MEASURING BLUFF TOE RECESSION RATES: 1973 →2007

ADAM BONNYCASTLE & ROBIN DAVIDSON-ARNOTT

SUPPORTING DOCUMENT

Adam Bonnycastle & Robin Davidson-Arnott, 05/05/2016

ESTIMATING SHORELINE EROSION RATES, 1973→2007: METHODOLOGY NOTES

The following document outlines the methodologies employed to estimate 1973-2007 erosion rates. It is presented according to four main sections:

- Input Data
- Final Output Data
- Original Proposed Methodology – Absolute positioning
- Final Methodology – Scale-based concept

INPUT DATA

BACKGROUND

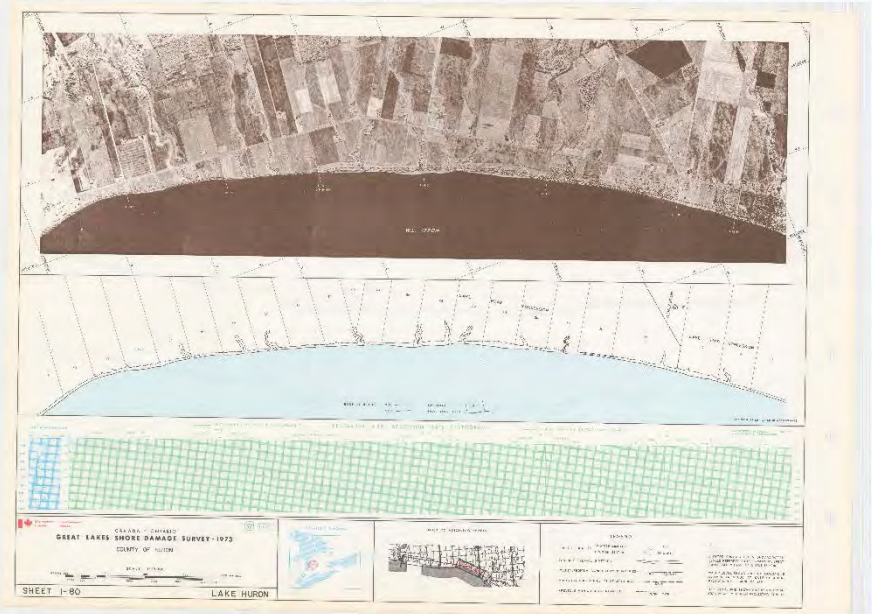
- Original Bluff recession rates based on 1935 survey and 1987 imagery. Some potential issues with 1935 data
- ABCA has excellent data on 2007 and 2010 toe and top of bank but needed data from historic aerial photographs giving at least a 34 year time span from which to update the recession rates used to determine setbacks
- Standard approach to obtain the "Shoreline Change Rate" is to digitize the historic and recent shorelines and to bring them into a common geodatabase.
- The change rate is then determined within a GIS by generating a baseline parallel to the shoreline and setting up transects perpendicular to this that cross the two shorelines. The difference in the position of the two shorelines at each transect allows the determination of the change between the two dates and this can then be converted to an average annual recession (or accession) rate.

BACKGROUND

- Would require acquisition and orthorectification of photographs from 1960s or early 1970s to generate the historic shoreline – an expensive and time-consuming process. Also difficult because relatively few stable control points going back this far
- We suggested possibility of using the orthorectified photo mosaic sheets produced for the 1973 Canada/Ontario Shore Damage Atlas as a way to get this done quickly and reasonably inexpensively because they were orthorectified at the time they were created therefore no issues with control points.
- This has now been completed, though the task was more complicated than we originally anticipated.

