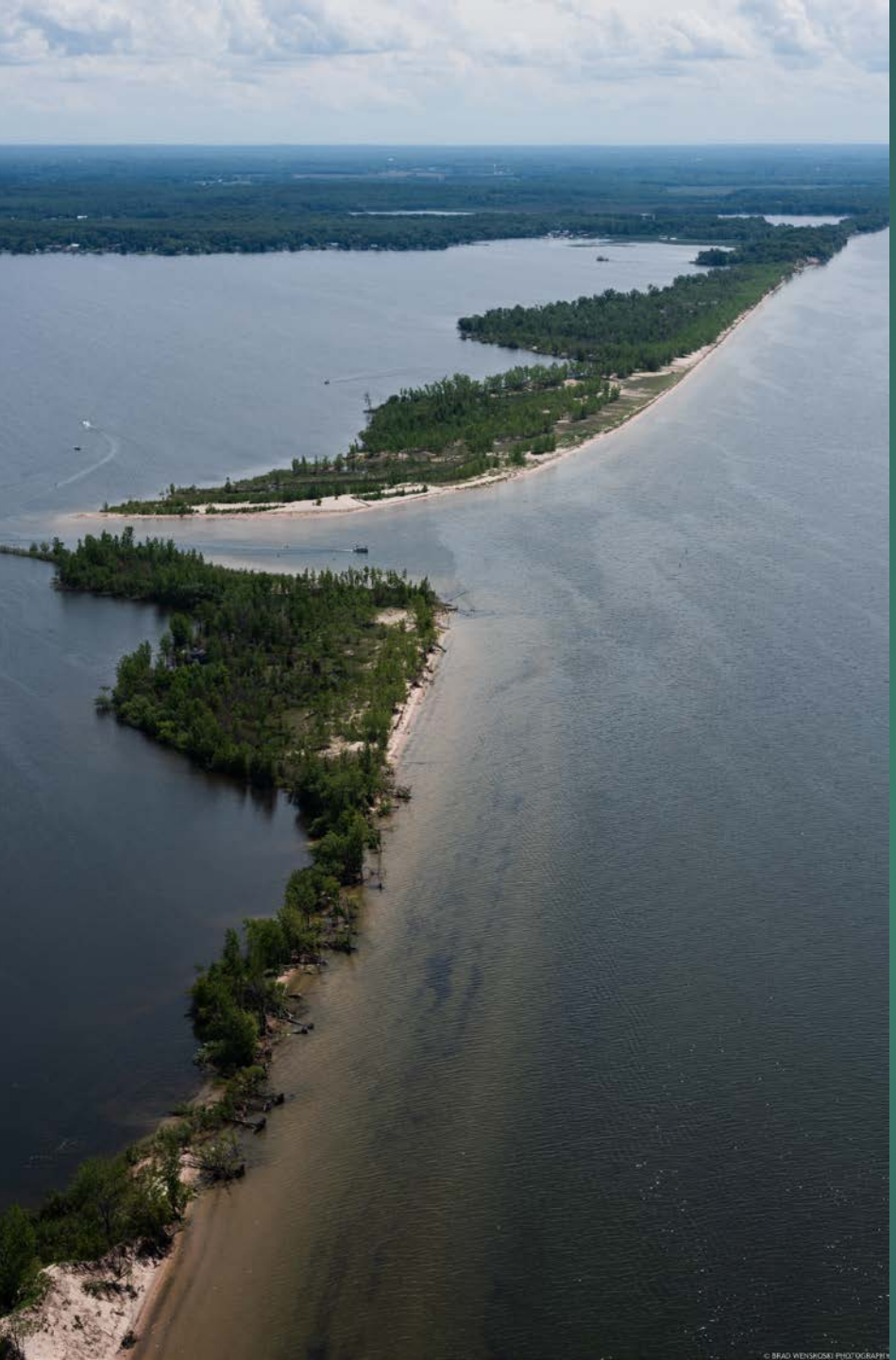


North Sandy Pond Long Term Shoreline Analysis and Recent High Lake Ontario Water Level Impacts

A presentation by
Thomas F. Hart, Jr.
to the NYS GIS Conference

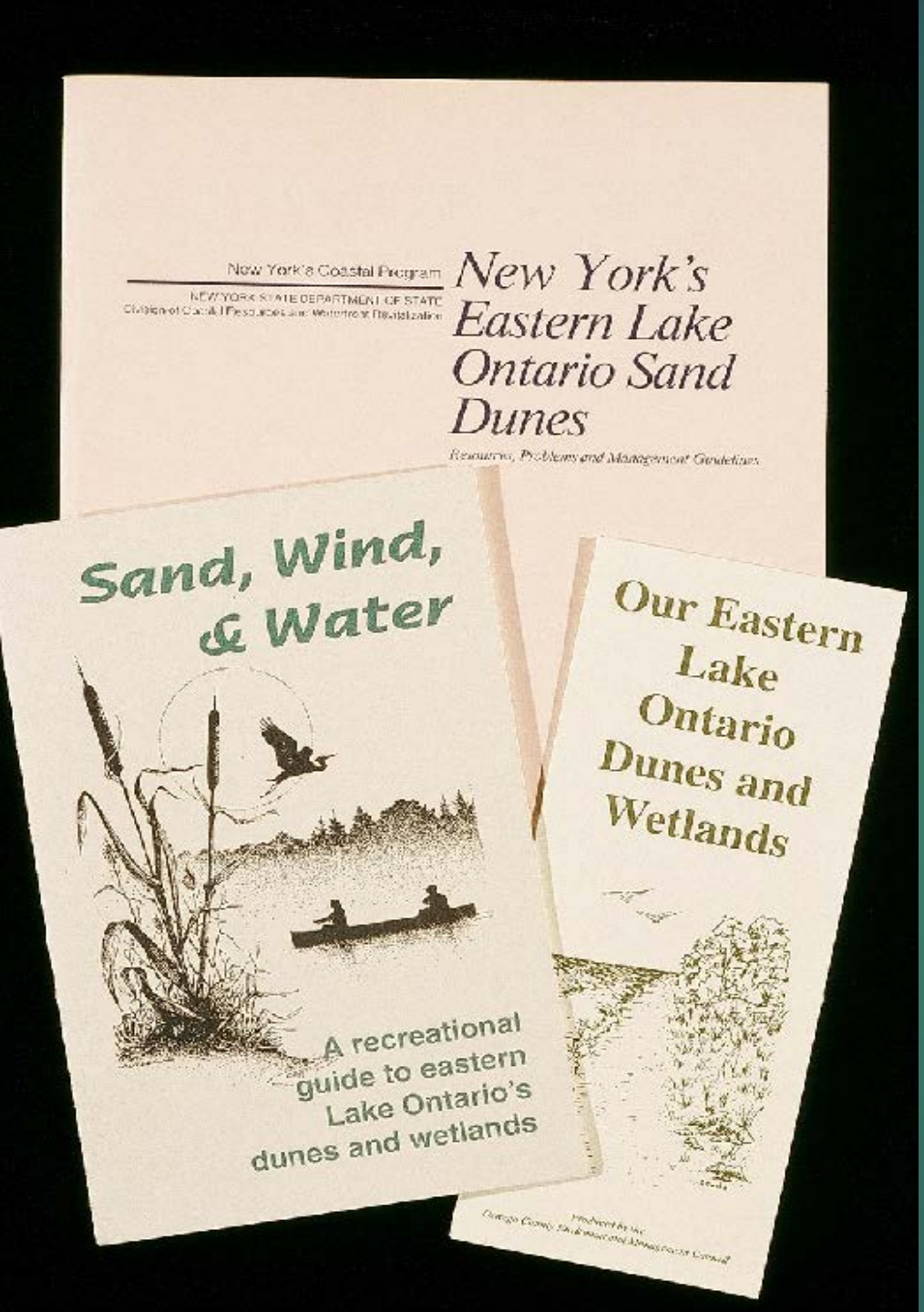
September 25, 2019

North and South Ponds

Sandy Island Beach State Park

Sandy Pond Beach
Natural Area


North Pond Dunes



1989 "Dunes Report": A Foundation for Resource Management

- Funded and directed by Department of State
- Identified issues
- Increased public awareness and understanding
- Provided recommendations for cooperative, voluntary actions
- Recipient of Planning Award

