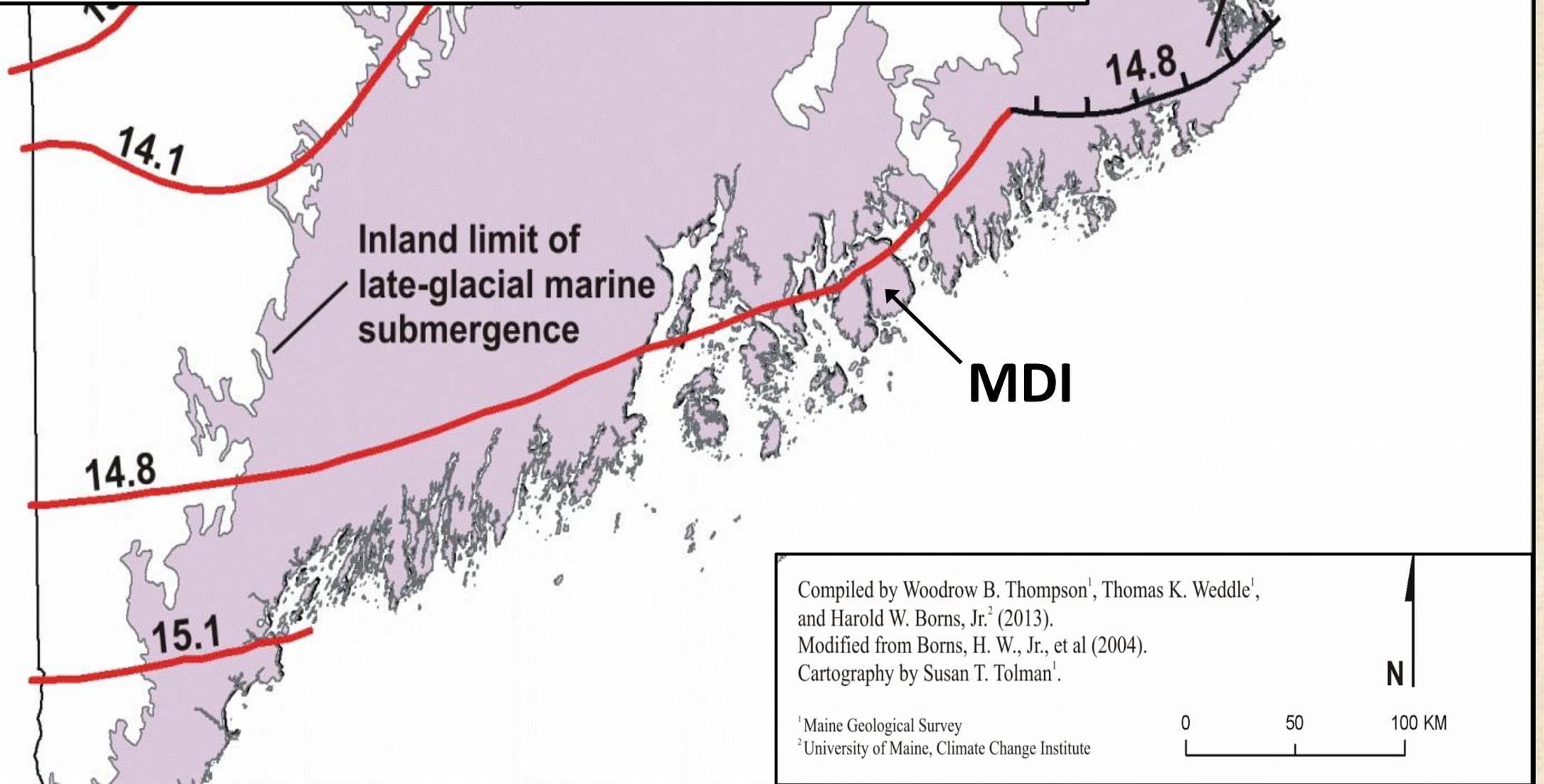
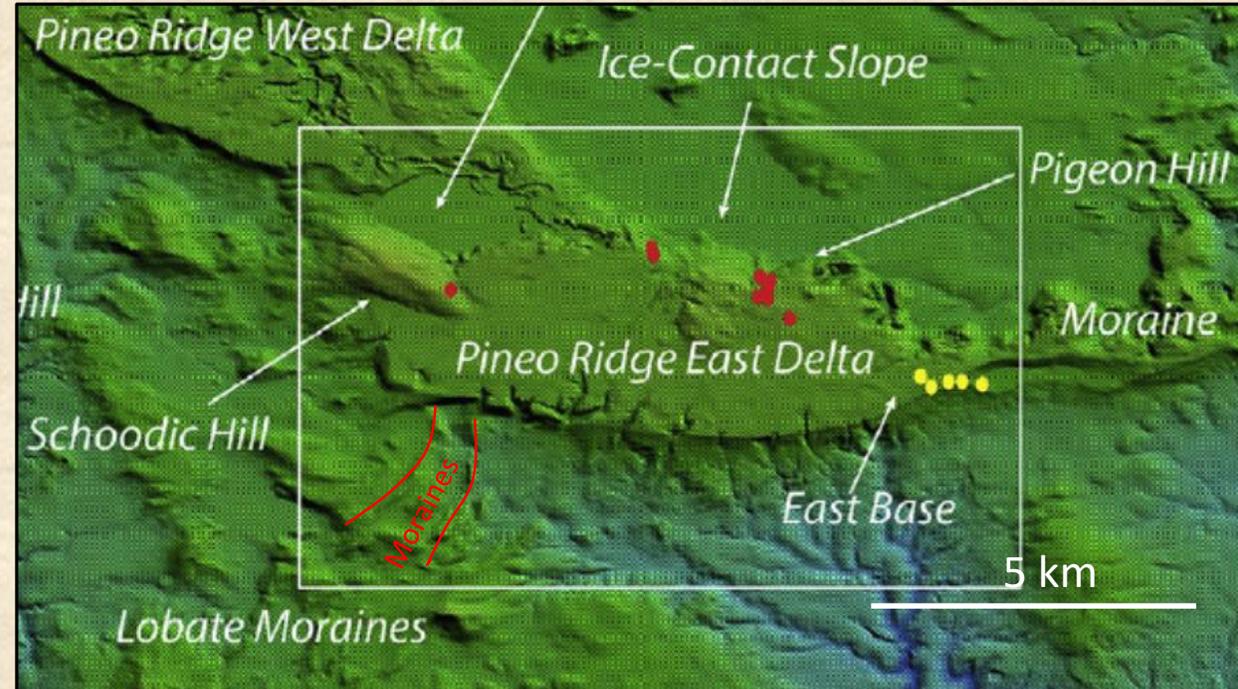
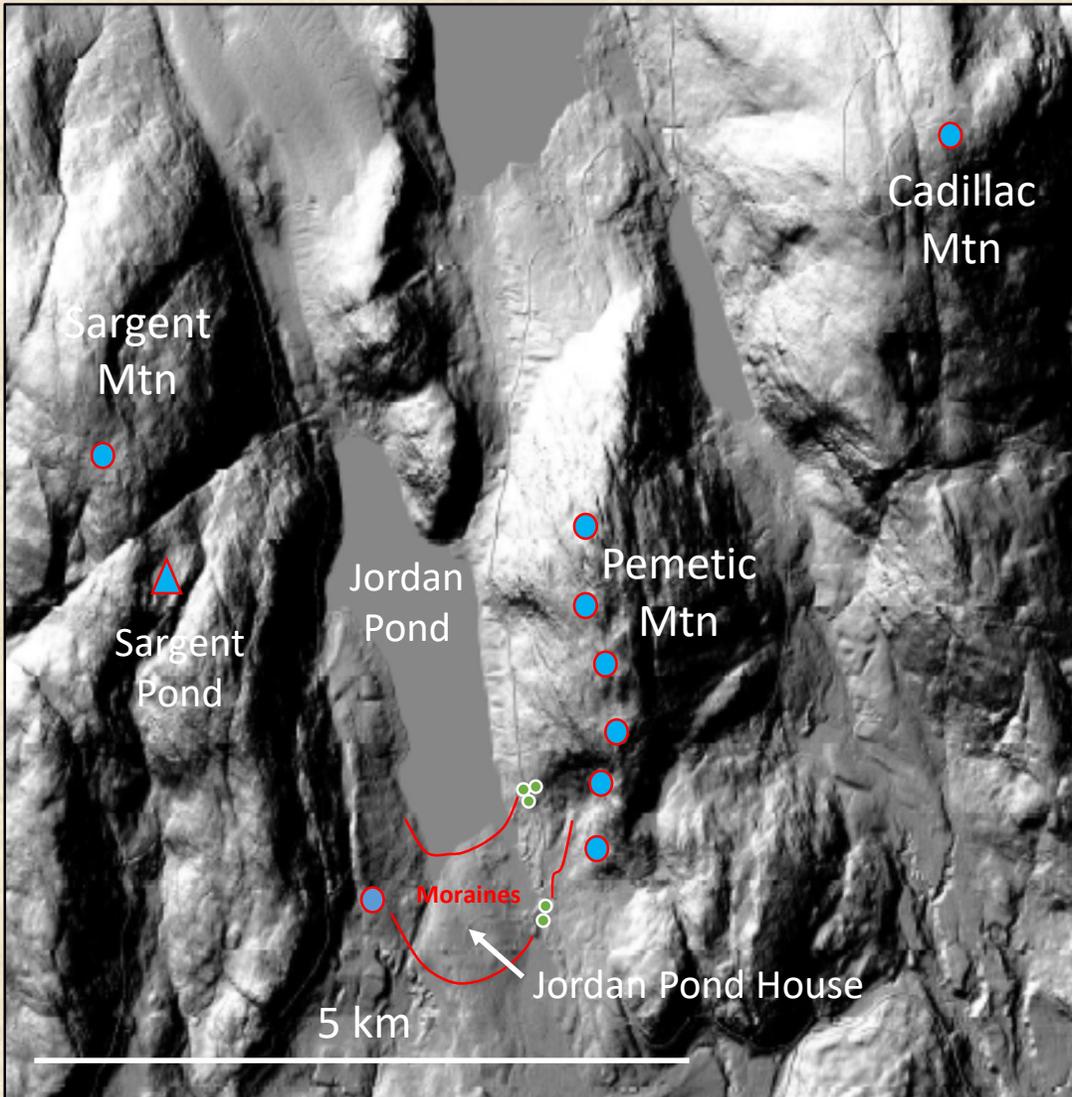


CORRELATION OF THE EASTERN MAINE PINEO RIDGE SYSTEM TO MORAINES ON MOUNT DESERT ISLAND THROUGH LIDAR IMAGERY AND ^{10}Be SURFACE EXPOSURE AGES

Braun, D.D., Thompson, W.B., Davis, P.T., Shakun, J., Bierman, P., and Corbett, L.

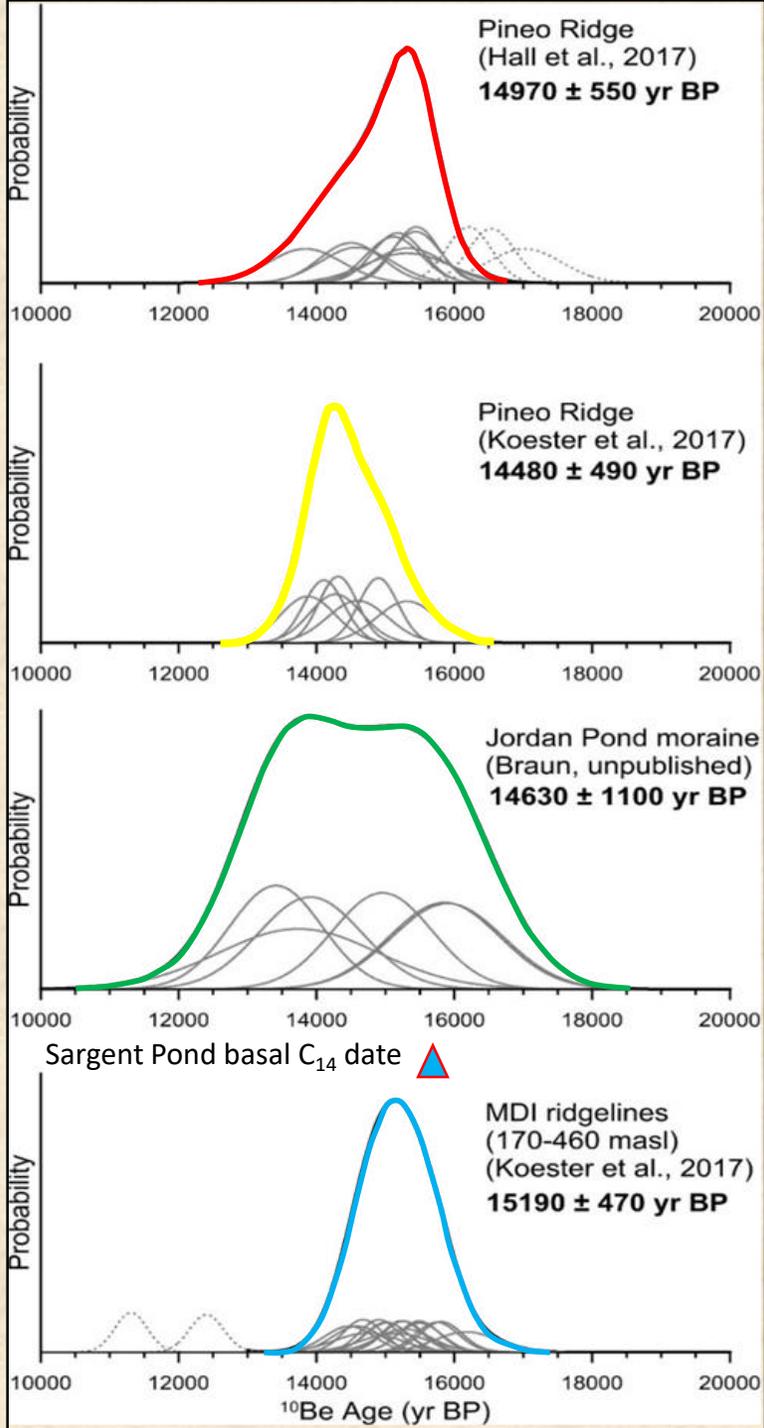


**PRS – MDI 10Be Surface exposure ages
– 28 sites so far - enough is enough?**



Digital elevation map of the Pineo Ridge System 10Be exposure ages sample sites. Yellow dots are samples sites from Koester et al. (2017). Red dots are sample sites from Hall et al. (2017). (Part of Figure 3, page 346, Hall et al. 2017)

LiDAR hillshade of Mount Desert Island showing 10Be exposure ages sample sites. Blue dots are samples sites from Koester et al. (2017). Green dots are sample sites from Braun et al. (2018). The site with the triangle is Sargent Mountain Pond where there is a calibrated near basal radiocarbon age of $15,718 \pm 363$ yrs (Norton et al., 2011).



PRS & MDI surface exposure ages are essentially the same age

Average of 3 moraine averages = 14,693 !??
We will see the 14.7 ka again later on.

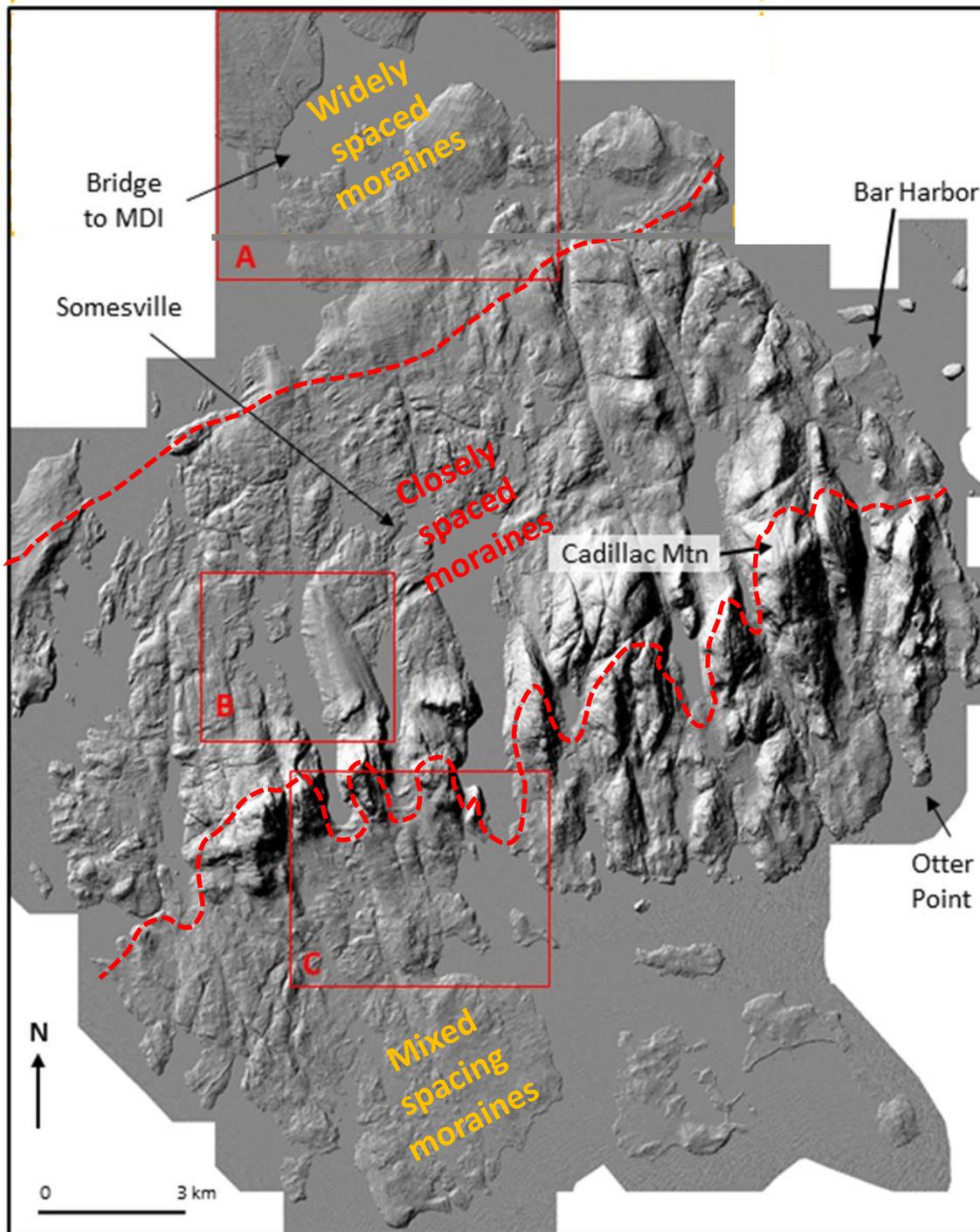
Probability distribution functions (camel plots) of ^{10}Be surface exposure ages from Pineo Ridge and Mount Desert Island, Maine. Mean ^{10}Be surface exposure ages for each grouping labeled in bold, and all four mean ages are indistinguishable at one standard deviation.