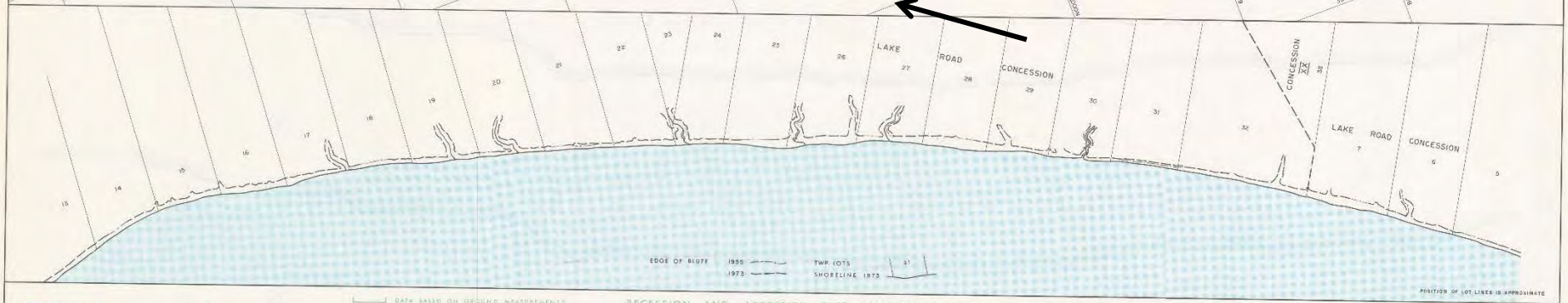
INPUT DATA

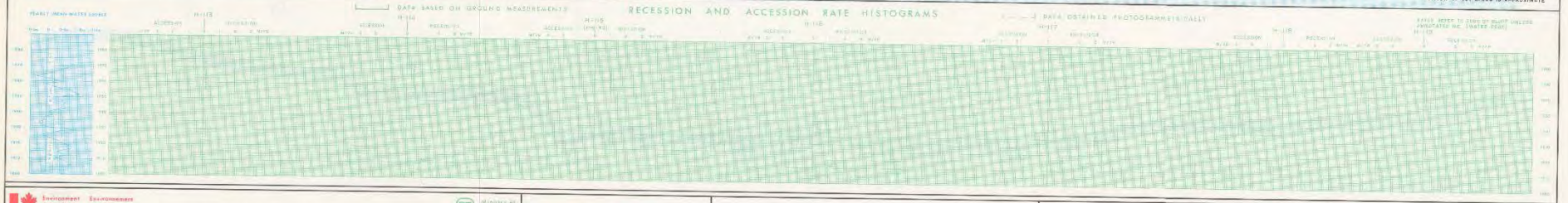
GREAT LAKES SHORE DAMAGE SURVEY, 1973



AUSABLE BAYFIELD CA

- ShorelineErosion.gdb
  - Shoreline2007DerivedData
    - Toe2007
    - Top_of_bank
  - Shoreline_2010_Data
    - TOB_2010
  - Imagery: shore2007.ecw





Environment Canada — Environnement Canada

Ministry of Natural Resources

CANADA - ONTARIO

GREAT LAKES SHORE DAMAGE SURVEY - 1973

COUNTY OF HURON

SCALE 1:20,000

METRES 500 0 500 1000 1500 METRES

FEET 1000 0 1000 2000 3000 4000 FEET

SHEET 1-80

LAKE HURON

LOCATION DIAGRAM

INDEX TO ADJOINING SHEETS

LEGEND

PROFILE LOCATION — PHOTOGRAMMETRIC EROSION STATION — E-2 (E-8-10)

