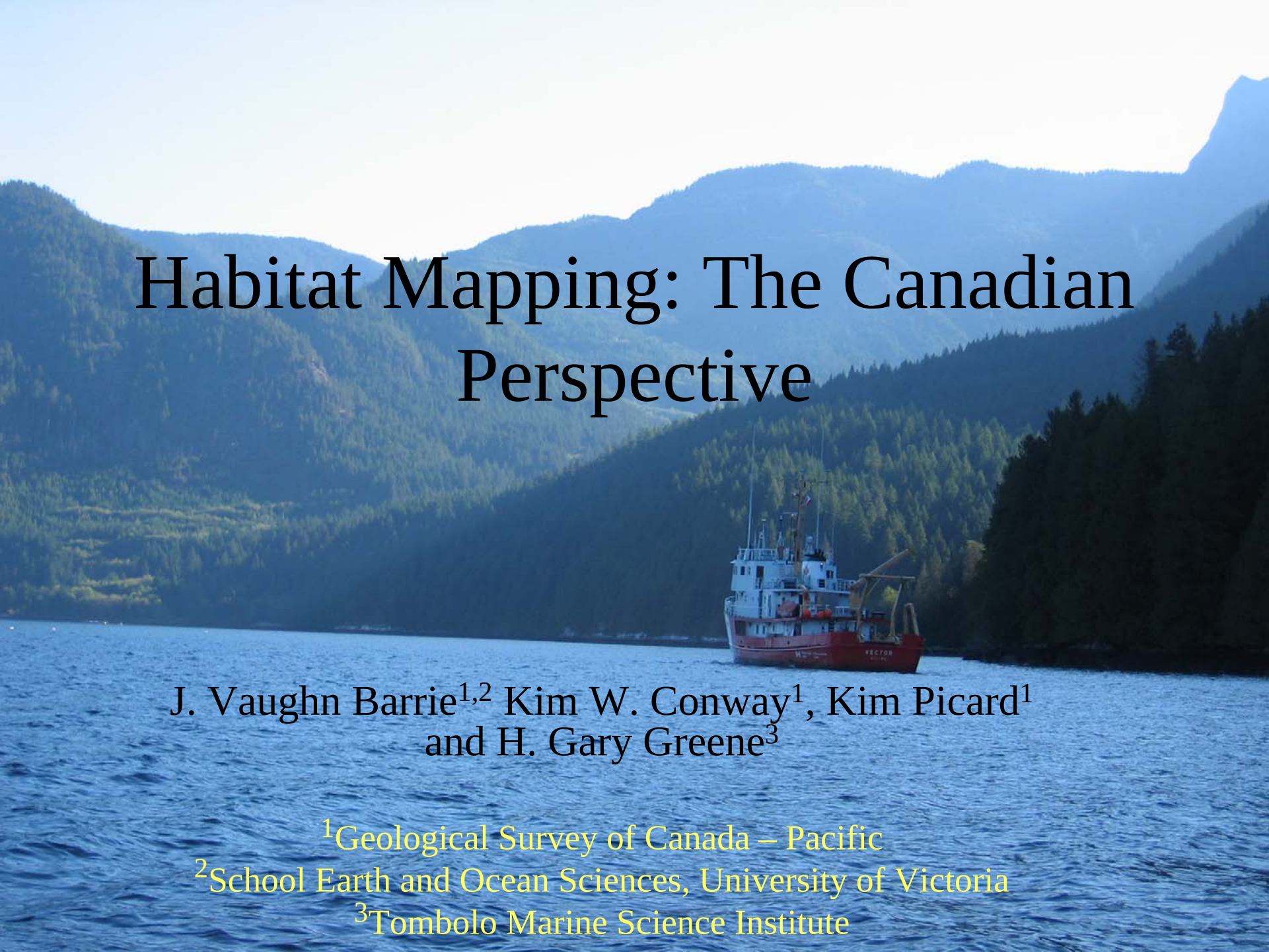
Habitat Mapping: The Canadian Perspective



J. Vaughn Barrie[1,2] Kim W. Conway[1], Kim Picard[1] and H. Gary Greene[3]

[1]Geological Survey of Canada – Pacific
[2]School Earth and Ocean Sciences, University of Victoria
[3]Tombolo Marine Science Institute

OUTLINE:

Geoscience for Ocean Management

Surficial Geology and Habitat Mapping

Examples of Special Habitat Maps

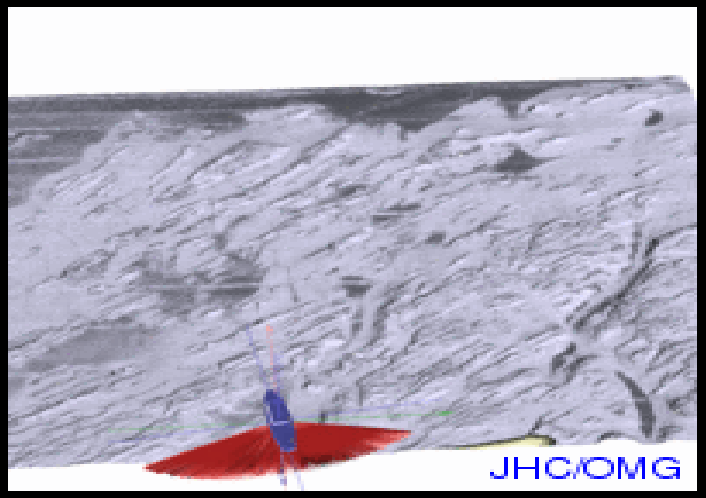
- **Seabird Habitat**
- **Hydrocarbon Seeps**
- **Sponge Reefs**
- **Coral Reefs**

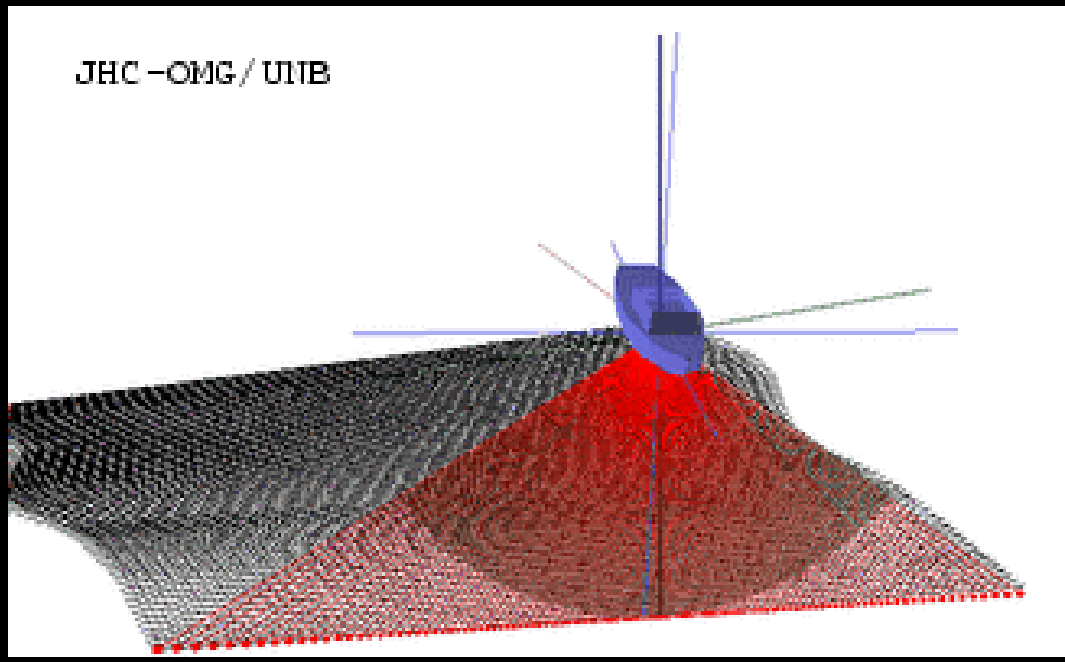
Conservation Areas

British Columbia/Washington State

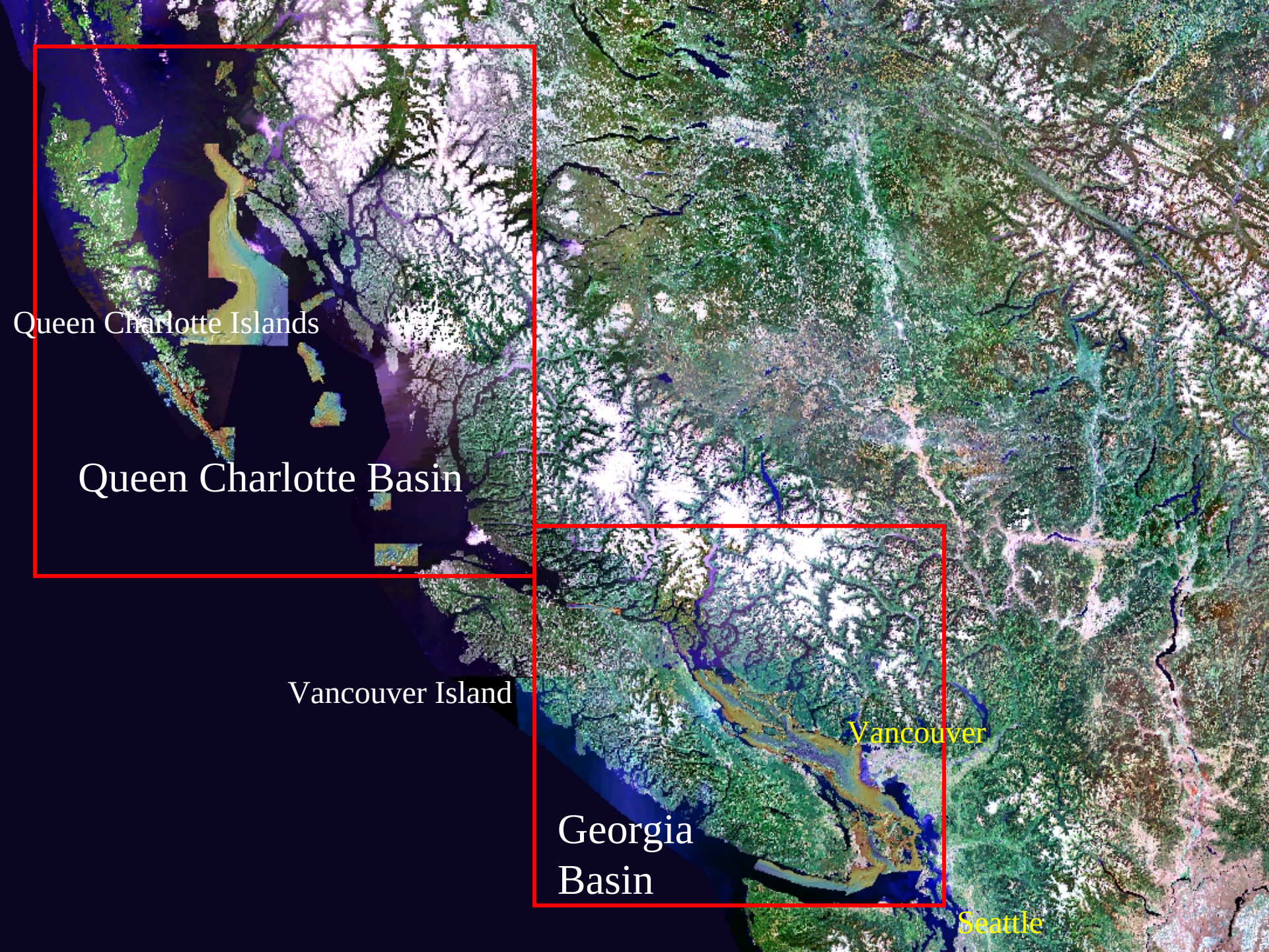
Multibeam Sonar and GIS

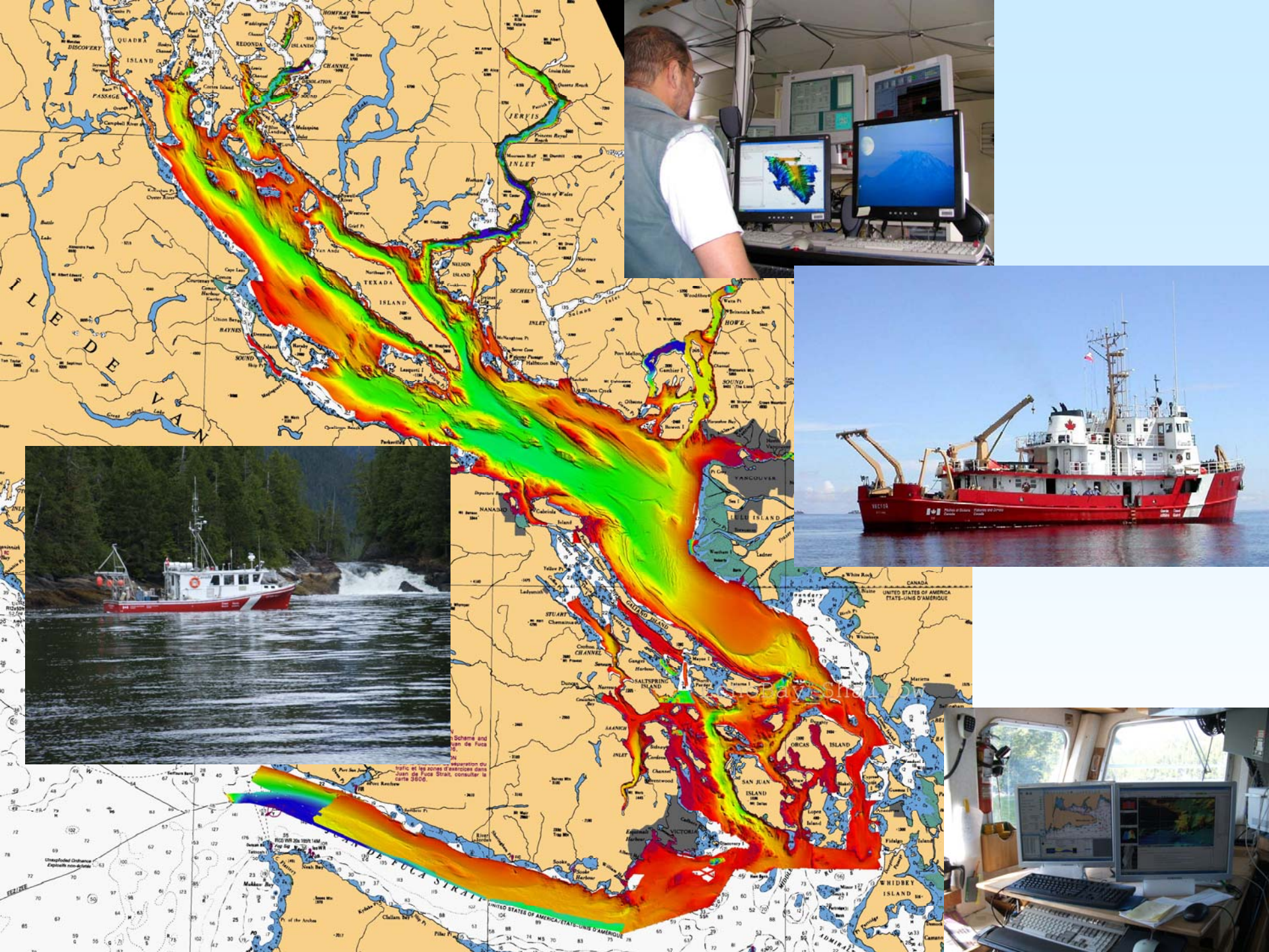
- Mapping sedimentary deposits and surfaces
- Refined basin-scale morphology
- Change detection using repeat surveys



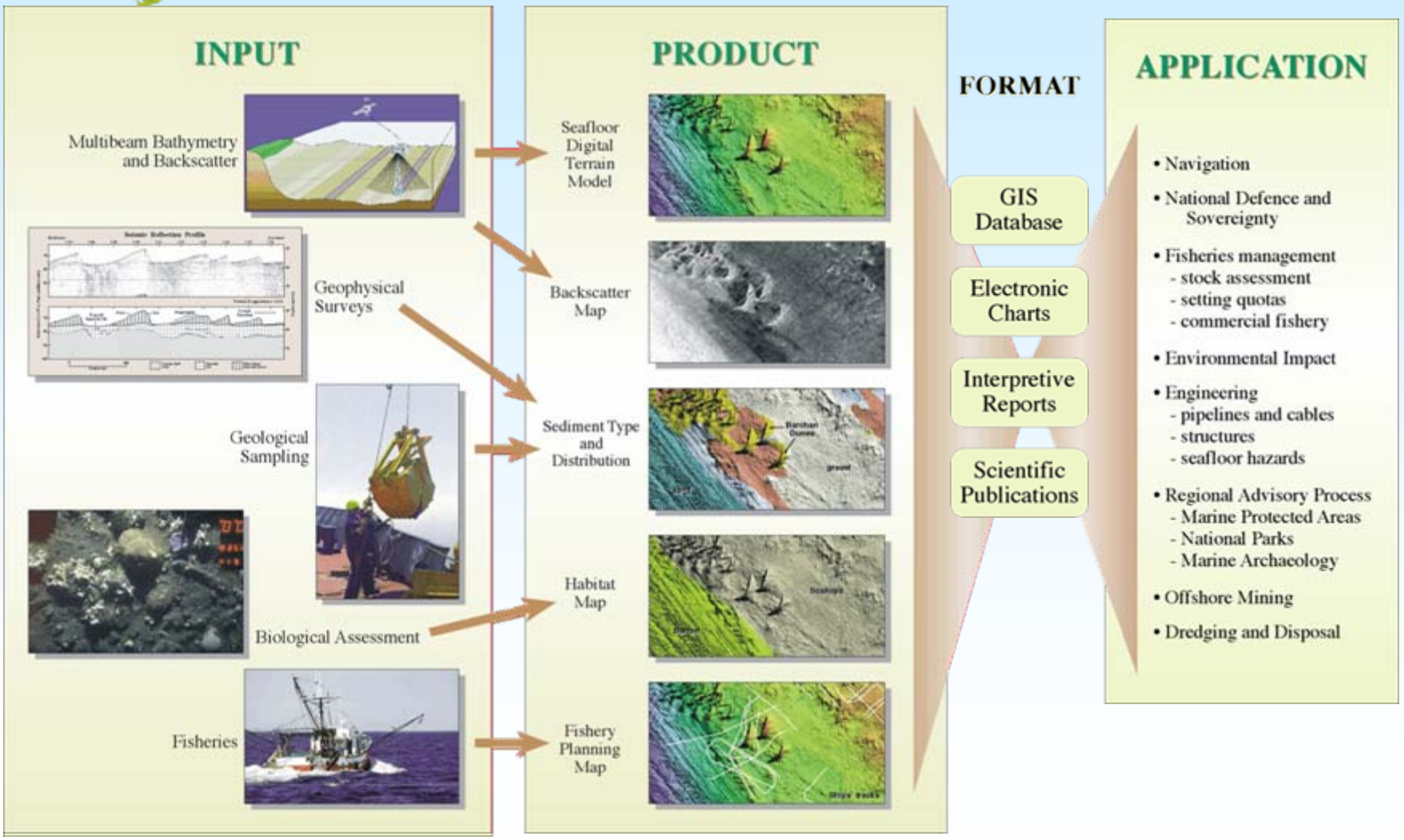


Courtesy: John Hughes-Clarke


Queen Charlotte Islands
Queen Charlotte Basin
Vancouver Island
Vancouver
Georgia
Basin
Seattle


QUADRA ISLAND
DISCOVERY PASSAGE
REDONDA ISLANDS
HOMFRAY CHANNEL
JERVIS INLET
TEXADA ISLAND
NELSON ISLAND
SECHELT INLET
HOWE SOUND
BAYNES SOUND
ÎLE DE VAN
YANCOUVER
TULU ISLAND
NANAIMO
GALIANO ISLAND
STUART CHANNEL
SALTSPRING ISLAND
SAANICH INLET
ORCAS ISLAND
SAN JUAN ISLAND
VICTORIA
WHIDBEY ISLAND
CANADA
UNITED STATES OF AMERICA
ÉTATS-UNIS D'AMÉRIQUE
JUAN DE FUCA STRAIT
UNITED STATES OF AMERICA/ÉTATS-UNIS D'AMÉRIQUE