2007 Dune and Wetland System Study

Funded and directed by the Department of State

Updated existing conditions

Presented progress made and lessons learned from the “Dunes Report”

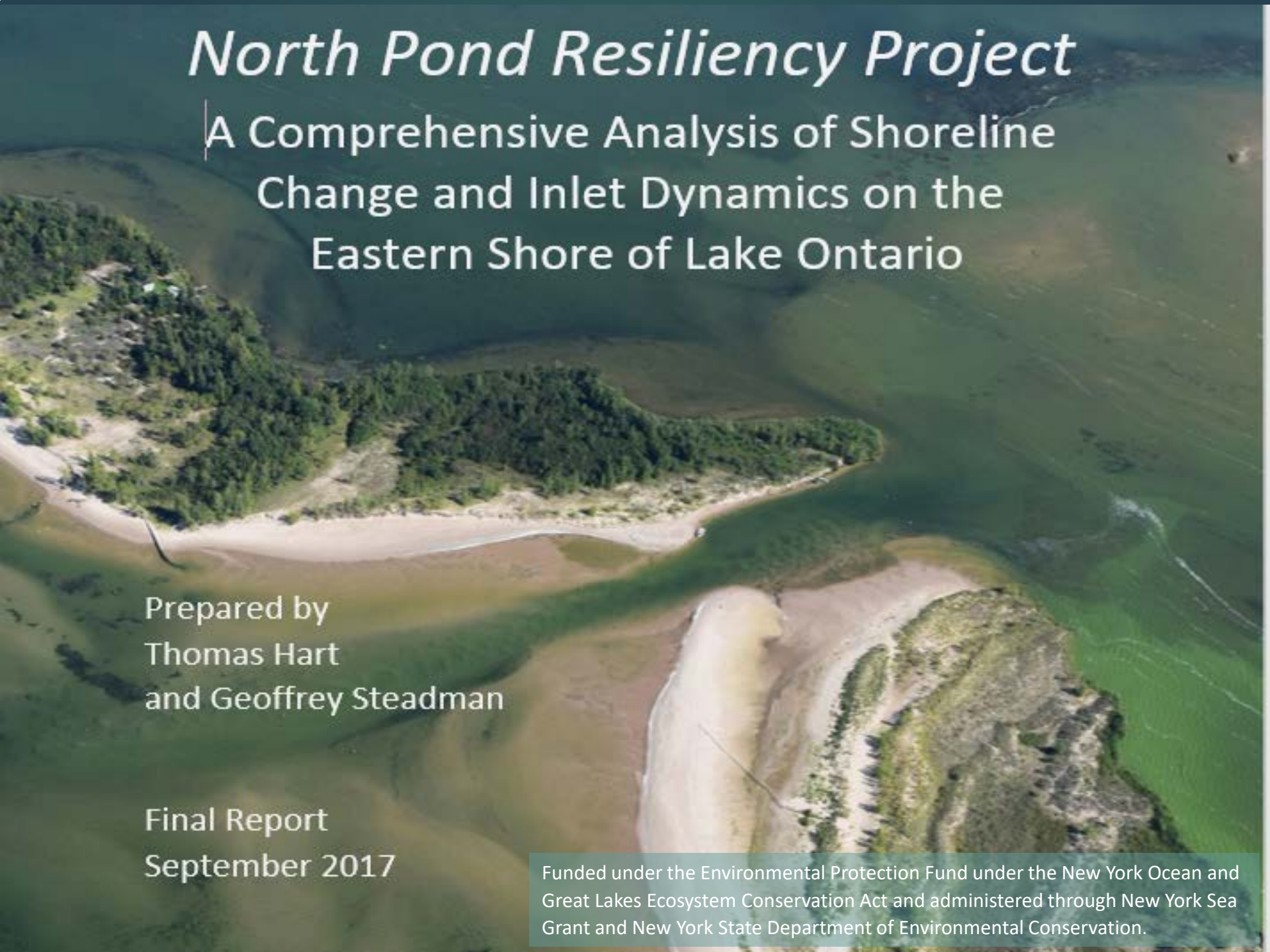
Established stewardship goals and priorities for the through 2017

One priority was to study coastal processes and shoreline change


Wind-driven waves, combined with Lake water level, are the principal natural forces modifying and eroding the shoreline.
Photo by Nick Stowell

North Pond Resiliency Project

A Comprehensive Analysis of Shoreline Change and Inlet Dynamics on the Eastern Shore of Lake Ontario



Prepared by
Thomas Hart
and Geoffrey Steadman

Final Report
September 2017

Funded under the Environmental Protection Fund under the New York Ocean and Great Lakes Ecosystem Conservation Act and administered through New York Sea Grant and New York State Department of Environmental Conservation.

Digital Orthoimagery (2001-2013)

20 sets of digital orthoimagery were obtained.

Only 2014, 2012, 2010, 2005, 2002 and 2000 are not represented since 2000

Of these, 15 shorelines were digitized.

Historic Aerial Photography (1938-1995)

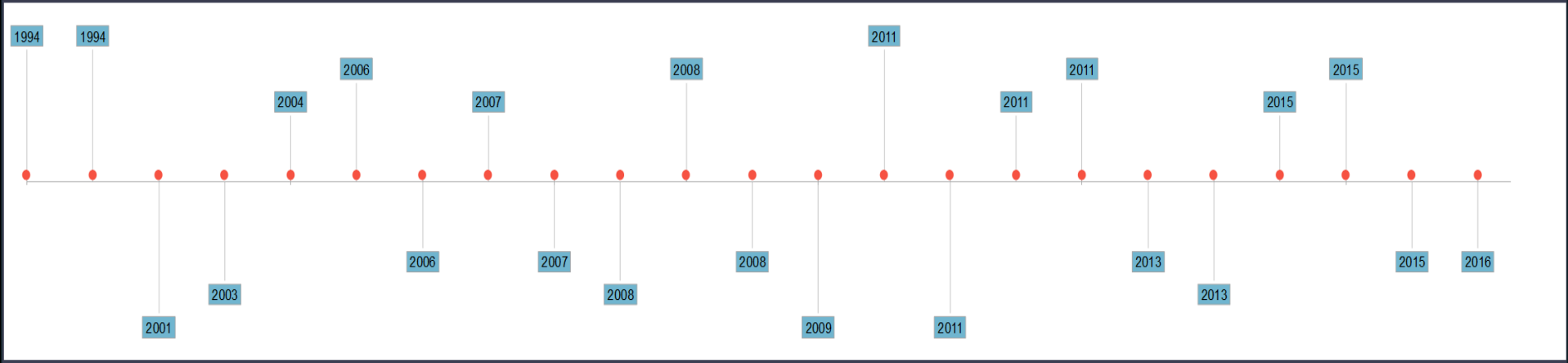
27 sets of imagery were obtained.