CONTOUR INTERVAL 3 METRES — 06

COUNTY, REGIONAL, MUNICIPALITY BOUNDARIES — ESSEX COUNTY

MUNICIPAL BOUNDARIES AS OF JAN. 1 1970 — DELHI

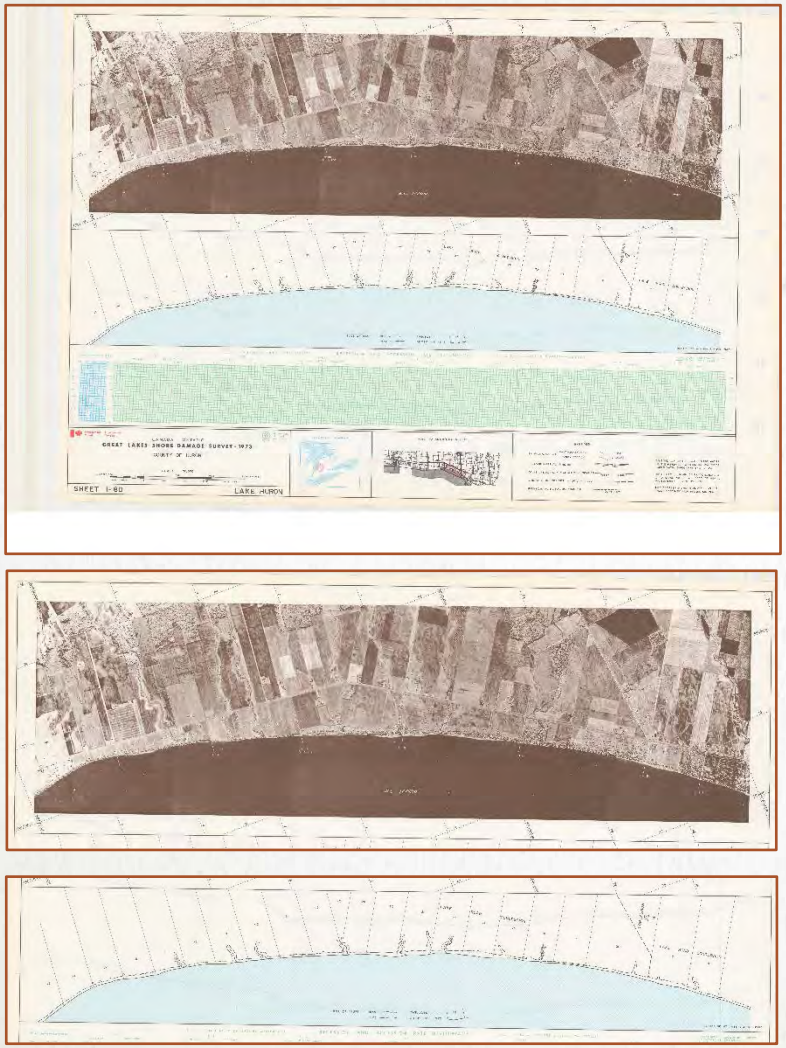
PREVIOUS MUNICIPAL BOUNDARIES — DUNN TWP.

3 METRE CONTOUR ELEVATIONS AND WATER LEVELS REFERRED TO INTERNATIONAL GREAT LAKES DATUM (1955) LAKE ERIE 174·2m.

WATER LEVEL SHOWN ON PHOTO-MOSAIC IS DAILY MEAN VALUE AT DATE OF AERIAL PHOTOGRAPHY JUNE 23 1973

1000 METRE GRID SHOWN ON A 6° UNIVERSAL TRANSVERSE MERCATOR PROJECTION ZONE 17

ORIGINAL METHODOLOGY



1. **Scan Erosion Survey pages @ 600 dpi**
2. **Crop to image and to map (Photoshop)**
3. Register image (ArcGIS, 1st order polynomial):
    1. Easting/Northings, then
    2. ABCA roads & imagery
4. Register map to image (ArcGIS, 1st order polynomial)
5. Digitize Toe of Bluff from map (ArcGIS

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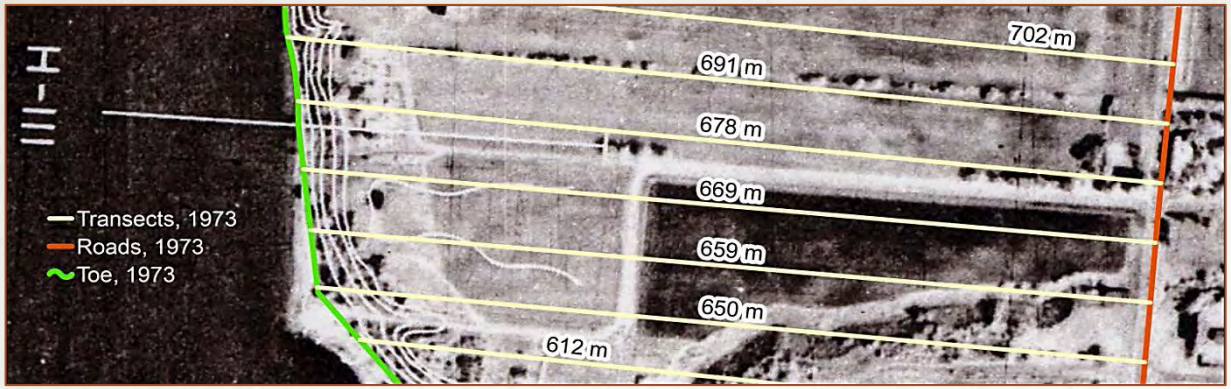
ISSUES ENCOUNTERED

