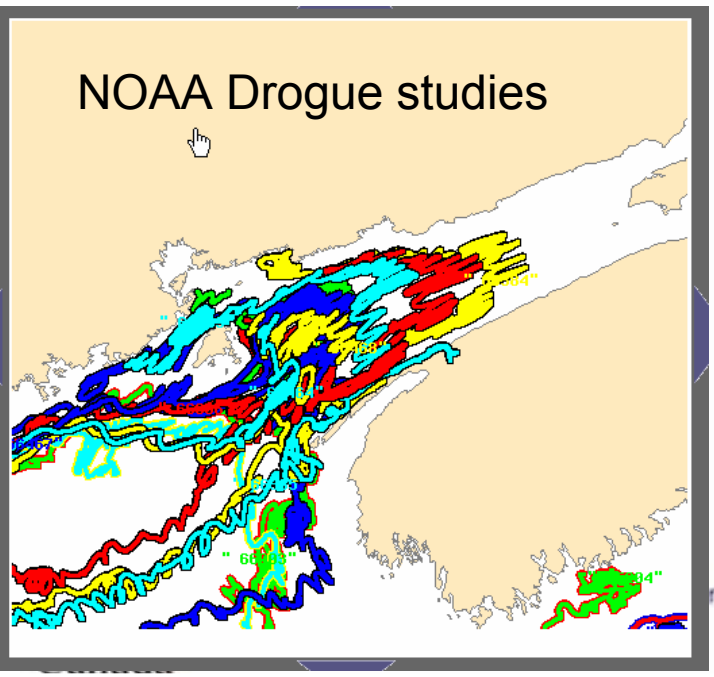
G. Duffy 2008

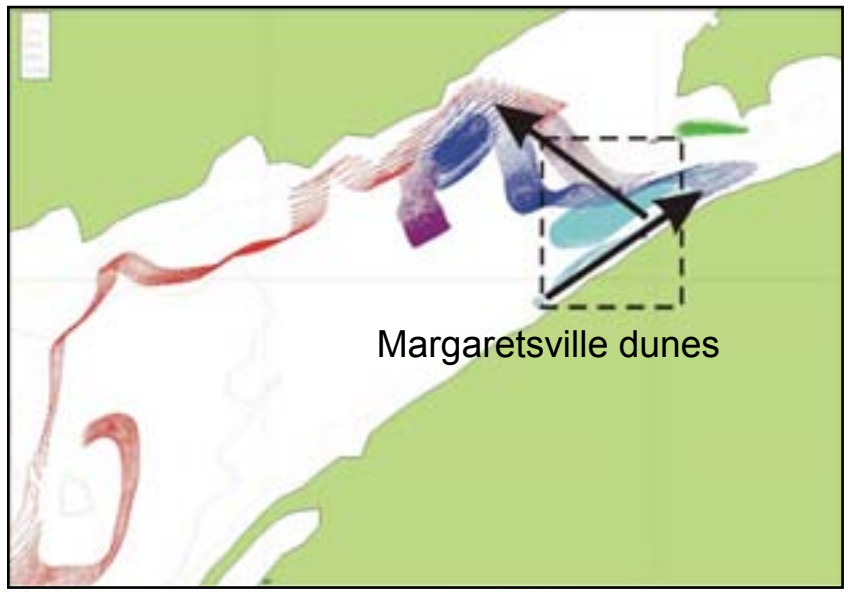
PDF at GSCA performing sediment transport studies on the Bay of Fundy data set