Of these, 14 shorelines were digitized.

Orthoimagery (1994 – 2015)

North Pond Resiliency Project: Modern Era Imagery

Digital Orthoimagery Timeline



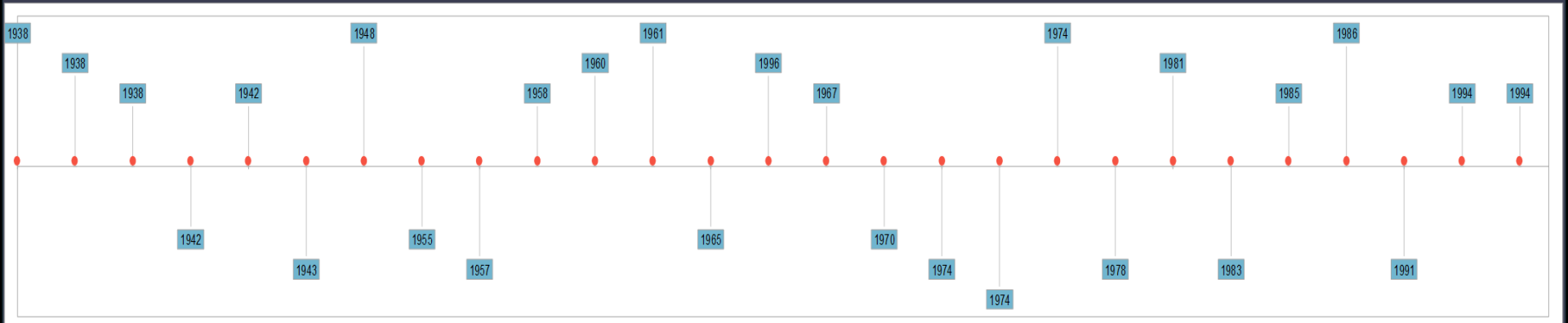
Digital Orthoimagery Map Inventory

Date	Source	Project	Pixel Size	Image Type	Comment	Accuracy	Digitized	Lake Level	MILESTONE	245+-0.15	245.5+-0.15	246+-0.15	246.5+-0.15
5/3/1994	USGS EE	DOQQ	1 .0m	Color Infrared		20 ft	yes	246.2	1994			C	
5/3/1994	Date+B21:B43	DOQQ	1.0 m	Color Infrared	modified color balance set from DOS	20 ft	yes	246.2	1994			x	
6/23/2001	USACOE	IJC	0.5 m	True Color	not online - delivery by CDROM 6/03/16; custom projection	4 ft	yes	246.0	2001			C	
4/1/2003	NYS GIS	DOP	2.0 ft	Color Infrared		8 ft	yes	244.6	2003	Low			
7/1/2004	NRCS	NAIP	1 m	True Color	county mosaic	19.7 ft	yes	246.4	2004				D
4/1/2006	NYS GIS	DOP	2 ft	True Color		8 ft	no	245.4	2006		x		
6/6/2006	NRCS	NAIP	1 m	True Color	pond image from 7Jul06	19.7 ft	yes	245.7	2006		B		
6/14/2007	USACE	JALB	0.4 m	True Color	5 km along shoreline/ June-August	2.5 ft	yes	246.0	2007			C	
6/14/2007	USACE	JALB	5 m	Reflectance	June up to 04Aug07	2.5 ft	no	246.0	2007	x			
7/2/2008	NRCS	NAIP	1 m	True Color	shore image from 24Sep08 (see 9/24/08 NAIP)	19.7 ft	yes	246.6	2008	x			
8/26/2008	USGS	unknown	0.3 m	True Color	tif and jpg products	19.7 ft	yes	246.0	2008			C	
9/24/2008	NRCS	NAIP	1 m	True Color	pond image fr 2Jul08	19.7 ft	yes	245.1	2008	A			
7/10/2009	NRCS	NAIP	1 m	True Color	county mosaic	19.7 ft	yes	246.5	2009				D
5/92011	NYS GIS	DOP	2 ft	4 band		8 ft	yes	246.6	2011				D
5/9/2011	USGS EE	HiRes Ortho	2 ft	4 band	same as NYSDOP, UTM projection	8 ft	no	246.6	2011				x
5/11/2011	USGS EE	NAIP	1 m	4 band	date verified w metadata	19.7 ft	no	246.6	2011				x
5/11/2011	NRCS	NAIP	1 m	True Color	county mosaic	19.7 ft	no	246.6	2011				x
5/26/2013	Google	Google	1 ft	True Color	Resolution net specified	UNK	no	245.8	2013	x			
6/19/2013	NRCS	NAIP	1 m	True Color	county and DOQQ	19.7 ft	yes	246.5	2013				D
4/15/2015	NYS GIS	DOP	1 ft	4 band	flight dates extended to May 9; lake el - 244.8-245.3	4 ft	no	244.8	2015	A			
6/6/2015	NRCS	NAIP	0.5m	True Color	county mosaic	19.7 ft	yes	245.7	2015		B		
6/6/2015	NRCS/SWCD	NAIP	0.5m	4 band	DOQQ - use for vegetation analysis	19.7 ft	yes	245.7	2015		x		
9/5/2016	Google	Google	1 ft	True Color	Resolution net specified	UNK	no	245.2	2016	x			

Historic Imagery (1938 – 1991)