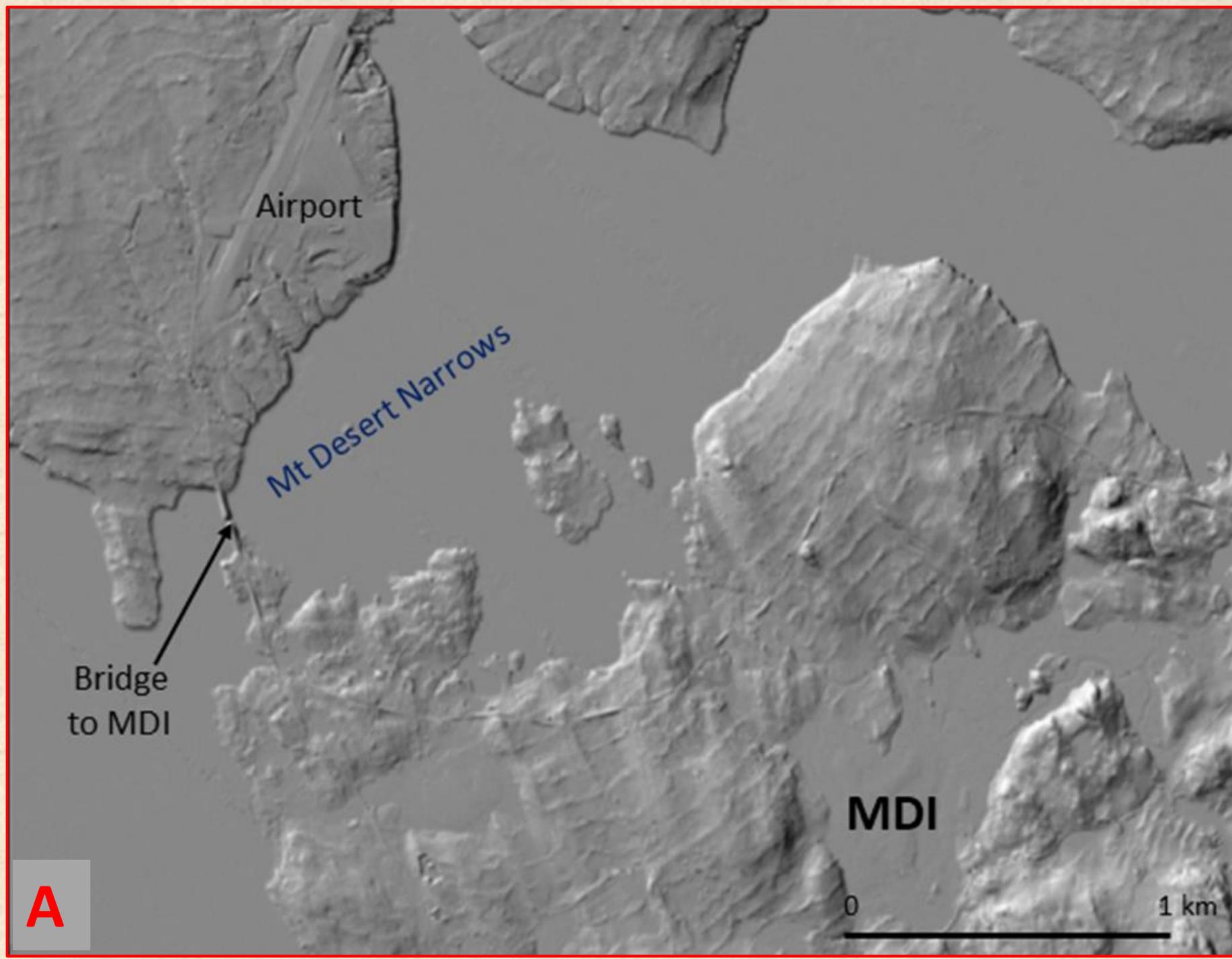
From Braun, D., 2018, Moraines on MDI and their relation to Pineo Ridge, fig. 33.FOP 2018 guidebook p. 30

Moraine spacing on MDI

LiDAR hillshade image of MDI; even at this scale some of the push moraines are visible. Red rectangles A – C are enlarged same-scale images shown next for comparison of moraine spacing.

LiDAR from COA GIS laboratory



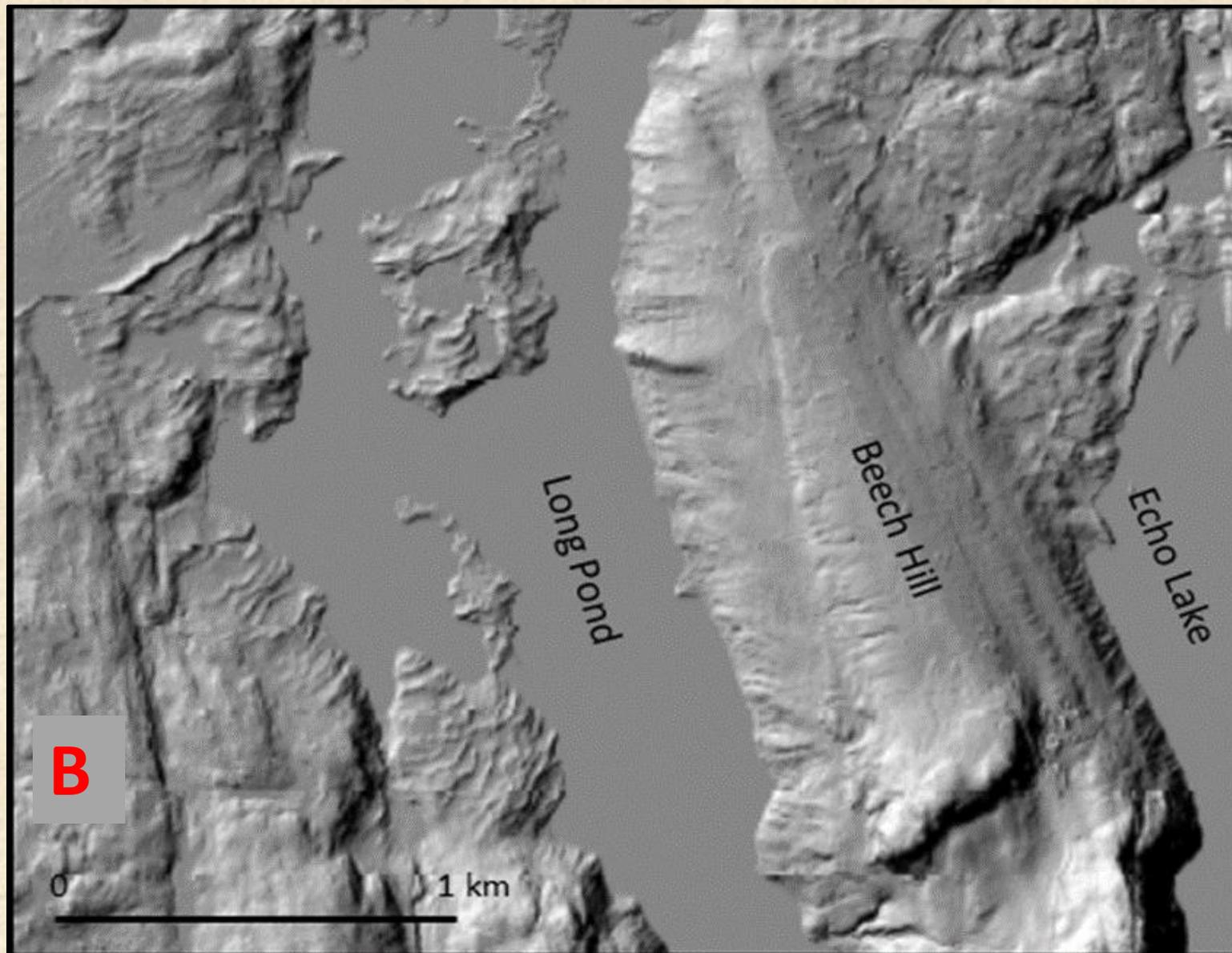


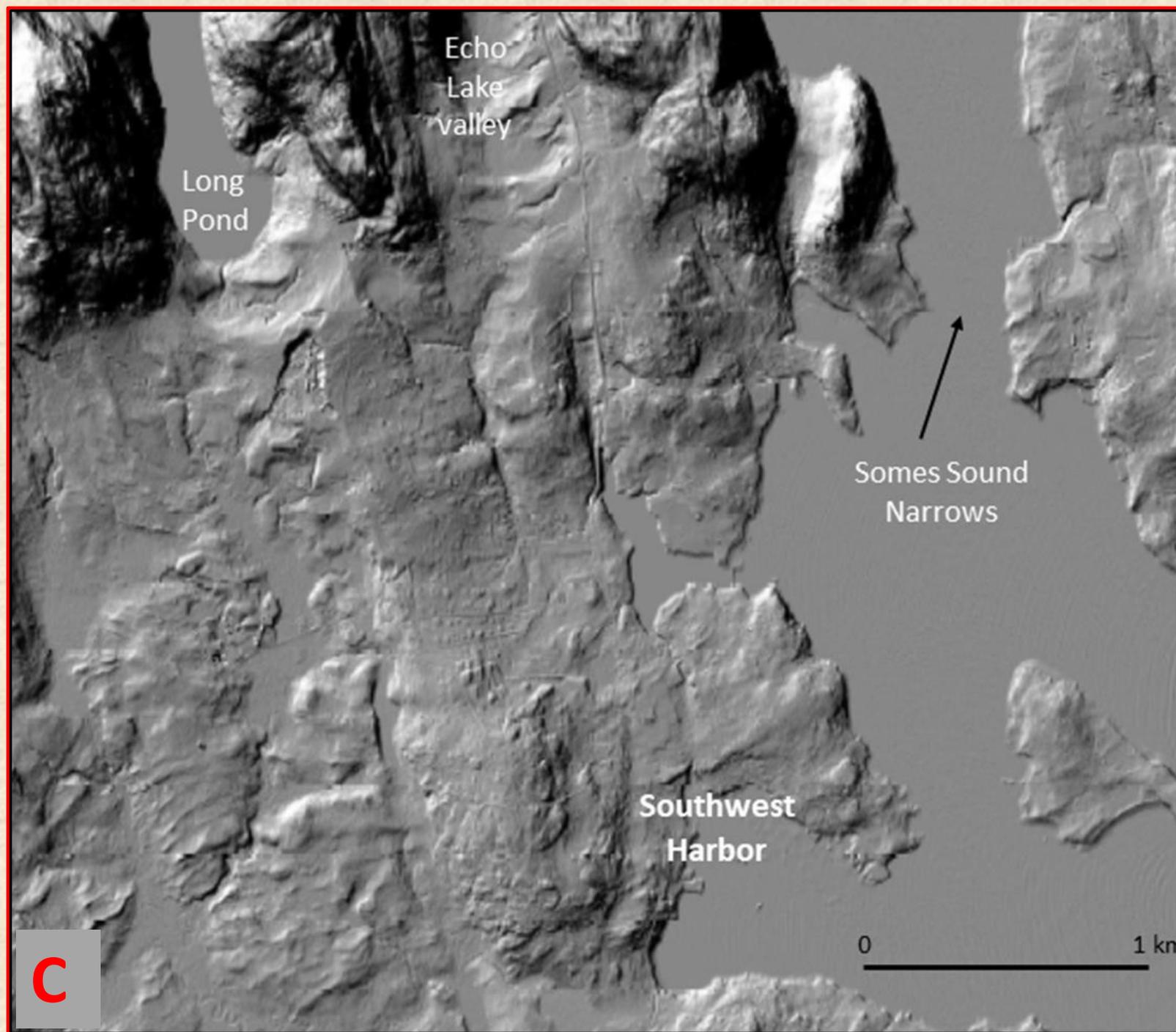
Northern MDI and farther north

LiDAR close-up of the **widely spaced moraines**, 100-150 m (330–500 ft) between successive ridges, on the northern part of MDI and on the mainland north of MDI. Same scale as B and C that follow.

Central MDI just north of the NE – SW mountain range crest

LiDAR close-up of the **closely spaced moraines** 20-50 m (60-165 ft) between successive ridges) on the middle part of MDI. The crests of the northeast – southwest trending mountain range on MDI are just south of this image and are at the top of the next image C

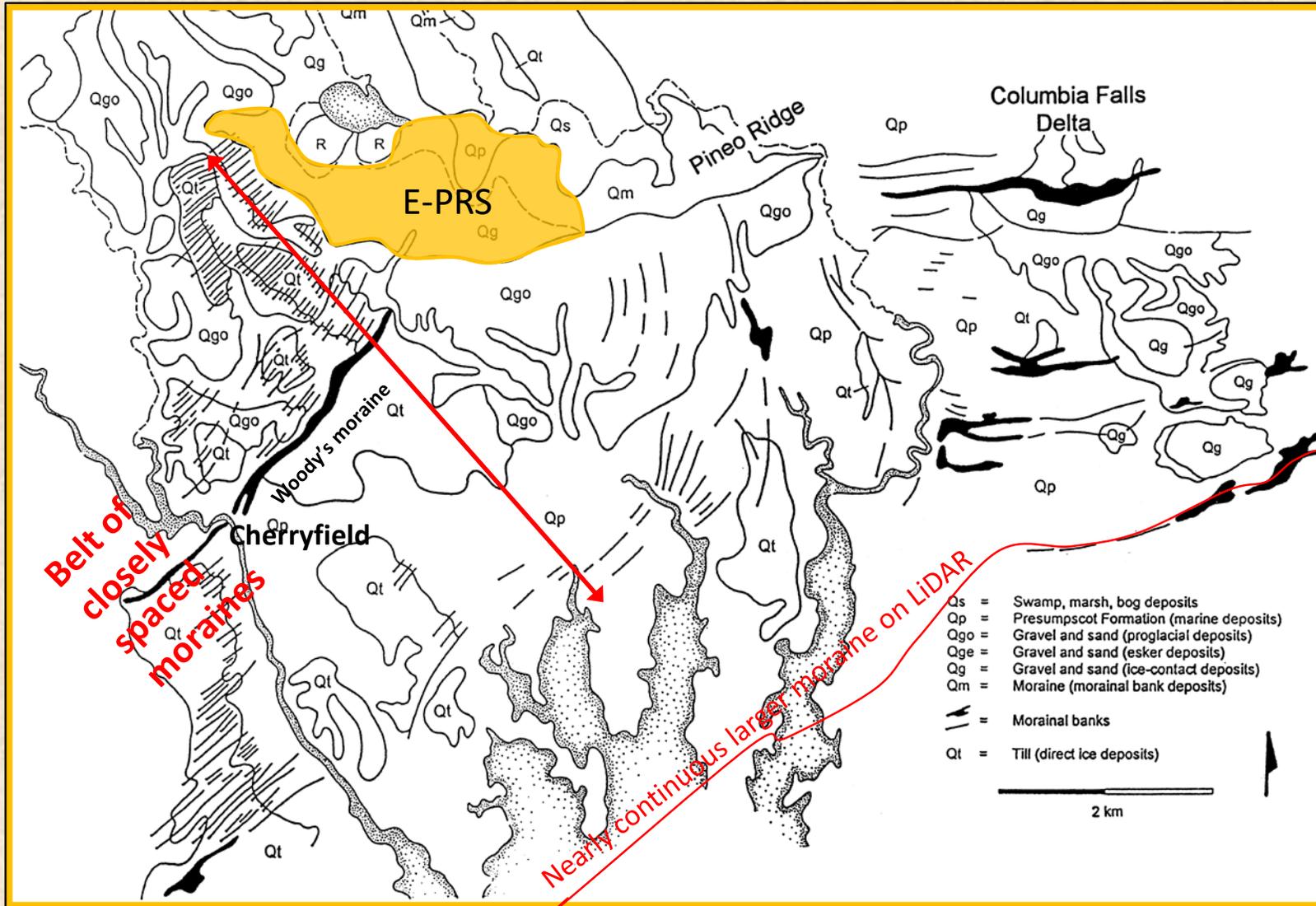




MDI at and south of the mountain crests

LiDAR close-up of the south ends of the glacial troughs with several much larger moraines. South of there the moraines have a **somewhat variable spacing** of 30–100 m (100–330 ft).