- Because of the way the maps and the underlying grid were printed there were visible shift between image and Easting-Northing grid causing unreasonably high registration residual error.
- We tried a number of possible fixes for this but none provided an acceptable level of accuracy in part because of the limited overlap between sheets and the long, straight coastline
- However we recognised that the actual scale of the maps had an acceptable level of accuracy and so we developed an approach that allowed us to use the centre line of Hwy 21 as our baseline and to generate transects at 50 m intervals along the shoreline separately on the 1973 maps and the 2007 ABCA GIS base.
- We then measured the distance to the toe on each map and substracted one from the other to get the shoreline change. (This process is all automated)

Example



1973 map and Hwy 21 centre line with transects at 50 m intervals showing distance to 1973 toe of bluff

2007 map and Hwy 21 centreline with transects at 50 m intervals showing distance to 2007 toe of bluff

2007 map with transects at 50 m intervals showing final smoothed average annual change rate.

INITIAL EVALUATION AND ADJUSTMENT

- After AB had generated the initial transects and change rates RD-A compared the recession rates to evidence from the field visible in the 2007 aerial photographs and 2014 and some 2016 oblique aerial photographs provided by ABCA.

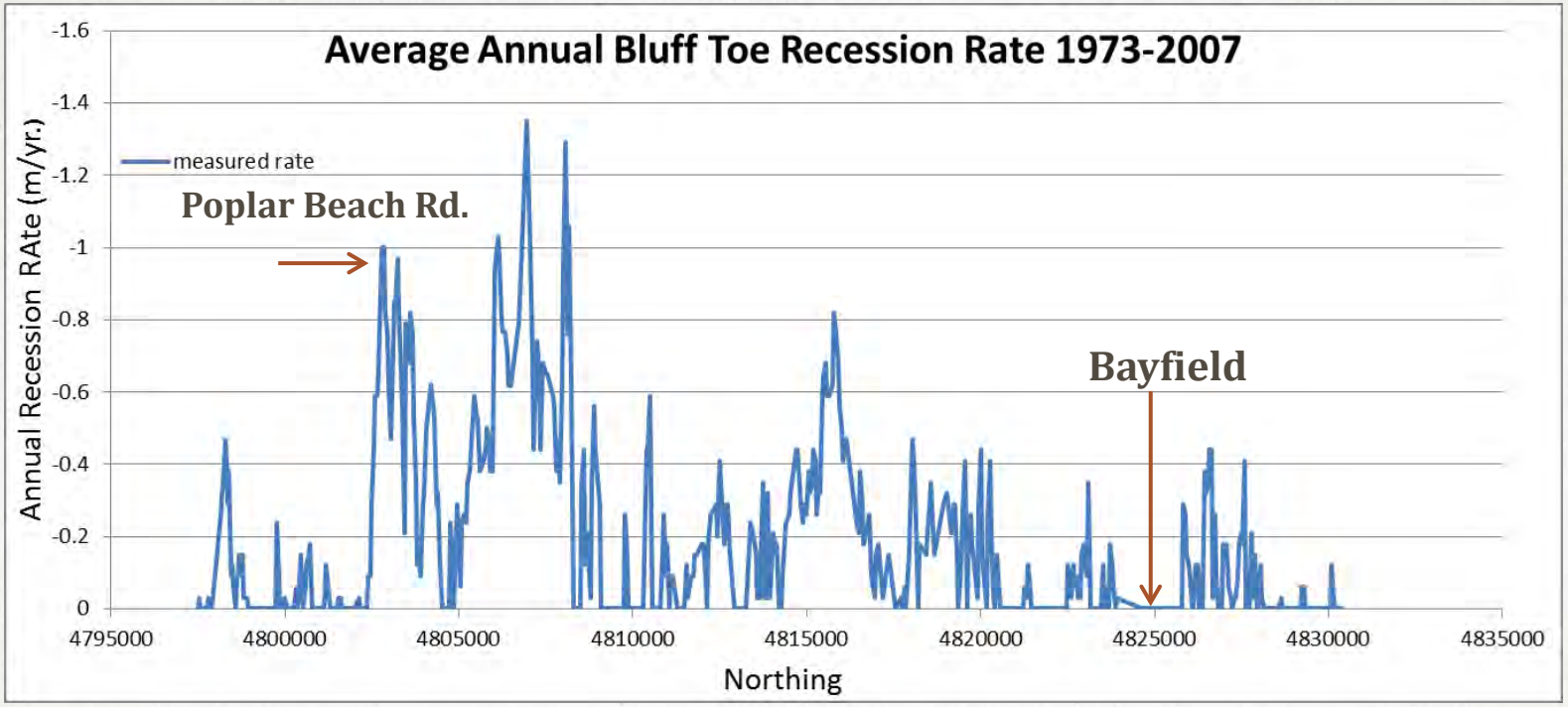
- The primary focus here was to examine areas where there might be errors in digitizing the 1973 toe of bluff. In several places it was necessary to make adjustments to the 1973 shoreline where the lowest contour line obviously did not conform to the bluff toe – for example the filet beach north of the harbour breakwall at Bayfield and in areas around the mouth of large gulleys