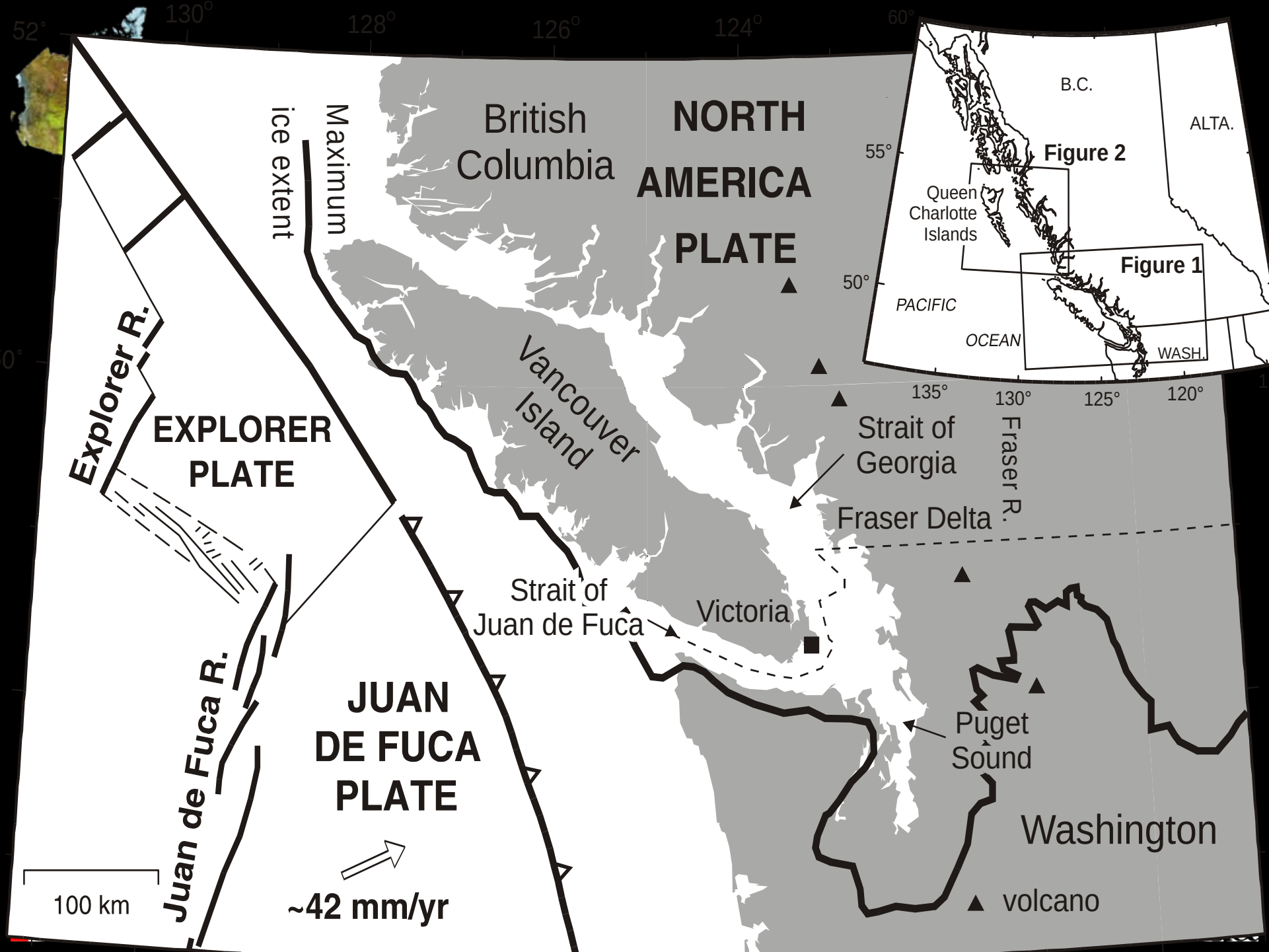
Geoscience for Ocean Management

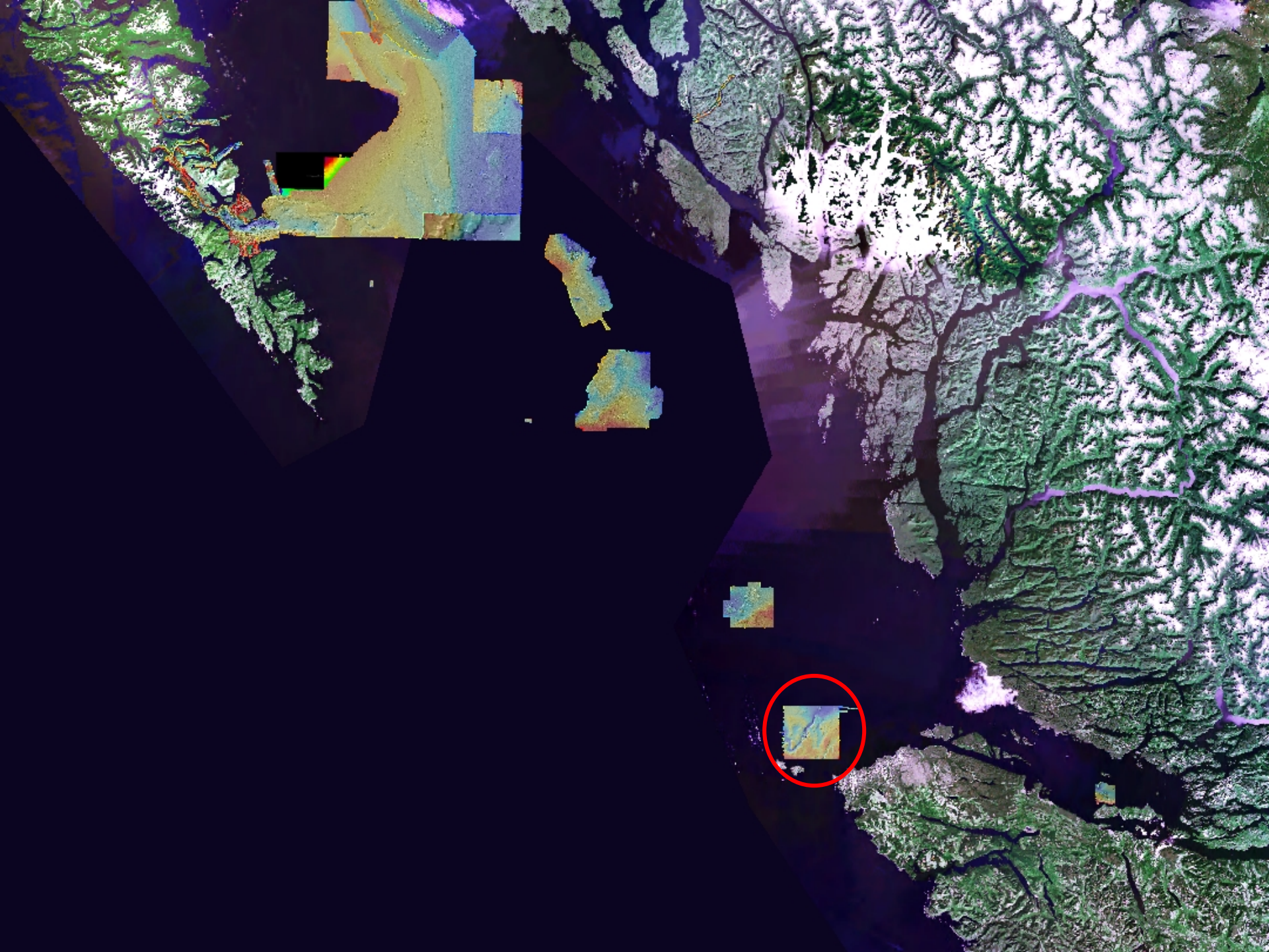


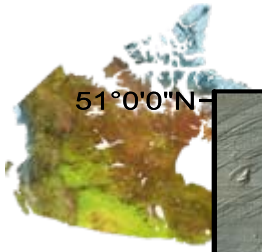
Marine Surficial Geological Maps

Map of the distribution of ocean floor characteristics, including morphology, sediment or bedrock type, physical properties, benthos, and an understanding of origin

Quaternary is the geological history of the last two to three million years up until the present divided into two Epochs the **Pleistocene** and the **Holocene**. The Holocene covers the period from the end of the last glaciation until present (last 10,000 years).


British Columbia
NORTH AMERICA PLATE
Maximum ice extent
Explorer R.
EXPLORER PLATE
Vancouver Island
Strait of Georgia
Fraser R.
Fraser Delta
Strait of Juan de Fuca
Victoria
Juan de Fuca R.
JUAN DE FUCA PLATE
Puget Sound
Washington
100 km
~42 mm/yr
volcano
B.C.
ALTA.
Figure 2
Queen Charlotte Islands
Figure 1
PACIFIC
OCEAN
WASH.
55°
50°
135°
130°
125°
120°





Multibeam

128°35'0"W 128°30'0"W

51°0'0"N

50°55'0"N

50°50'0"N

128°35'0"W 128°30'0"W 128°25'0"W

0 2 4

Kilometers

Legend

Grab Samples

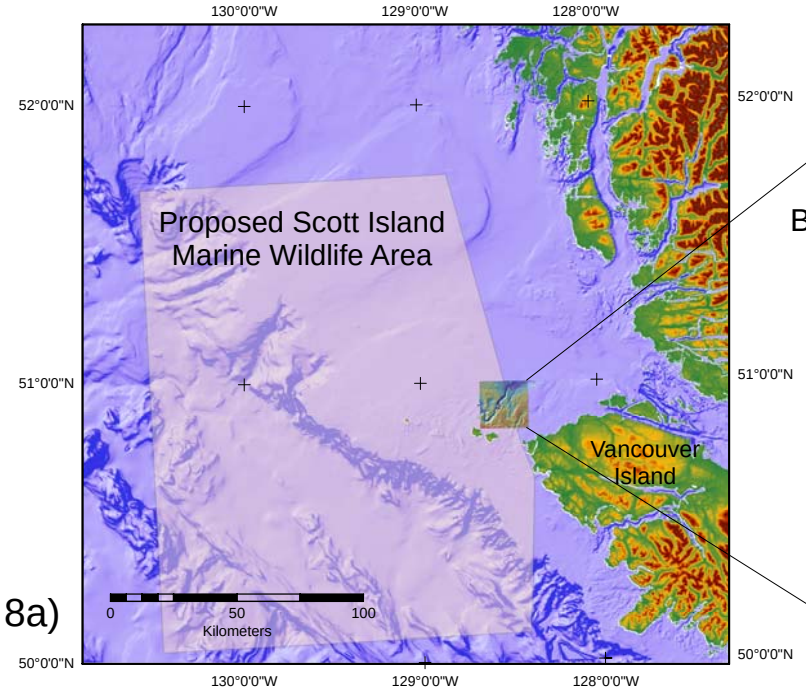
Core Samples

Huntec Seismic Line

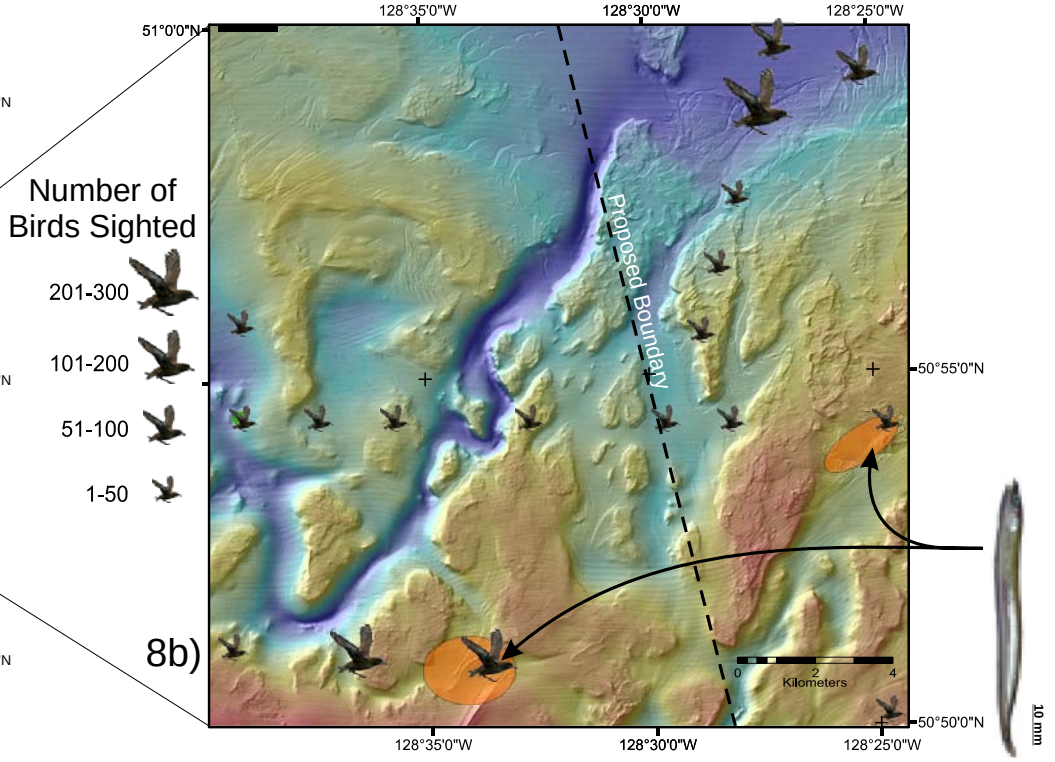
Natural Resources Canada

Ressources naturelles Canada

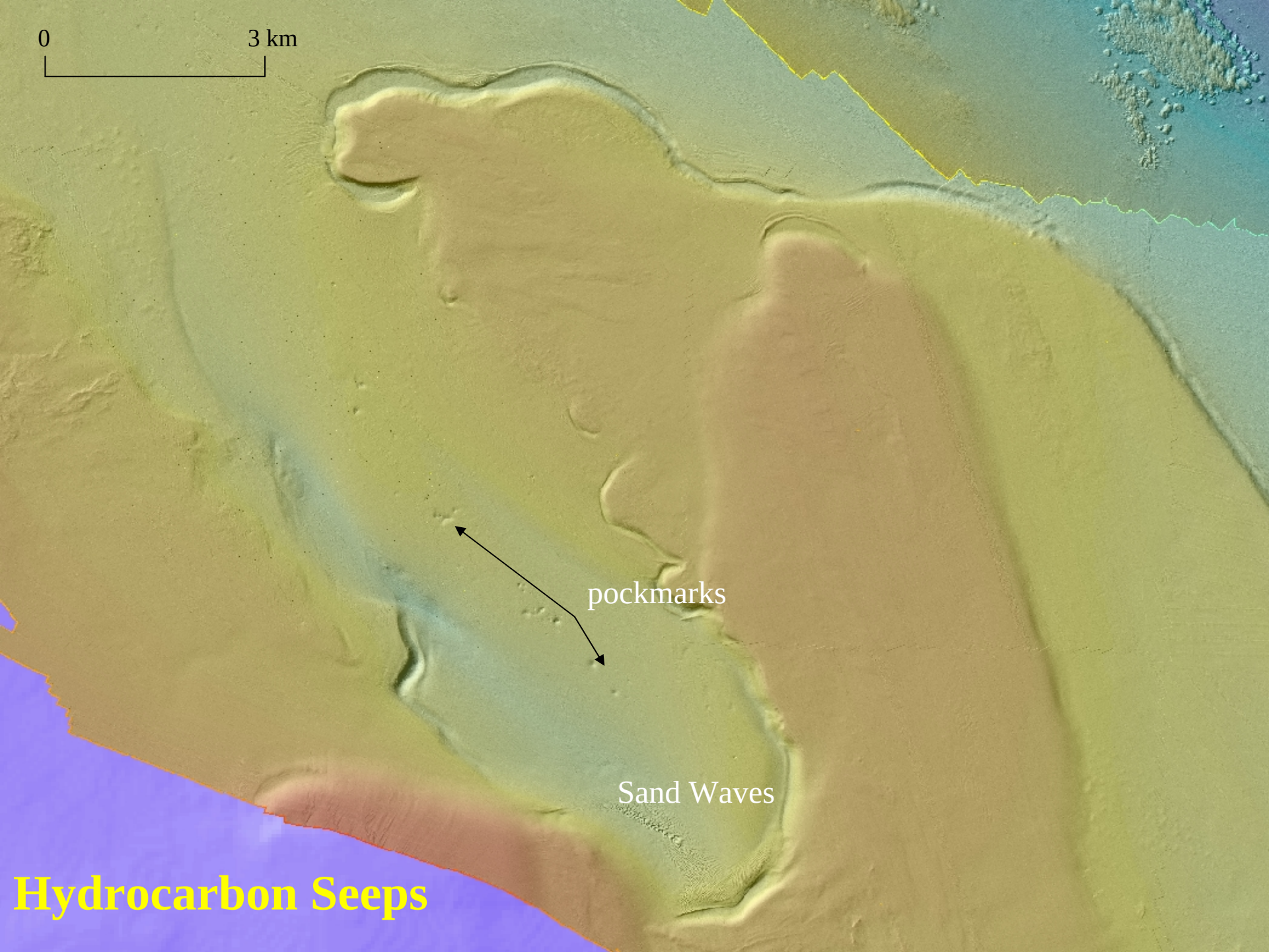
Canada


130°0'0"W
129°0'0"W
128°0'0"W
52°0'0"N
51°0'0"N
50°0'0"N
Proposed Scott Island
Marine Wildlife Area
Vancouver
Island
0
50
100
Kilometers

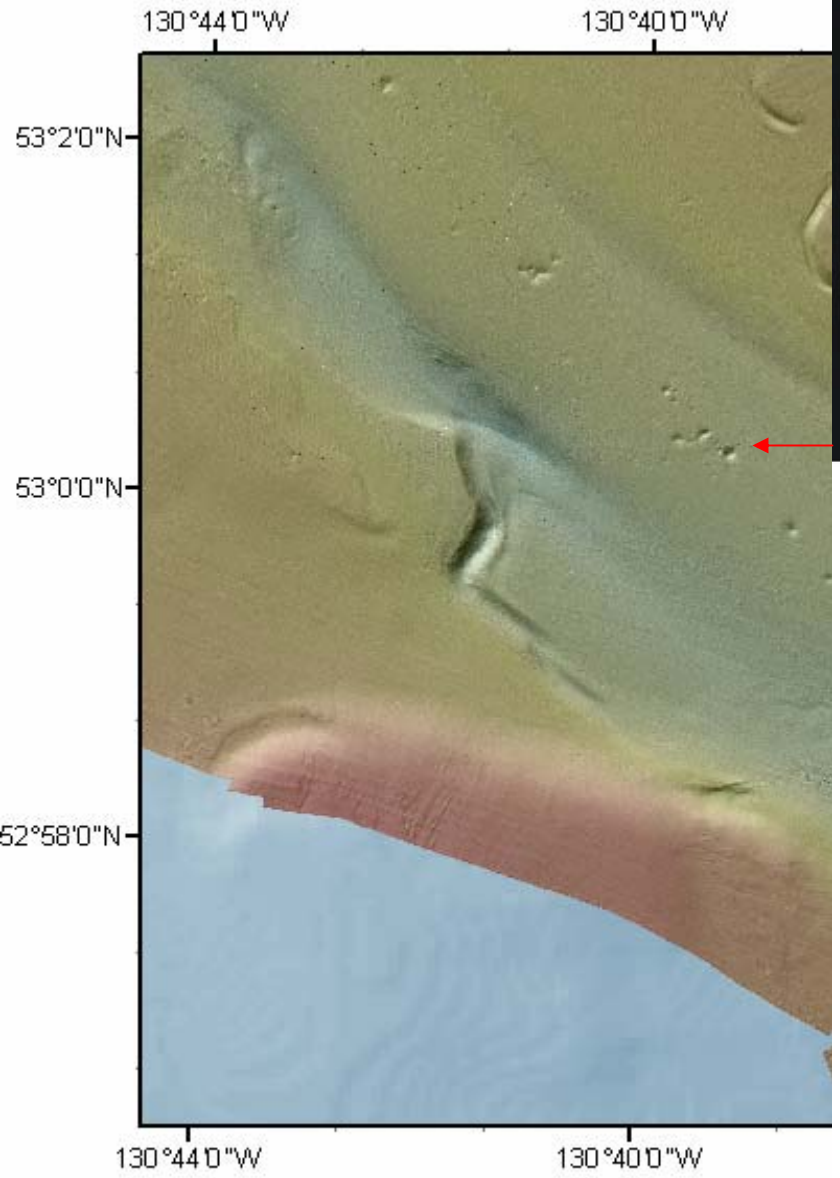
8a)


Number of
Birds Sighted
201-300
101-200
51-100
1-50
128°35'0"W
128°30'0"W
128°25'0"W
51°0'0"N
50°55'0"N
50°50'0"N
Proposed Boundary
0
2
4
Kilometers
10 mm

8b)


0
3 km
pockmarks
Sand Waves
Hydrocarbon Seeps

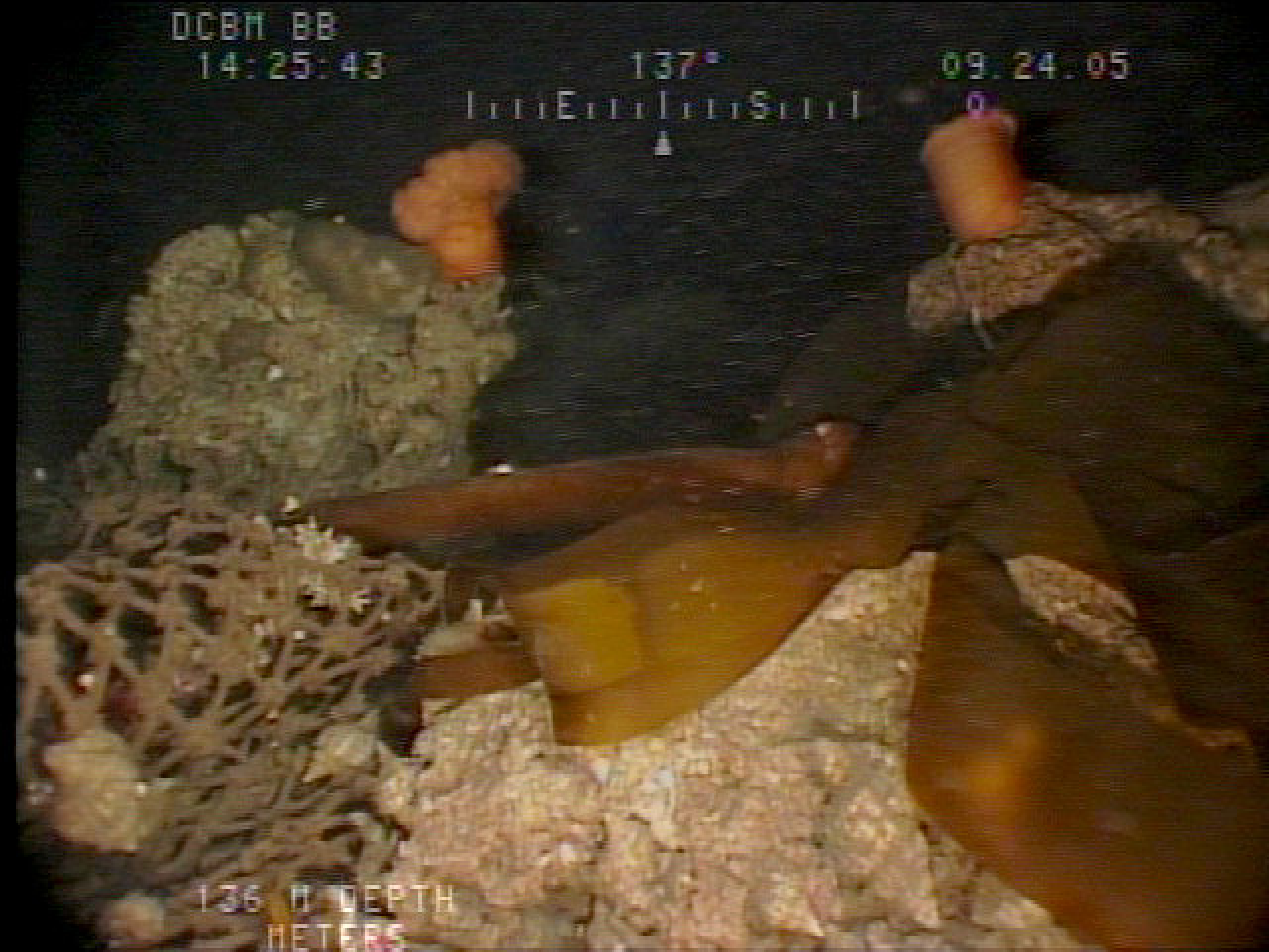
Shallow Gas


130°44'0"W
130°40'0"W
53°2'0"N
53°0'0"N
52°58'0"N
130°44'0"W
130°40'0"W

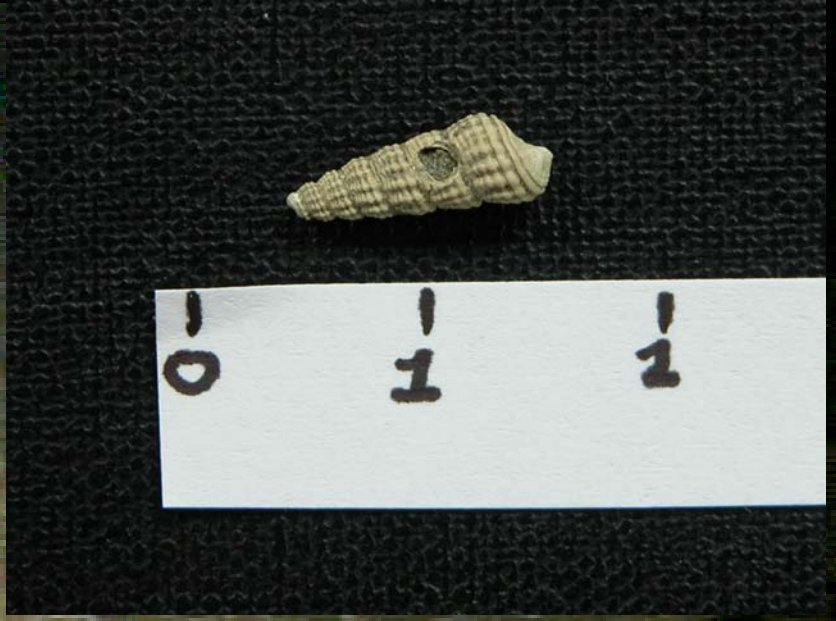
DCBM BB
13:32:28
129°
09.24.05

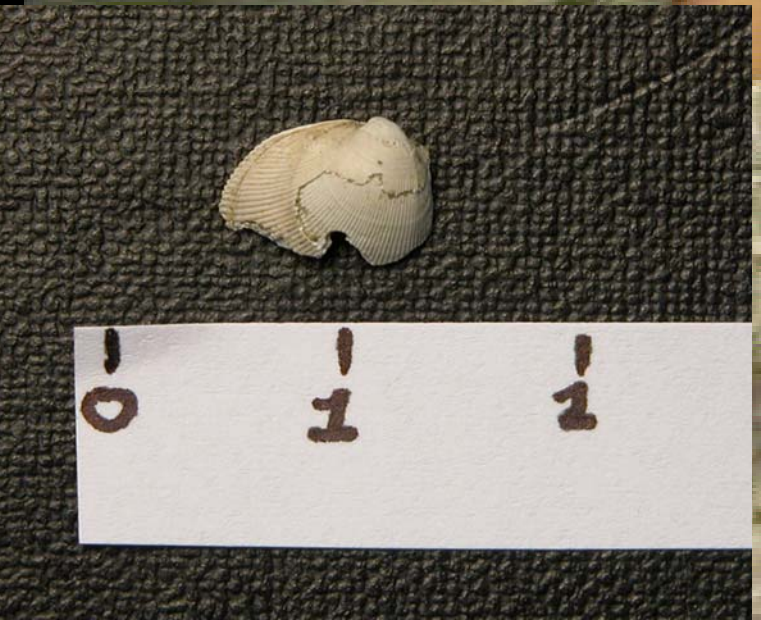
DCBM BB
18:27:33
345°
09.23.05

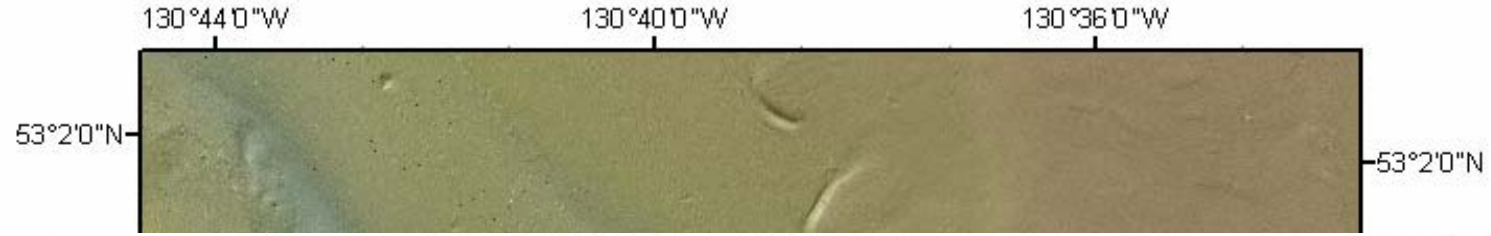
DCBM BB
129°
09.24.05
134 M DEPTH
METERS