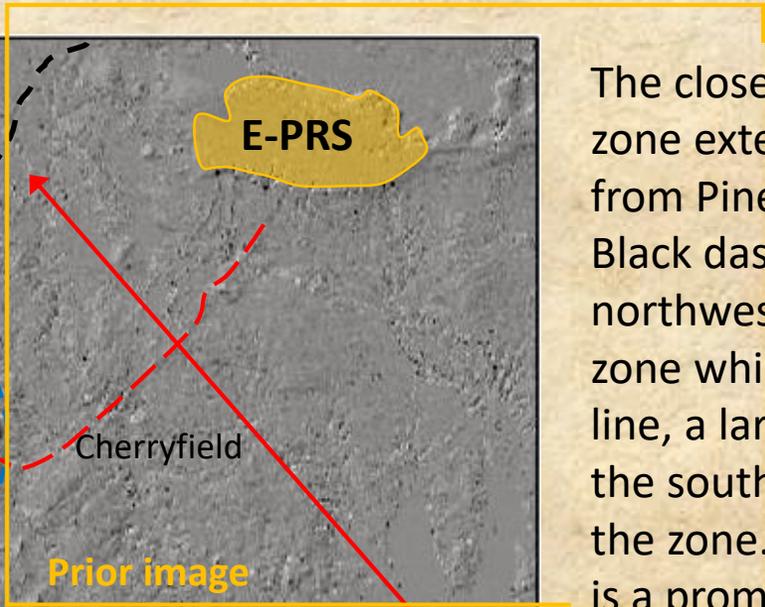
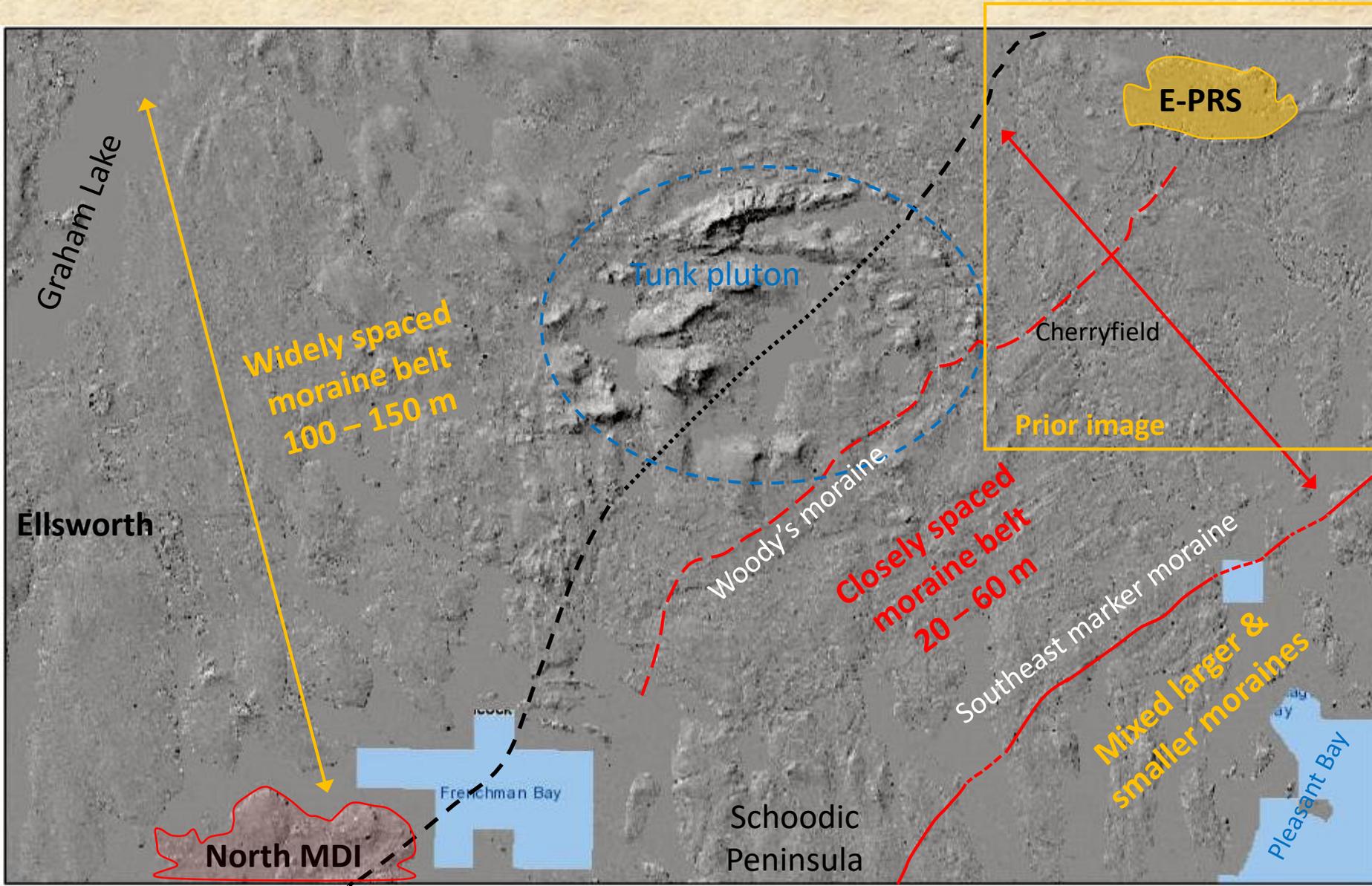
Identification of a zone of closely spaced moraines southwest of PRS prior to advent of LiDAR imagery



Surficial geology of portion of Cherryfield and Columbia Falls 7.5-minute quadrangles, Maine, showing location of Pineo Ridge (morainal bank) and Columbia Falls delta relative to the closely spaced moraine belt.

Quadrangle maps (Borns, 1975; Borns and Andersen, 1982). From Hunter & Smith, 2001, Morainal banks and the deglaciation of coastal Maine, fig. 6

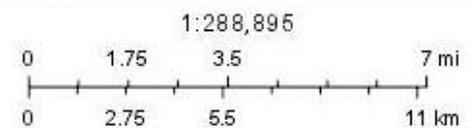
Closely spaced moraines in eastern Maine from the Pineo Ridge System (PRS) to MDI with the advent of LiDAR



The closely spaced moraine zone extends southwesterly from Pineo Ridge to MDI. Black dashed line marks the northwestern border of the zone while the continuous red line, a larger moraine, marks the southeastern border of the zone. The dashed red line is a prominent larger moraine within the zone that was traced southeast from PRS by Woody Thompson in 2010 - 2011.

Blue areas are where there is no LiDAR coverage.

LiDAR from Maine Geologic Survey

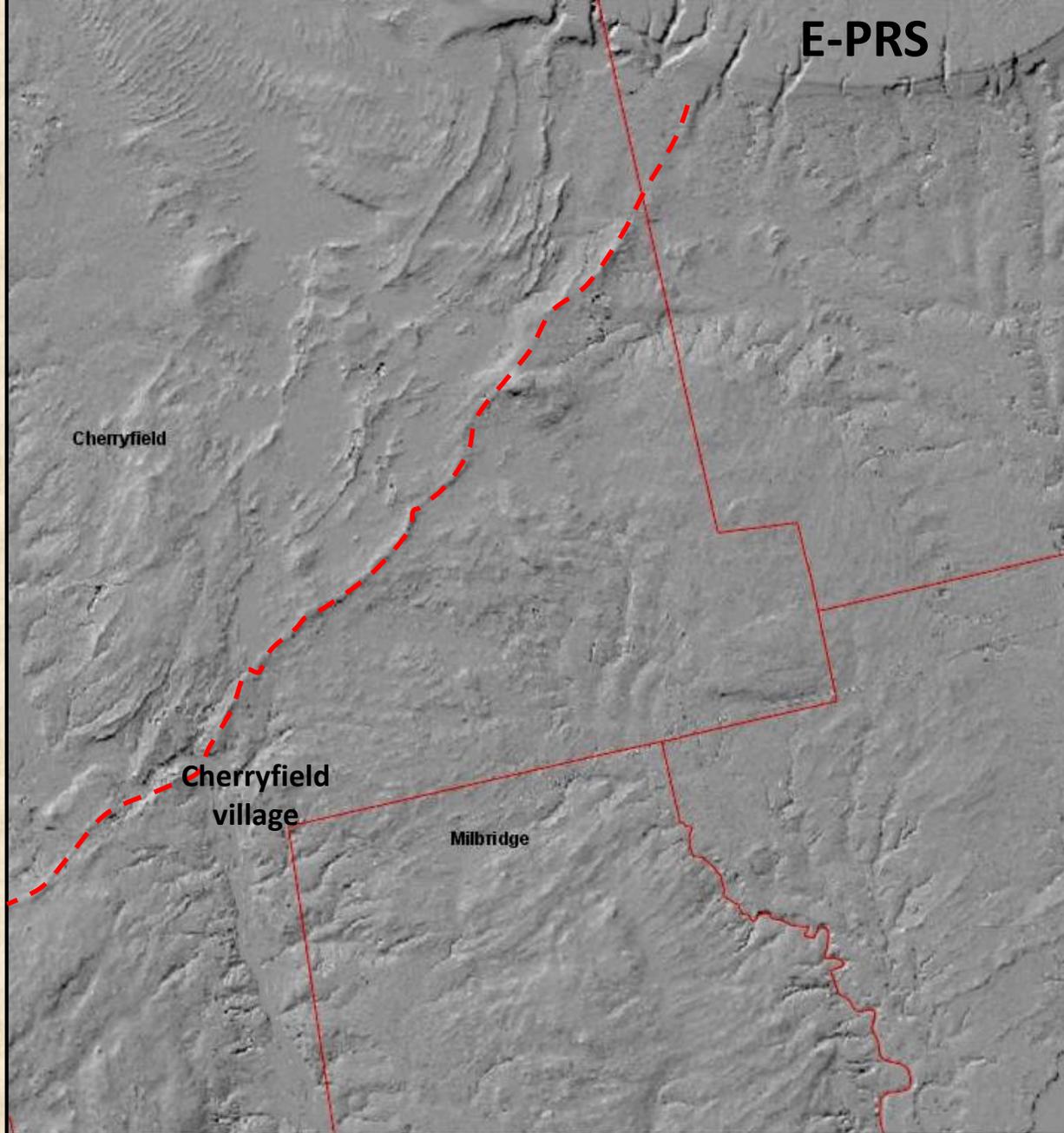


E-PRS

Tracing the larger distinct moraine
(Woody's moraine) from PRS
southwest towards MDI

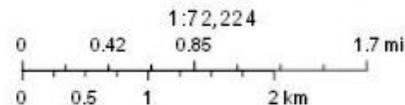
Thicker dashed red line is
the crest of the moraine

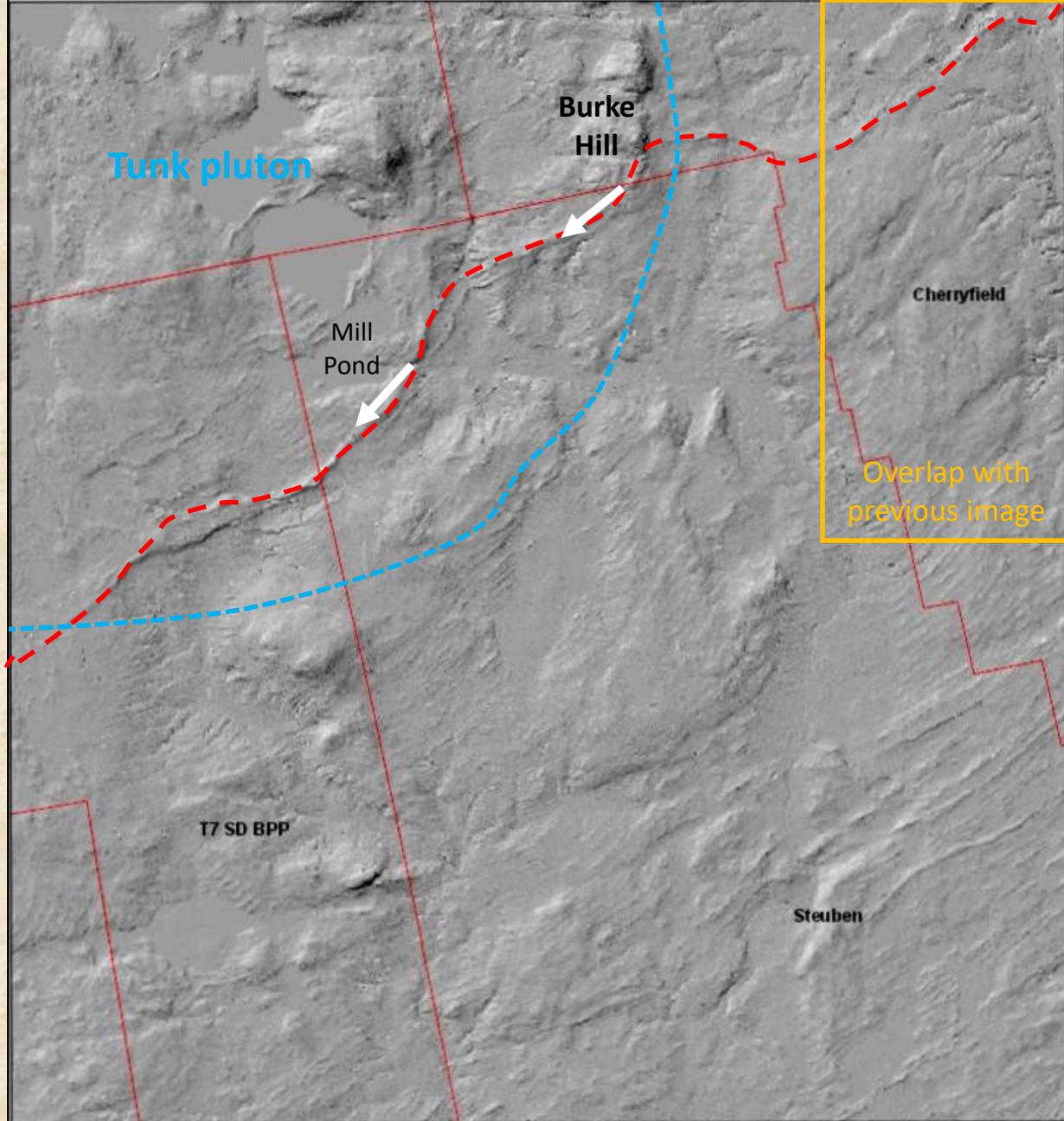
Town boundaries are
thin **red lines**, some
towns are named.



2/19/2019, 4:08:51 PM

□ Maine Towns



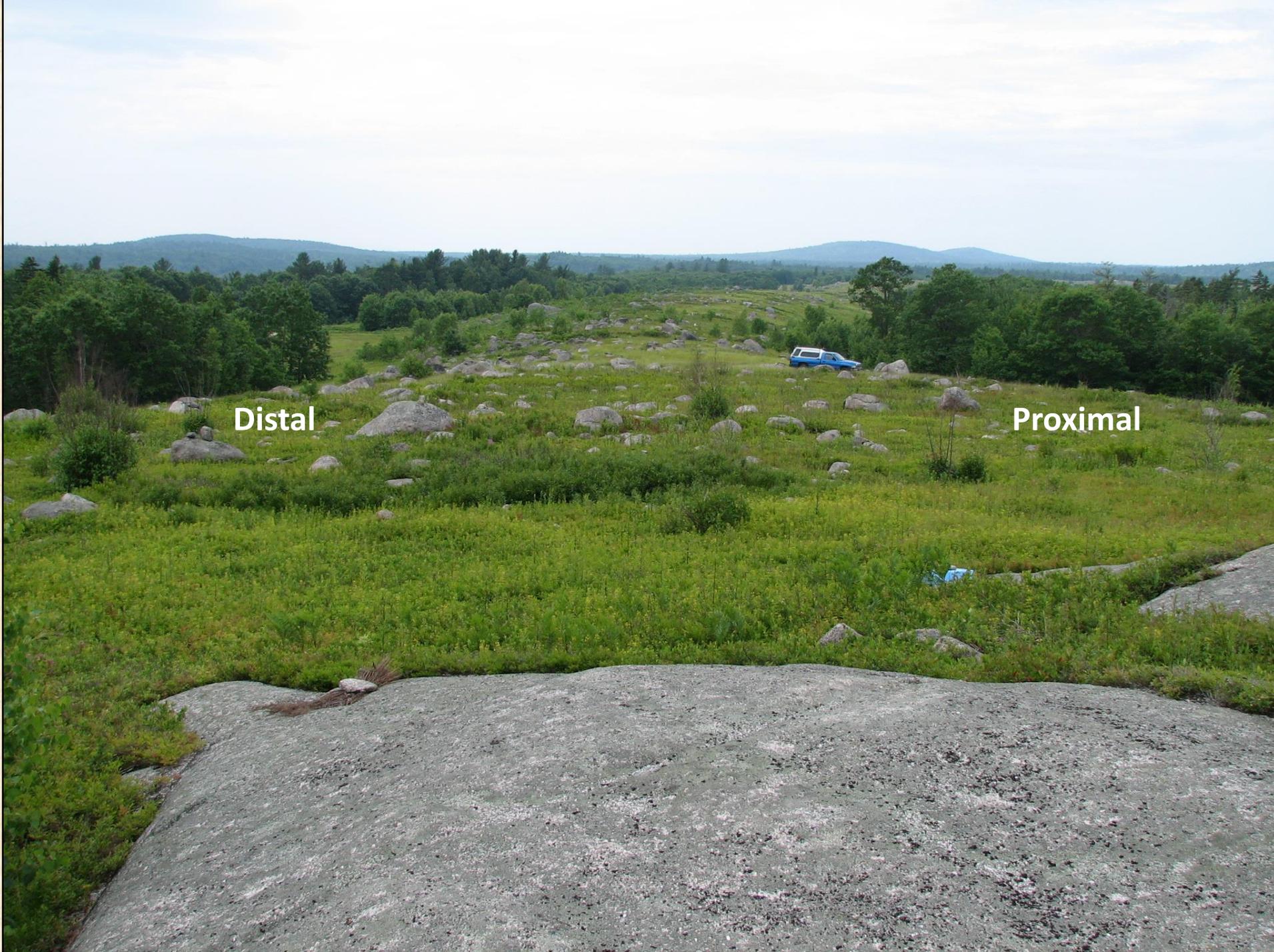


Tracing the larger distinct moraine (Woody's moraine) from PRS southwest towards MDI

Thicker dashed red line is the crest of the moraine

White arrows – next images - photos of the moraine in blueberry fields

Town boundaries are thin **red lines**, some towns are named.