- In other places transect length had to be adjusted manually where the transect stopped at a line marking a gulley. Also at this time some additional lines were generated to fill in areas where there were large gaps from the automated process due to gulleys.

INITIAL EVALUATION AND ADJUSTMENT

- The process was then repeated and a number of other issues were identified and corrected with a focus on the 2007 toe of bluff and its relation to the 1973 shoreline.
- In a few cases the 2007 shoreline was not continuous or had a secondary line drawn part way up a bluff. This resulted in the transect stopping before it reached the true 2007 toe of bluff and these transect were corrected manually
- Finally, it was noted that in several areas erroneous bluff recession rates were generated where houses were situated at the base of the bluff (e.g., Rocky Point and Dewey Point). The 2007 toe of bluff was drawn (correctly) at the toe of the bluff behind the houses but the shoreline on the 1973 maps was located on the lakeward side of the houses thus generating an apparent retreat where there was none.

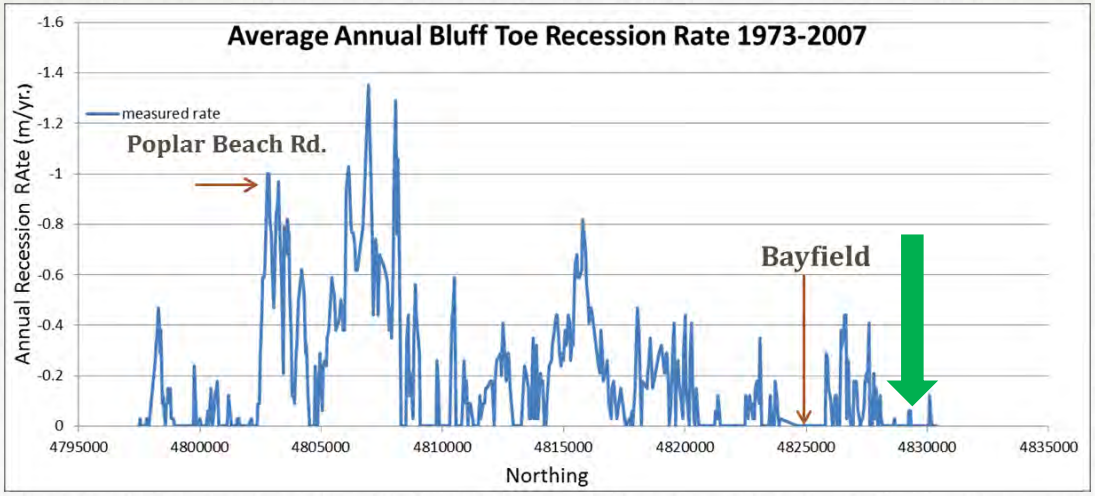
RECESSION RATES



Measured average annual bluff toe recession rates. All positive values (accretion) are set to 0.