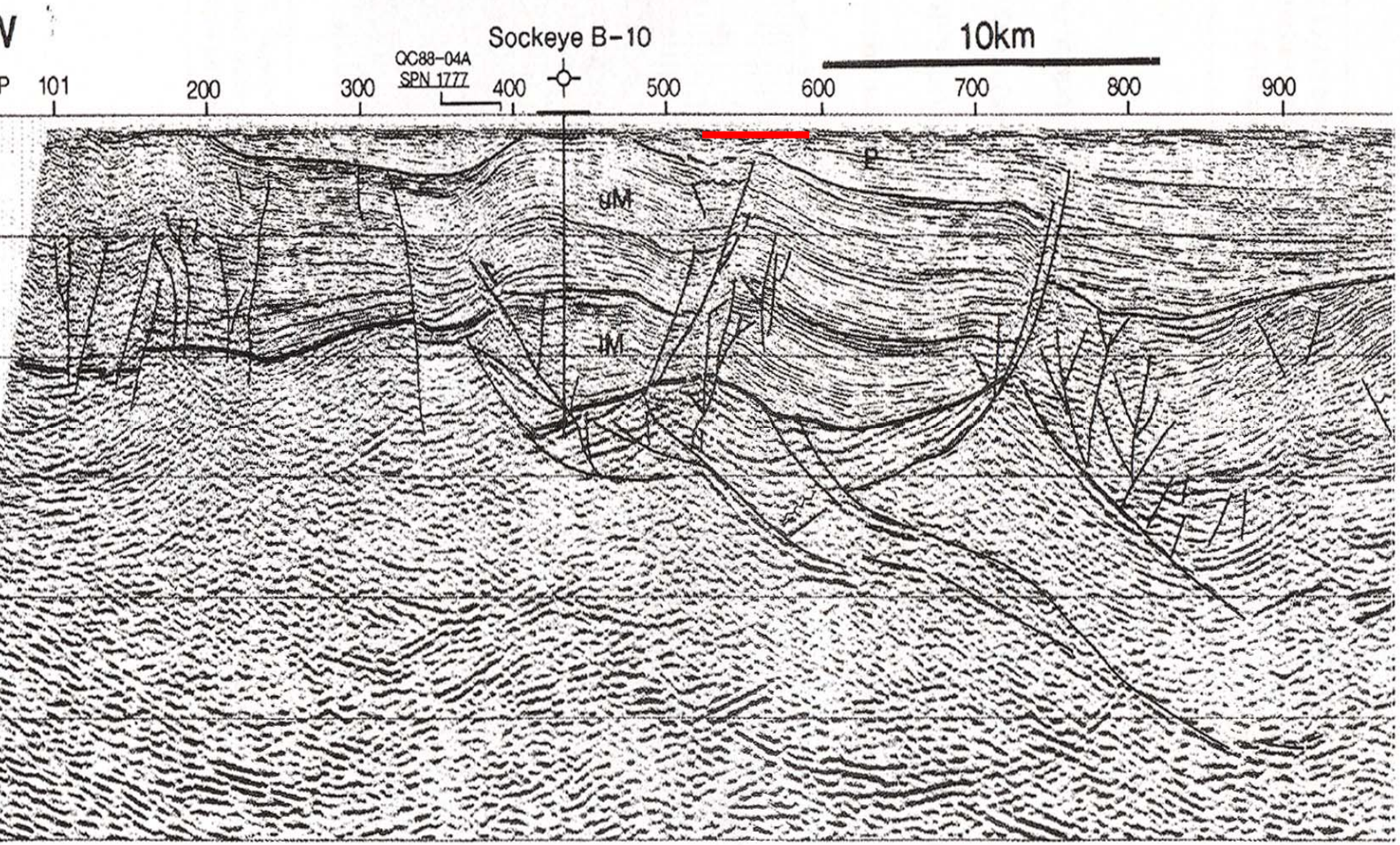

DCBM BB
14:25:43
137°
09.24.05
E
S
136 M DEPTH
METERS

DCBM BB
13:46:04
87



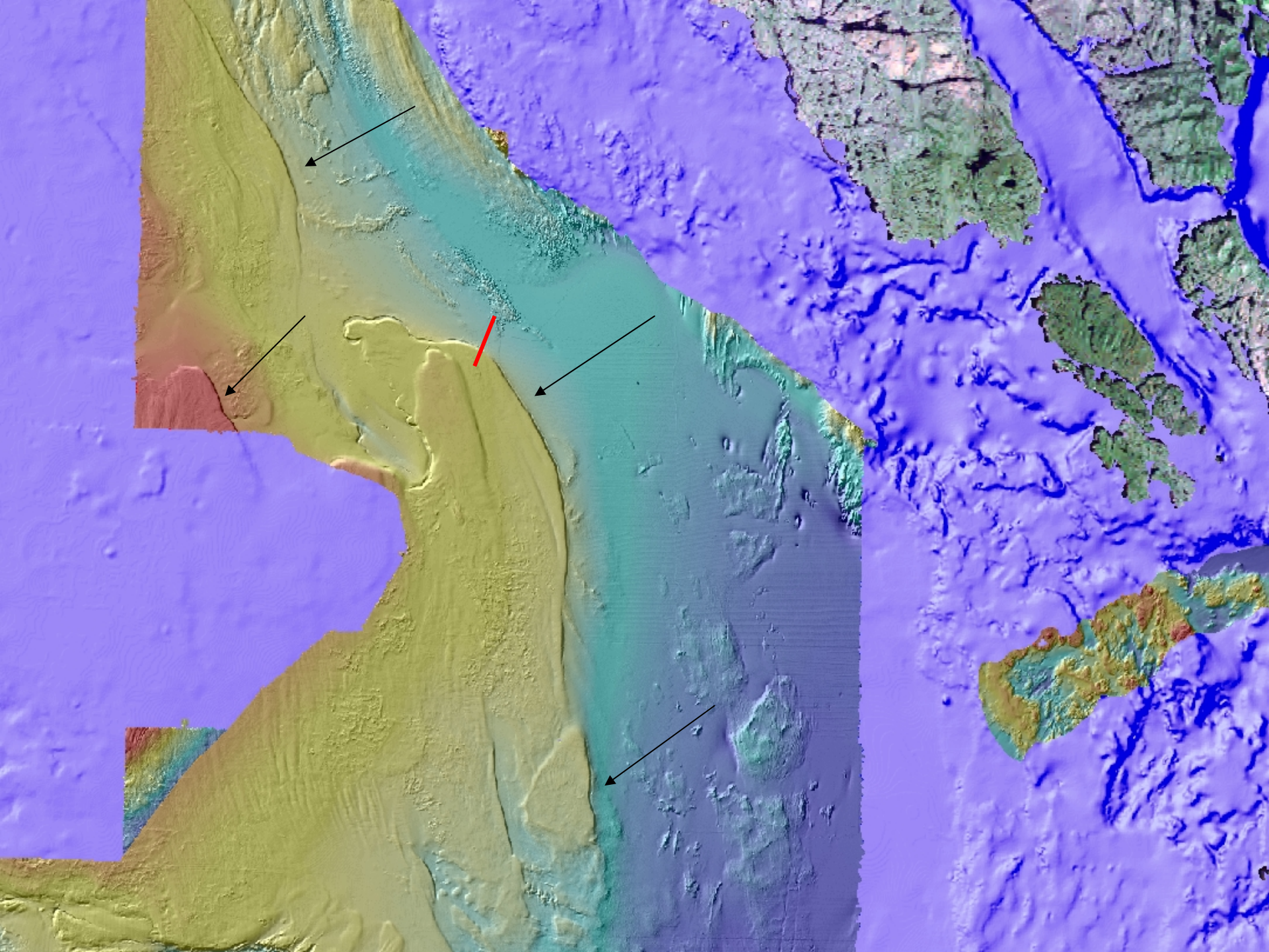




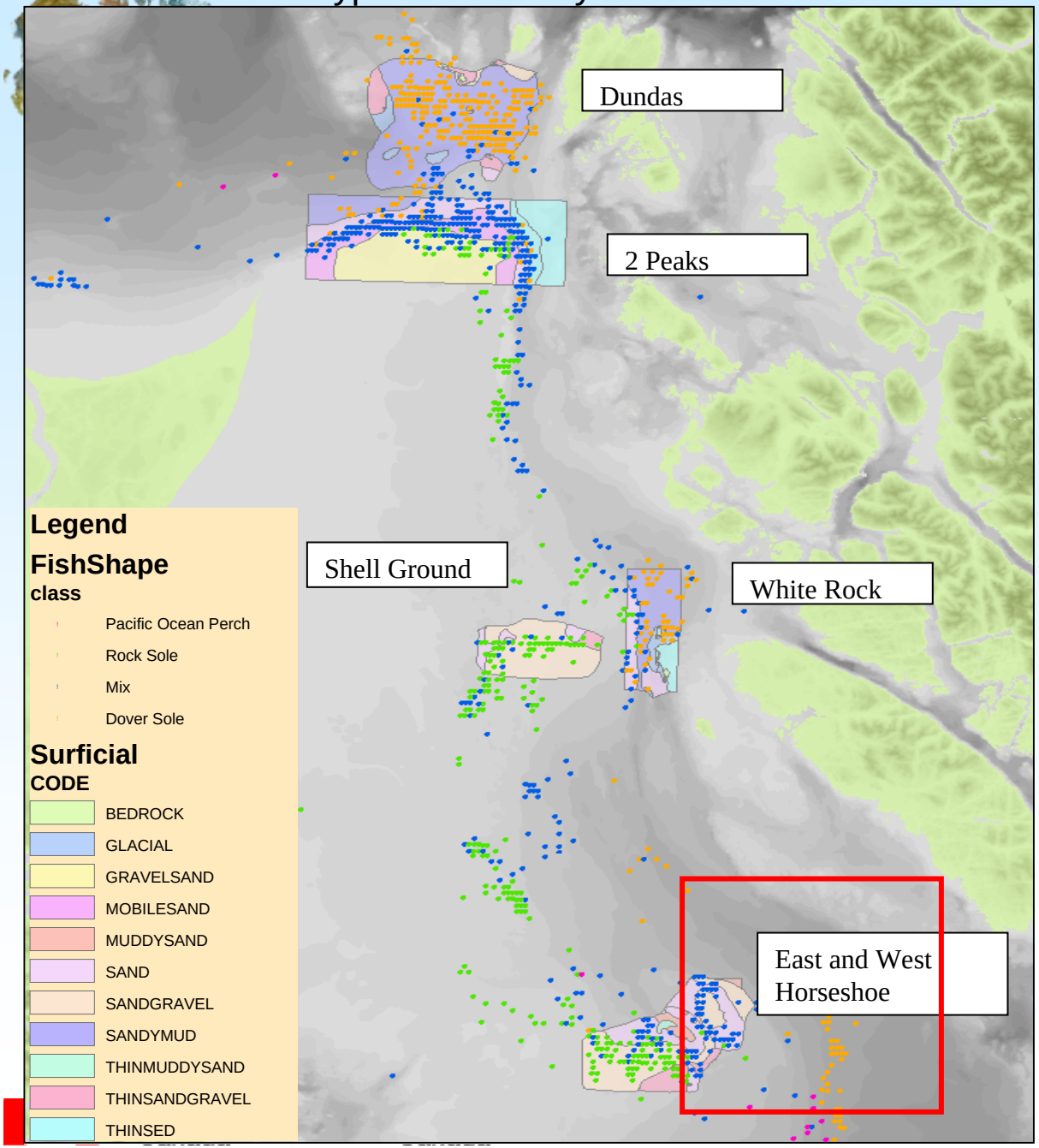


Rohr et al., 2000 – J. Geophys. Res

Canada



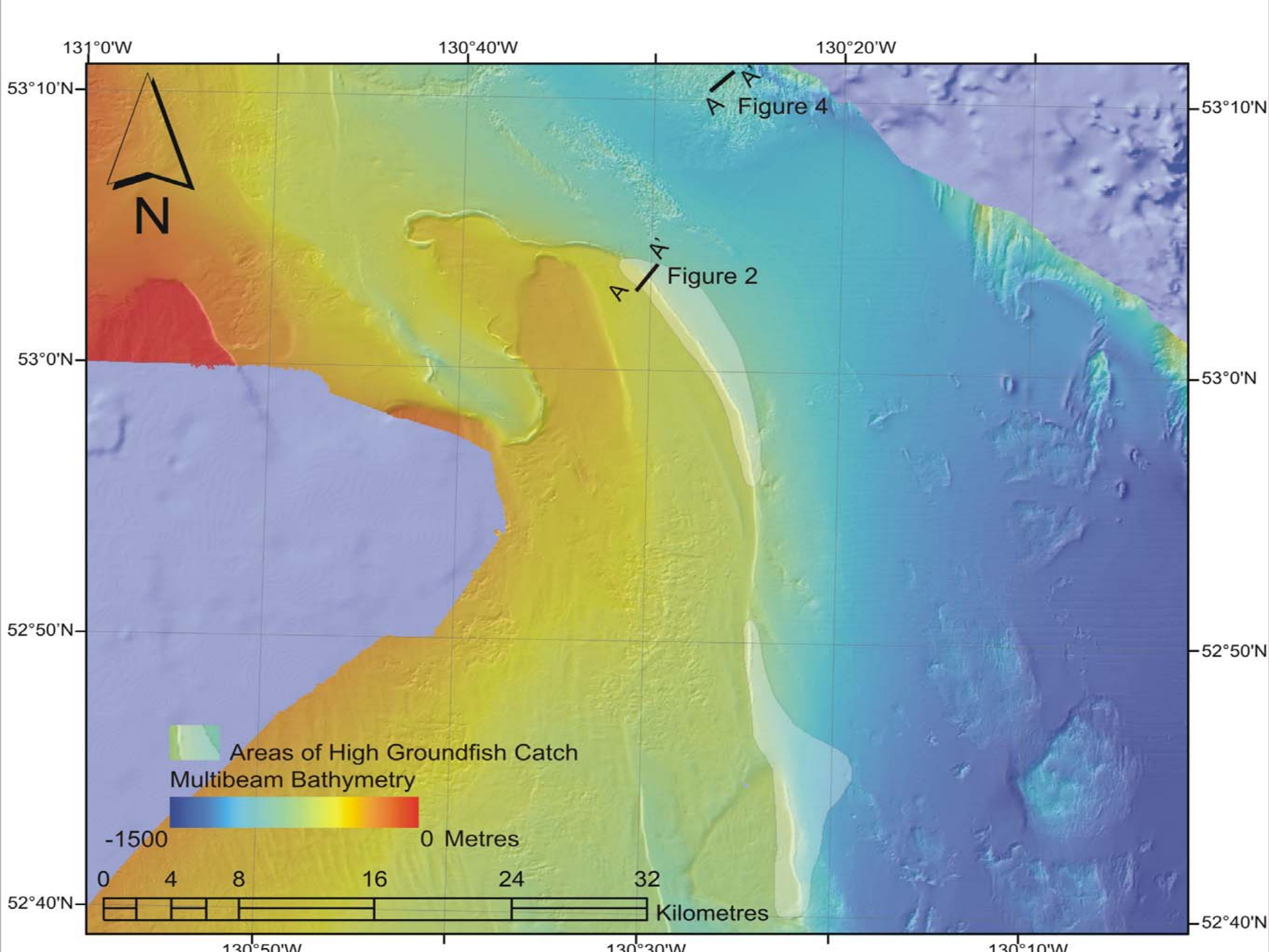
HecStEP Bottom Type and Fishery Distribution

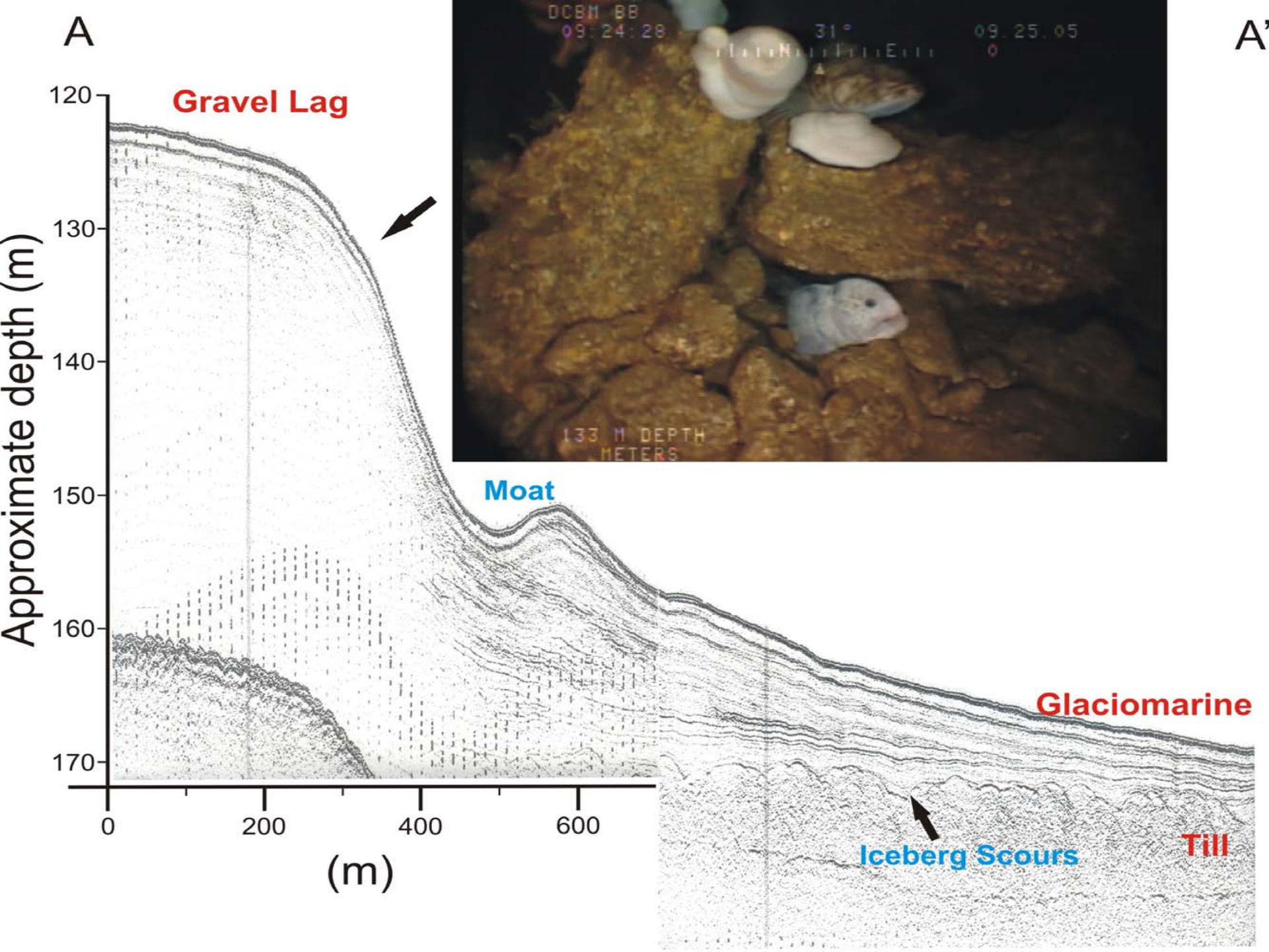


Surficial Geology and Groundfish Distribution

Sinclair et al, 2005, ICES

Canada


131°0'W
130°40'W
130°20'W
53°10'N
53°0'N
52°50'N
52°40'N
N
A
A'
Figure 4
A
A'
Figure 2
Areas of High Groundfish Catch
Multibeam Bathymetry
-1500
0 Metres
0
4
8
16
24
32
Kilometres