North Pond Resiliency Project: Historic Photography

Photography Timeline



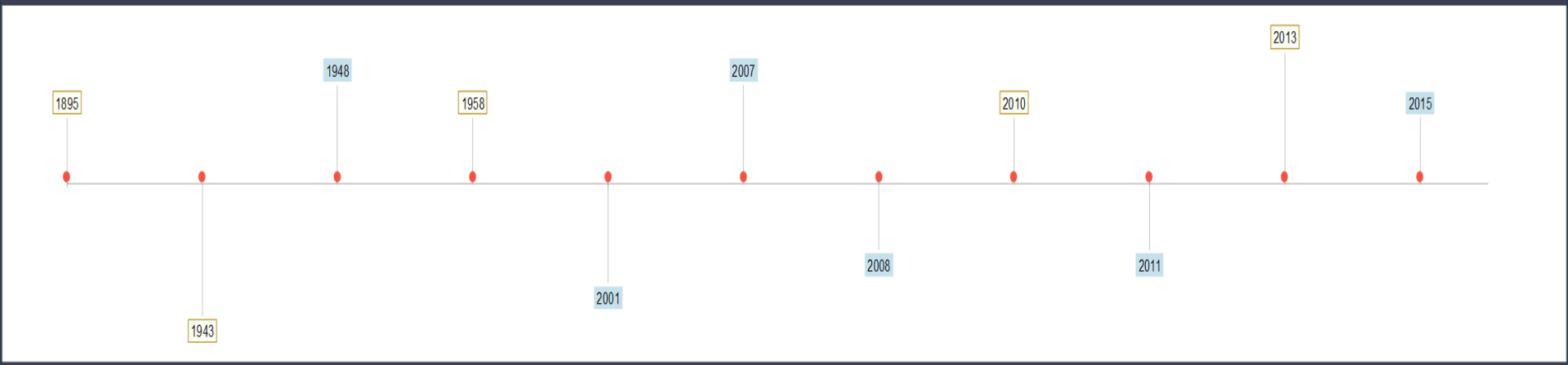
Aerial Photography Inventory

DATE	Source	Project	Scale or Pixel	Image Type	Comment	Accuracy	RMSE	Digitized	Lake Level	MILESTONE	POSITION	BASELINE	245+-0.15	245.5+-0.15	246+-0.15	246.5+-0.15
4/21/1938	National Archiv	Unknown	Unknown	Black and White	not obtained -	na		no		1938	20	1				
6/?/1938	SWCD	Unknown	Unknown	Black and White	obtained later date image	na		no	245.0	1938	15	1				
6/29/1938	SWCD	Unknown	Unknown	Black and White	chose only higher level date	na	21.00	yes	245.0	1938	10	1	A			
4/1/1942	SWCD	Unknown	Unknown	Black and White	YMCA only / TVA			no		1942	-10	1				
5/9/1942	National Archiv	TVA - McClennen	Unknown	Black and White	poor scan at 50 dpi		S_71;N_19.3	yes	245.1	1942	10	1	A			
9/6/1955	SWCD	Unknown	660' (1.7920)	Black and White		27.00	27.00	yes	247.5	1955	-15	1				D
5/6/1957	USGS	Mosaic	Unknown	Black and White	spline then readjust 2nd order	70.00	76.00	yes	245.6	1957	20	1		B		
5/19/1960	USGS EE	single frame	1:60,000	Black and White	over washes, water level higher than gauge? See renshaw wetlar	10.00	9.70	yes	246.5	1960	-10	1				D
5/5/1961	NYS Museum	DOT	1:40,000	Black and White	northern smaller scale			no		1961	-15	1	x			
7/2/1965	SWCD	Unknown	Unknown	Black and White	good imagery	20.00	7.2-16.2	yes	245.0	1965	10	1	A			
7/2/1966	SWCD	Unknown	Unknown	Black and White	renshaw and carl only			no		1996	15	1	x			
4/28/1967	NYS Museum	OPC	1:24,000	Black and White	north/center	20.00	19.70	yes	245.6	1967	20	1		B		
6/24/1970	USGS EE	single frame	1:11,087	Color Infrared	similar to 1983 data set for Color Infrared, Vegetation change? H	10.00	9.20	yes	245.9	1970	-10	1			C	
4/26/1974	NYS Museum	Oswego co	1:24,000	Black and White	northern, inlets, southern? (two not in file) _poor exposure			no		1974	15	1	x			
?/?/1974	SWCD	Unknown	Unknown	Black and White	lake level at 248 all June, date set to 7/1 based on crops in field	15.00	12.00	yes	248.0	1974	10	1				D
5/1/1974	USGS EE	single frame	1:10,390	Color	single frames - many needed to cover the study area			no		1974	-10	1				
9/23/1978	NYS Museum	SCS USDA	1:24,000	Black and White	center - priority for registration, west (not used)		7.00	yes	245.0	1978	-15	1	A			
5/1/1981	USGS EE	single frame	1:80,000	Black and White	small scale			no		1981	-20	1				
7/13/1983	USGS EE	single frame	1:13,167	Color Infrared	used this imagery	15.00	12.00	yes	246.2	1983	20	1			C	
4/29/1985	USGS EE	single frame	1:65,000	Color Infrared	small scale			no		1985	-15	1	x			
4/28/1986	USGS EE	NHAP	1:58,000	Black and White and Color Infrare	small scale			no		1986	15	1	x			
10/29/1991	NYS Museum	DOT	1:24,000	Black and White	centered	10.00	5.30	yes	244.1	1991	-15	1	Low			
5/3/1994	USGS EE	single frame	1:34,000	Color Infrared	many frames scale 34K-68K			no	246.2	1994	10	1	x			
5/3/1994	NYS Museum	NAPP	1:40,000	Black and White	not needed	20.00		no	246.2	1994	20	1	x			
6/8/1994	USGS EE	single frame	1:68,000	Color Infrared		10.00	8.70	yes	246.4	1994	-15	1				D
4/17/1995	NYS Museum	NAPP	1:40,000	Black and White	top 2/3 of pond, not registered			no	245.0	1995	10	1	x			
4/17/1995	USGS EE	NAPP	1:40,000	Color Infrared	registered 5/23/16	10.00	8.50	yes	245.0	1995	10	1	A			

Topographic maps (1895 – 2010)
Bathymetry 1948
Topobathymetric LiDAR (2001, 2007, 2011)

North Pond Resiliency Project: Elevation and Bathymetry Data

Topographic Map and Elevation Data Set Timeline



Topographic Maps and Elevation Data Sets

Date	Source	Project	Scale or Pixel	Data Type	Comment	Accuracy	RMSE	Digitized	Lake Level	MILESTONE	POSITION	245+-0.15	245.5+-0.15	246+-0.15	246.5+-0.15
01/01/1895	USGS	historical topo	1:62500	NA	accuracy of shoreline is unknown	80 Ft		yes	244.0	1895	10	Low			
01/01/1943	USGS	historical topo	1:24000	NA	used for accuracy assessment 1942 images	40 ft				1943	-20				
7/1/1948	NOAA	bathymetry - 244 lwd	NA	point file	xyz point file collection - shows inlet change, elevation est	unknown		NA	245.6	1948	15		B		
01/01/1958	USGS	historical topo	1:24000	NA	use for accuracy assessment 1957 images	40 ft				1958	10				
5/28/2001	USACOE	JALB	0.4 pt /m2	LiDAR TB	not as good as following lidar in 2007/2011	30 cm	30 cm	yes	245.8	2001	-15			C	
6/8/2007	USACE	JALB	0.4 pt /m2	LiDAR TB	pt dens not meaningful with bathy incl	20 cm	20 cm	yes	246.2	2007	15			C	
6/30/1905	Oswego Count	FEMA DCS Terrain	not determined	LiDAR topo	0.66 vertical accuracy/ 1.4 m spacing. Data access not prov	not reported	not reportec	no		2008	-10				
01/01/2010	USGS	historical topo	1:24000	NA		40 ft				2010	10				
7/2/2011	USACE	JALB	1.3 pt / m2	LiDAR TB	date range: 06/06 - 09/23 (date est Lake Level)	20 cm	20 cm	yes	246.9	2011	-10				High
01/01/2013	USGS	topo	1:24000	NA		40 ft				2013	20				
7/1/2015	FEMA	flood plain mapping	0.2 pt/m2?	LiDAR Topo	available on 'The National Map"	20 cm	20 cm	no		2015	10				