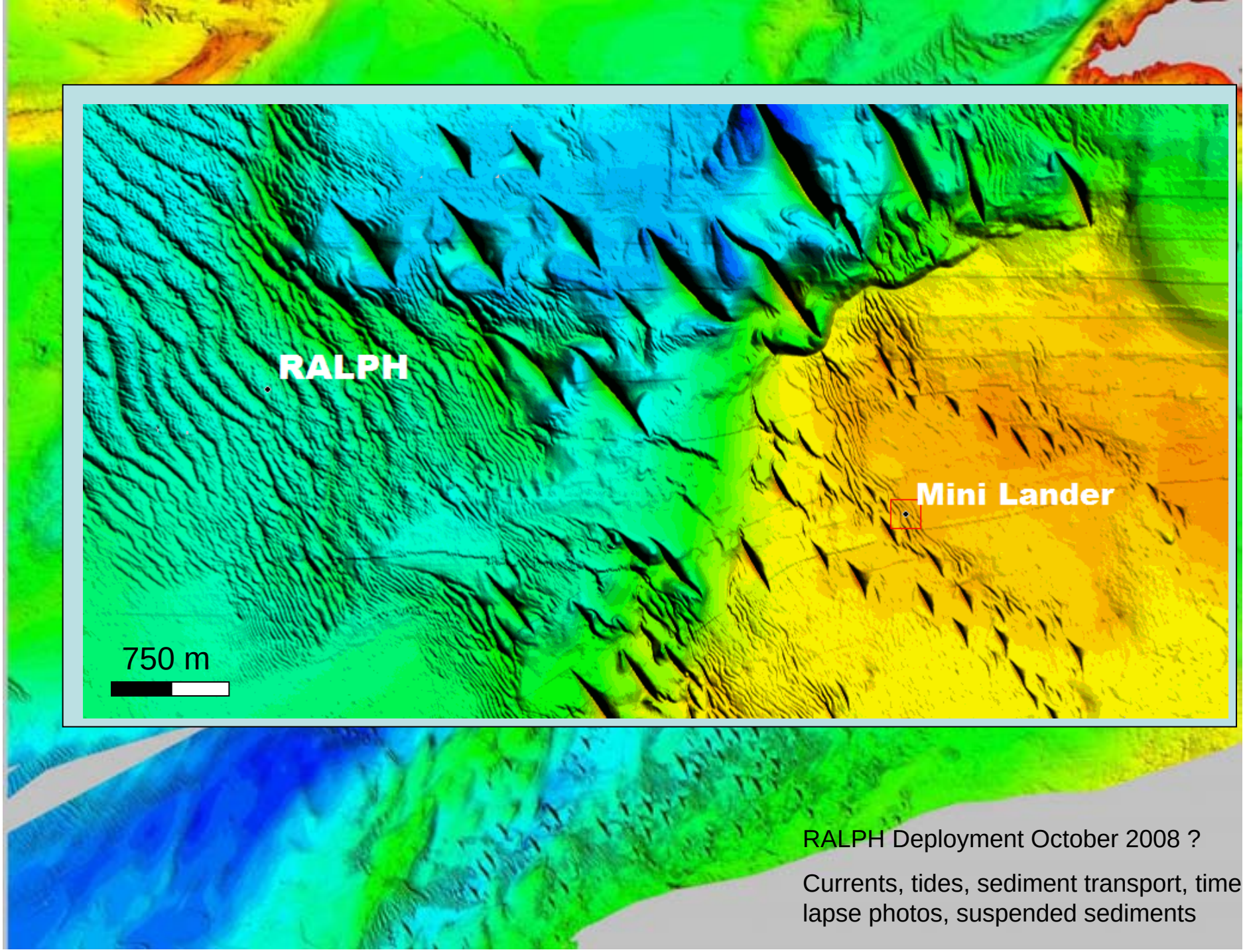
Automatic bedform detection and measurement

Tidal Circulation in the Bay of Fundy

- DFO's WebDrogue
- 2 main components of bottom-water movement
- M2 component moving up and down the Bay
- Smaller residual component oriented NNW
- Effect on Bedforms minimal



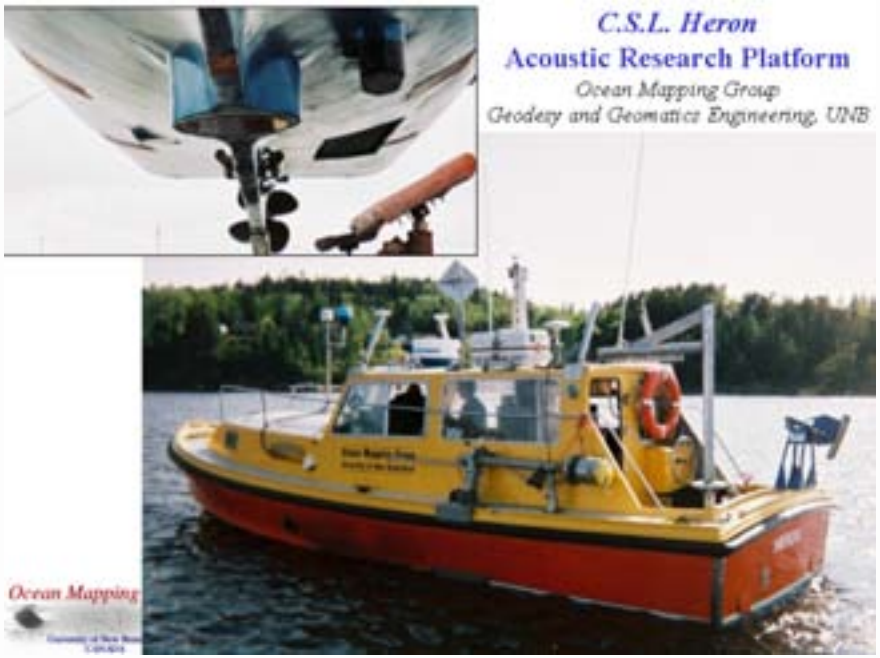




RALPH Deployment October 2008 ?