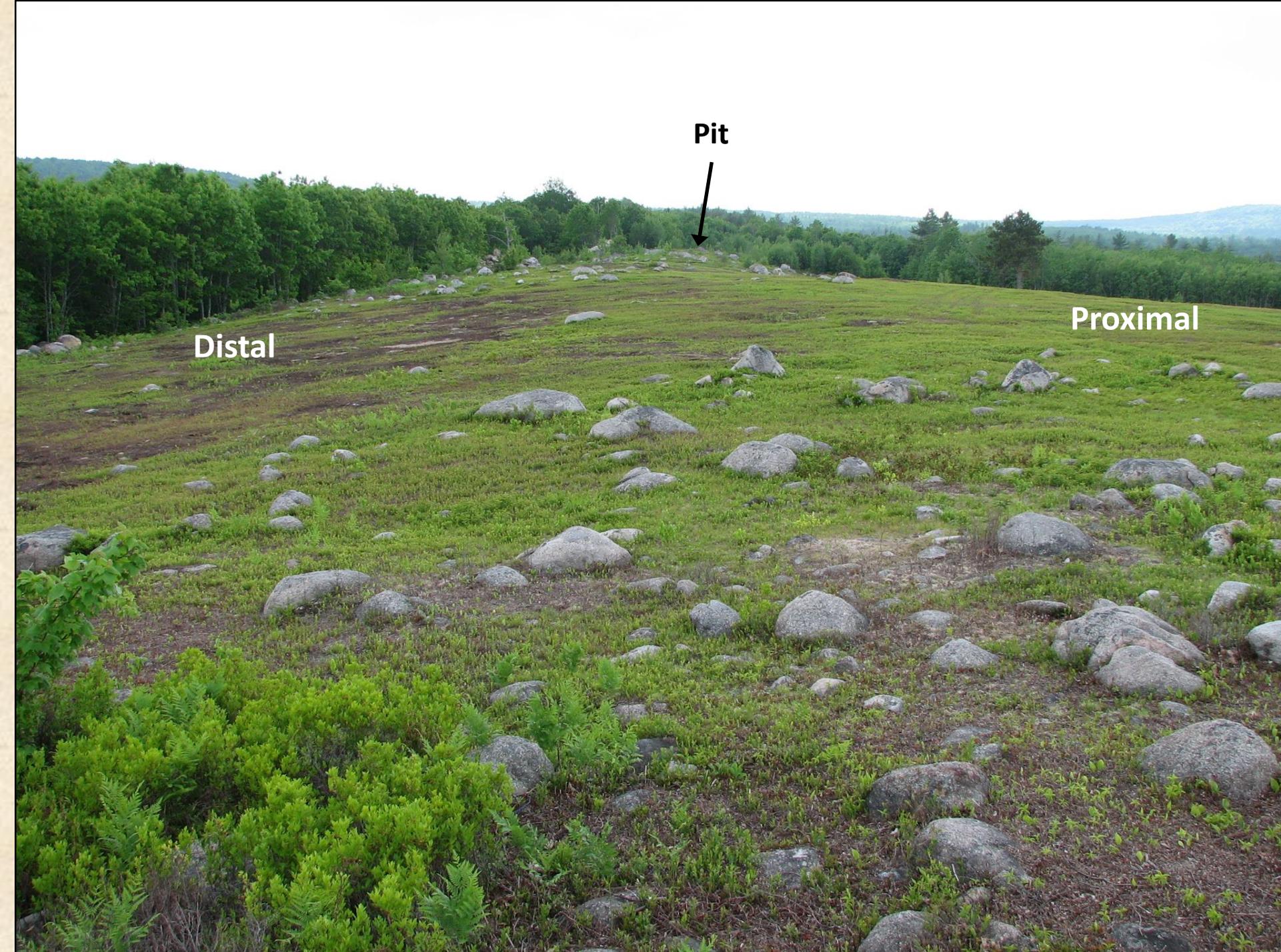


Distal

Proximal

View looking to southwest along Woody's moraine from the south end of Burkes Hill – moraine is pinned to the bedrock in the foreground

Ledge in foregrounds is at an elevation of about 73 m (240 ft), highest stand of sea level is at about 82 m (270 ft) in this area



**View to the southwest
along the moraine crest**

Site is south of Mill Pond
at an elevation of about
73 m (240 ft), highest
stand of sea level is at
about 82 m (270 ft) in
this area

Next image of a pit in
the moraine is just
southwest of this image

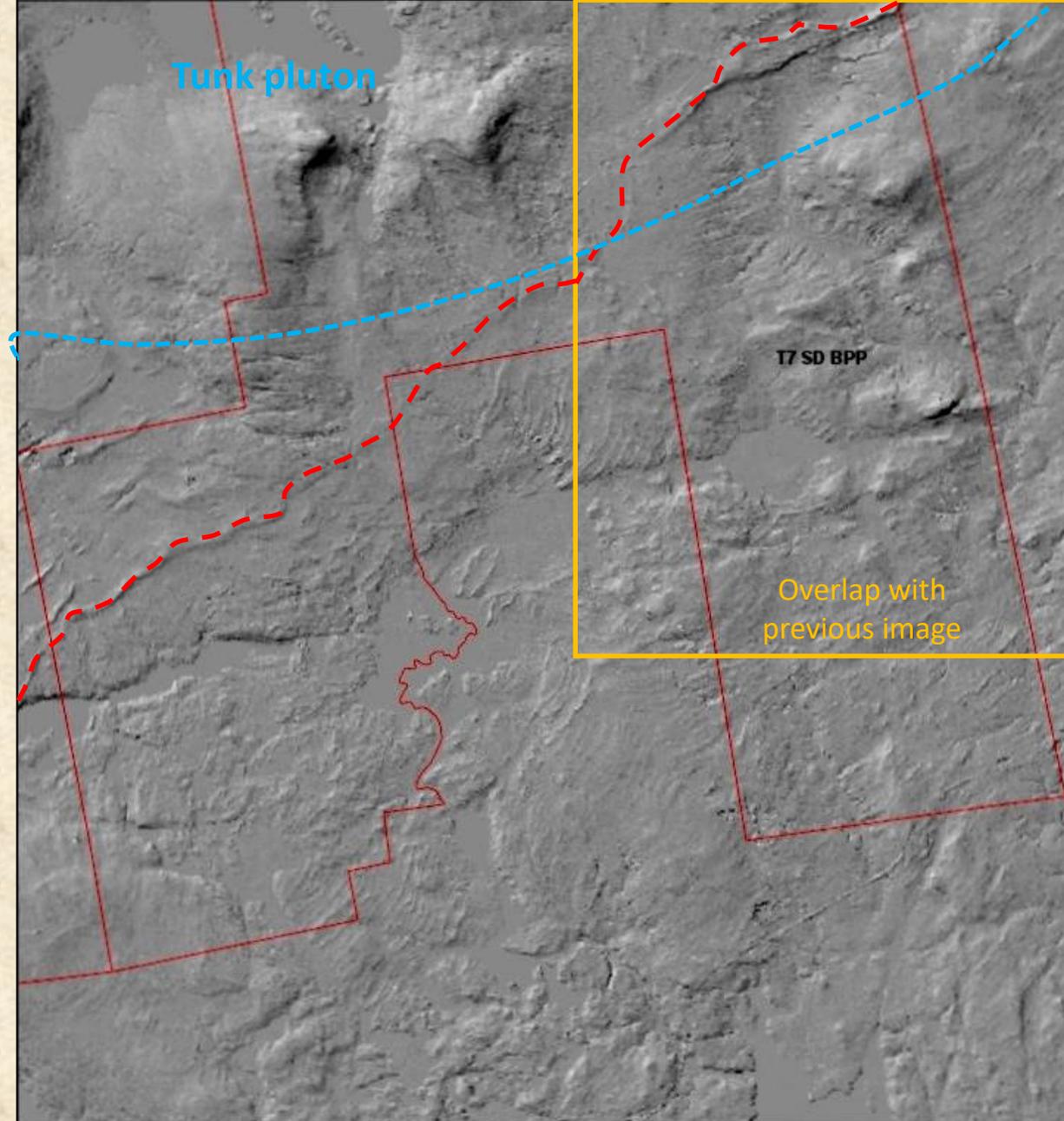


Proximal

Distal

Exposure in the moraine showing bouldery till

Boulder concentration at the surface suggests some wave erosion. Subtle layering visible on the left



Tunk pluton

17 SD BPP

Overlap with previous image

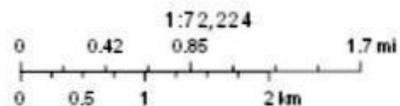
Tracing the larger distinct moraine (Woody's moraine) from PRS southwest towards MDI

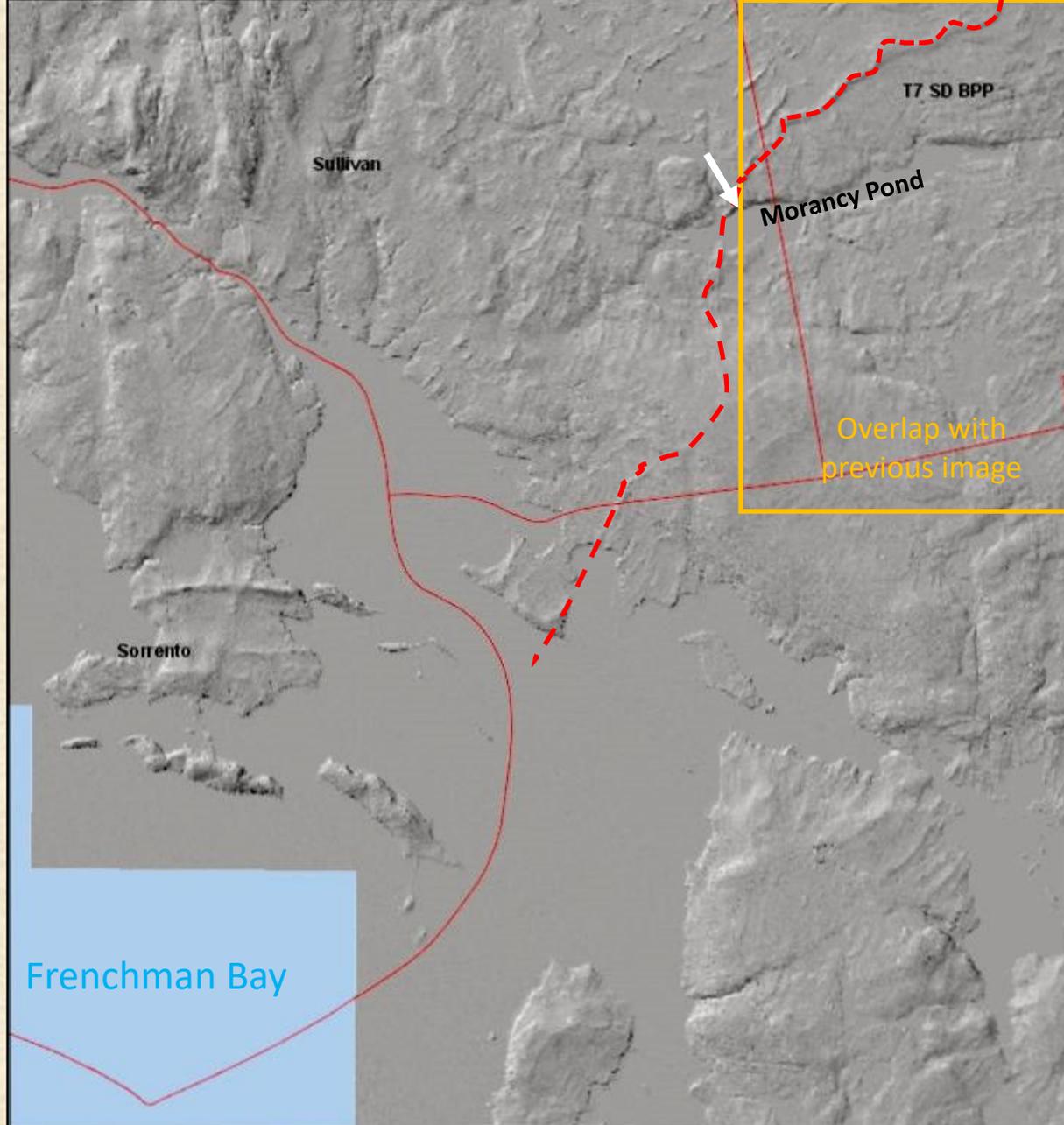
Thicker dashed red line is the crest of the moraine

Town boundaries are thin **red lines**, some towns are named.

2/19/2019, 4:19:12 PM

Maine Towns





Tracing the larger distinct moraine (Woody's moraine) from PRS southwest towards MDI

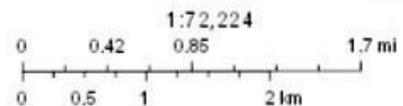
Thicker dashed red line is the crest of the moraine

White arrow – next image - photo of the moraine in a logged area

Town boundaries are thin **red lines**, some towns are named.

2/19/2019, 4:23:26 PM

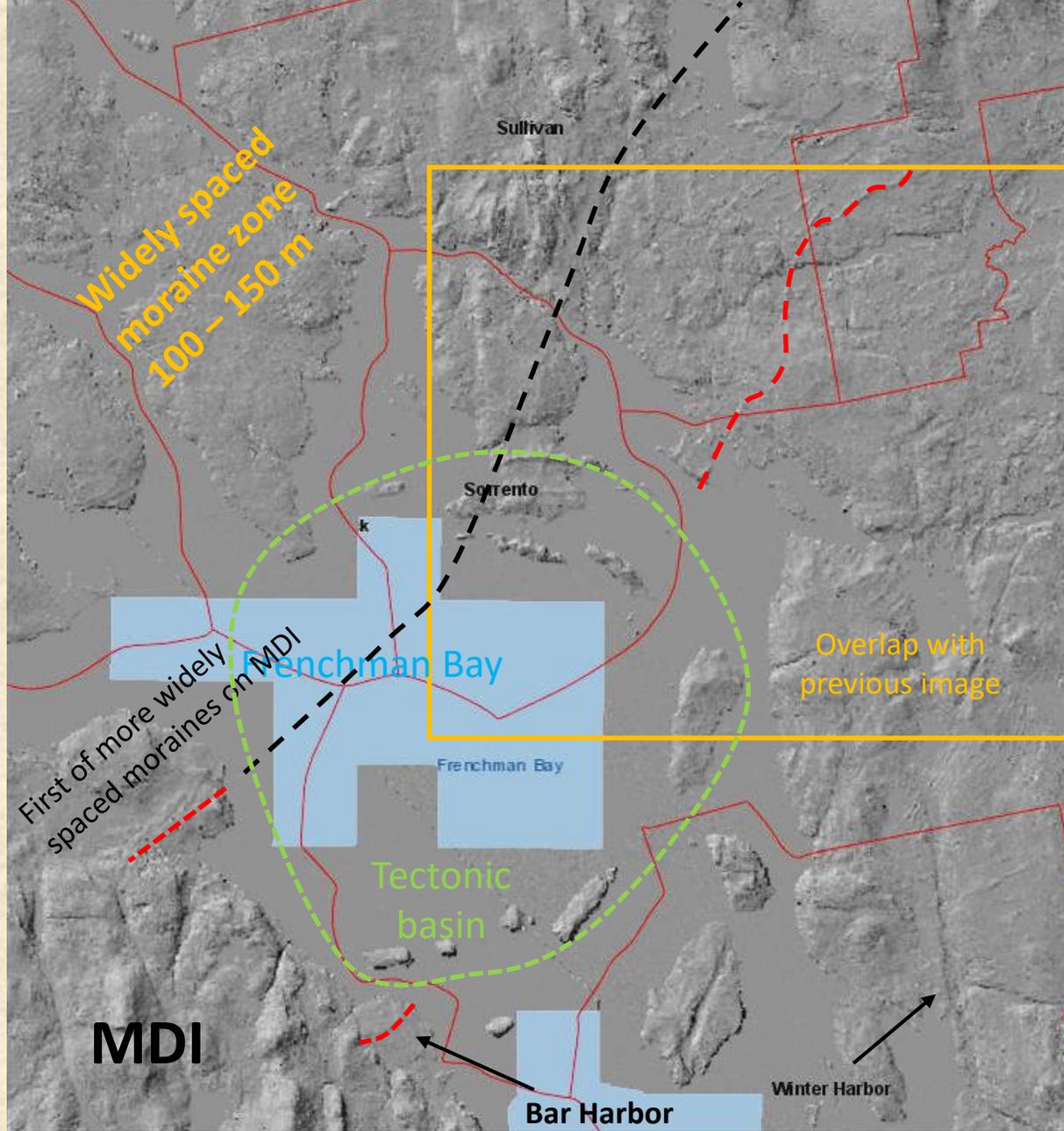
☐ Maine Towns





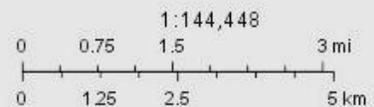
**View looking southeast
at the proximal side of
the moraine**

Site is near Morancy
Pond at an elevation of
about 55 m (180 ft),
highest stand of sea
level is at about 79 m
(260 ft) in this area