Updates since study completion

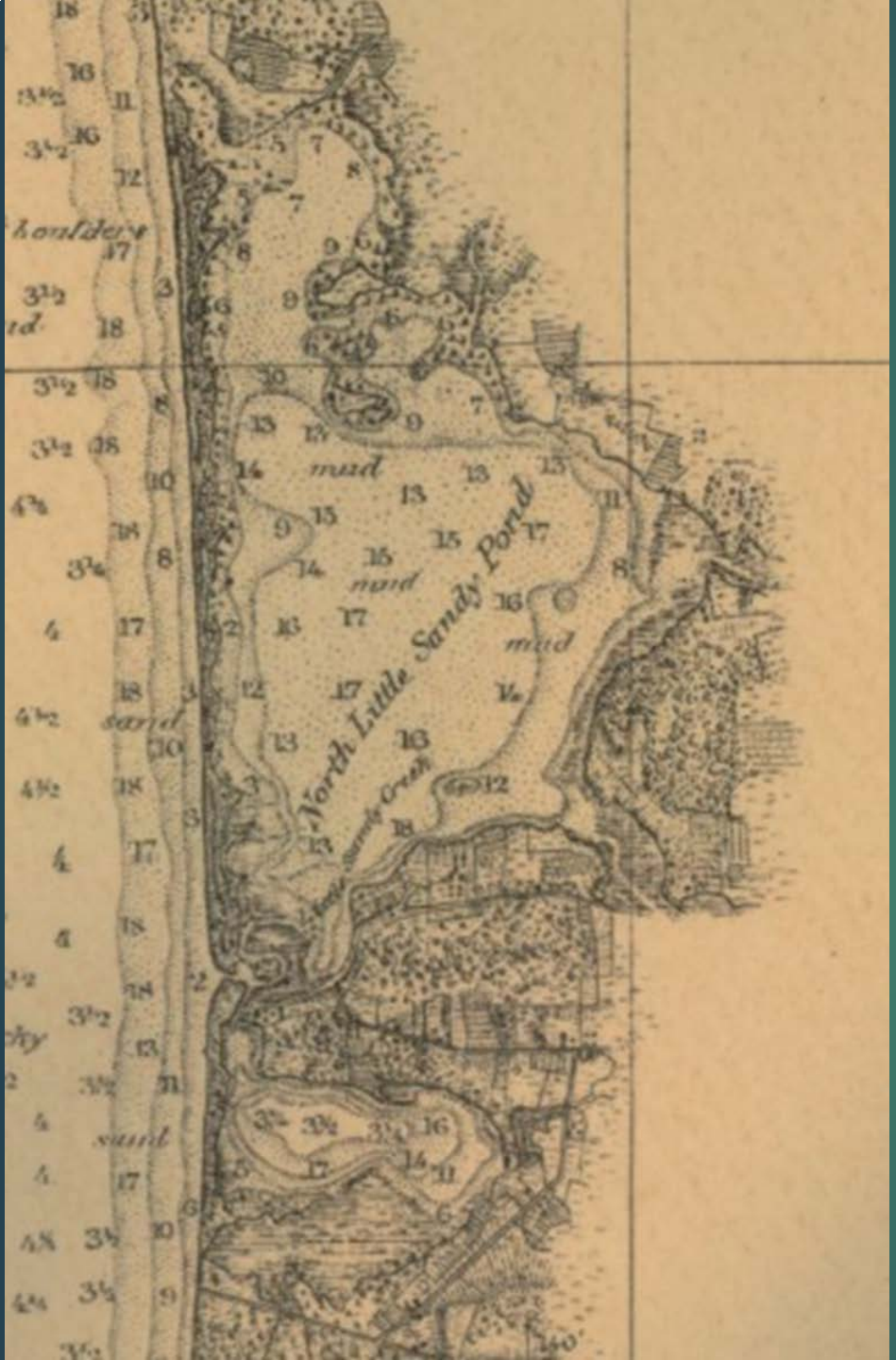
Topobathymetric LiDAR 2018

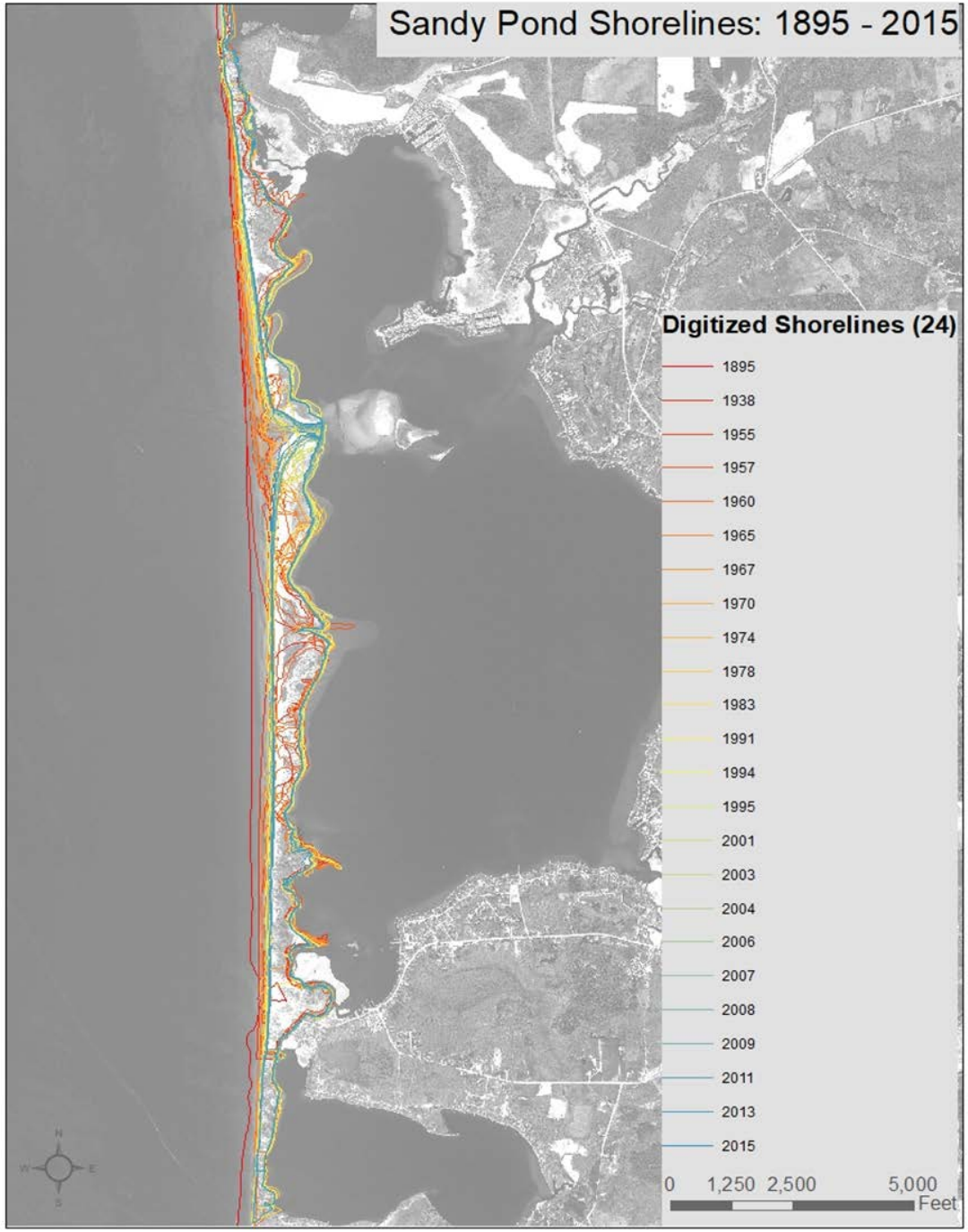
Orthoimagery:

- 2015(NYS)
- 2017(Google)
- 2018 (NAIP)
- 2019 (REDI Drone)

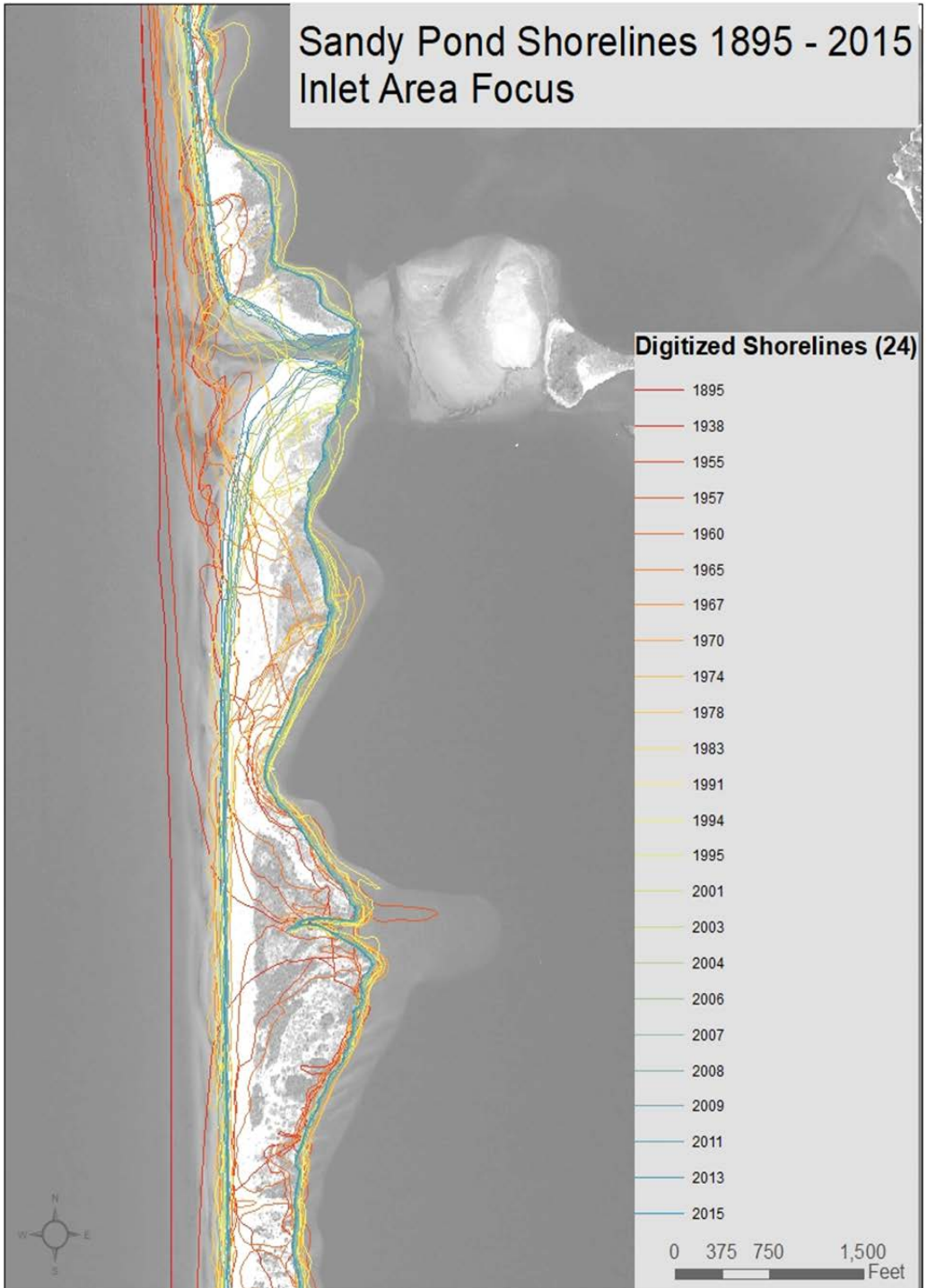
GPS derived shorelines: 2017 - 2019

1878 Survey Map





Of 30 digitized shorelines, 24 were selected for further analysis based on Lake elevation and quality



Digital Shoreline Analysis System USGS/Woods Hole

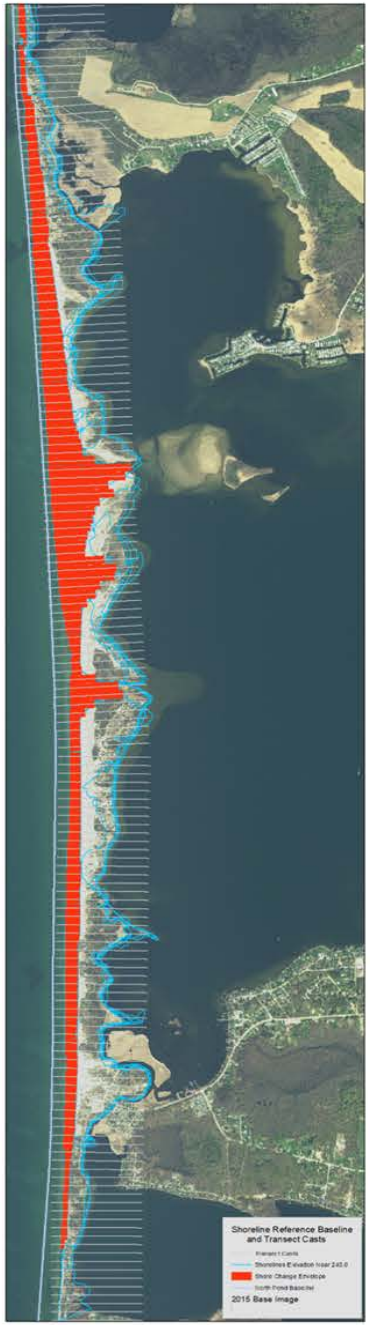
Comprehensive management of shoreline change information