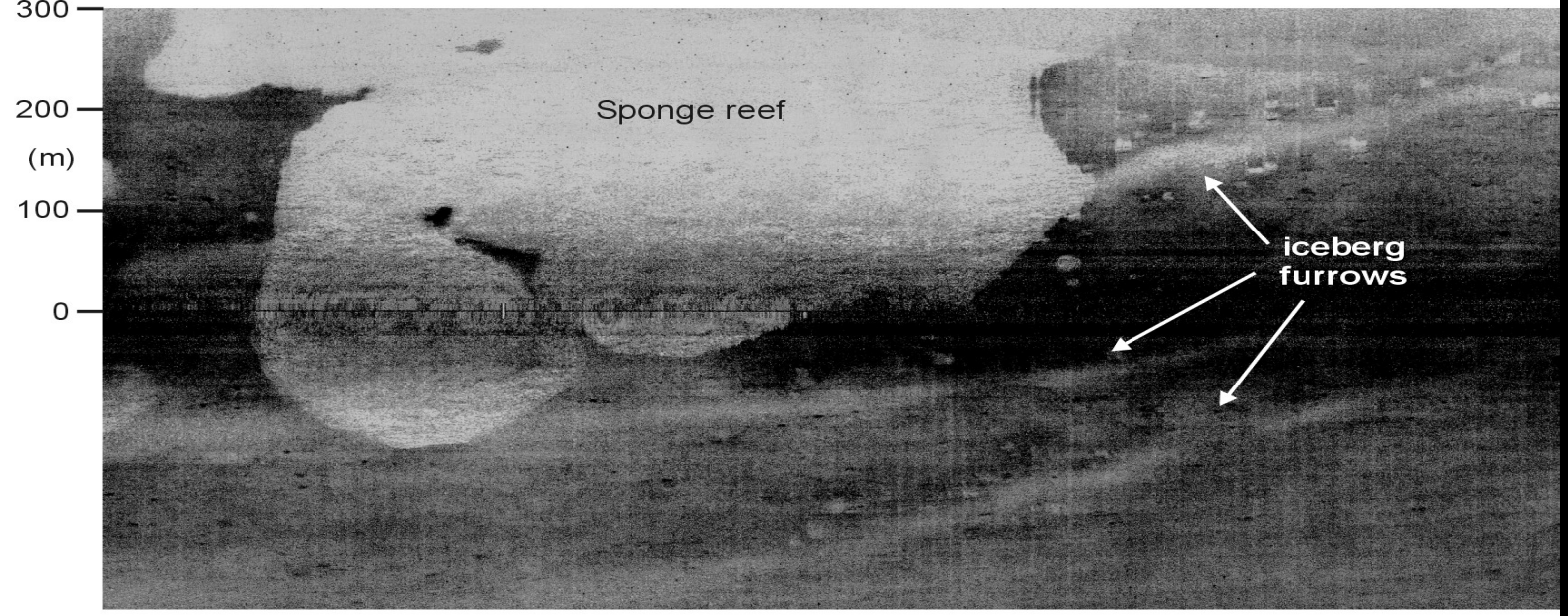

A
A'
Gravel Lag
Moat
Glaciomarine
Iceberg Scours
Till
Approximate depth (m)
120
130
140
150
160
170
0
200
400
600
(m)
DCBM BB
09:24:28
31°
09.25.05
133 M DEPTH
METERS

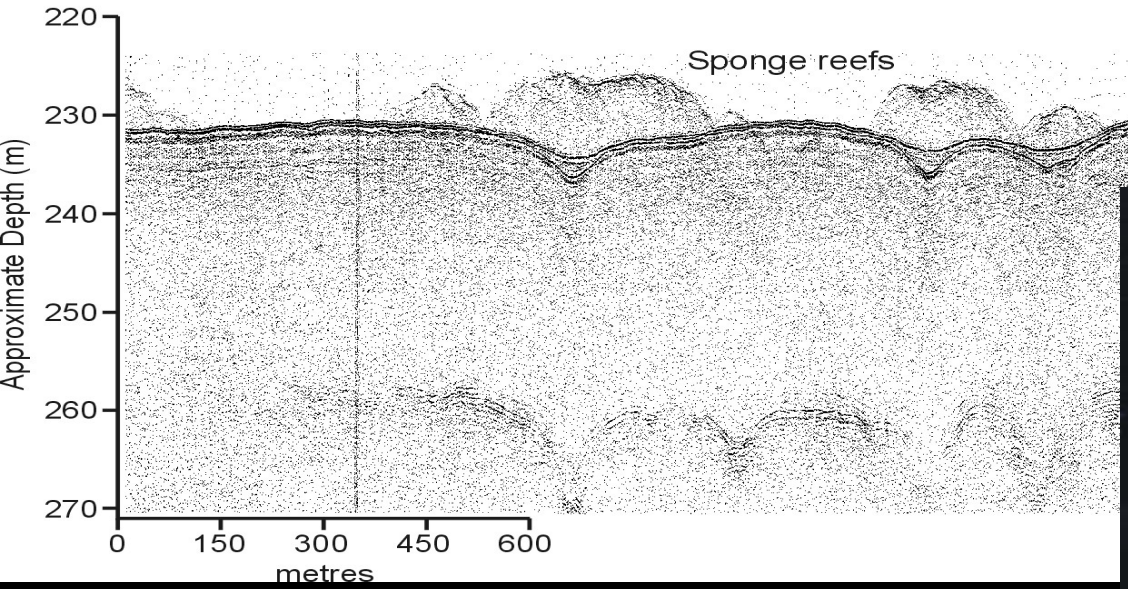
Paleogeographic situation in the Late Jurassic

modified after Blakey, 1992

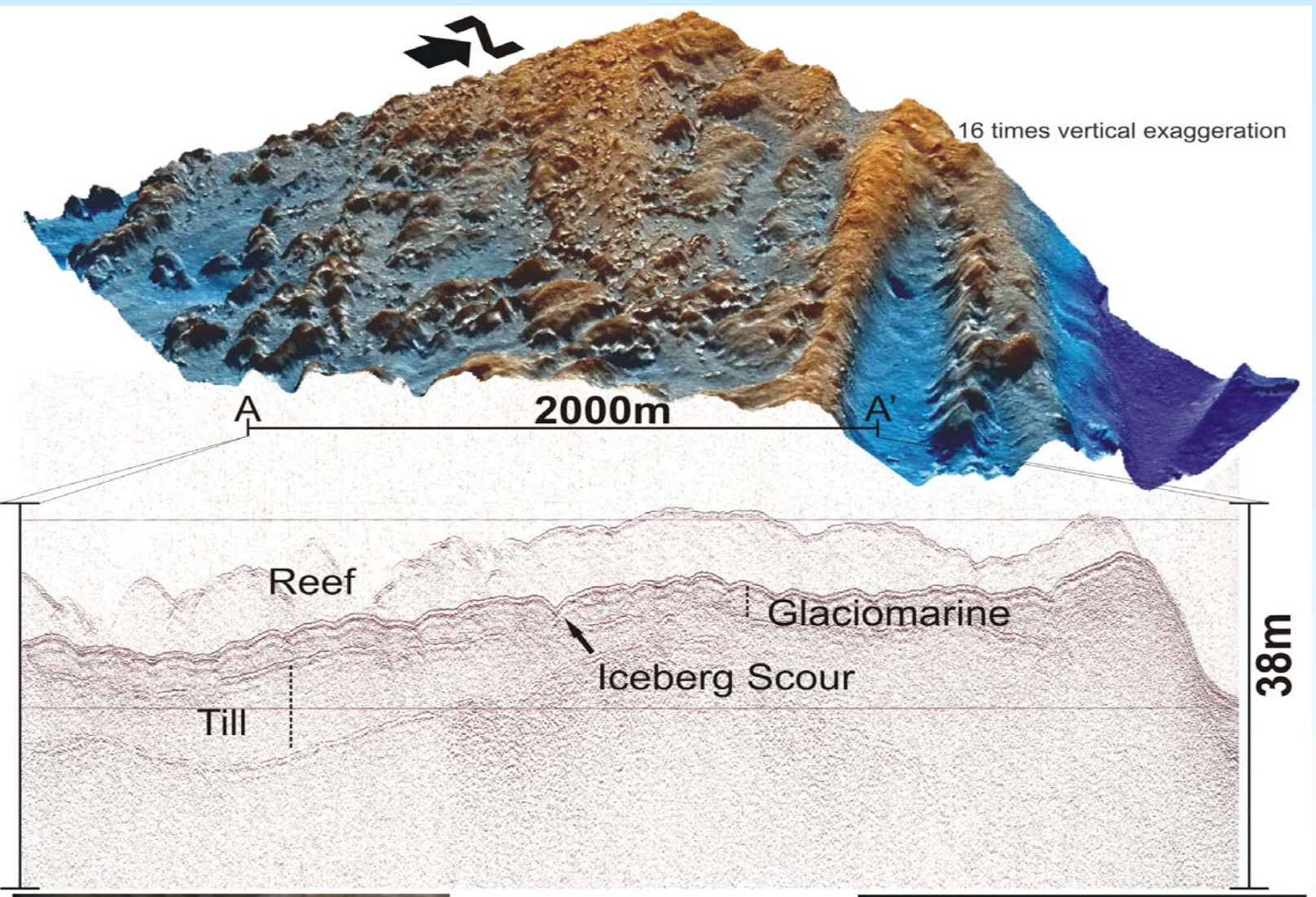
Canada

Sponge Reefs

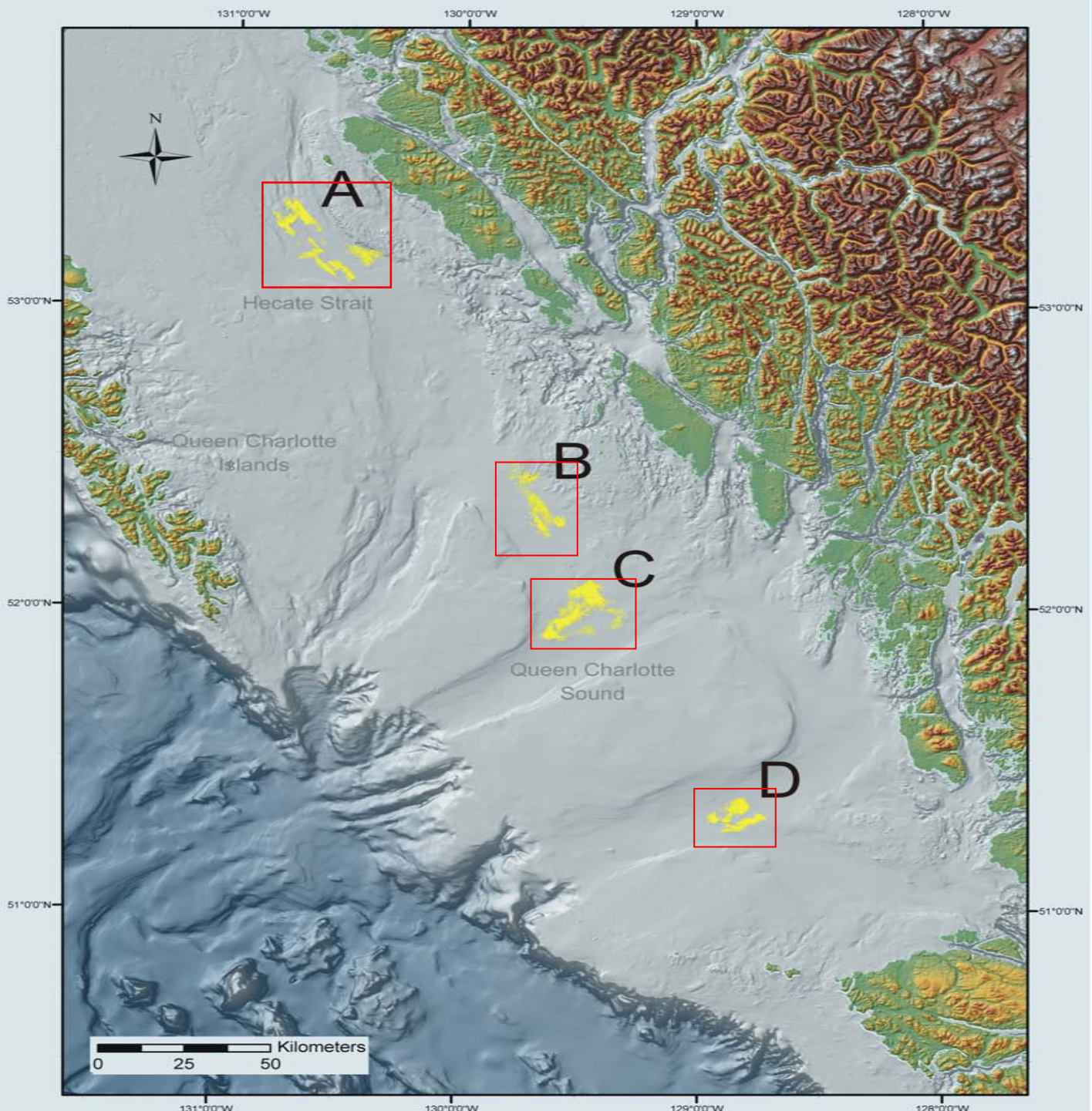




Natural Resources Canada | Ressources naturelles Canada

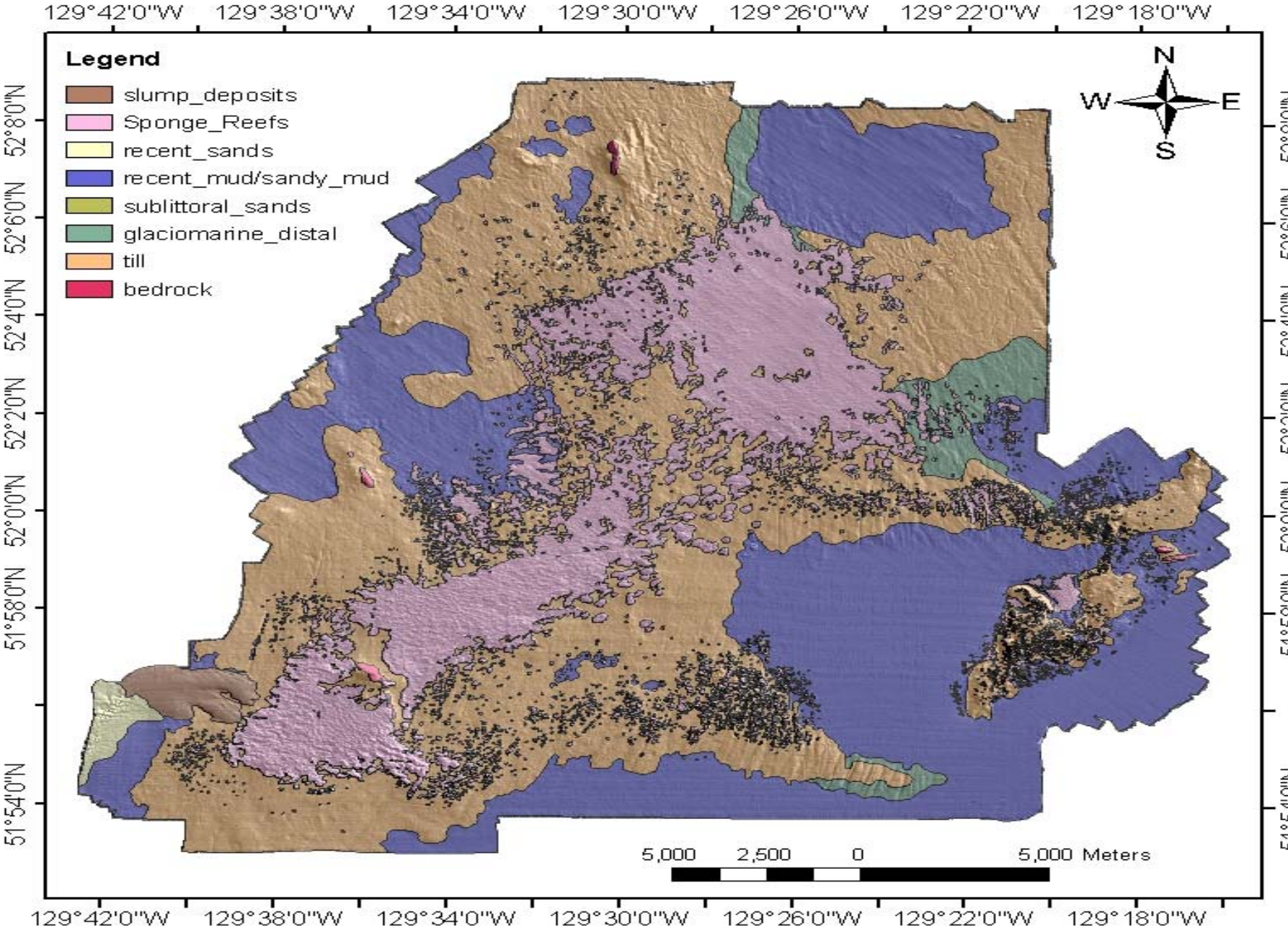

16 times vertical exaggeration
A
2000m
A'
Reef
Glaciomarine
Iceberg Scour
Till
38m

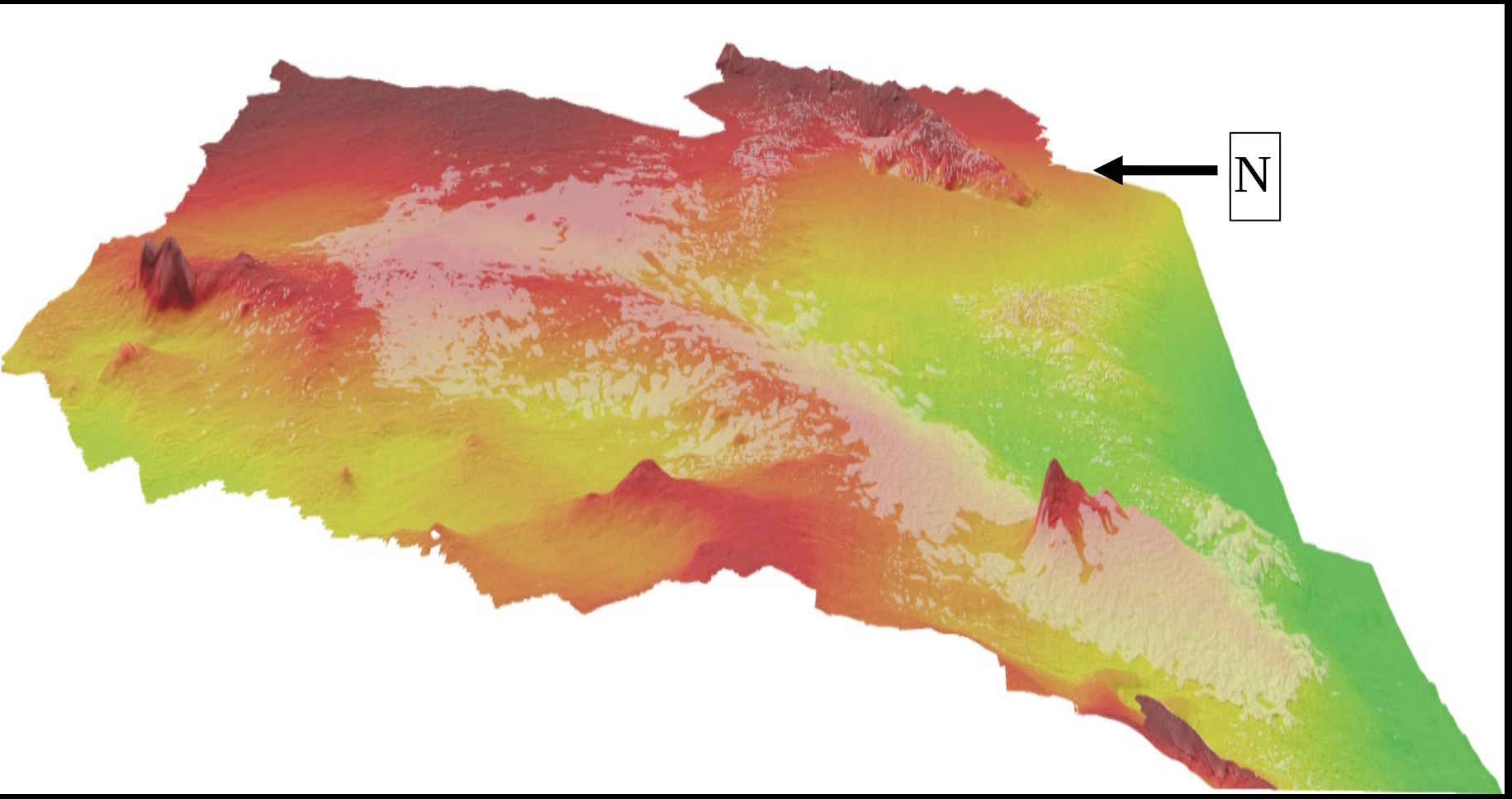
Canada

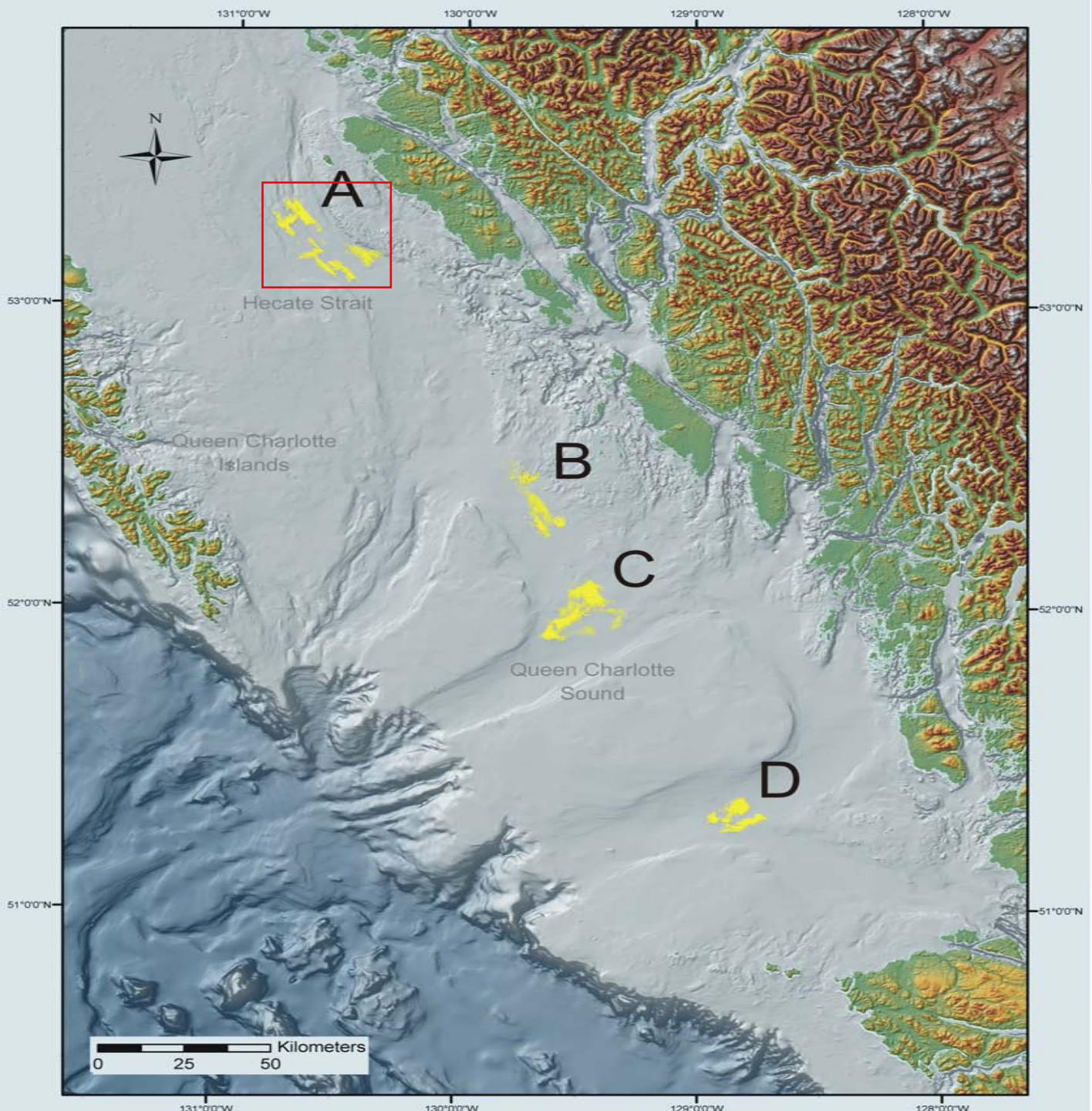

131°0'0"W
130°0'0"W
129°0'0"W
128°0'0"W
N
A
Hecate Strait
53°0'0"N
Queen Charlotte
Islands
B
C
52°0'0"N
Queen Charlotte
Sound
D
51°0'0"N
Kilometers
0
25
50