2/19/2019, 4:39:20 PM

— Maine Towns



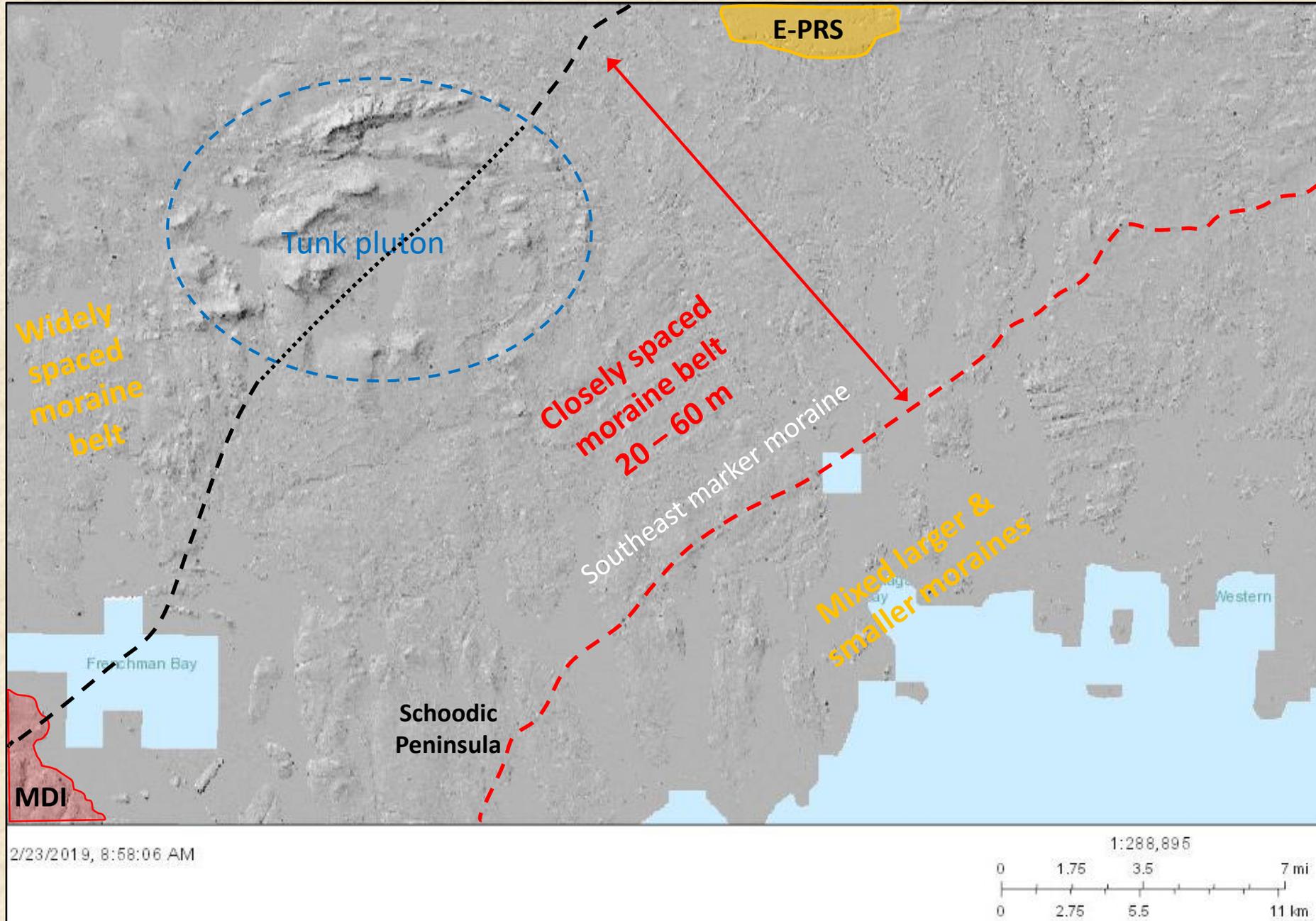
Tracing the larger distinct moraine (Woody's moraine) from PRS southwest towards MDI

Thicker dashed red line is the crest of the moraine

Town boundaries are thin **red lines**, some towns are named.

This image is at a reduced smaller scale to reach across Frenchman Bay

Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest



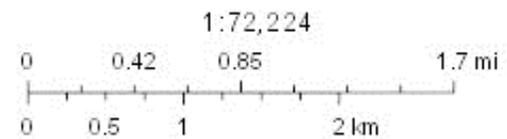
East end of East PRS is
8 km north of here