Currents, tides, sediment transport, time lapse photos, suspended sediments

University of New Brunswick
Ocean Mapping Group



CSL Heron

Kongsberg Simrad EM3002 multibeam bathymetry system

Knudsen 3.5 and 28 kHz sounders, and sidescan sonar

ADCP

Brooke Ocean MVP

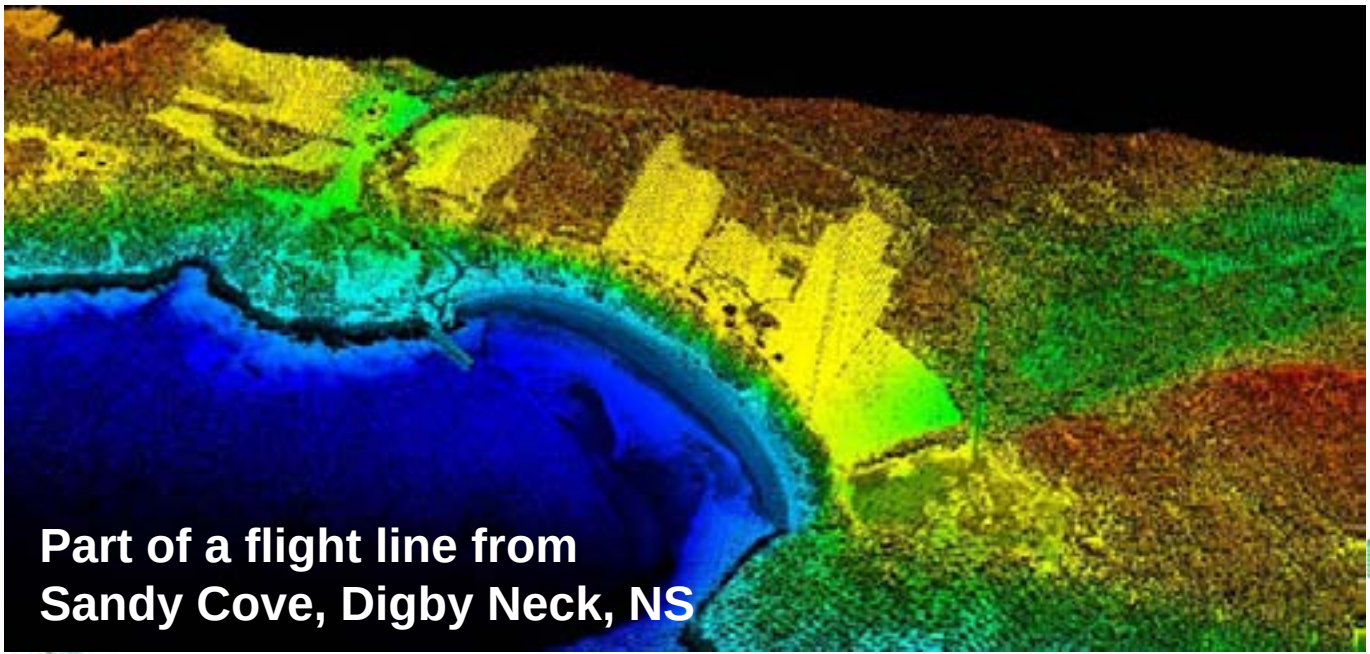
Near shore surveys and projects in partnership with GSC

- Data compilation and archiving using web tools
- Passamaquoddy Bay – data compilation and reduction to common datum
- Grand Manan near shore survey
- Maces Bay near shore survey
- Saint John harbour – surveys and data compilation
- MSc project to look at surficial geology between Saint John and Grand Manan using multibeam and 3.5 kHz data
- Long transects of temperature, depth and salinity collected with MVP on CCGS Creed and Matthew and all individual MVP profiles