Canada

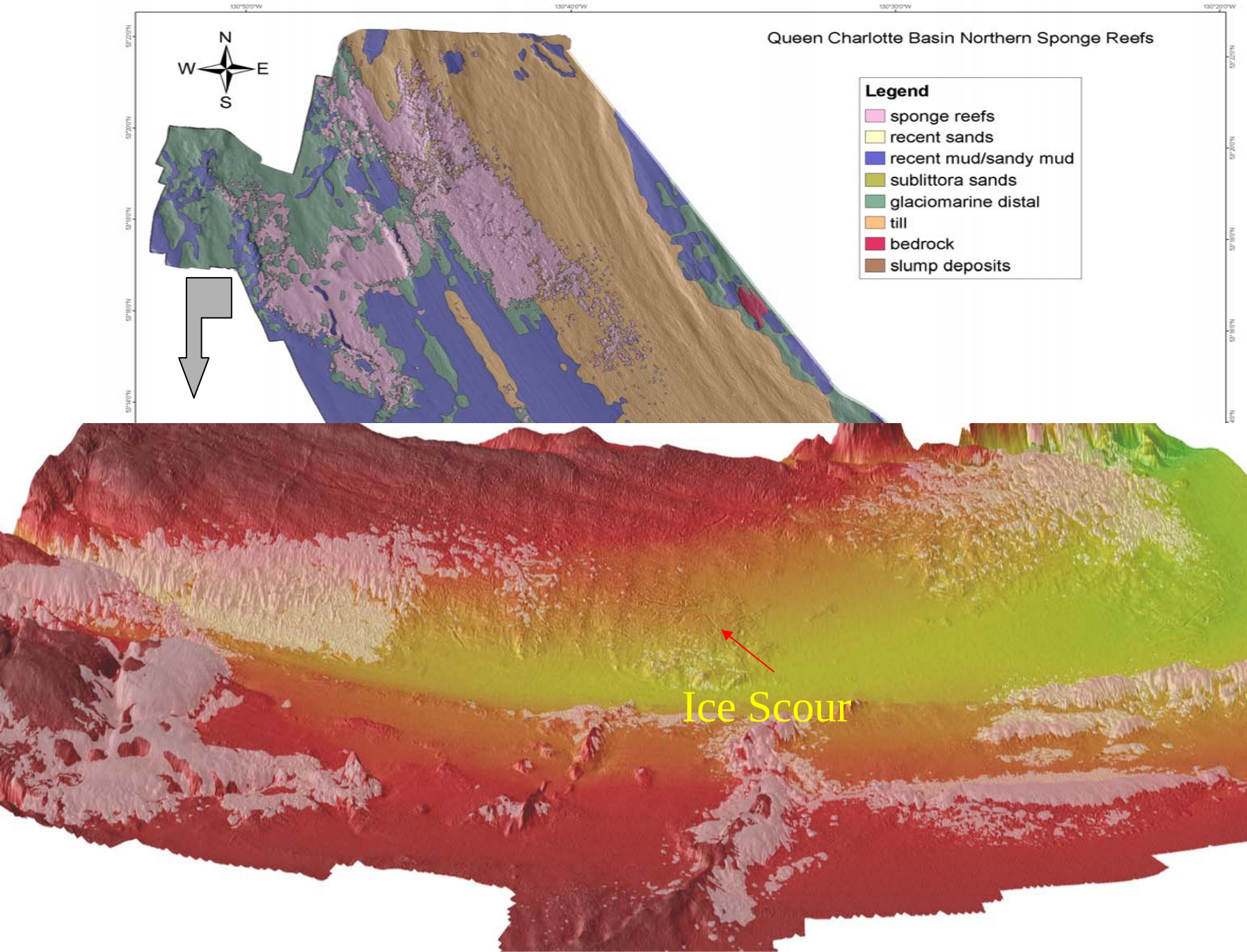
Surficial Geology Map of the Middle-South Sponge Reefs

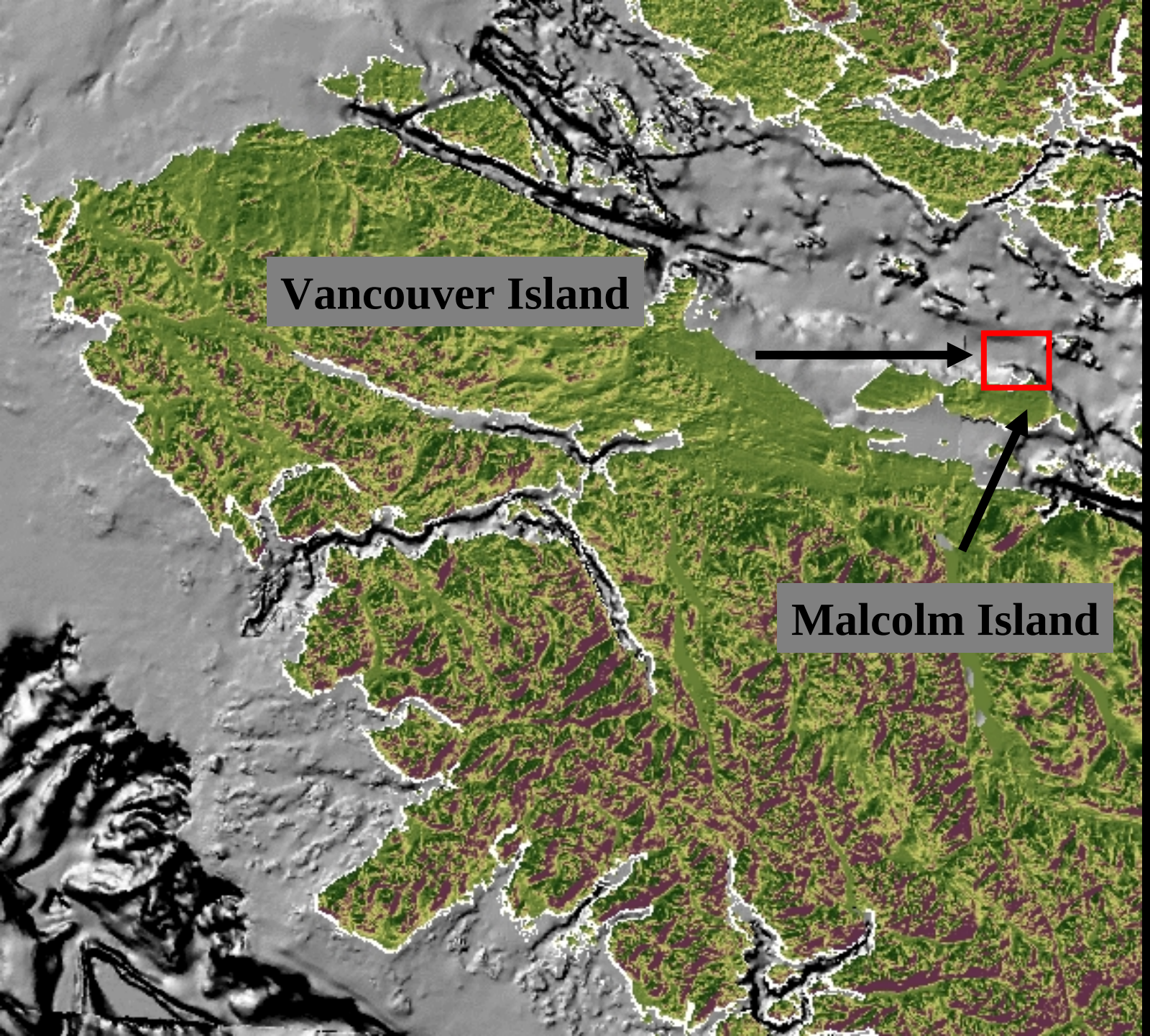


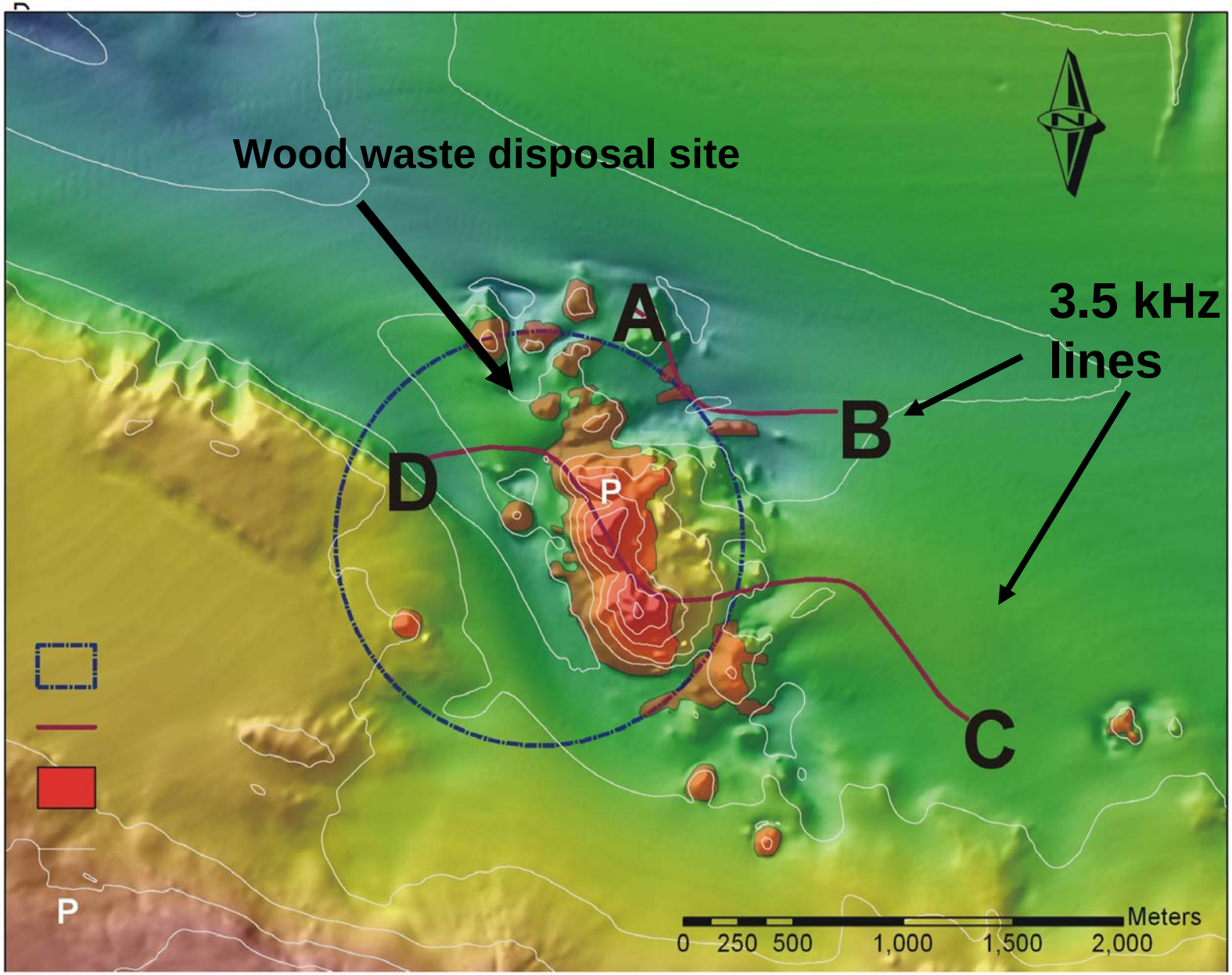

N


131°0'0"W
130°0'0"W
129°0'0"W
128°0'0"W
N
A
Hecate Strait
53°0'0"N
Queen Charlotte
Islands
B
C
52°0'0"N
Queen Charlotte
Sound
D
51°0'0"N
Kilometers
0
25
50

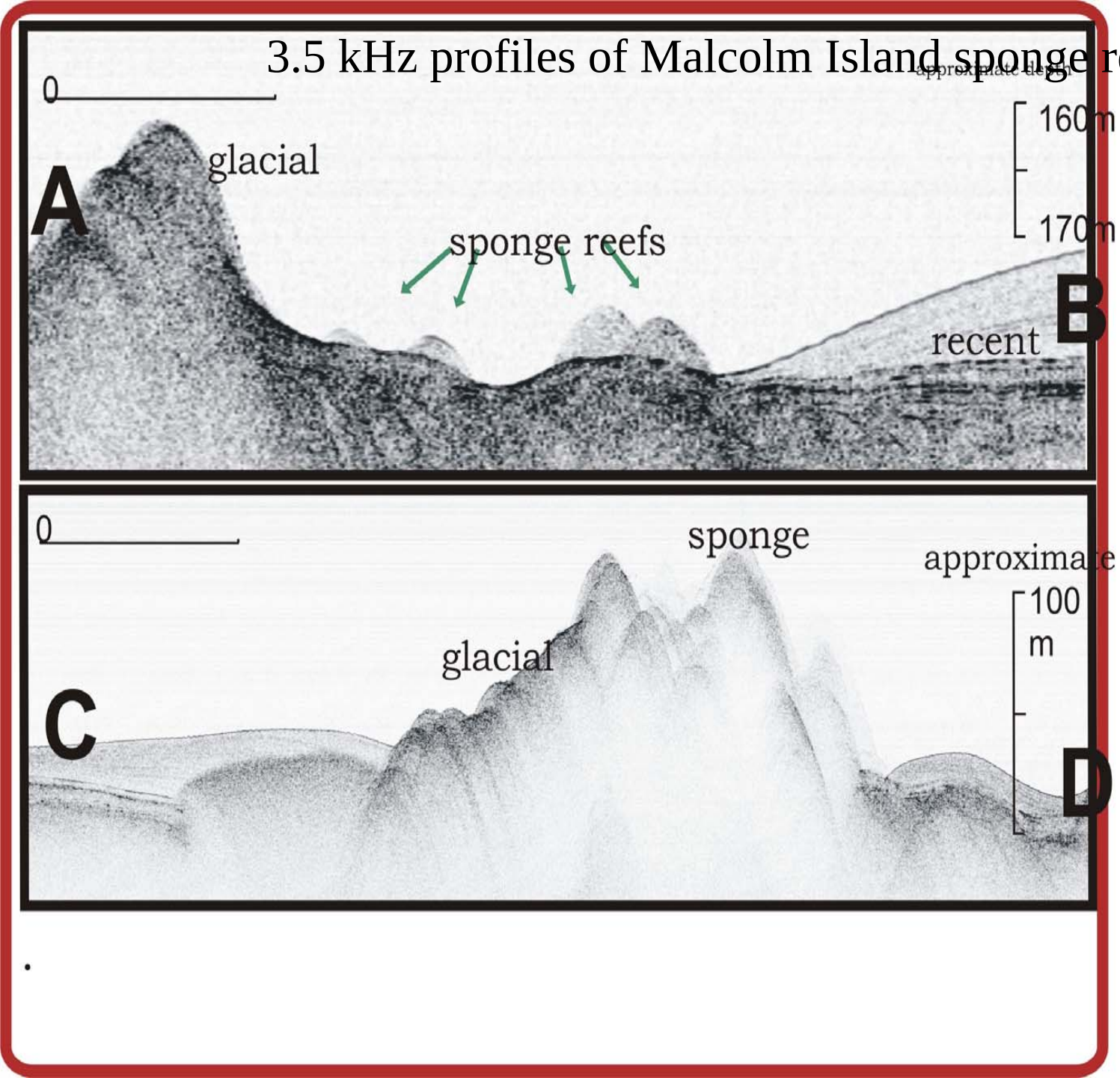
Canada


Queen Charlotte Basin Northern Sponge Reefs
N
W
E
S
Legend
sponge reefs
recent sands
recent mud/sandy mud
sublittora sands
glaciomarine distal
till
bedrock
slump deposits
Ice Scour


Vancouver Island
Malcolm Island


Wood waste disposal site
3.5 kHz lines
A
B
C
D
P
P
Meters
0 250 500 1,000 1,500 2,000