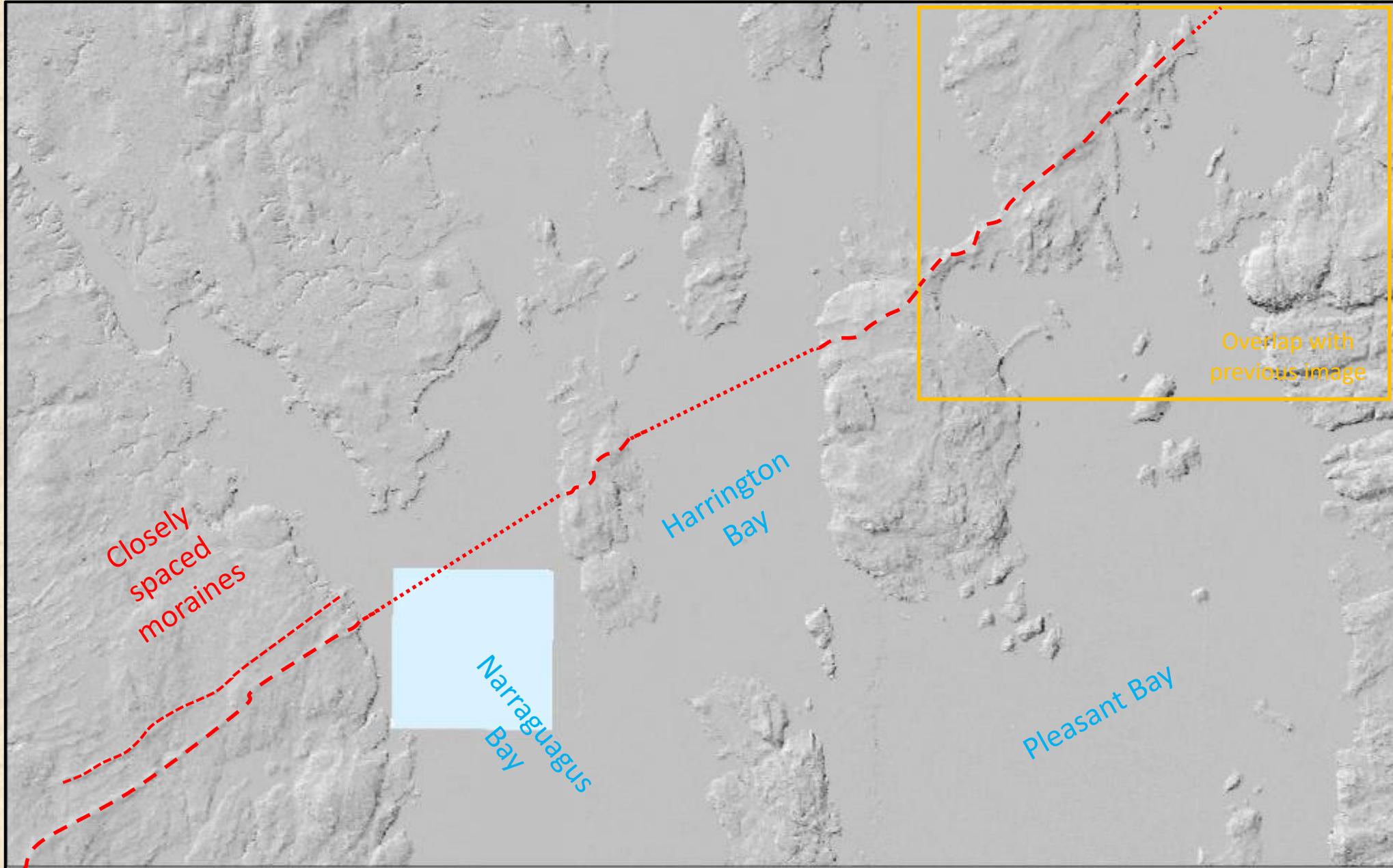
Pleasant River

Esker with a chain
of fans and deltas
extending back to
the east end of PRS

**Tracing the larger
moraine that marks the
southeastern edge of
the closely spaced
moraine belt to the
southwest**

Northeast most image





Closely spaced moraines

Narraguagus Bay

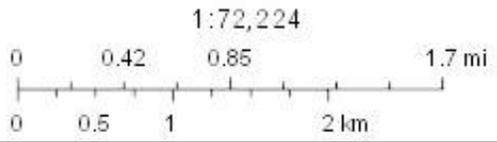
Harrington Bay

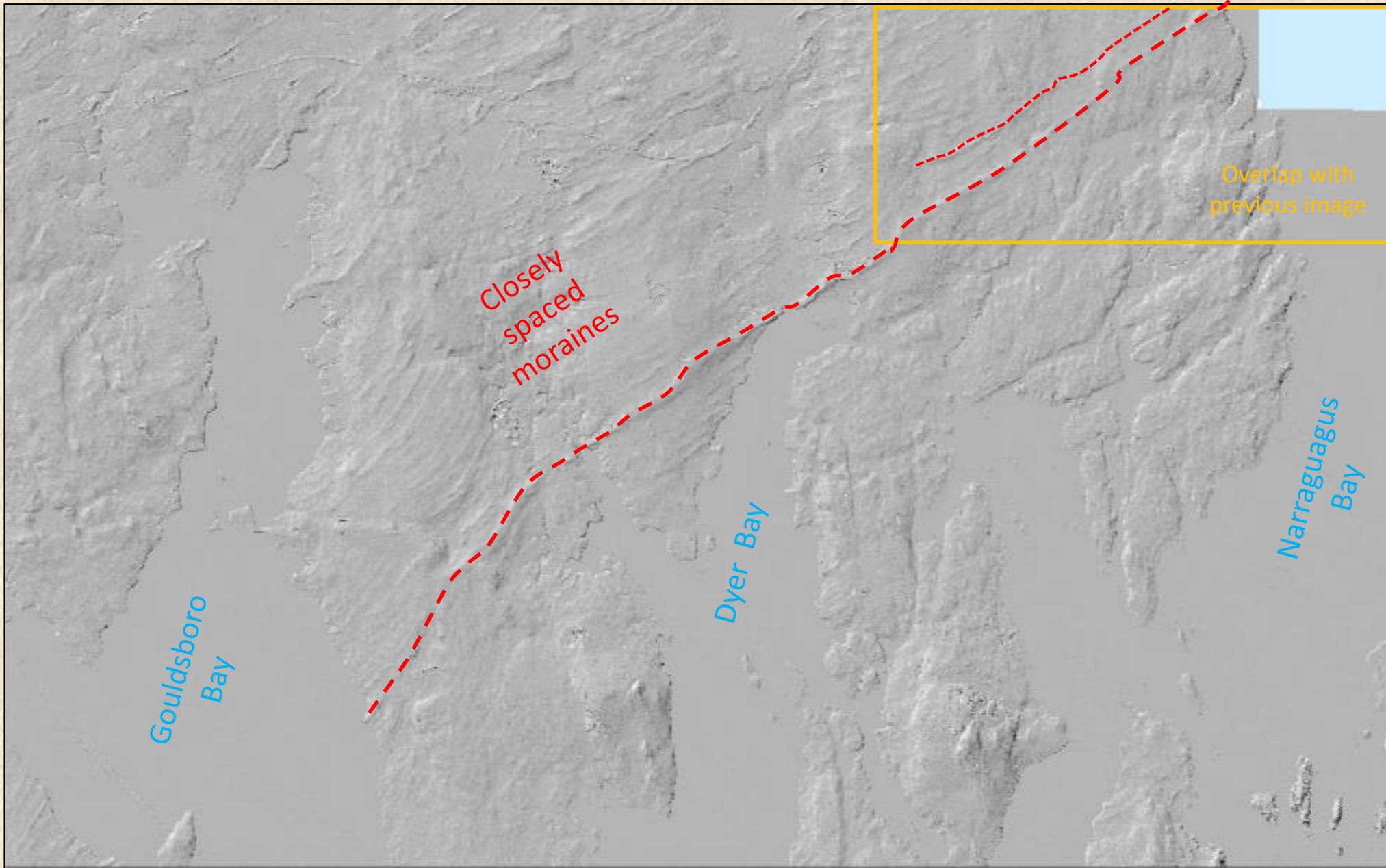
Pleasant Bay

Overlap with previous image

Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest

2/20/2019, 9:22:42 AM





Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest

Gouldsboro Bay

Closely spaced moraines

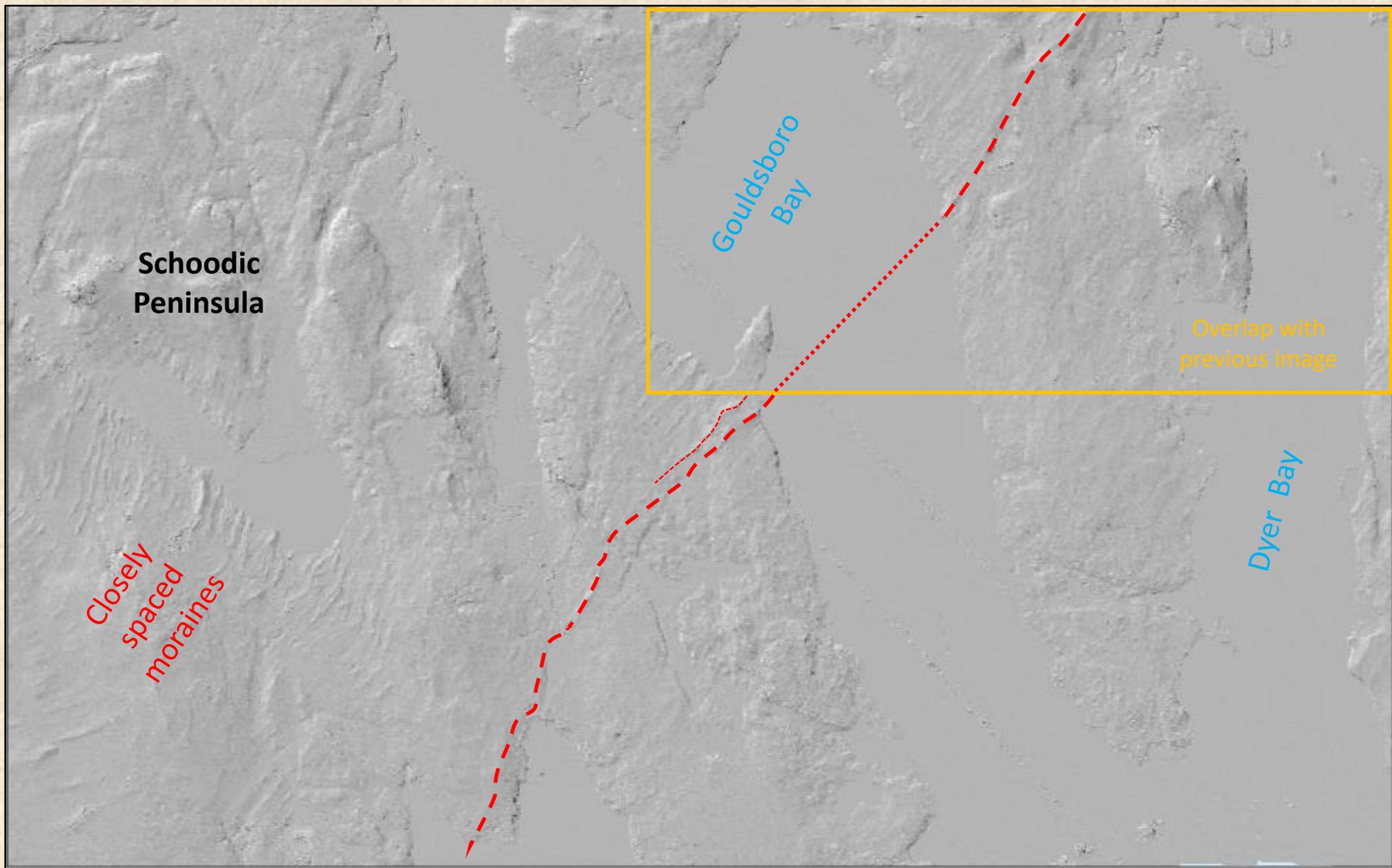
Dyer Bay

Narraguagus Bay

Overlap with previous image

2/20/2019, 9:25:17 AM





Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest

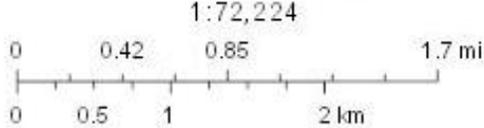
Schoodic Peninsula

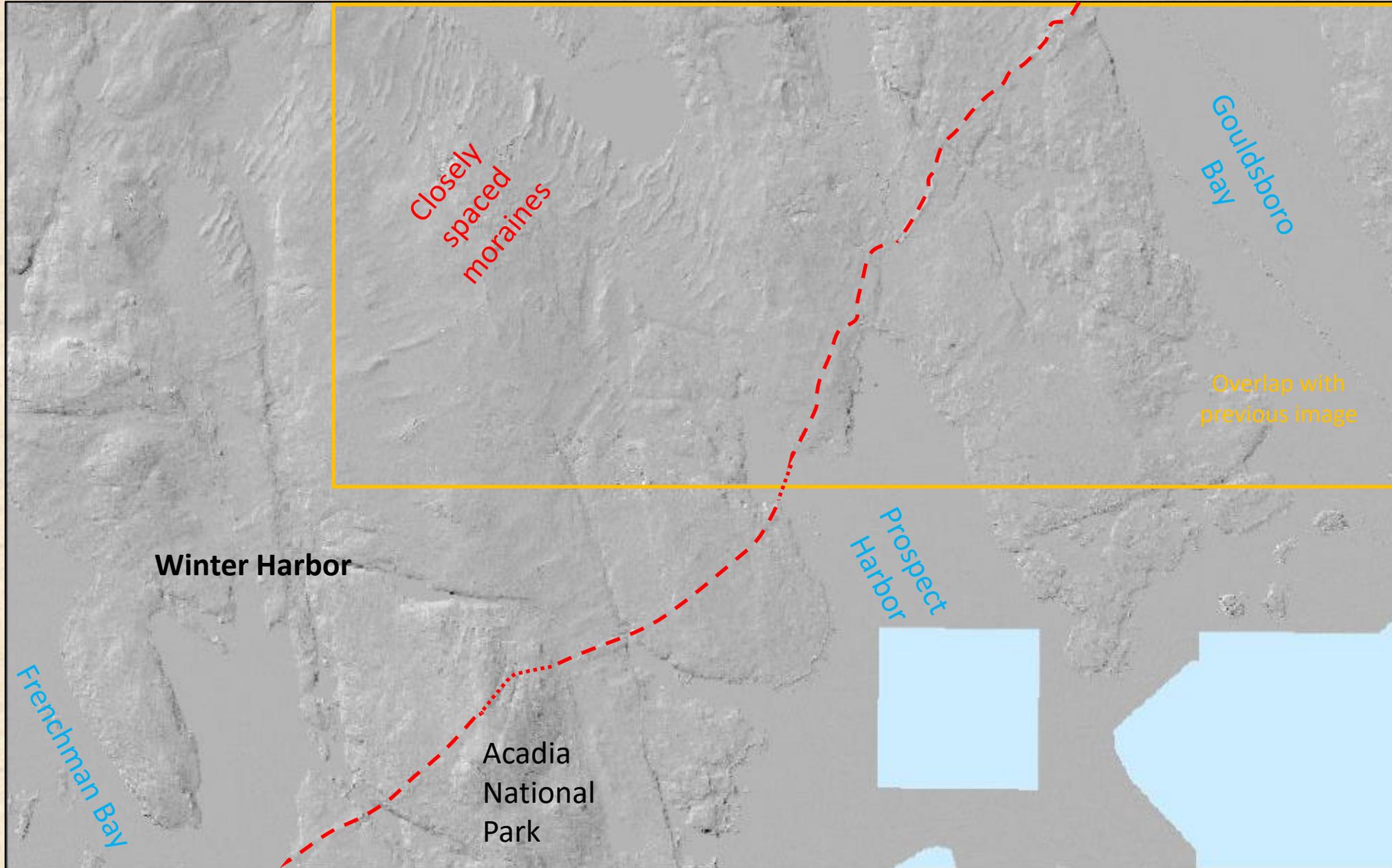
Gouldsboro Bay

Overlap with previous image

Dyer Bay

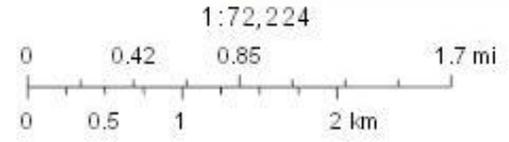
Closely spaced moraines

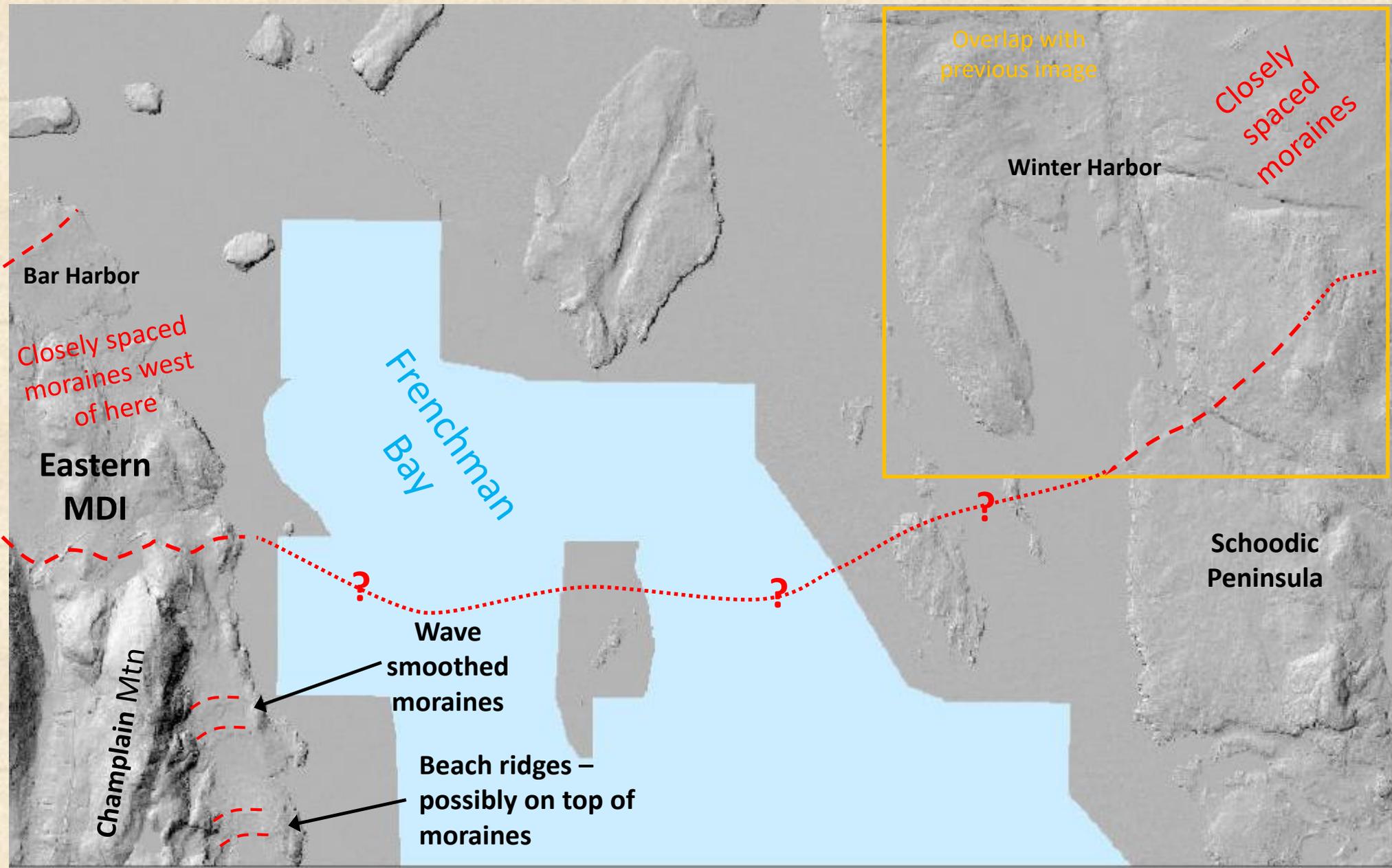




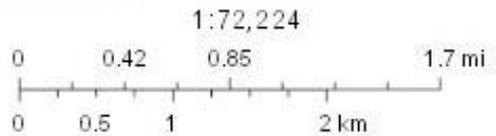
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest

2/23/2019, 9:08:27 AM

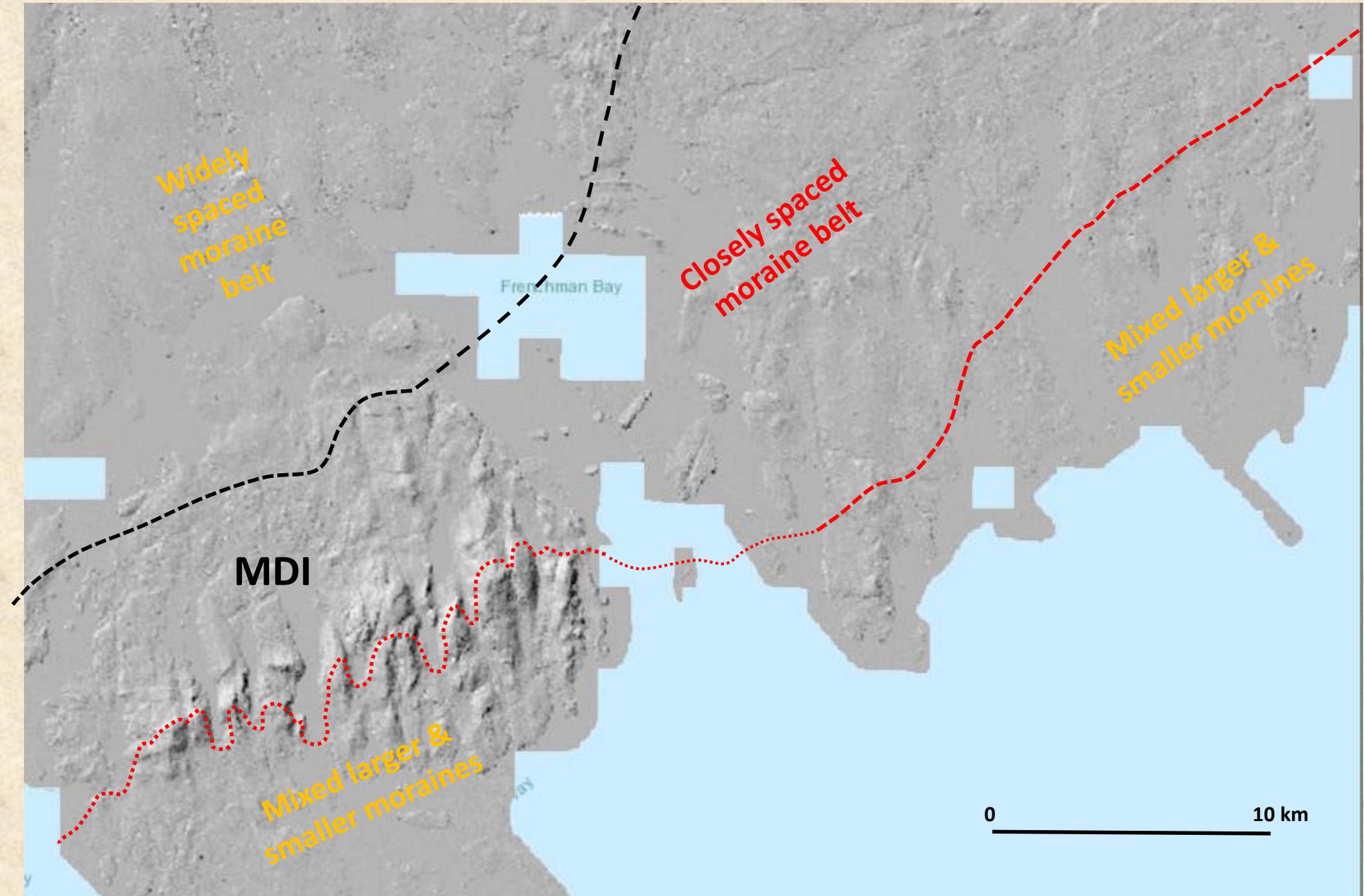




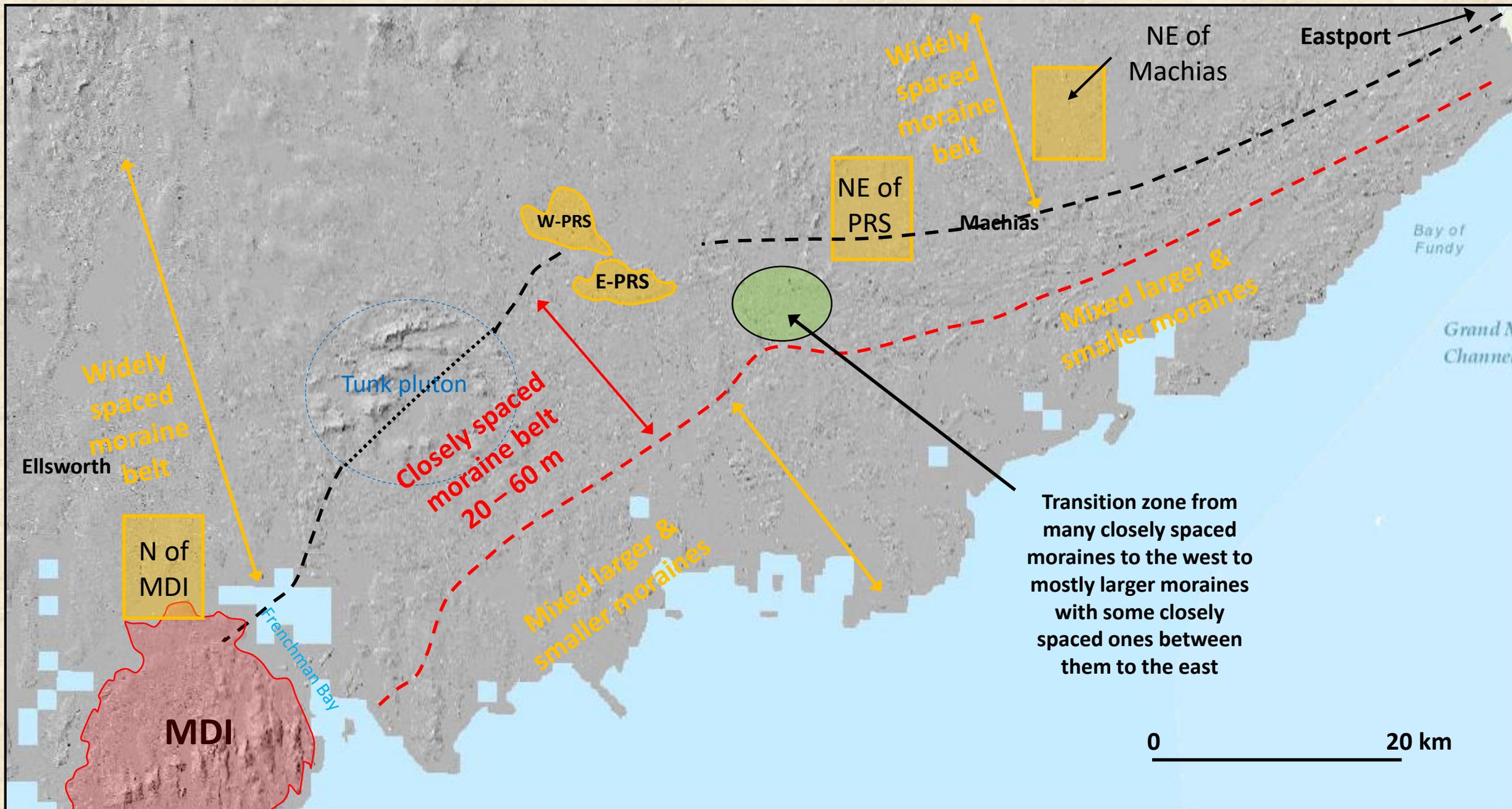
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest to MDI



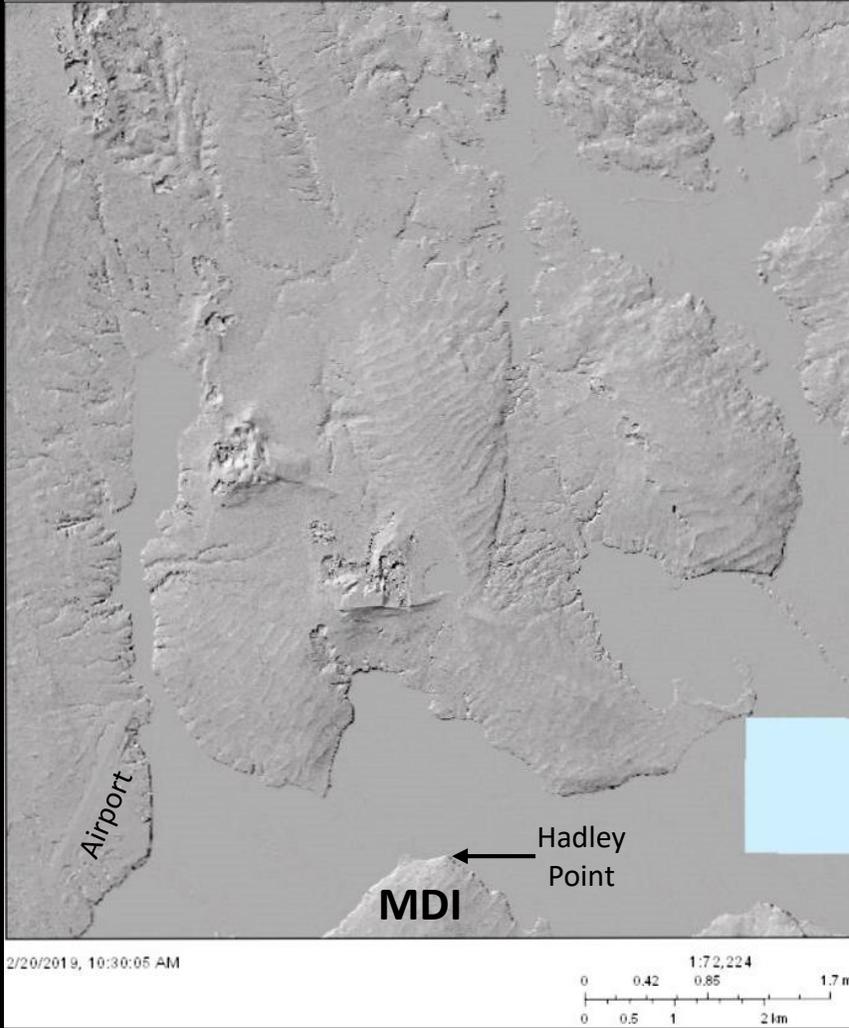
The two marker moraines from PRS can be traced towards but not directly to MDI thanks to Frenchman Bay