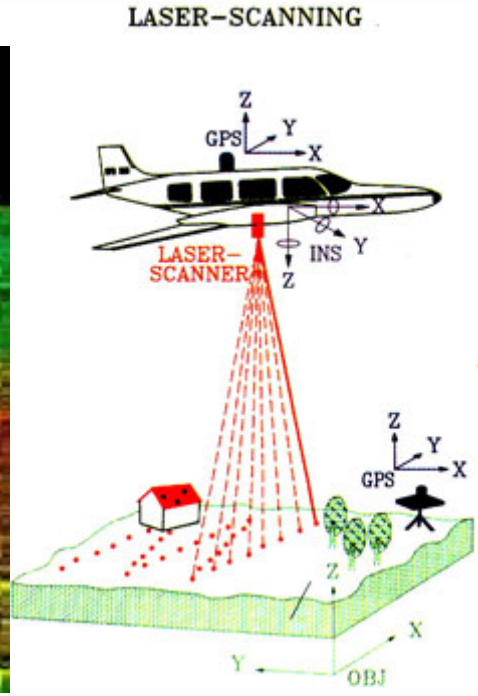
LiDAR

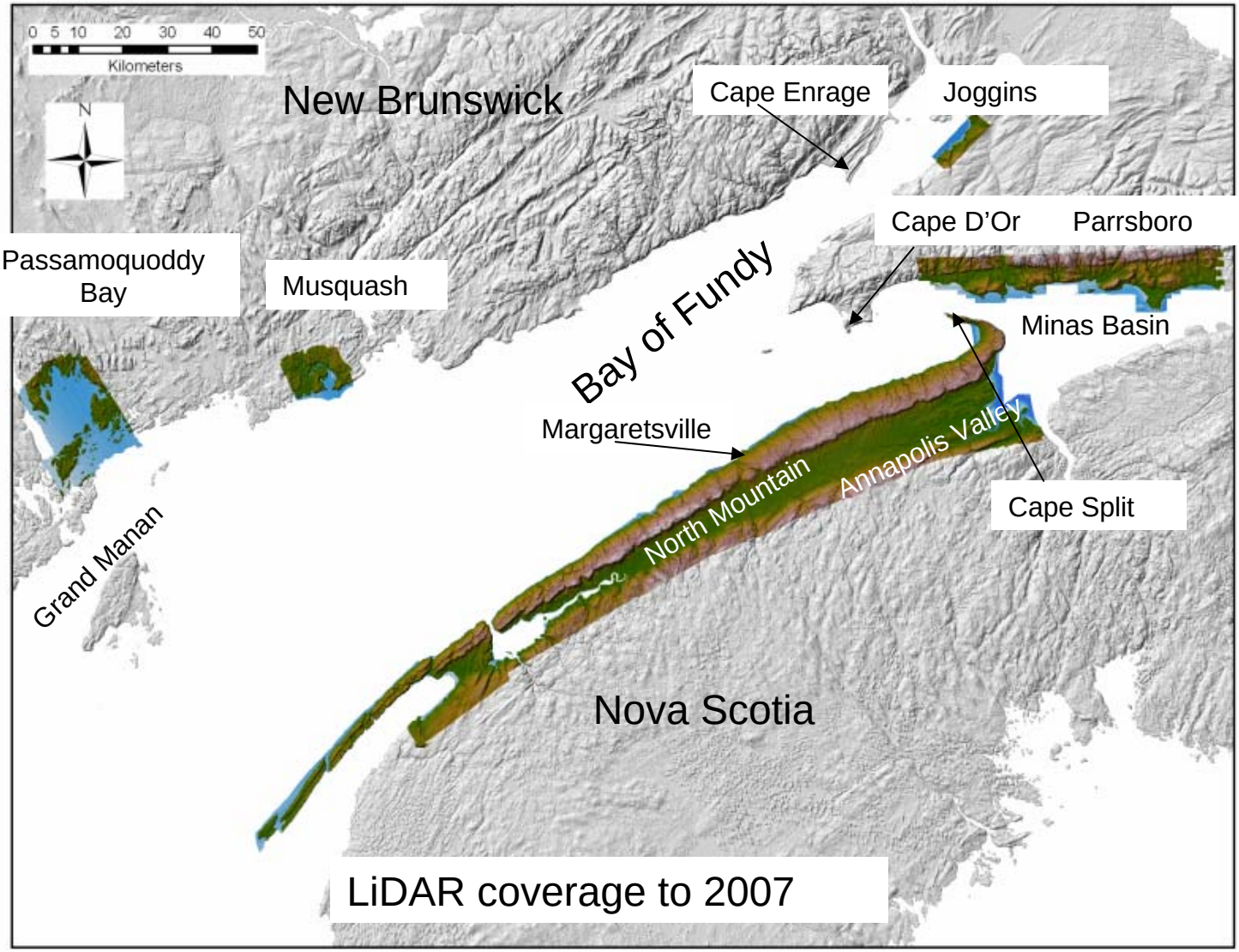
LiDAR was flown to provide coverage in the intertidal zone. Data has been collected along North Mountain, Passamaquoddy Bay, Musquash, Parrsboro, Joggins.

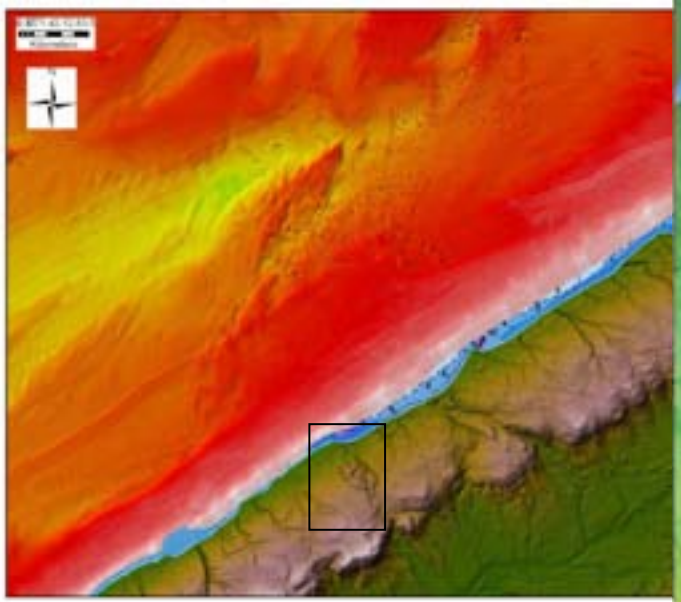
MSc thesis with COGS/Acadia to study raised beaches using LiDAR, low stands of sealevel using multibeam and integration of the data across the intertidal zone to provide a continuous record profile.