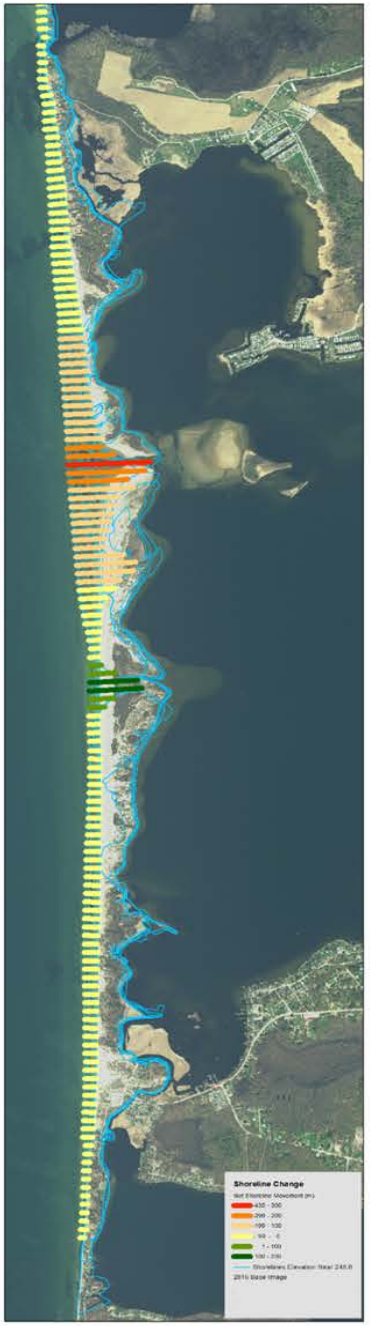
Automatic transect generation

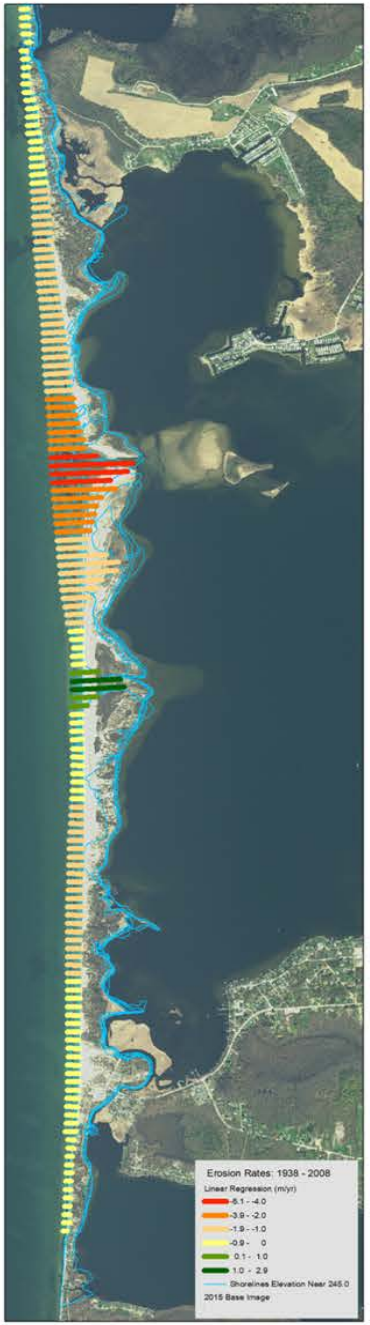
Distance measurements:
Shoreline change envelope
Net Shoreline Movement