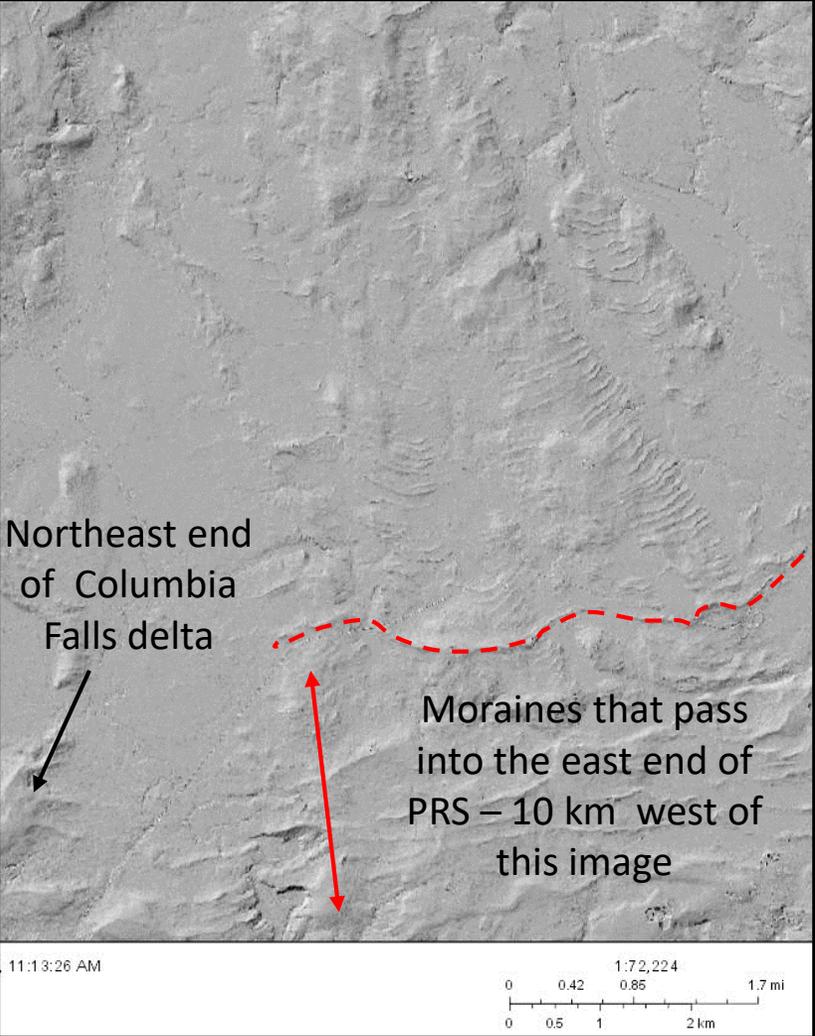
MDI to PRS to Eastport overview showing locations of widely spaced moraine images that follow



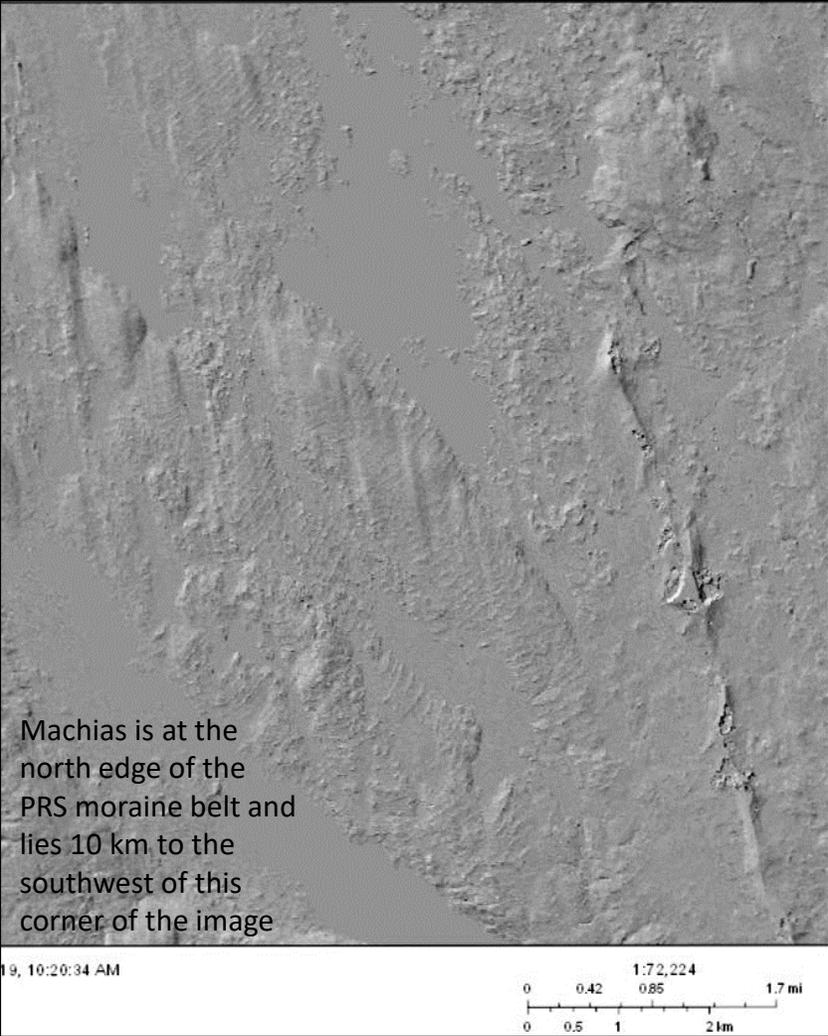
Widely spaced moraines north of MDI



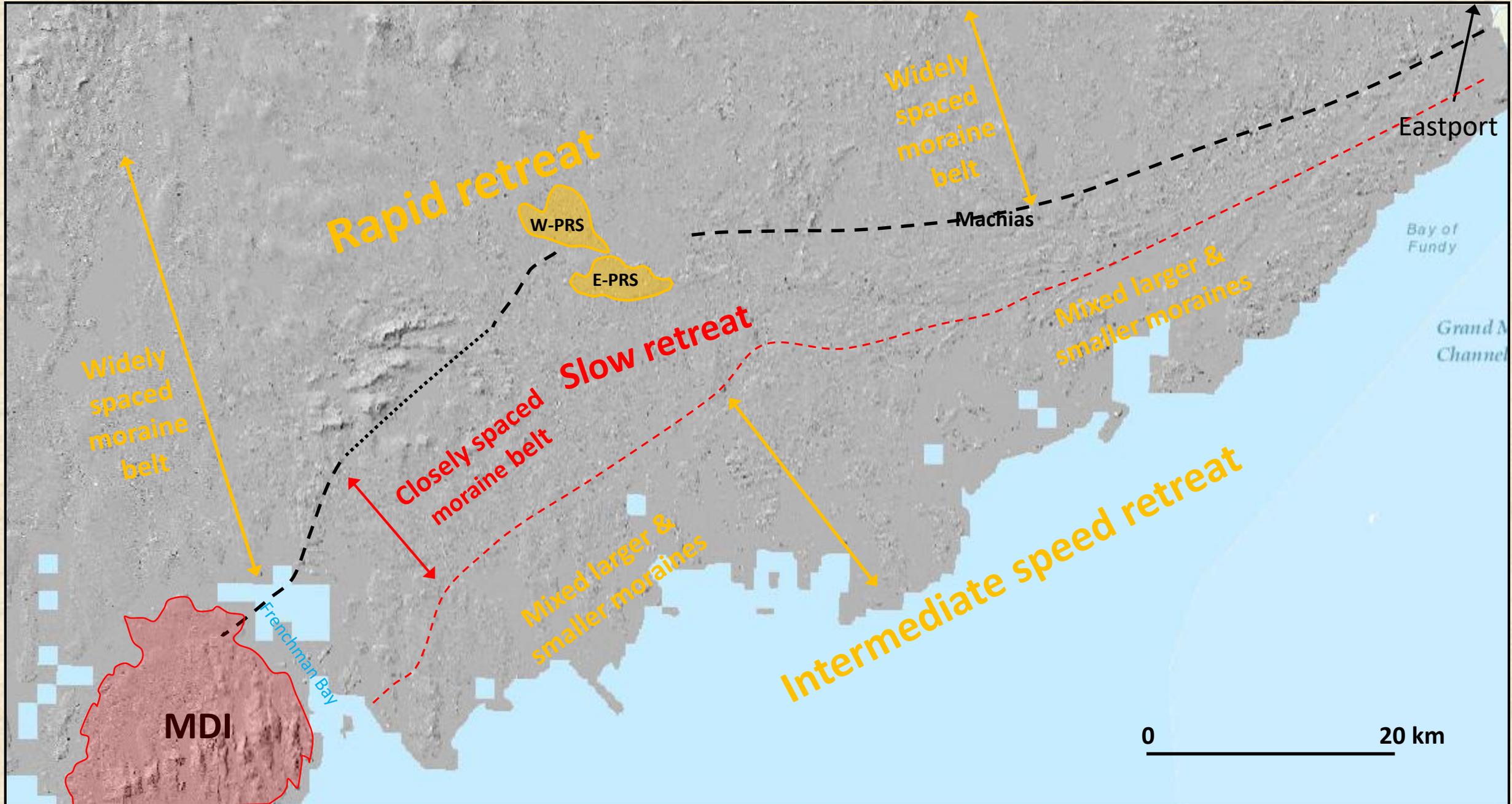
Widely spaced moraines northeast of PRS and Columbia Falls delta



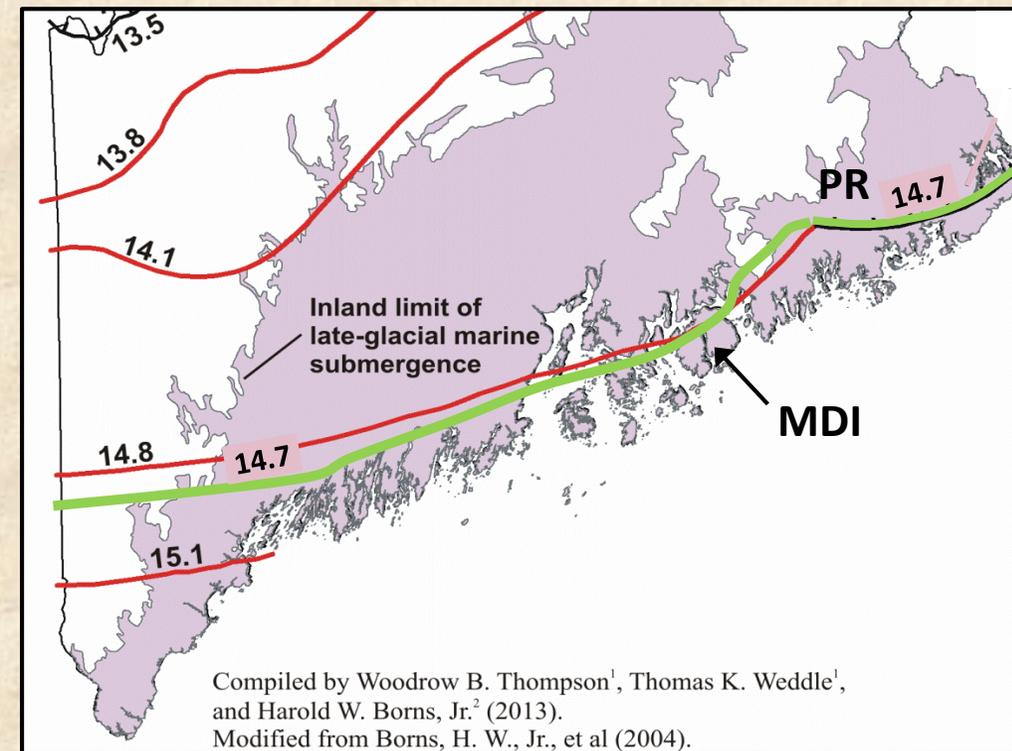
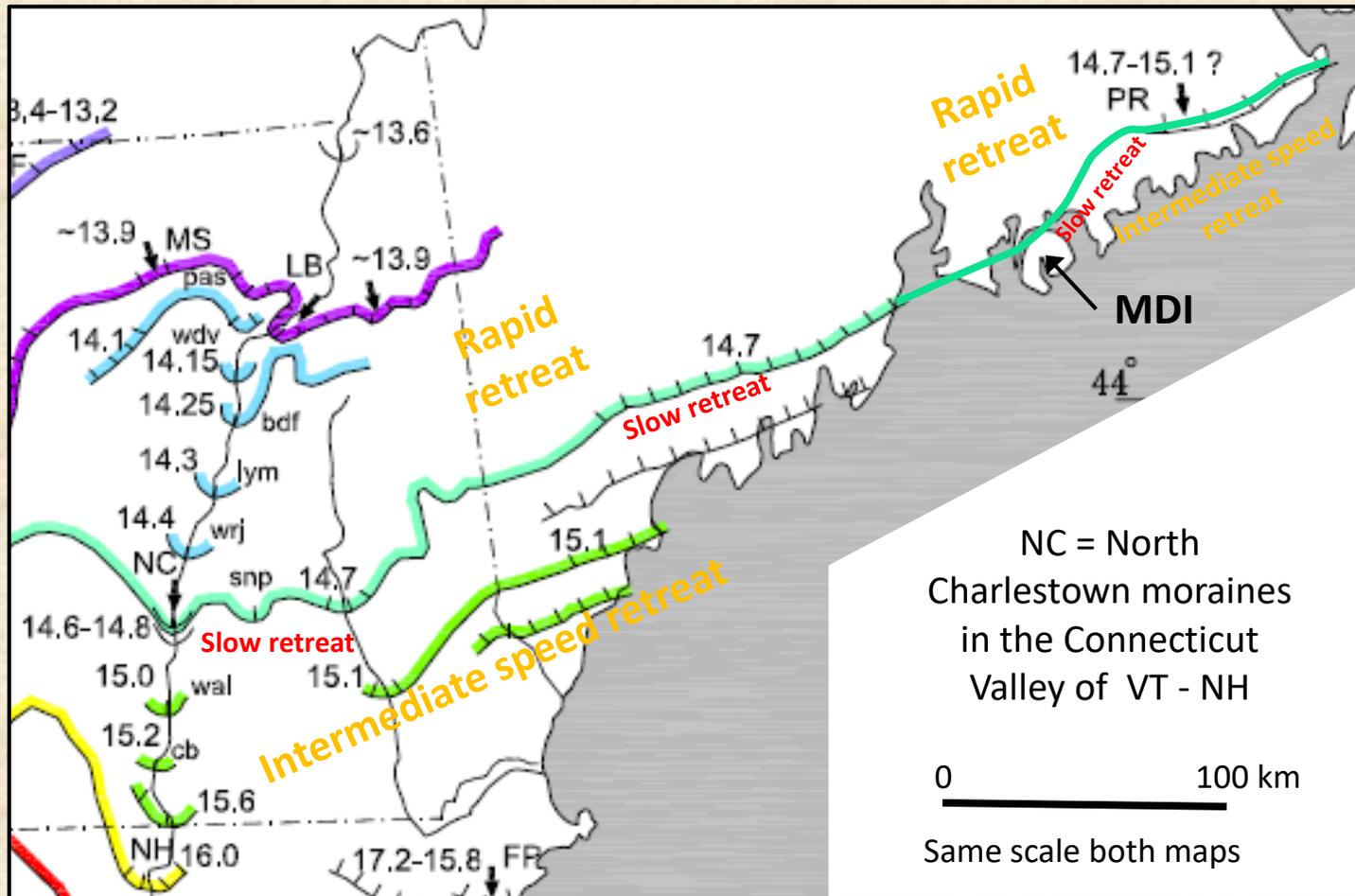
Widely spaced moraines northeast of Machias



Downeast Maine ice front retreat – intermediate speed - then a distinct slowing - then a rapid speed up for 100's of years



Matching the Connecticut Valley retreat record to the Downeast Maine retreat record at 14.7 ka

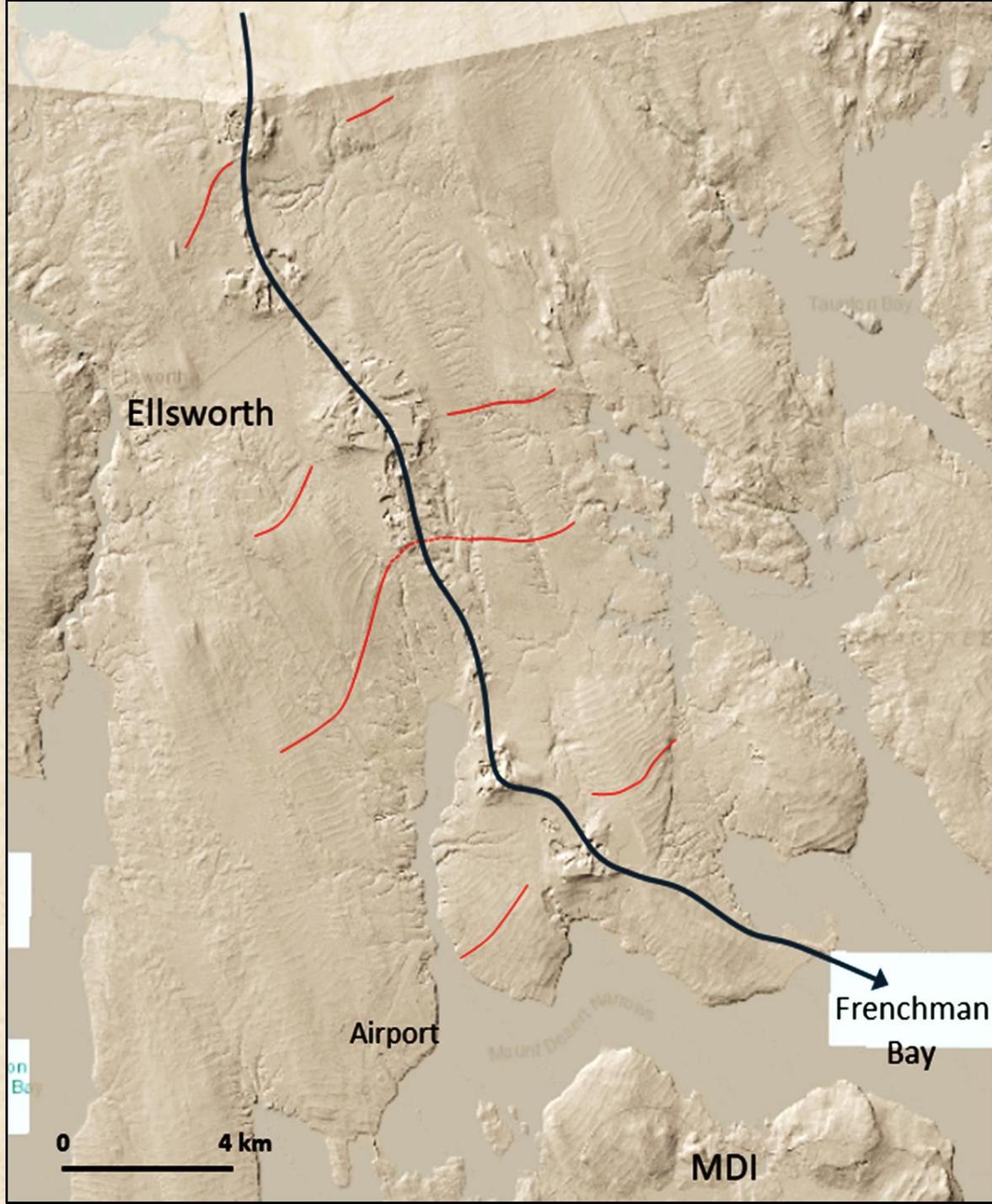


Green line above – Braun’s present preliminary projection the MDI – PRS closely spaced moraine belt to the southwest along mid-coast Maine and into western Maine.