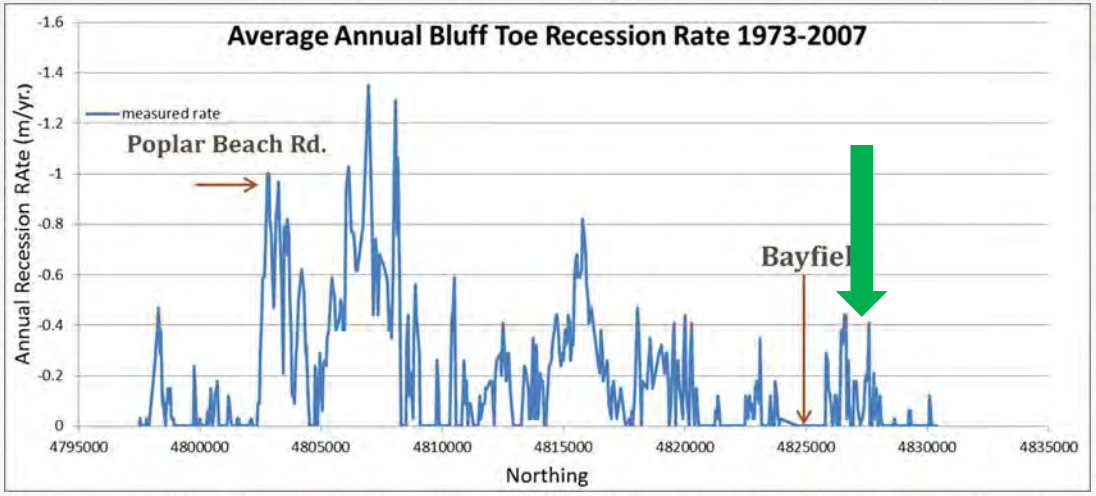
RECESSION RATE VERIFICATION

LOW RECESSION RATE



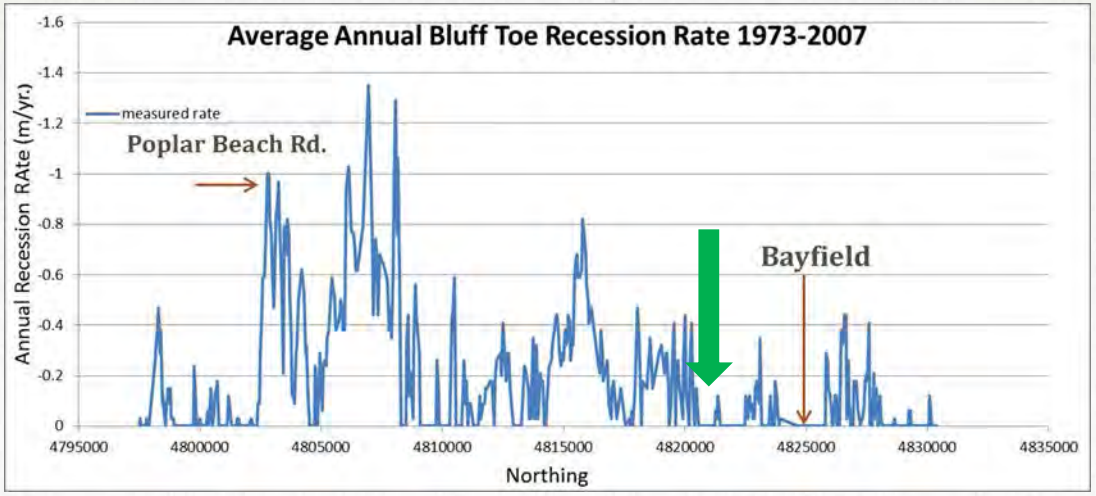
RECESSION RATE VERIFICATION

MEDIUM RECESSION RATE



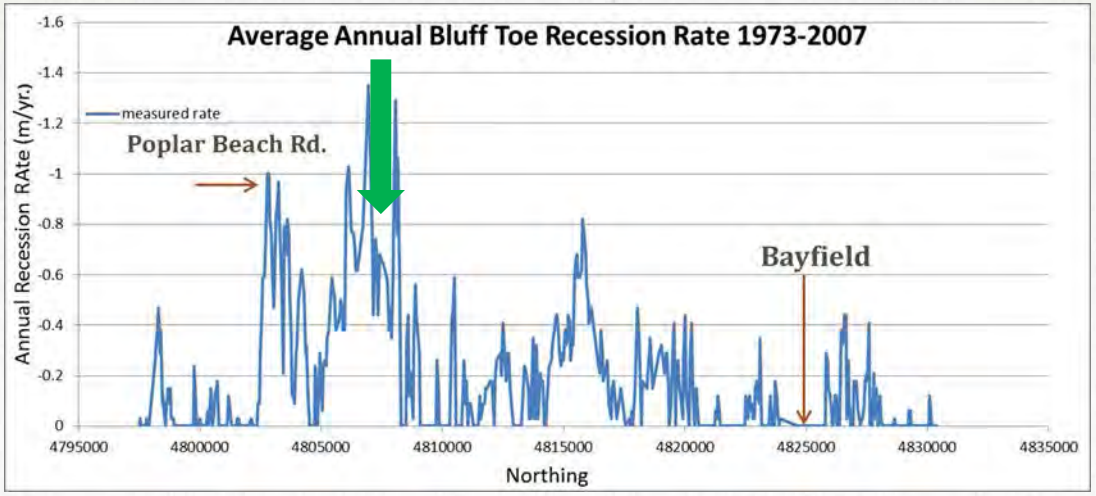
RECESSION RATE VERIFICATION

LOW RECESSION RATE

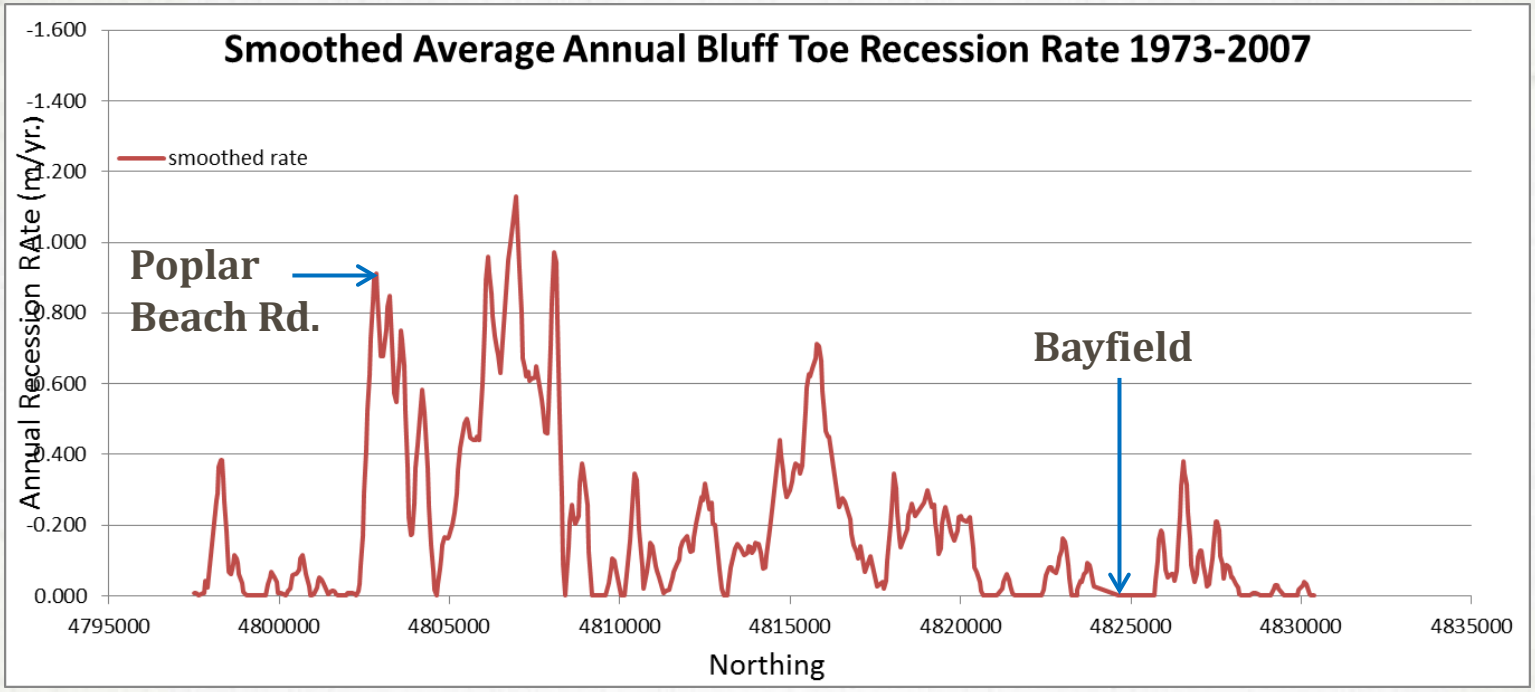


RECESSION RATE VERIFICATION

MEDIUM TO HIGH RECESSION RATE



RECESSION RATES



Smoothed average annual bluff toe recession rates. Value for each point is a weighted average of that point and two points on either side

FUTURE WORK

- We will continue the verification process to complete the area south of Cedar Beach Rd.
- We will then move to compare the recession rates generated here to other measurements, including those for 1935-1987 and the top of bank for 1987-2007
- Finally, we will compare short sections where there is information available from measurements to top of bank from subdivision plans