3.5 kHz profiles of Malcolm Island sponge reefs



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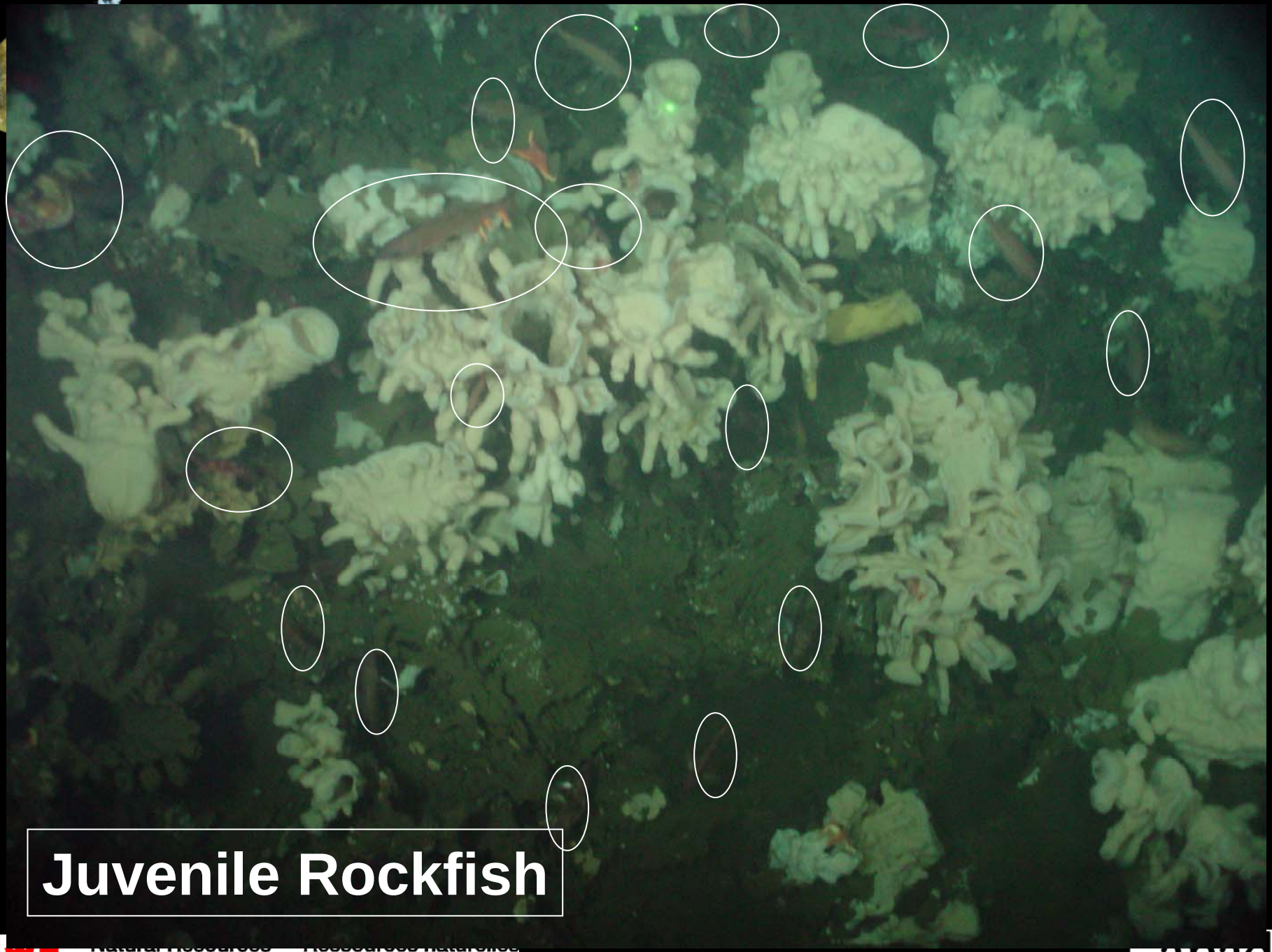
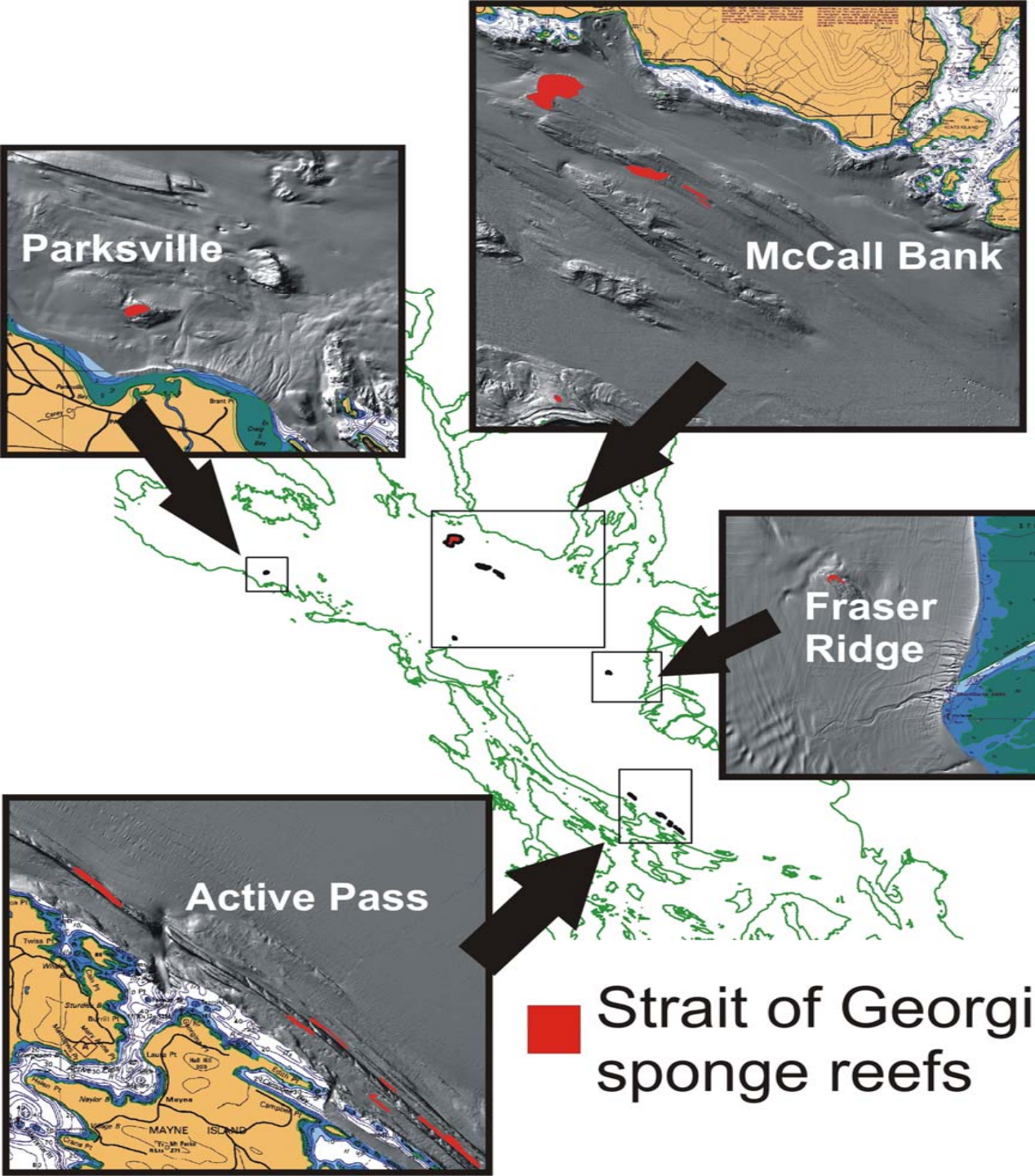
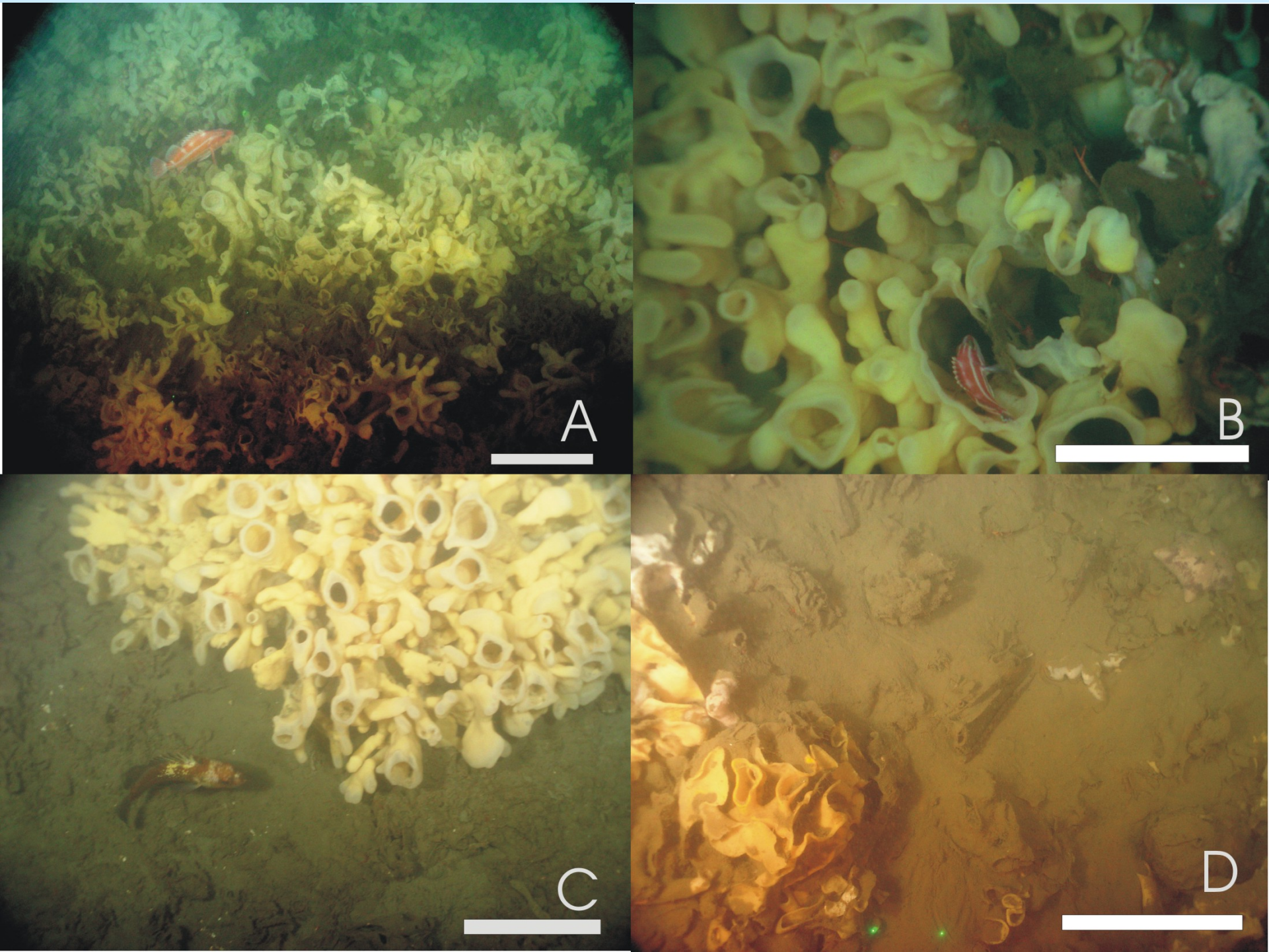
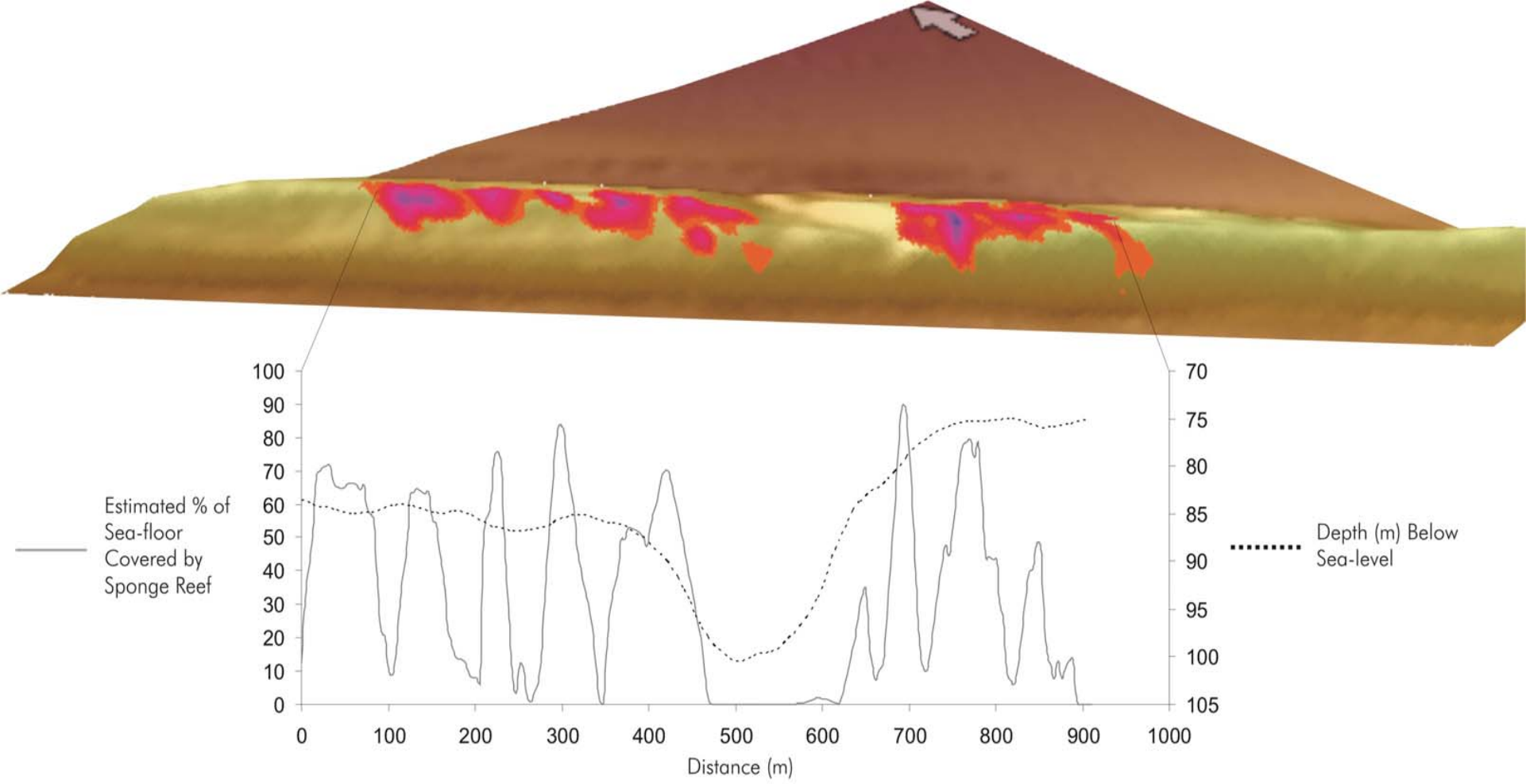
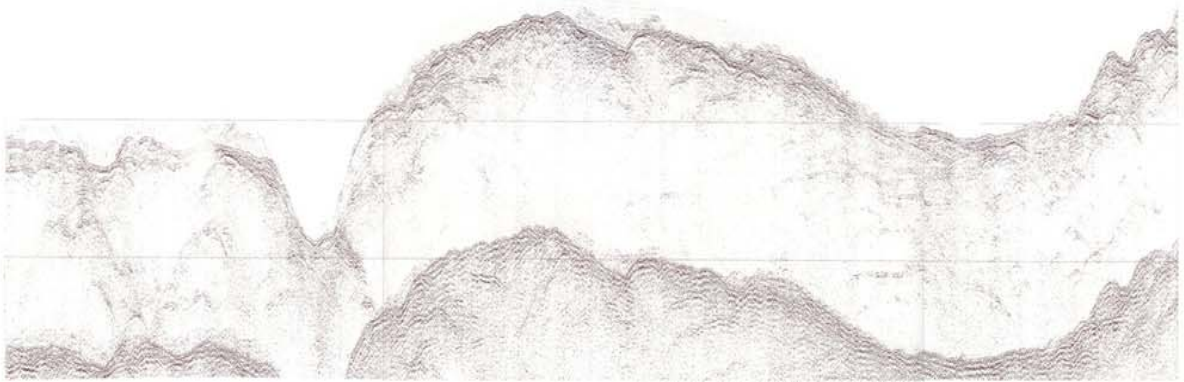

Juvenile Rockfish



Mapping sensitive habitats


A
B
C
D

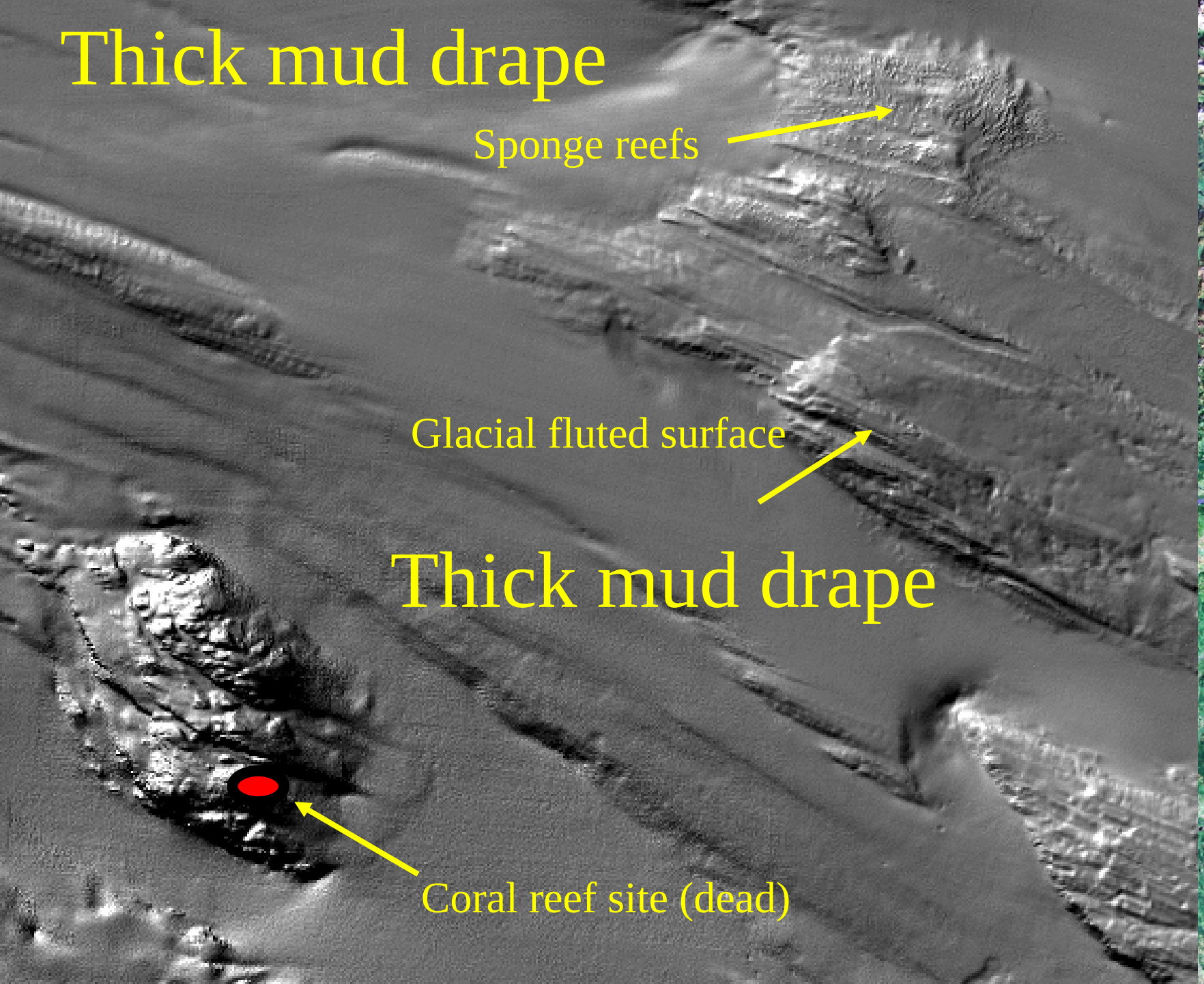




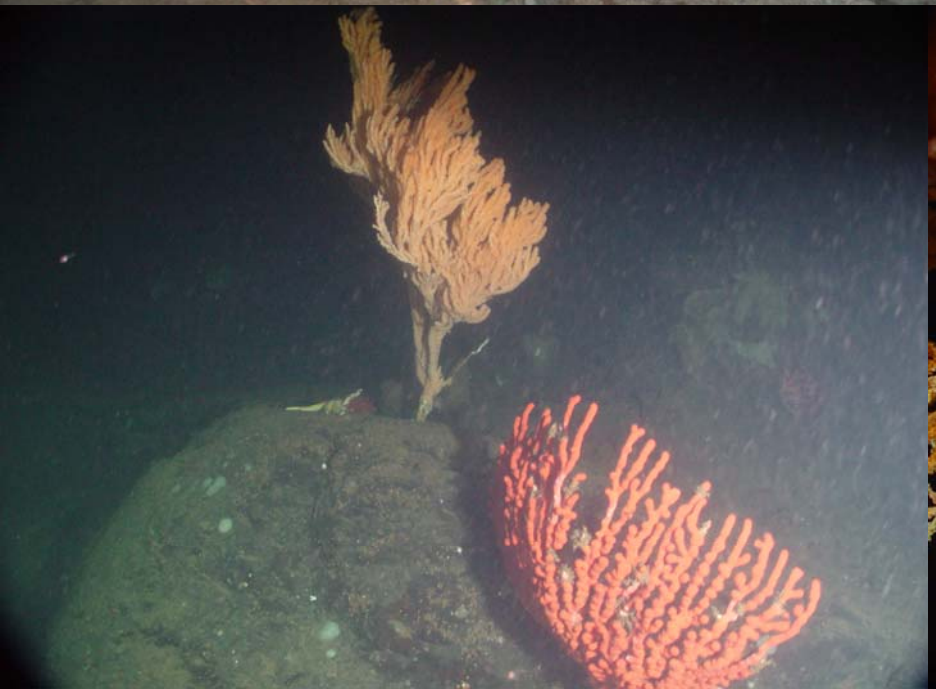
Active Pass
Sponge Reef

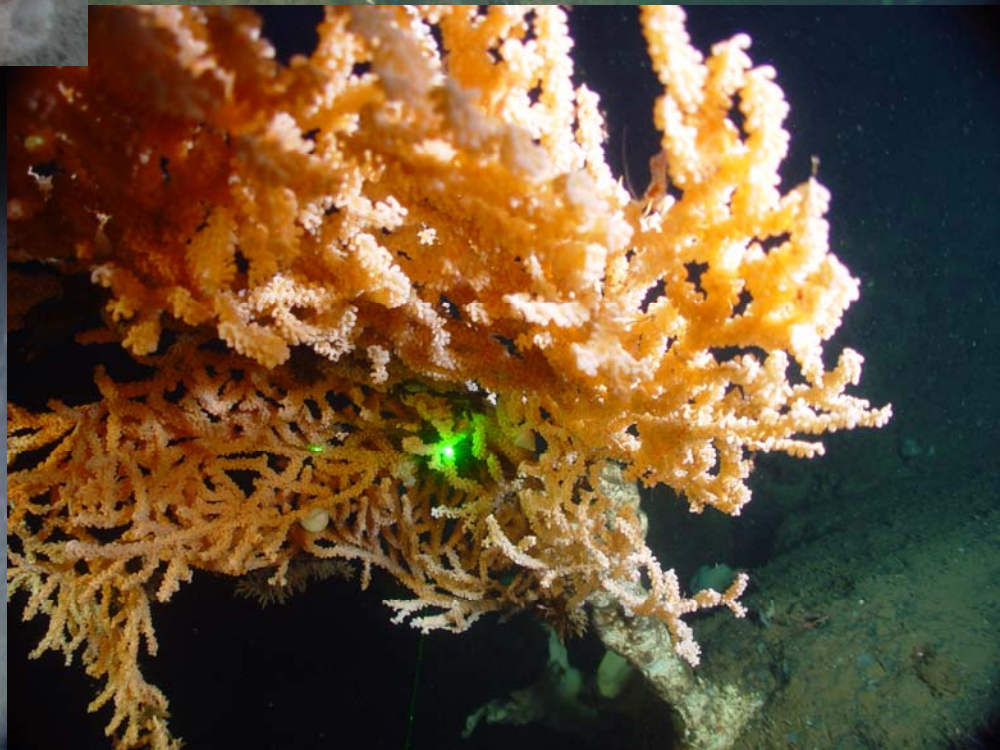
Coral reefs

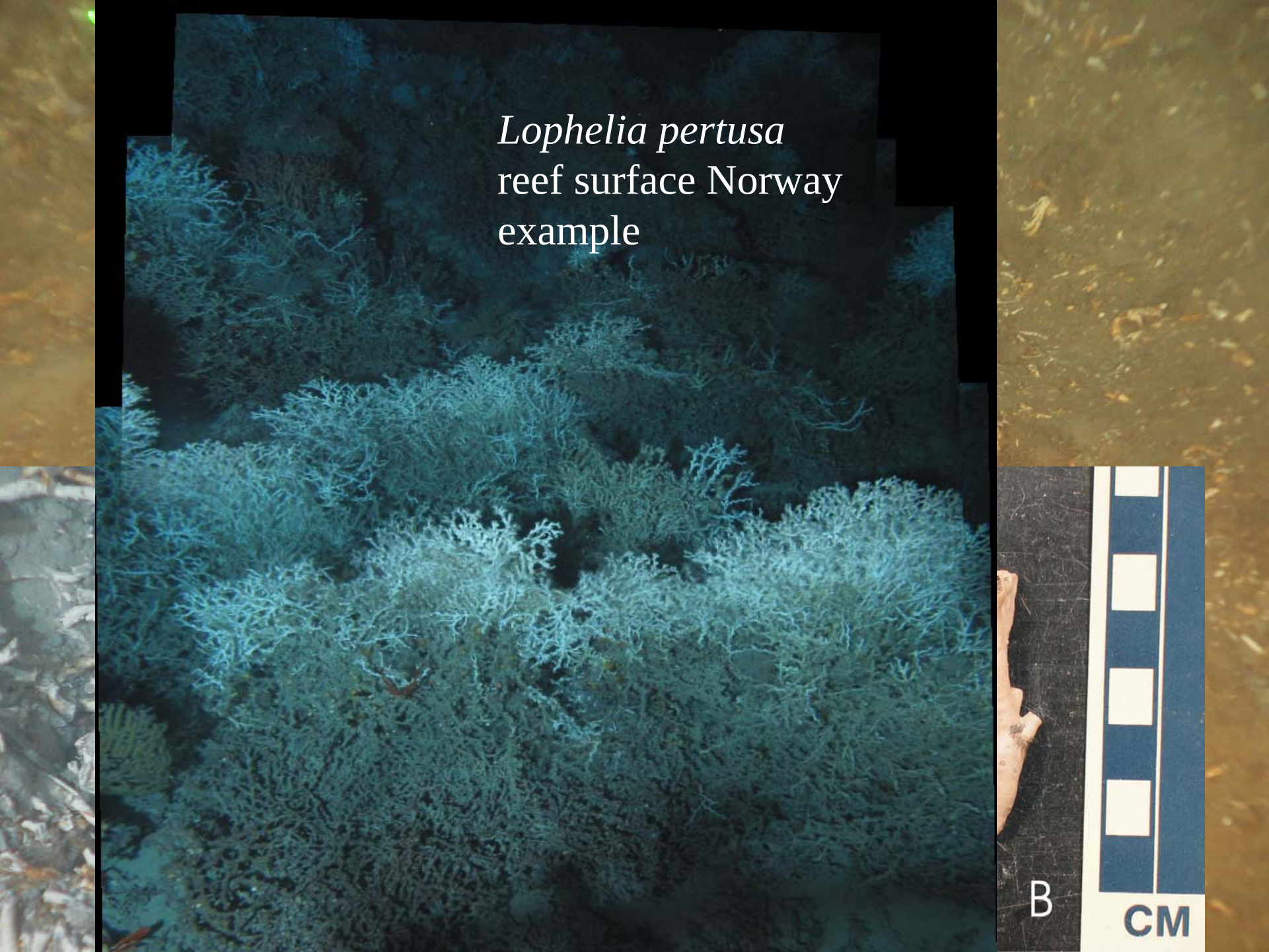
- Coral reef – *Lophelia pertusa* reef discovered.
  - Alive >7000 to approx. 5000 yBP
  - Died of natural causes
  - Suggests that other *Lophelia pertusa* reefs will be found in BC coastal waters


Thick mud drape
Sponge reefs
Glacial fluted surface
Thick mud drape
Coral reef site (dead)