Ice margin map from Ridge (2004) as revised by Ridge 2016, (<http://eos.tufts.edu/varves/NAVC/navcdeglac.asp>)

Closely spaced moraine segments southwest from MDI to Sebago Lake





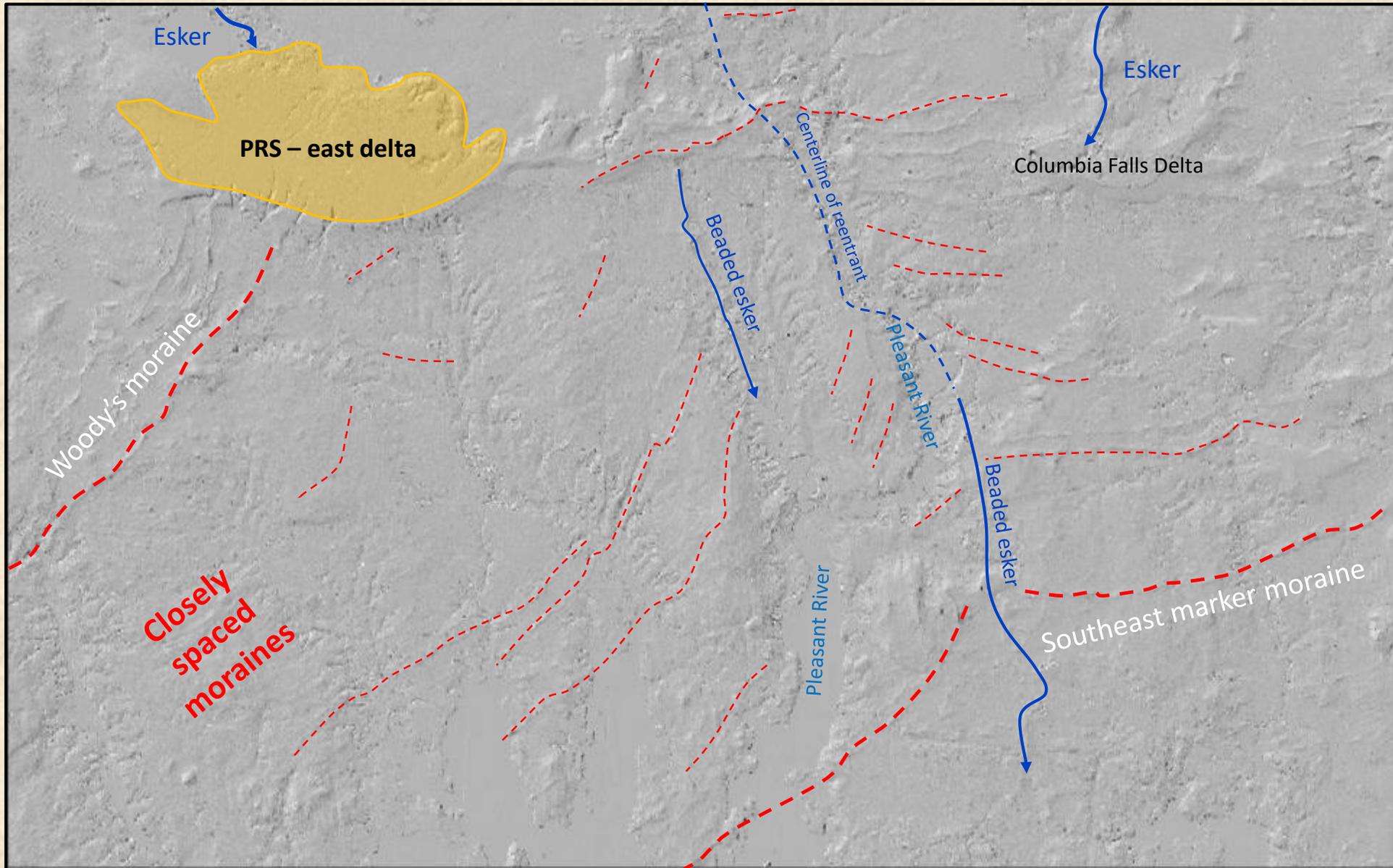
LiDAR image of the small push moraines with a 100-150 m (330–500 ft) spacing from the north side of MDI to north of Ellsworth. There are approximately 200 individual moraines in the 30 km from south to north on the image.

Blue arrow marks the crest of an esker that forms a reentrant in the ice front with the moraines curving northward into it.

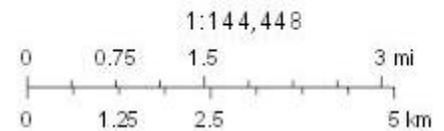
The moraine spacing does not change to either side of the deltas indicating the deltas represent pulses of meltwater sediment rather than slowing of the ice front retreat.

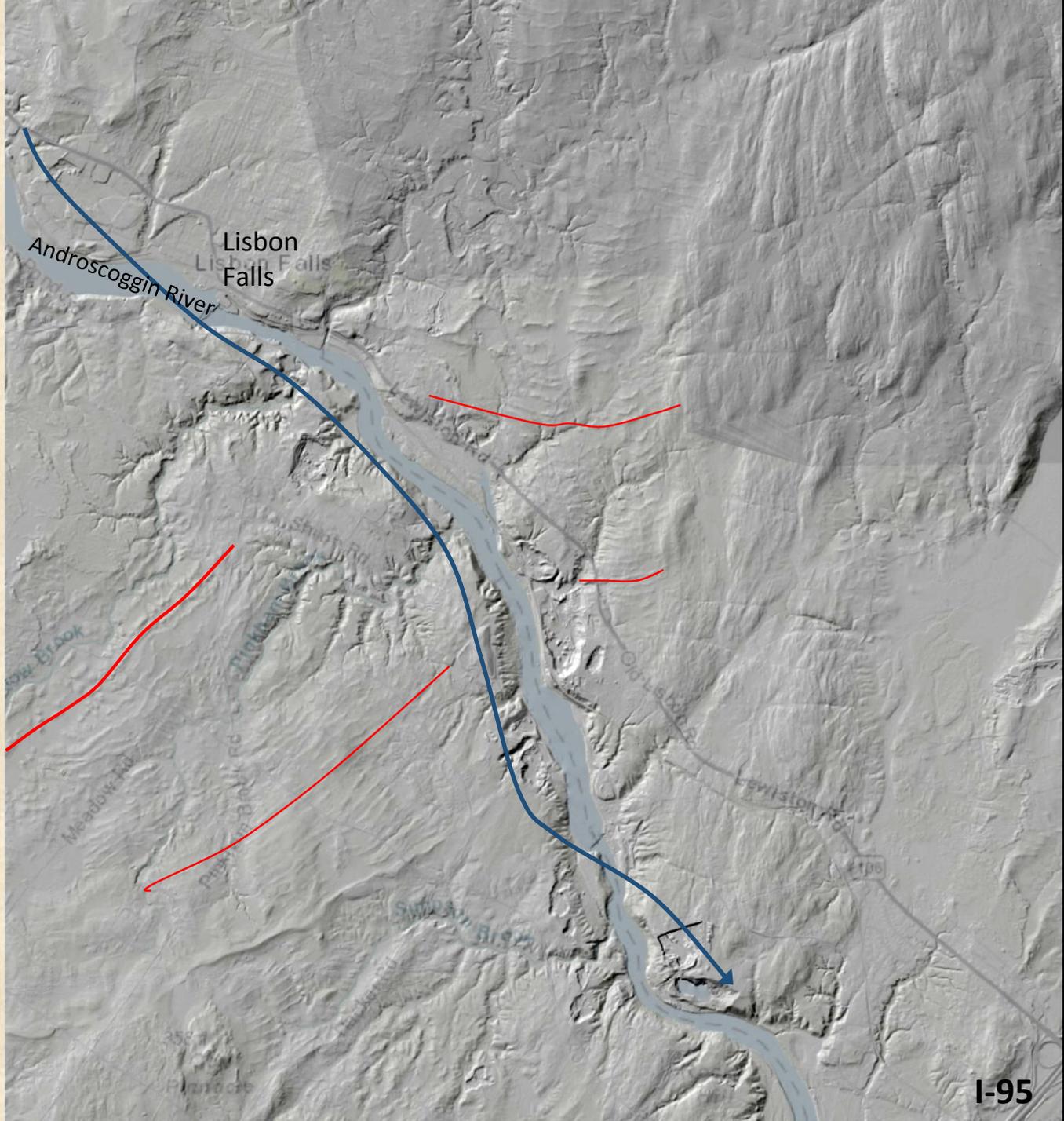
Light blue rectangles are places on the water with no LiDAR coverage.

PRS area moraine curvature



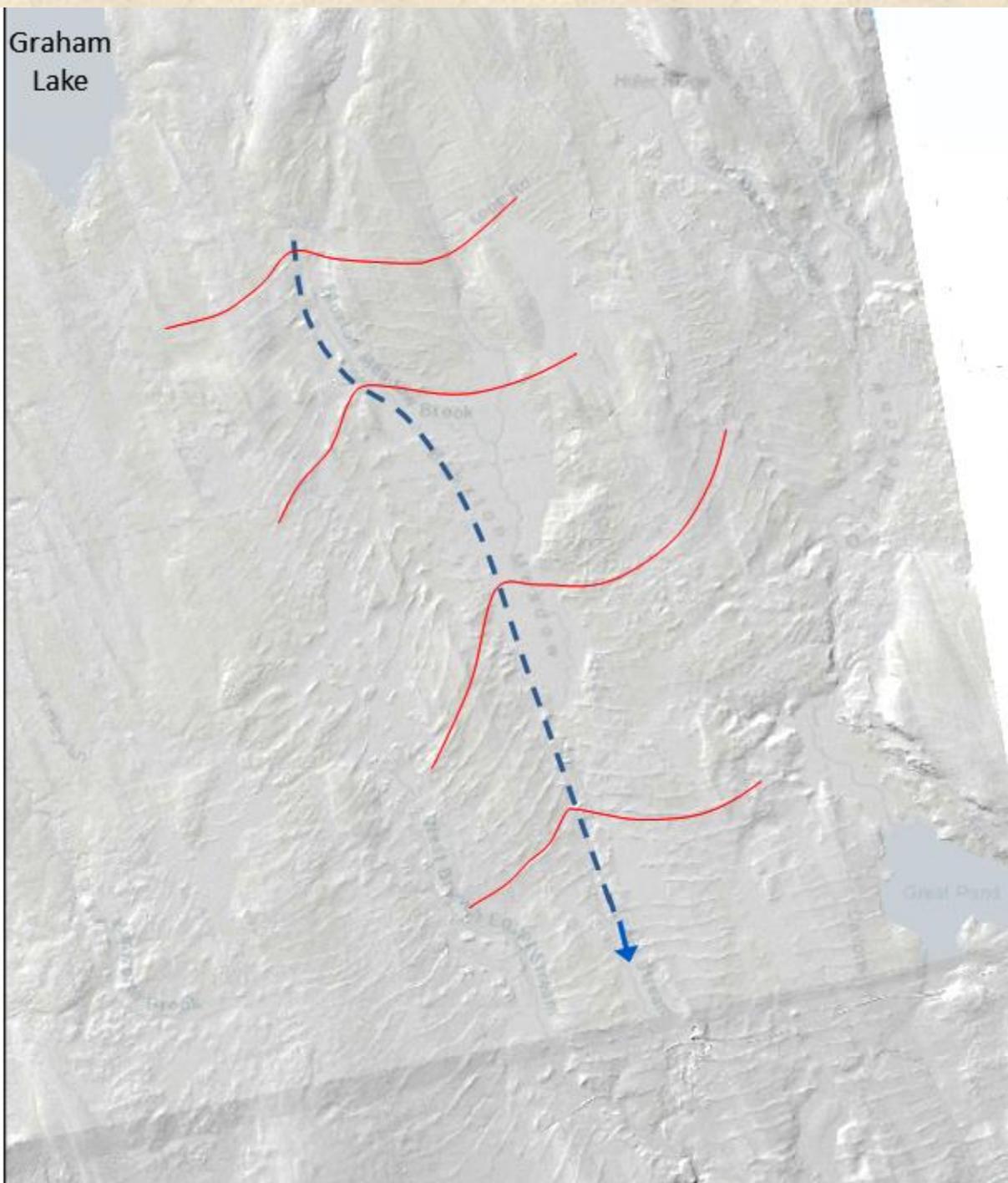
3/5/2019, 3:38:31 PM





Closer view of Brunswick area
moraines and curvature to
north into esker channel
around Lisbon Falls

Graham
Lake



Moraines northeast of Ellsworth and southeast of Graham Lake

Moraine curvature to either
side of a shallow valley with
no detectable esker

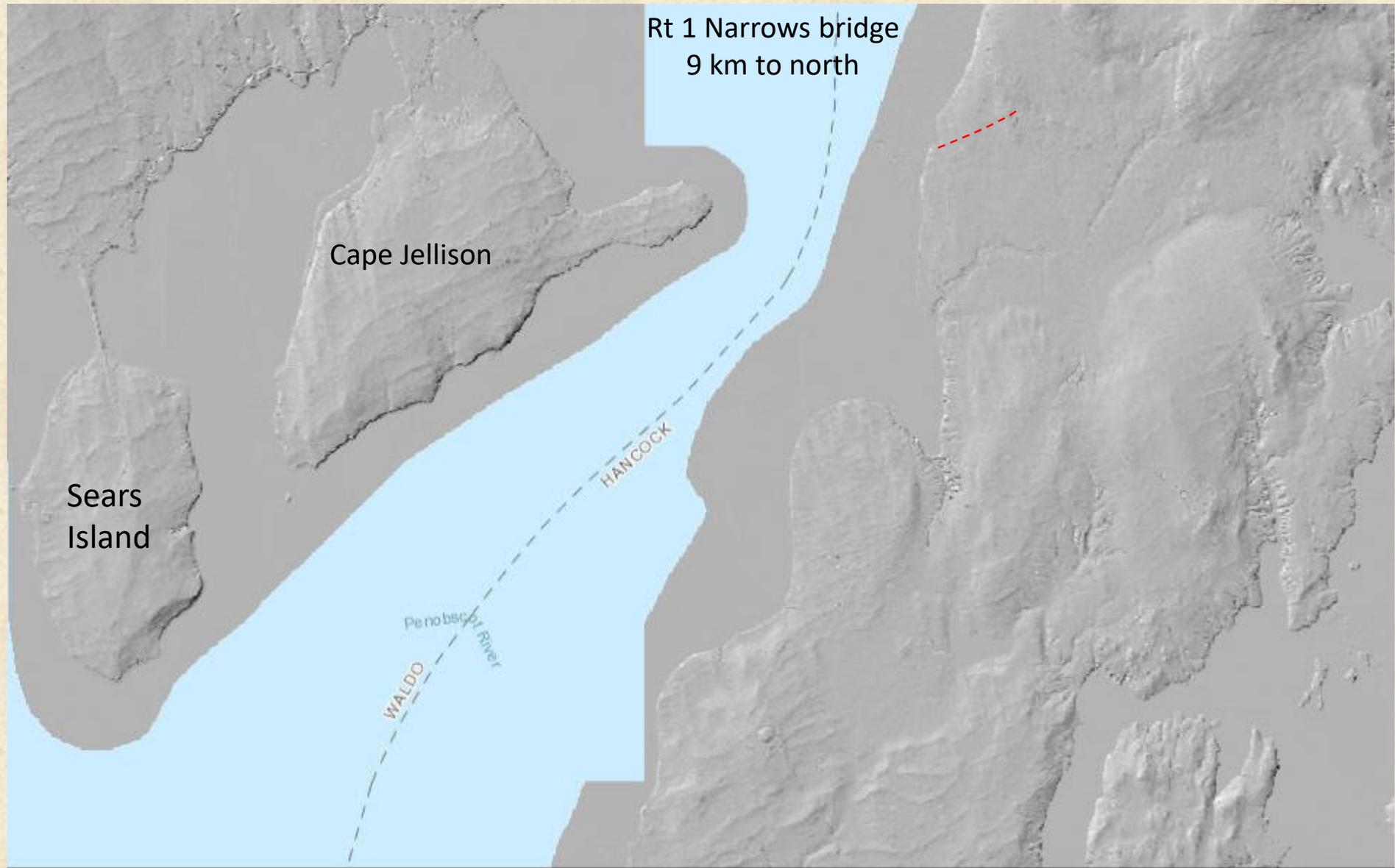
 Valley
Centerline

 Moraine
Ridge

0 1 2 km



Penobscot Bay – no calving bay reentrant at head of bay



3/5/2019, 4:05:49 PM