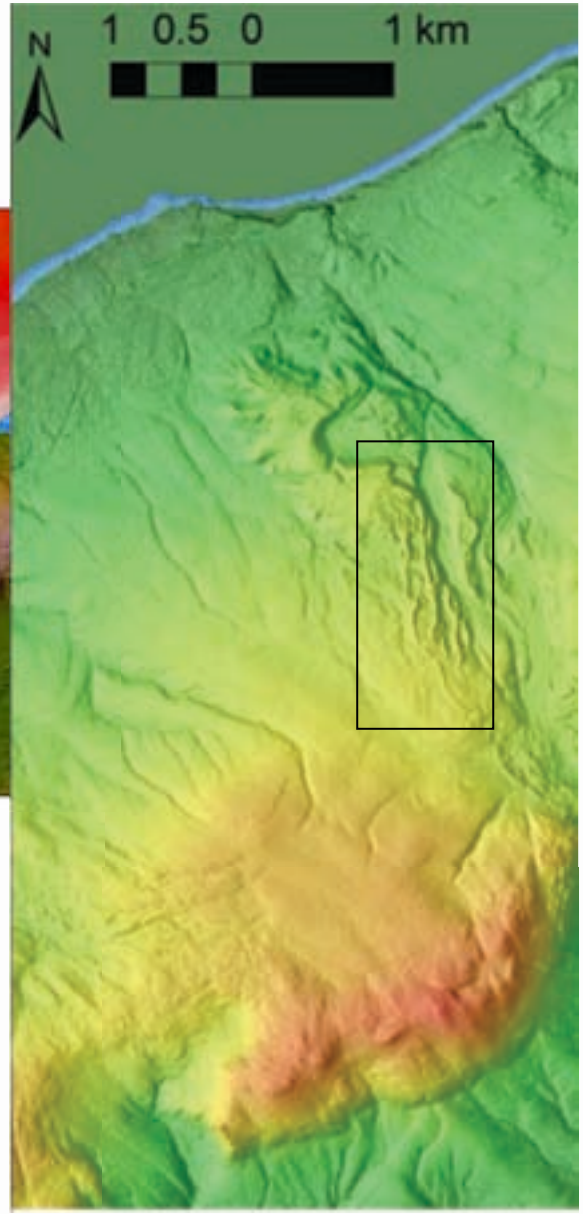


Part of a flight line from Sandy Cove, Digby Neck, NS

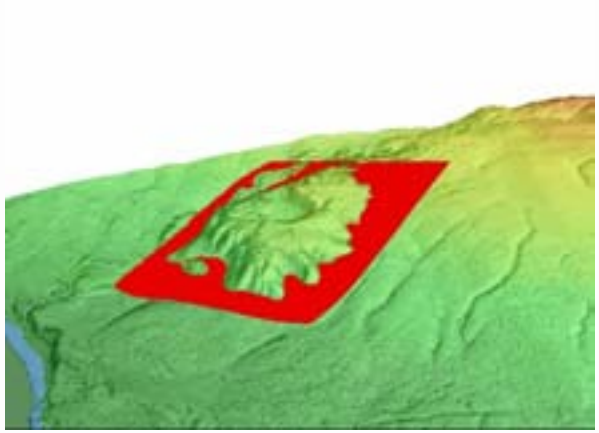



0 5 10 20 30 40 50
Kilometers
N
New Brunswick
Cape Enrage
Joggins
Cape D'Or
Parrsboro
Passamoquoddy Bay
Musquash
Bay of Fundy
Minas Basin
Margaretsville
Annapolis Valley
North Mountain
Cape Split
Grand Manan
Nova Scotia
LiDAR coverage to 2007