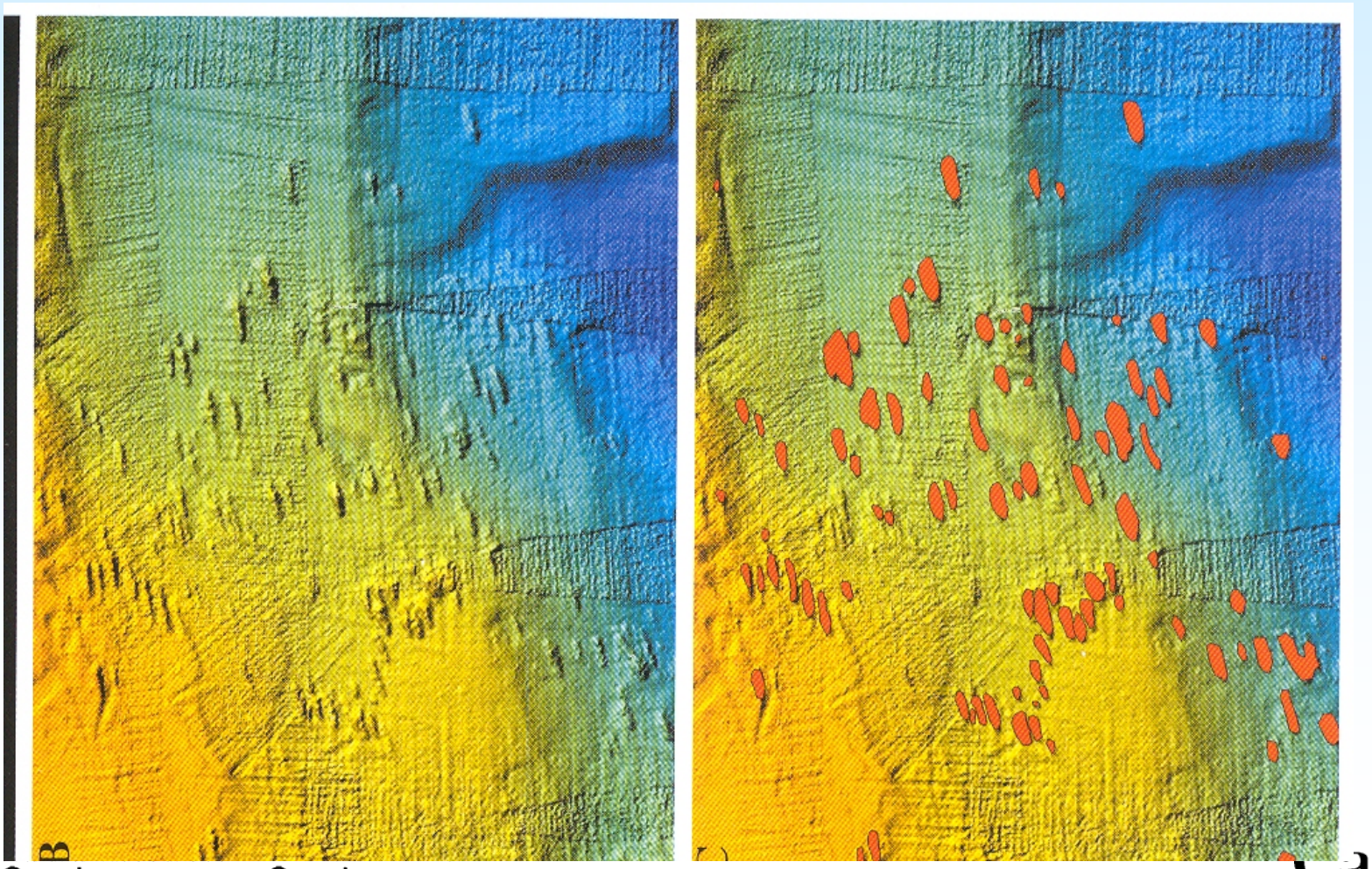
Central Georgia Basin Steep Knoll

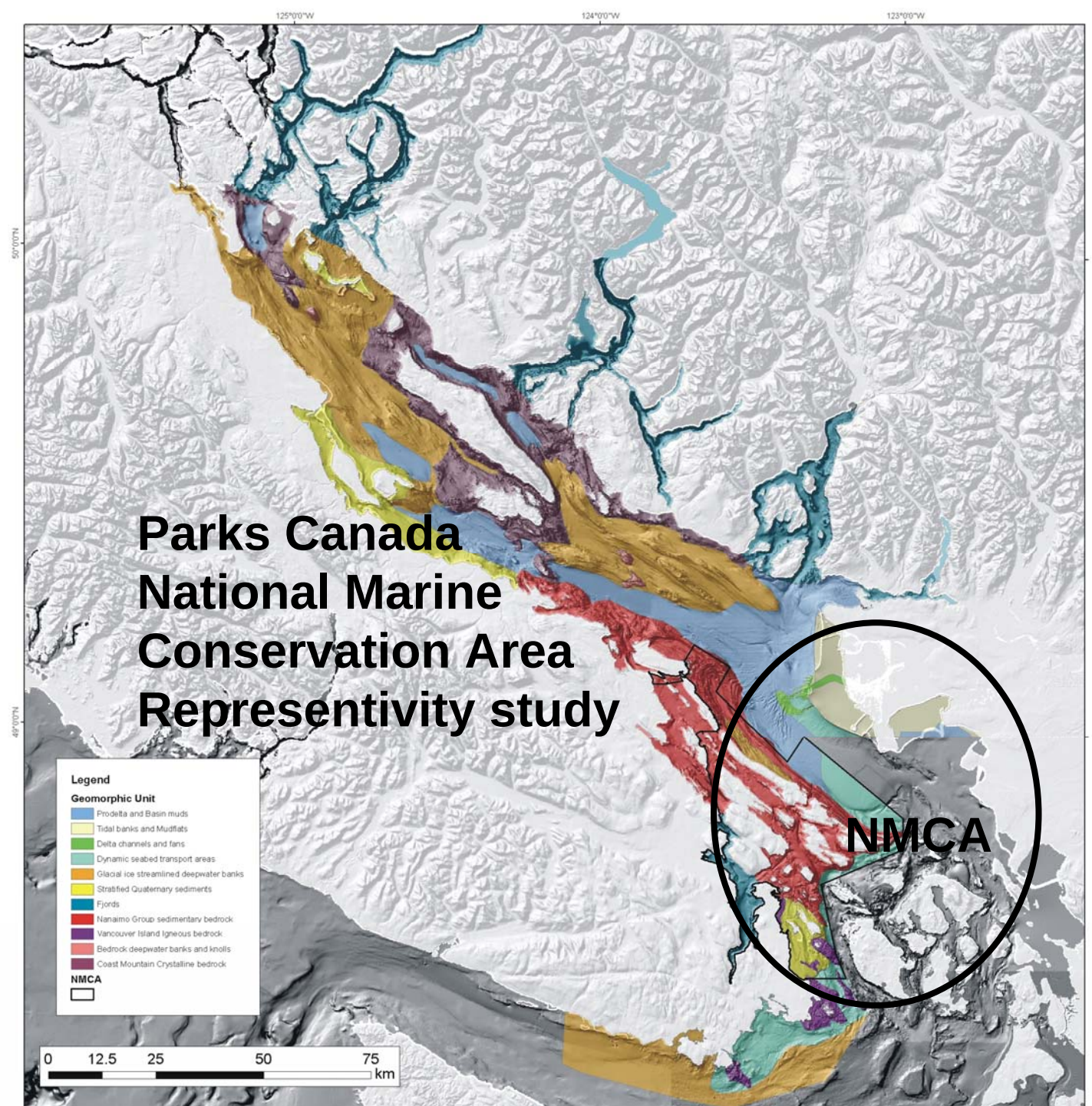




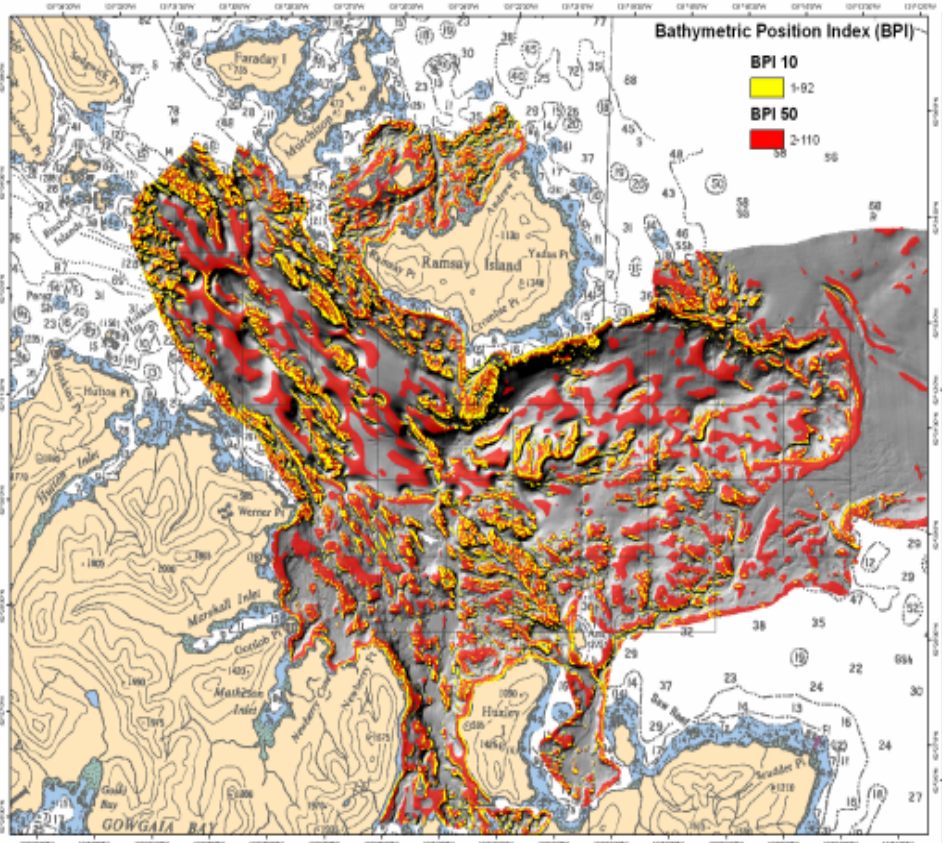

Lophelia pertusa
reef surface Norway
example
B
CM

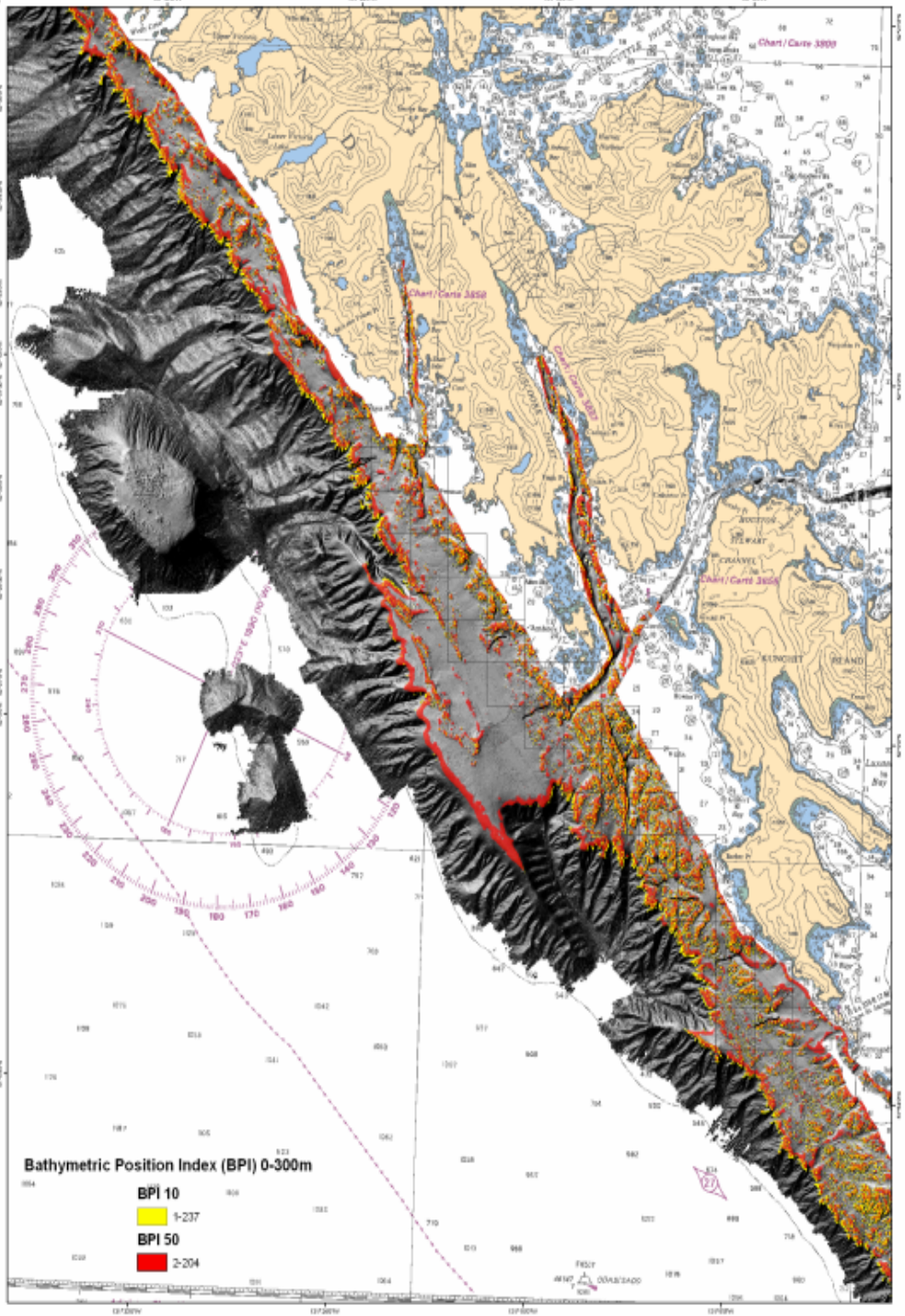
Lophelia reefs at the edge of the Norwegian shelf 300-400 m depth



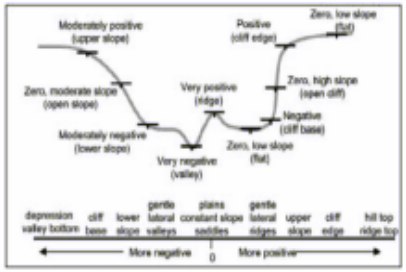

125°0'0"W
124°0'0"W
123°0'0"W
50°0'0"N
49°0'0"N
Parks Canada
National Marine
Conservation Area
Representivity study
NMCA
Legend
Geomorphic Unit
Prodelta and Basin muds
Tidal banks and Mudflats
Delta channels and fans
Dynamic seabed transport areas
Glacial ice streamlined deepwater banks
Stratified Quaternary sediments
Fjords
Nanaimo Group sedimentary bedrock
Vancouver Island Igneous bedrock
Bedrock deepwater banks and knolls
Coast Mountain Crystalline bedrock
NMCA
0 12.5 25 50 75
km

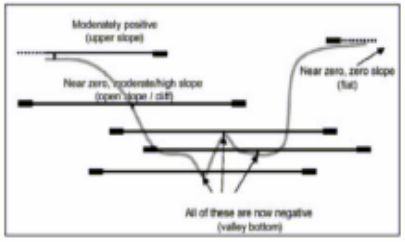
Canada





Bathymetric Position Index (BPI) is a second-order derivative of bathymetry modified from topographic position index as defined in Weiss (2001) and Iampietro and Kvitek (2002).





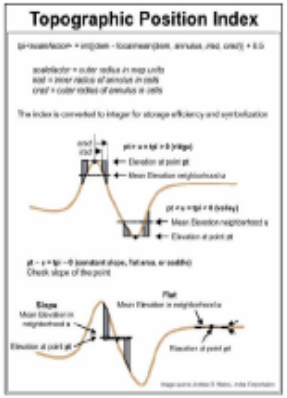
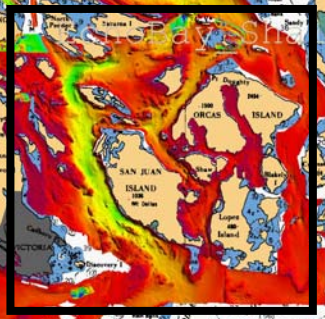


Figure 10: Algorithm and schematic describing topographic position index.

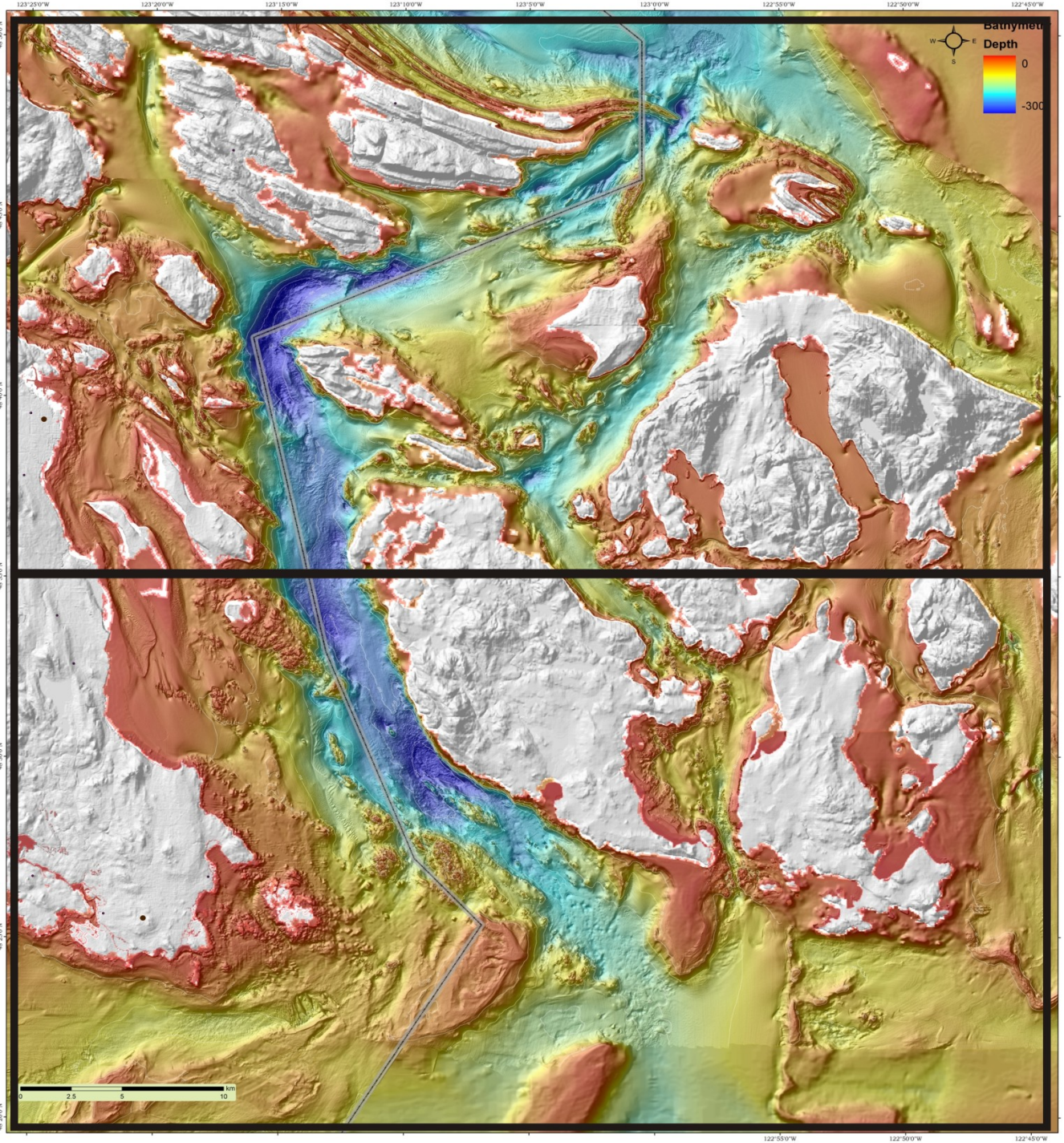
The algorithm first calculates the mean value of all the pixels within a specified neighborhood (e.g. rectangular kernel, circular ring, annulus) and then calculates the variance from that mean.