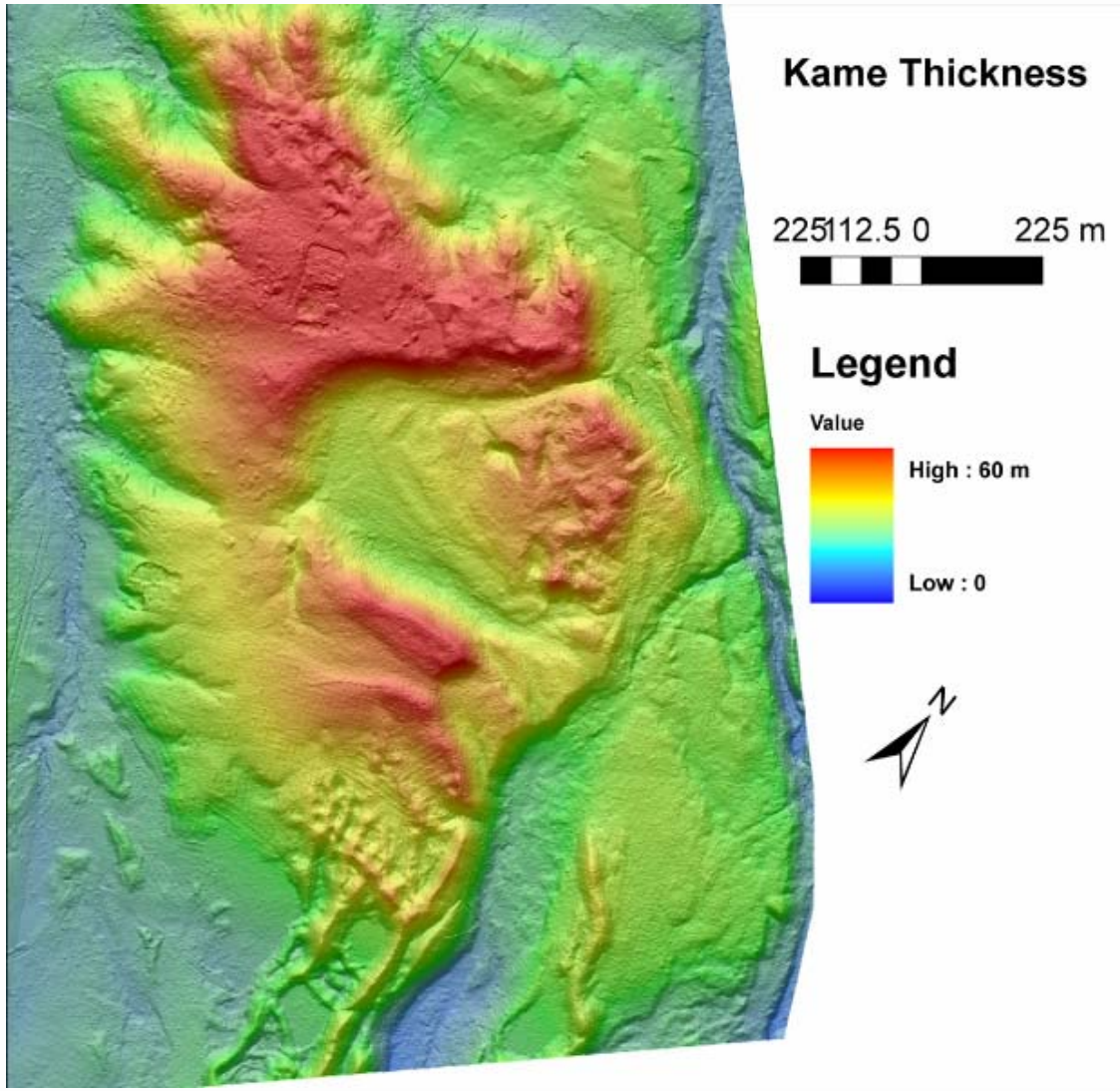




LiDAR, multibeam and Olex data from Margaretsville showing onshore and offshore character

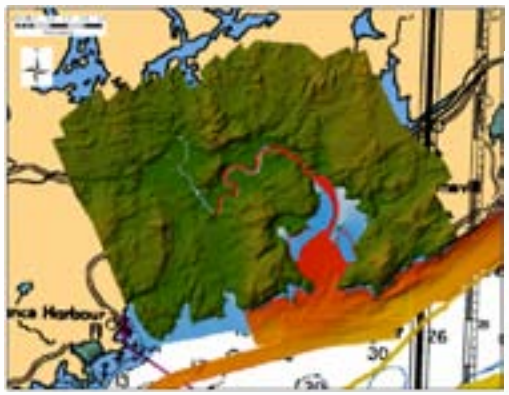


Fitting a regional surface to LiDAR data to determine the amount of glacial material deposited

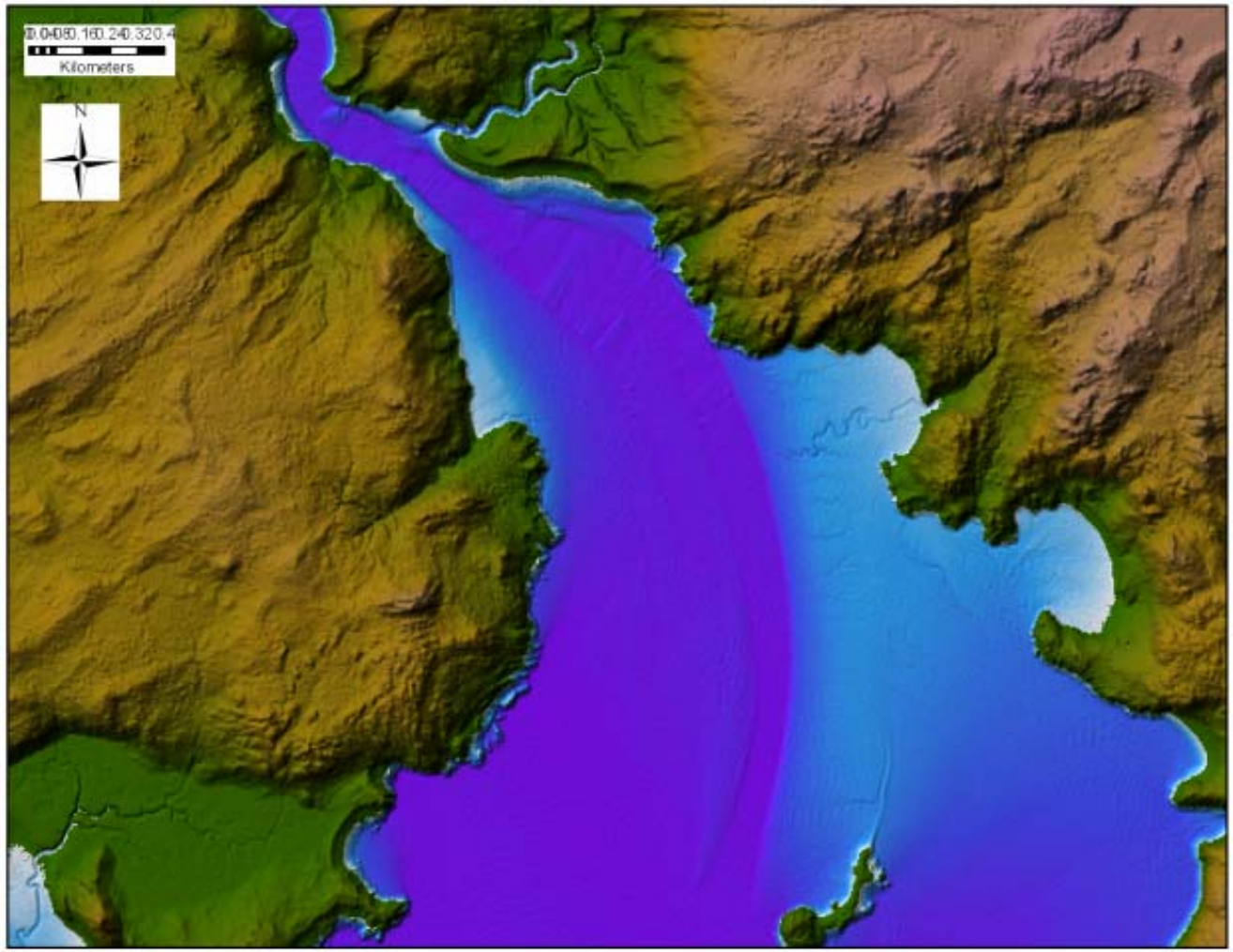


LIDAR

flown as a joint project with AGRG/COGS

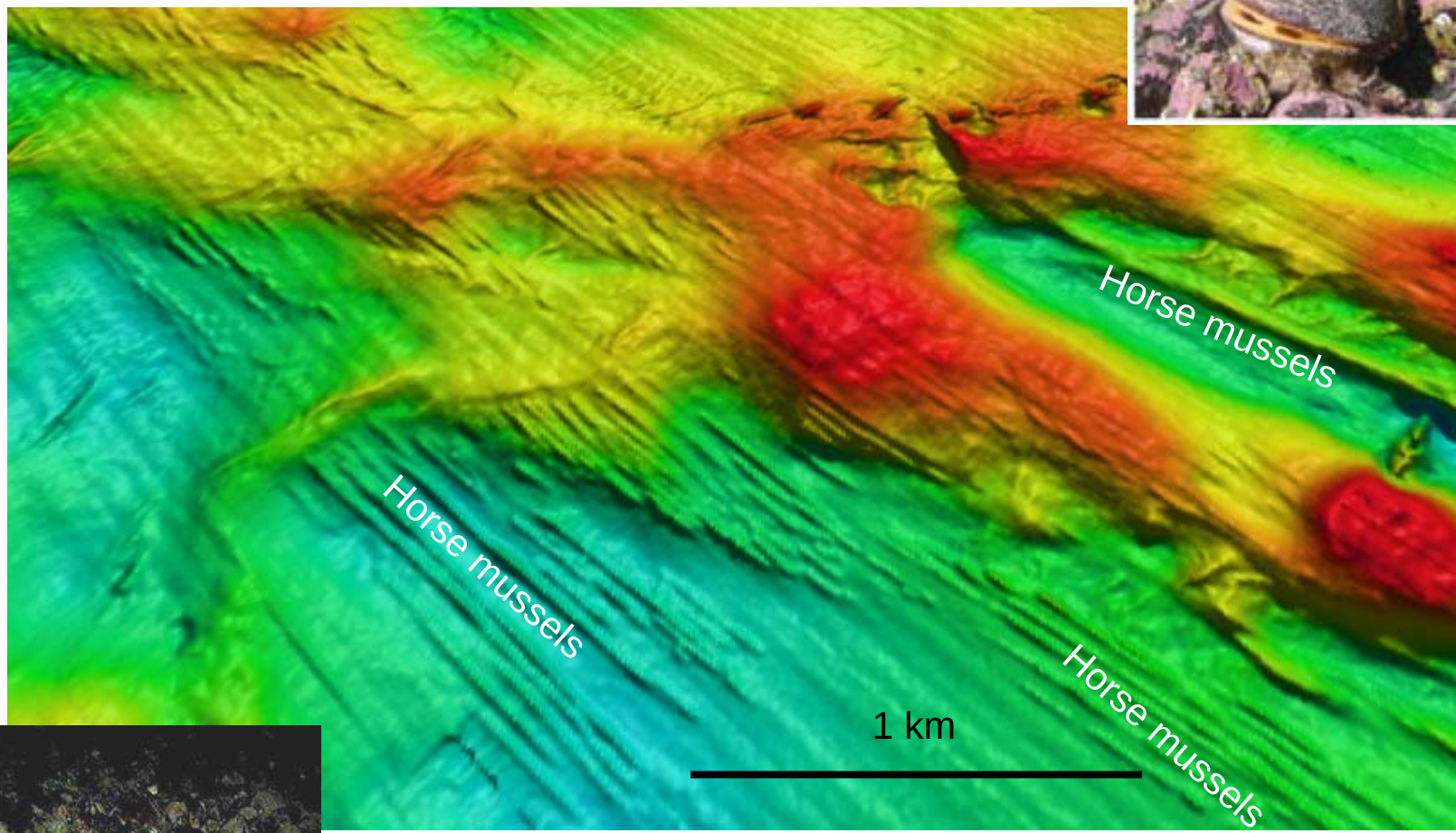


Coverage from Musquash NB



Canadian Hydrographic Conference
Victoria, BC
5-8 May 2008

Natural Resources Canada | Ressources naturelles Canada


Horse mussels
Horse mussels
Horse mussels
1 km

Surveys and field work

– 2006

- Multibeam Bathymetry Surveys
  - CCGS Frederick G Creed (**70 days**)