Vancouver
Georgia Strait
IOS
Victoria
N
0 5 10 20
km
Legend
Rockfish conservation area

San Juan Islands/ Southern Strait of Georgia



Canada



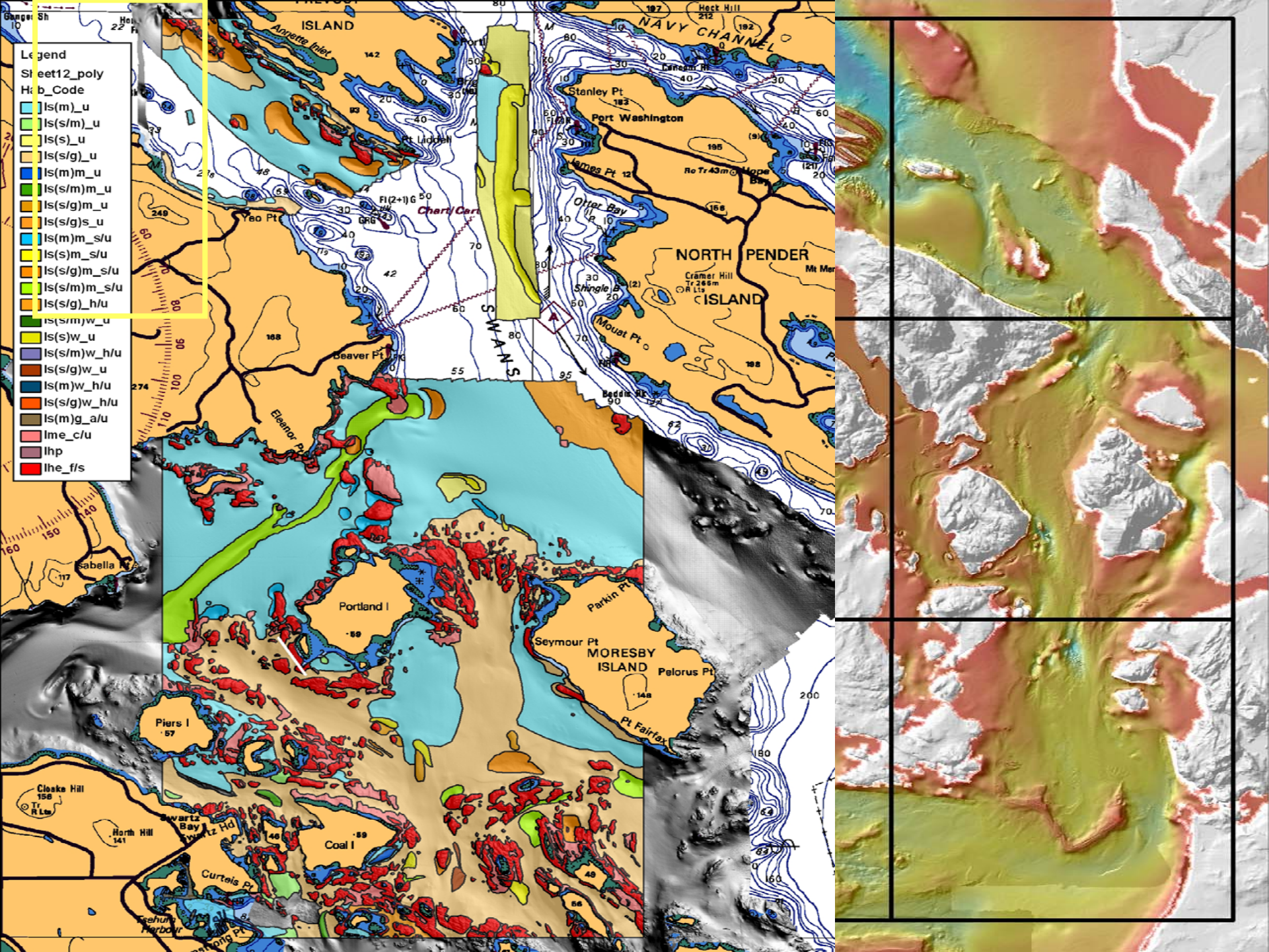
Multibeam

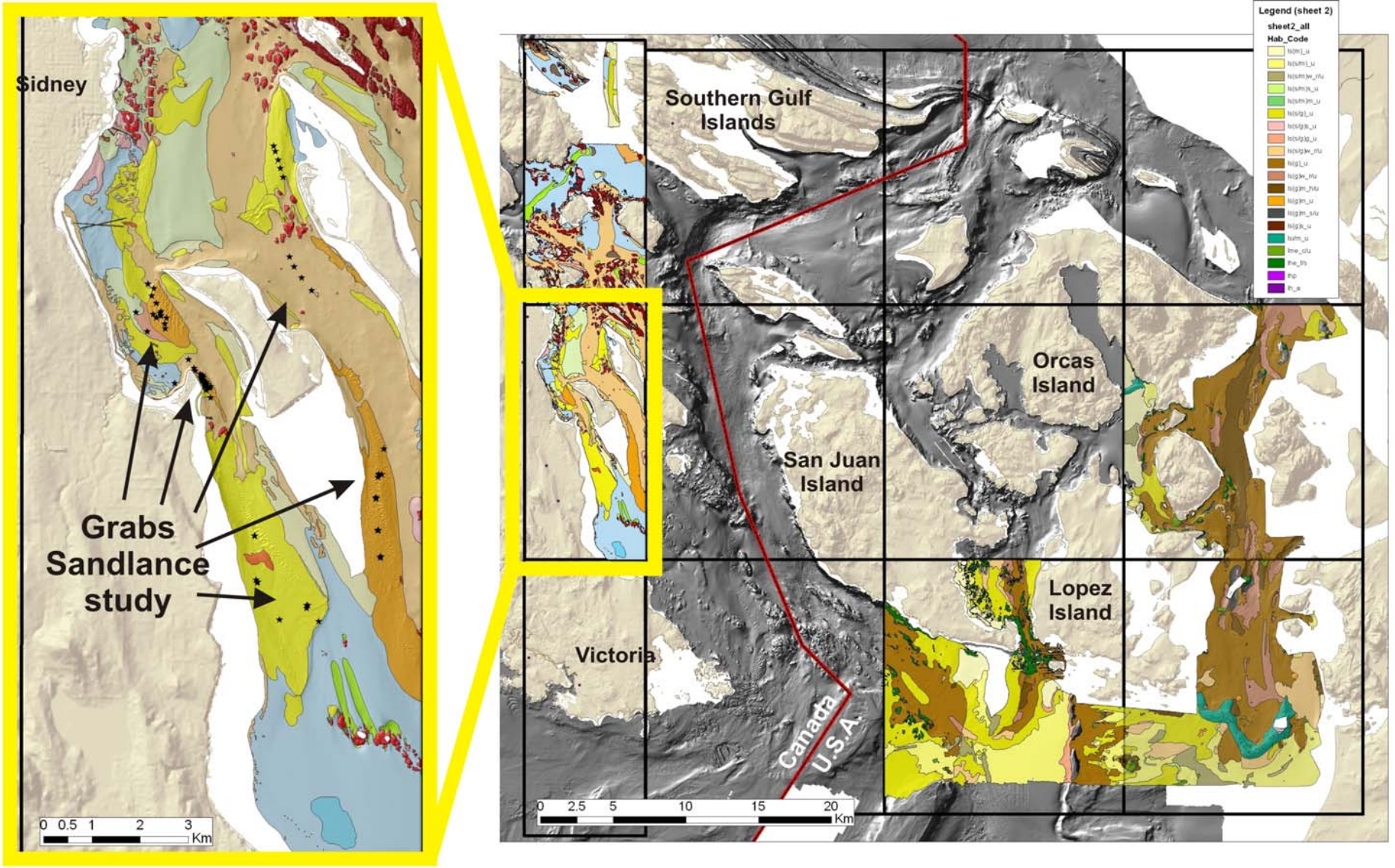
Backscatter/
Surface Sediments

Surficial Geology

Habitat

Canada


Legend
Sheet12_poly
Hab_Code
ls(m)_u
ls(s/m)_u
ls(s)_u
ls(s/g)_u
ls(m)m_u
ls(s/m)m_u
ls(s/g)m_u
ls(s/g)s_u
ls(m)m_s/u
ls(s)m_s/u
ls(s/g)m_s/u
ls(s/m)m_s/u
ls(s/g)_h/u
ls(s/m)w_u
ls(s)w_u
ls(s/m)w_h/u
ls(s/g)w_u
ls(m)w_h/u
ls(s/g)w_h/u
ls(m)g_a/u
lme_c/u
lhp
lhe_f/s
ISLAND
Annette Inlet
NAVY CHANNEL
Stanley Pt
Port Washington
James Pt
Otter Bay
NORTH PENDER
ISLAND
Cramer Hill
Shingle B
Mouat Pt
Yeo Pt
Beaver Pt
SWANS
Eleanor Pt
Portland I
Parkin Pt
Seymour Pt
MORESBY
ISLAND
Pelorus Pt
Pt Fairfax
Piers I
Cloake Hill
North Hill
Swartz Bay
Swartz Hd
Coal I
Curteis Pt
Isabella Pt

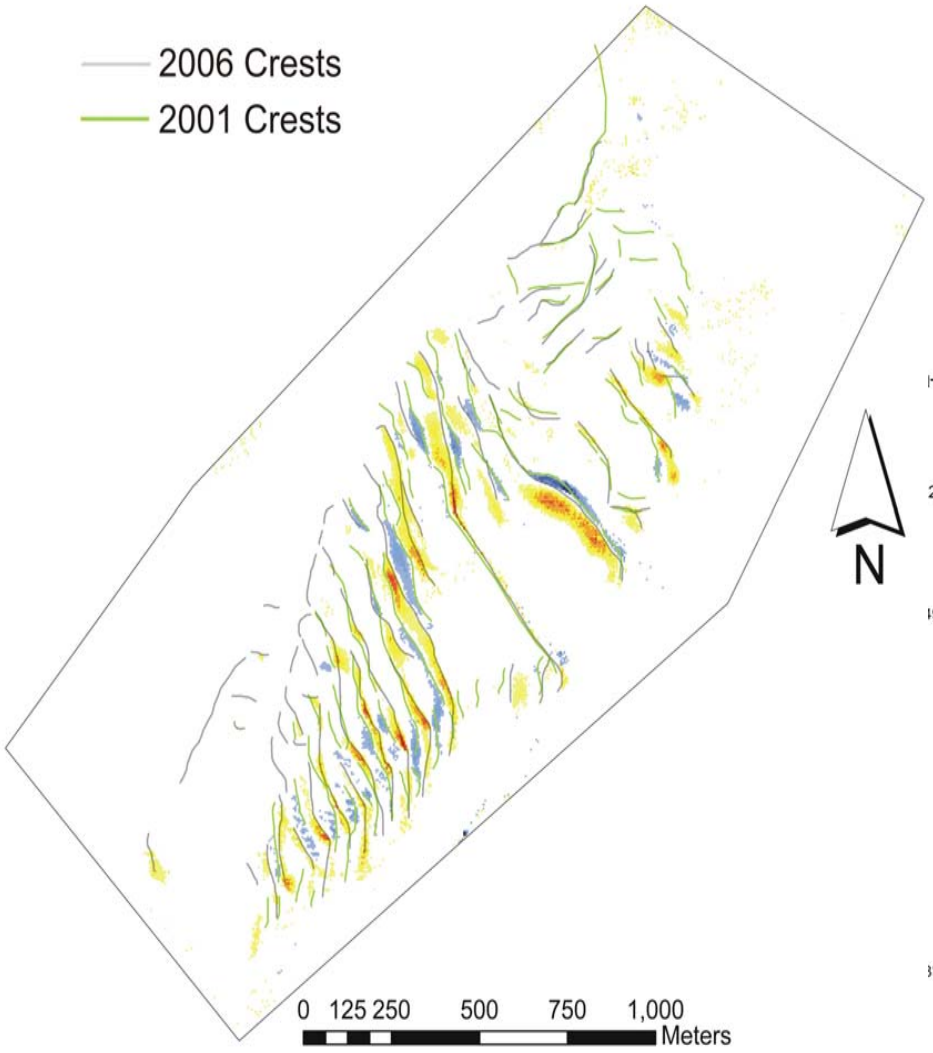


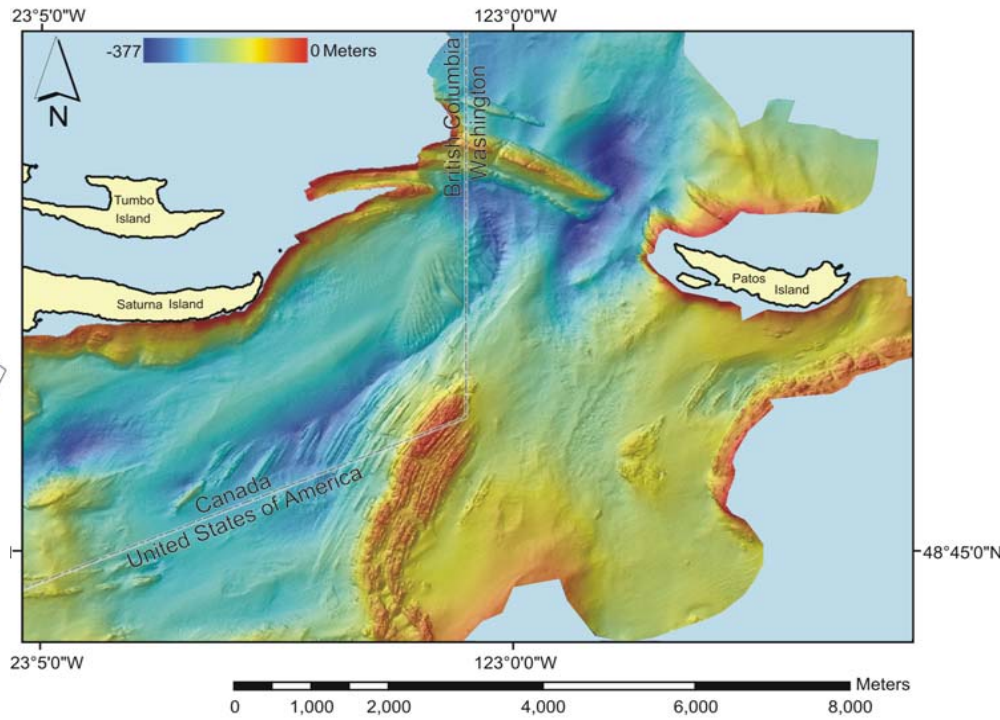
Sheet11 Habitats

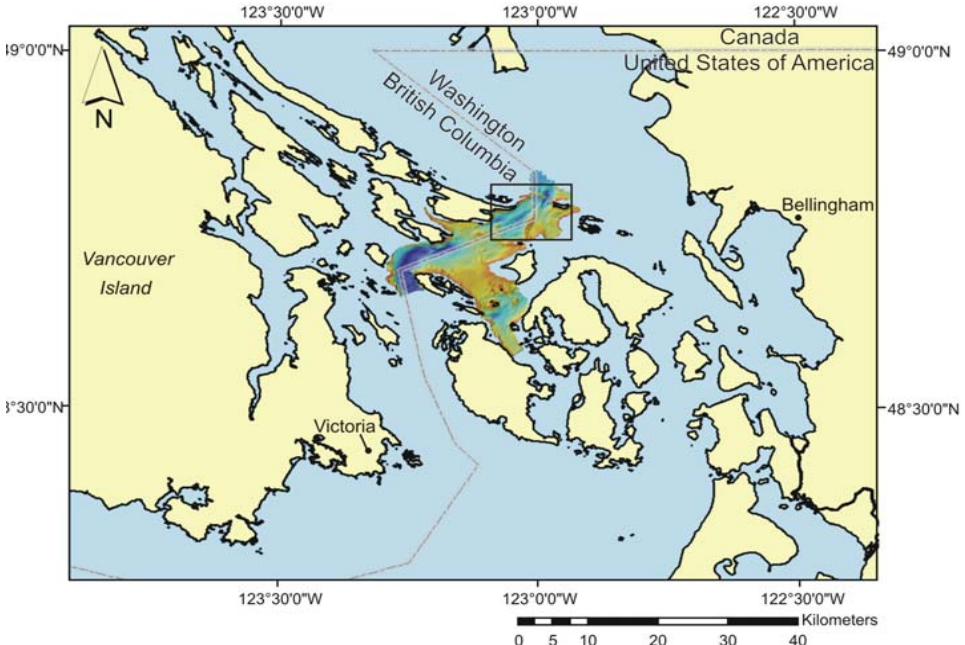
Hab_code, Hab_Desc

- lh_a, Pipeline
- lhe_f/s, Upper Cretaceous sedimentary Nanaimo Group exposure
- lhe_f/s, Undifferentiated bedrock exposure fractured and glacially scoured
- lhp, Pinnacle or boulder
- lme_c/u, Veneer of sediments covering bedrock and in place exposed
- ls(b)_a/u, Riprap (boulder)
- ls(b/c)_a/u, Former vessel loading facility
- ls(m)_u, Mud
- ls(m)_h/u, Hummocky Mud
- ls(m)m_u, Pockmarks (mud)
- ls(s)_u, Sand
- ls(s)w_u, Sandwaves
- ls(s)m_s/u, Current scoured depression in sandy sediments
- ls(s)m_u, Sand mound
- ls(s/g)_u, Sand and gravel
- ls(s/g)_h/u, Hummocky sand and gravel
- ls(s/g)w_u, Sand and gravel subaqueous dunes
- ls(s/g)_s/h/u, Hummocky and scoured sand and gravel
- ls(s/g)m_u, Sand and gravel mound
- ls(s/g)_a/u, Anthropogenically modified sand and gravel
- ls(s/m)_u, Sand and mud
- ls(s/m)m_s/u, Current scoured depression in sand and mud sediments
- ls(s/m)m_u, Sand and mud mound
- ★ Grab_sample_PC

Net Elevation Change and Crest Migration Between 2001 and 2006, Boundary Pass Sand Waves

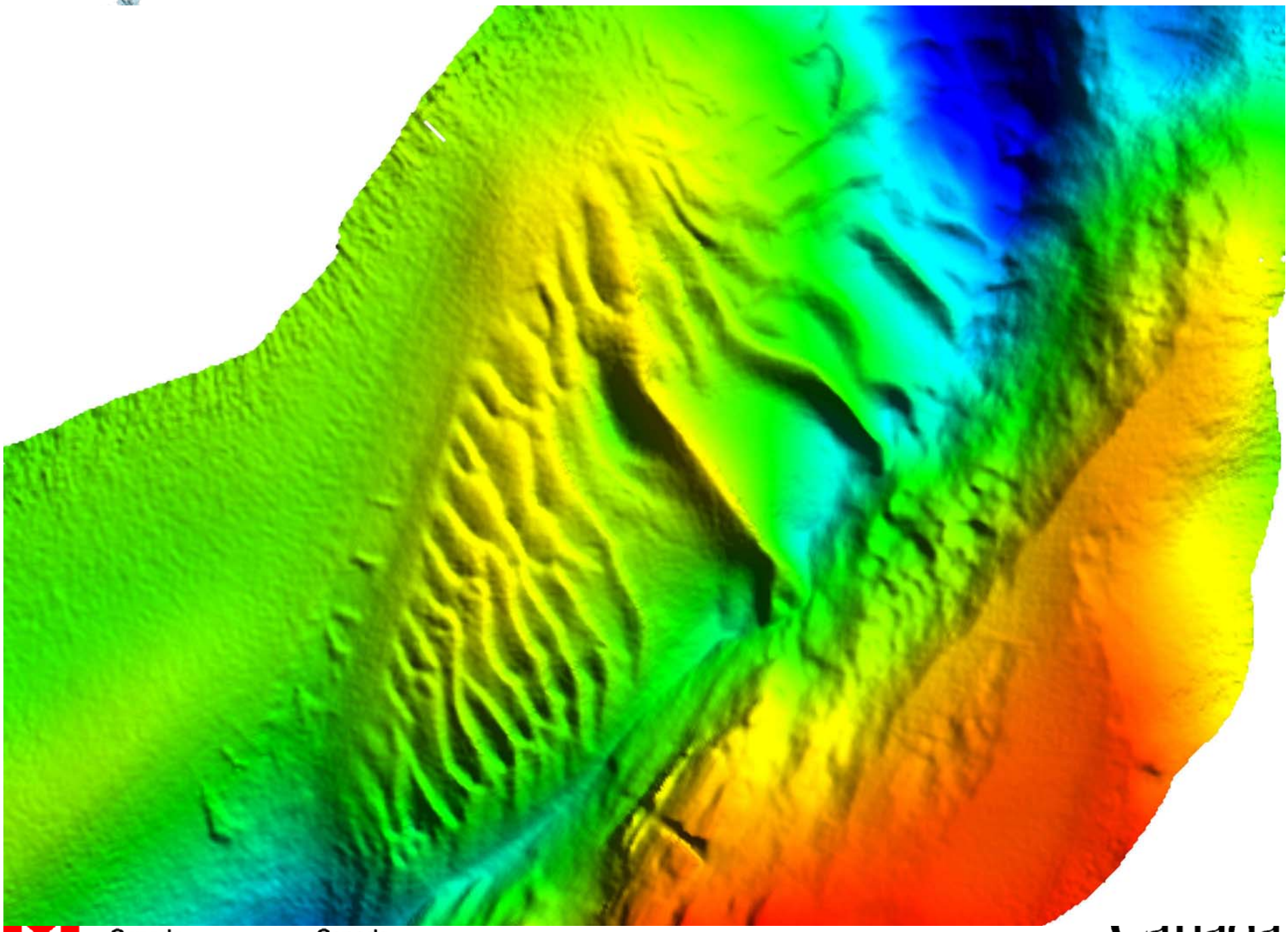






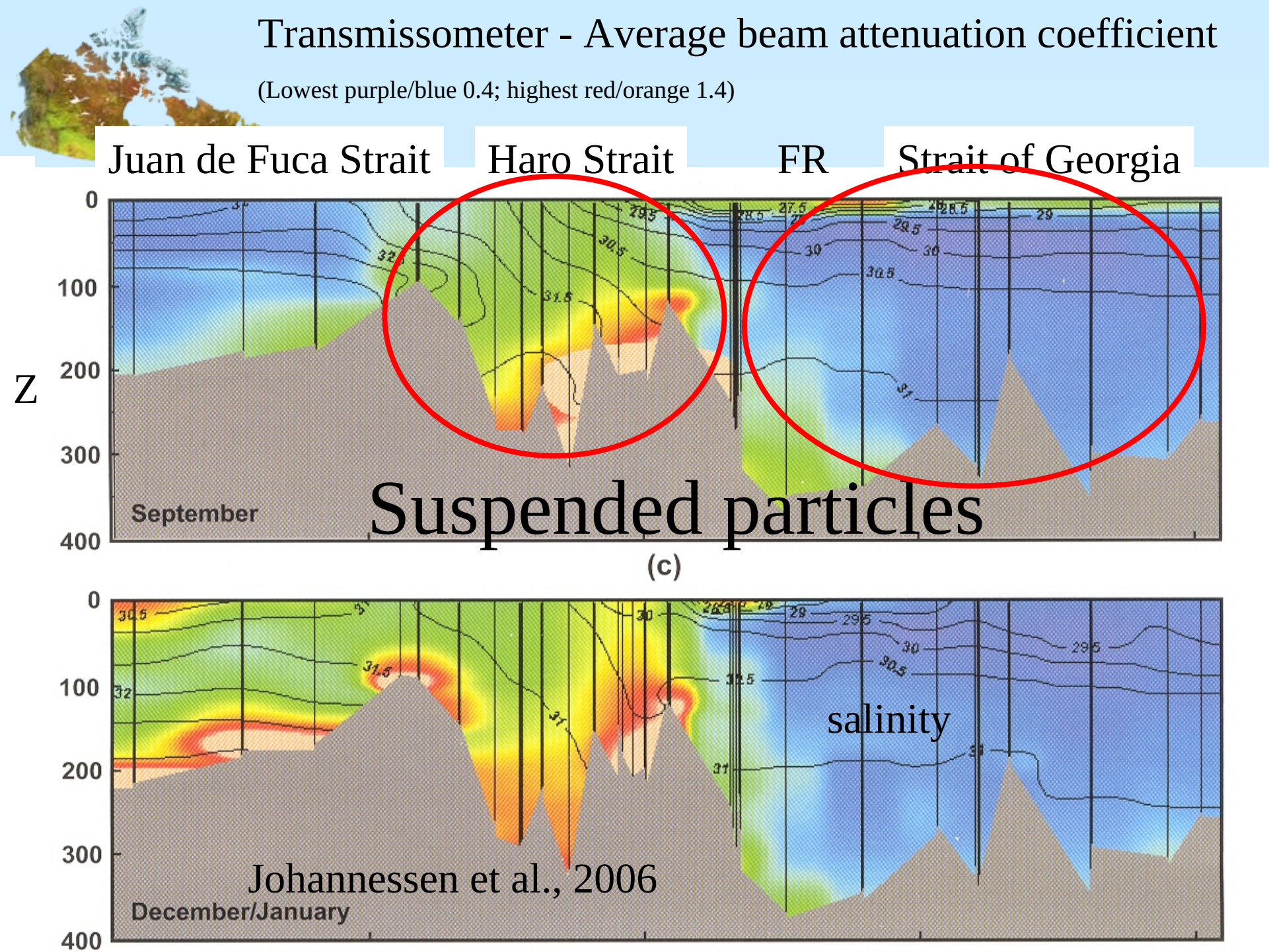
Increase in Elevation (m) >2 >6

Decrease in Elevation (m) >2 >11



Transmissometer - Average beam attenuation coefficient

(Lowest purple/blue 0.4; highest red/orange 1.4)



Summary:

Habitat Mapping for offshore British Columbia has primarily been for critical habitats such as sponge reefs

Surficial geology is a key component of understanding these critical habitats

The San Juan/Gulf Islands Transboundary Mapping Project provides a template for an international habitat mapping protocol