– 2007

- Current Meters and Tide Gauges
- Multibeam Bathymetry Surveys
  - CCGS Matthew **50 days** with 1-2 launches
  - CCGS Frederick G Creed **50 days**
  - UNB EM3002 launch **30 days** shore based
  - Currently negotiating with Port of Saint John to increase coverage in harbour with EM3002 launch
- DFO - Updating tidal and current models
- LIDAR surveys of intertidal zone with COGS
- Surveys in support of tidal stream electrical power generation
- Ralph seafloor observation platform – cameras, currents, suspended sediment, etc.
- With CHS – tide gauges in Minas Passage and upper Bay of Fundy

– 2008

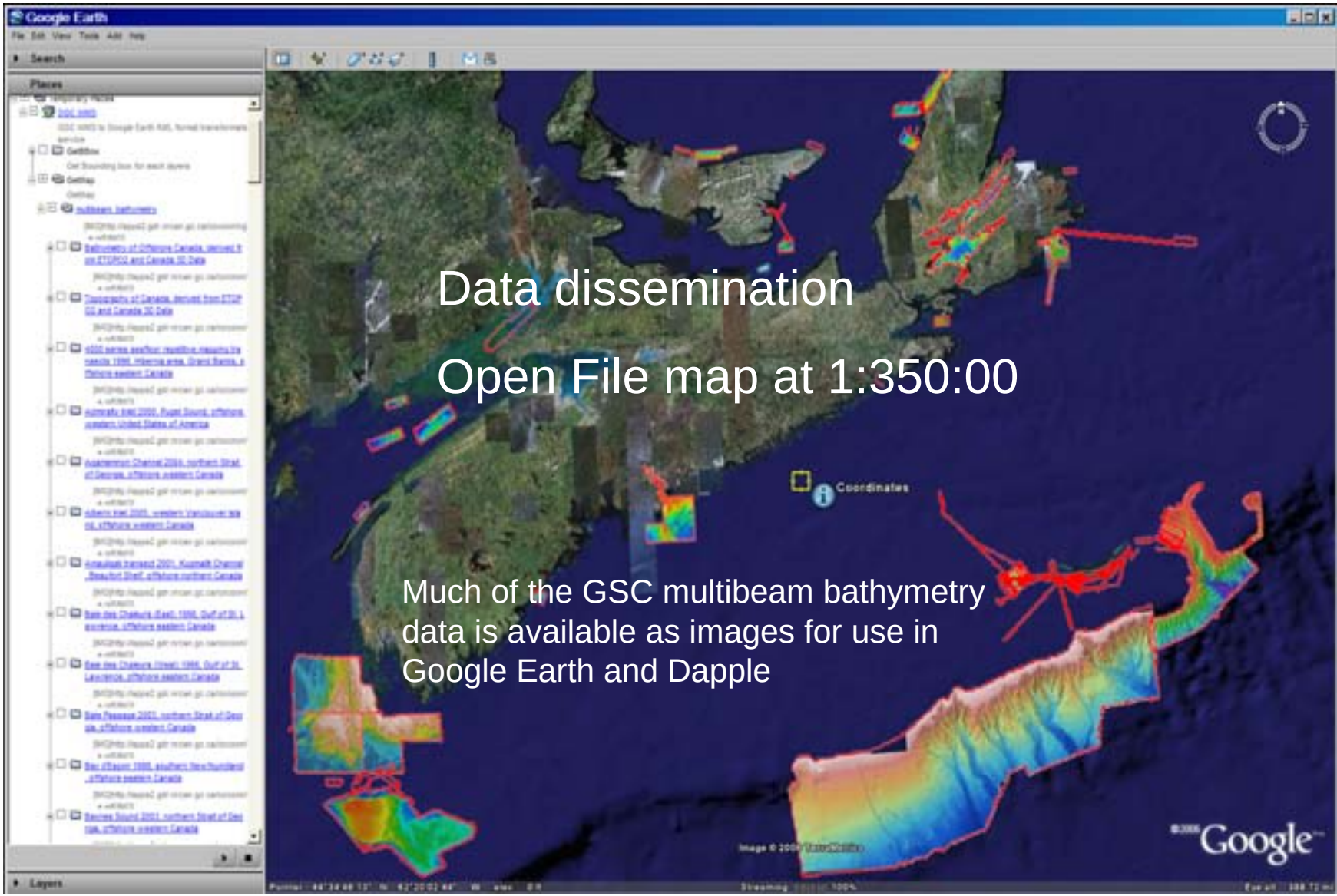
- Current Meters
- Multibeam Bathymetry Surveys
  - CCGS Frederick G Creed (**30 days**)
  - CCGS Matthew (**60 days**) with launches
  - UNB ?? If funding available.
- Sediment transport estimates based on updated models

– 2009 ??

CCGS Matthew

Multibeam bathymetry system for 24 hr/day operation

with 1 or 2 multibeam bathymetry launches for 12 hr/day operation



Data dissemination

Open File map at 1:350:00

Much of the GSC multibeam bathymetry data is available as images for use in Google Earth and Dapple

gdr.nrcan.gc.ca/multibath/index_e.php

Thank You

"Harbourville"
By Horst Maria Guilhauman,
http://www.fundylore.com