Statistics:
End Point Rate
Least Regression Rate
Weighted Least Squares

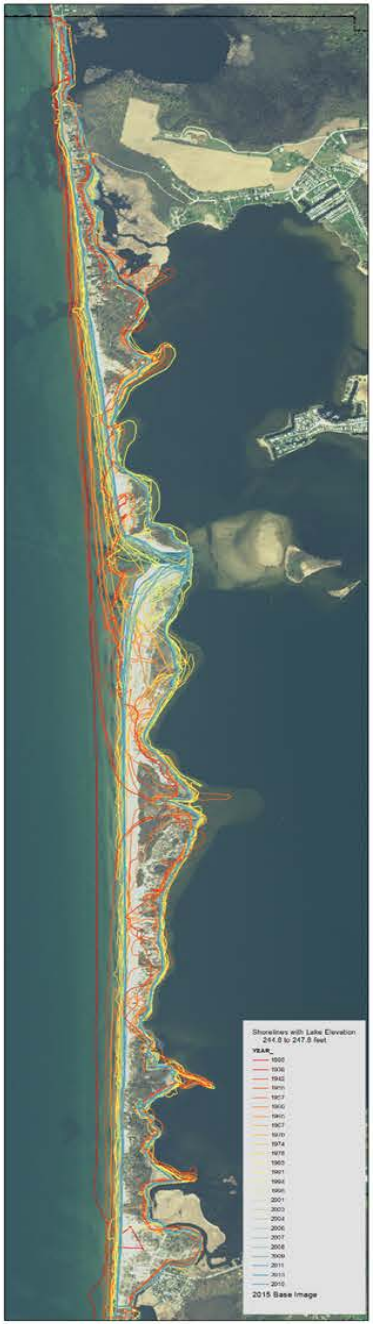
Plus confidence limits and forecasting

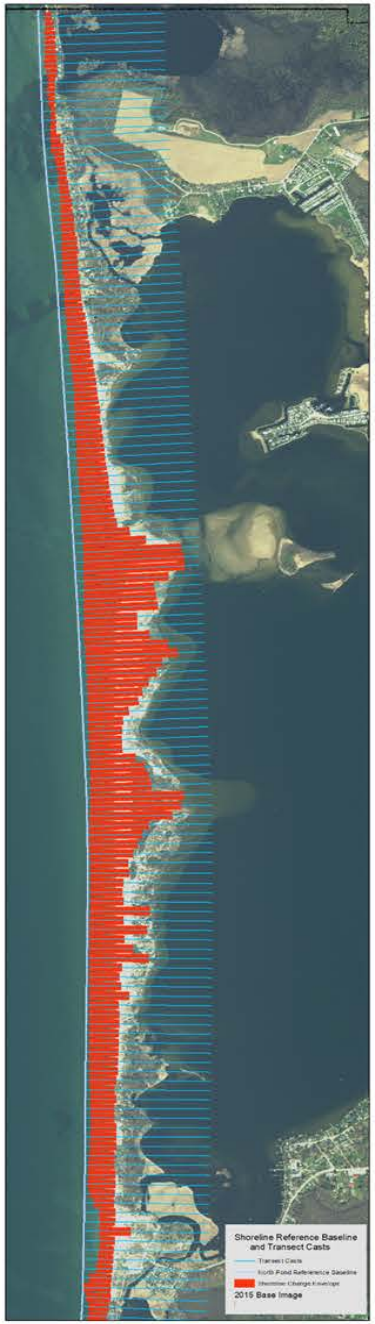


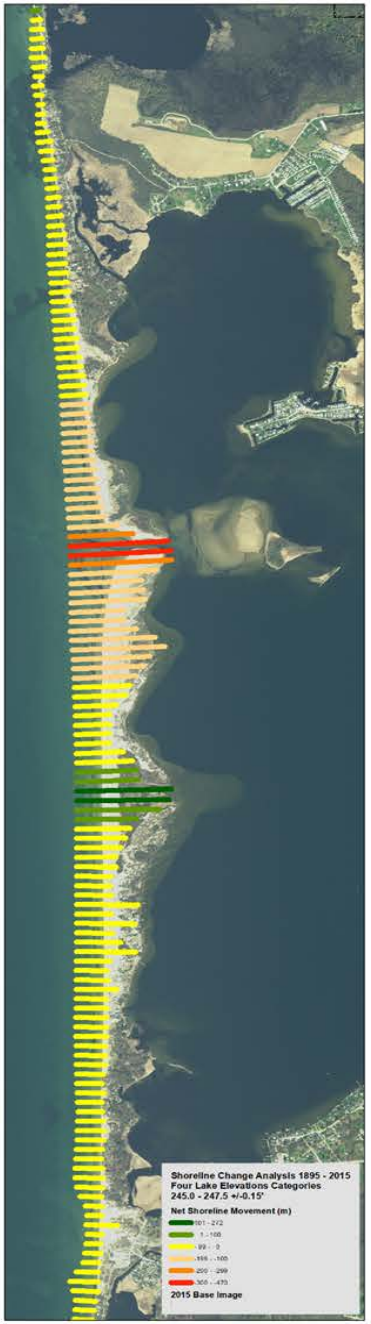


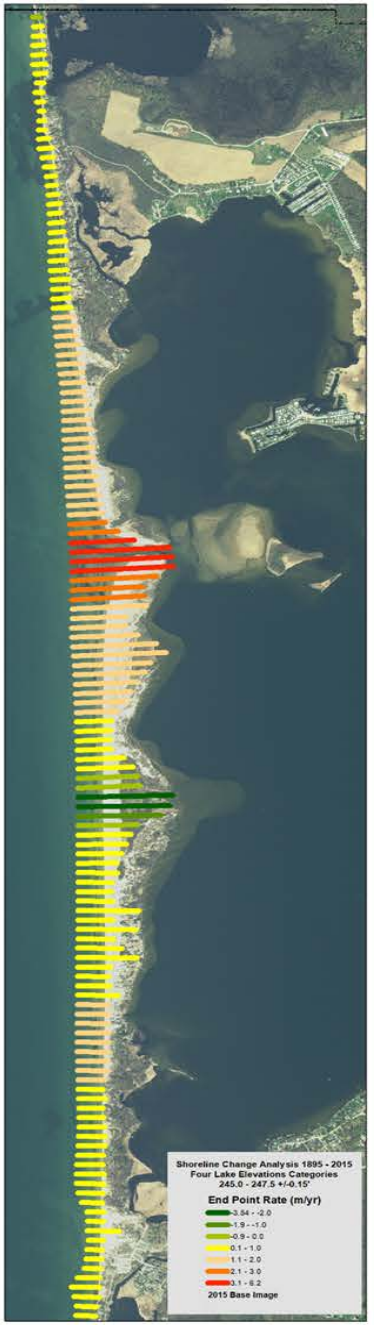


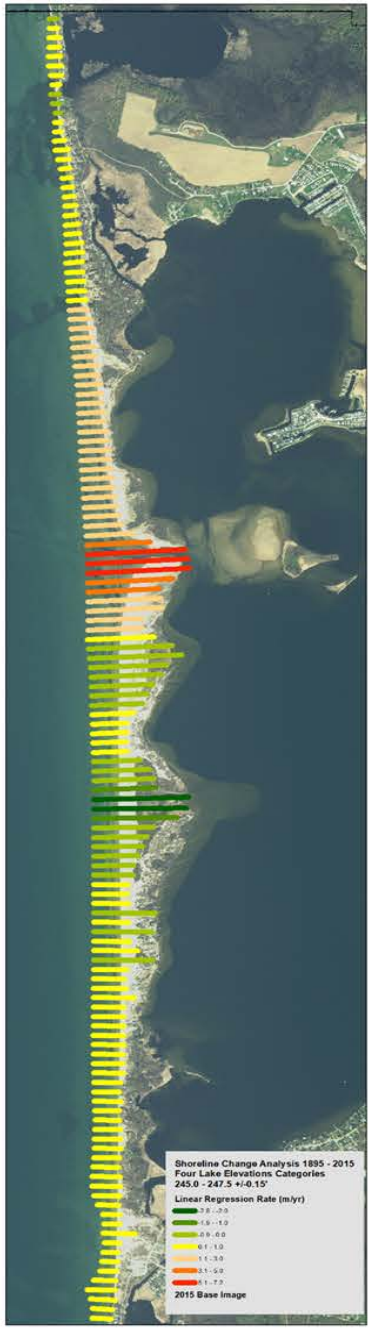
0 1,000 2,000 4,000 Feet



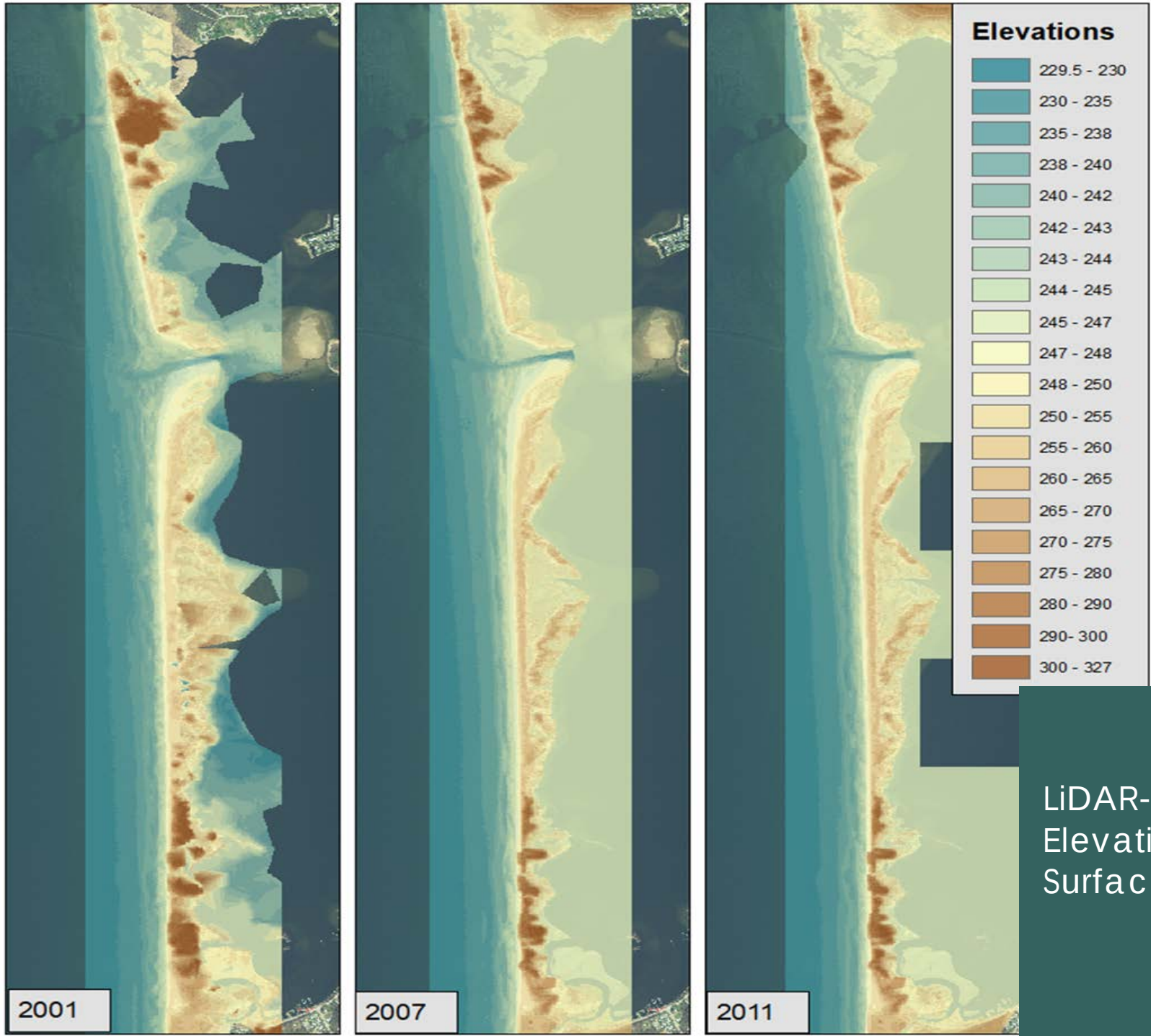




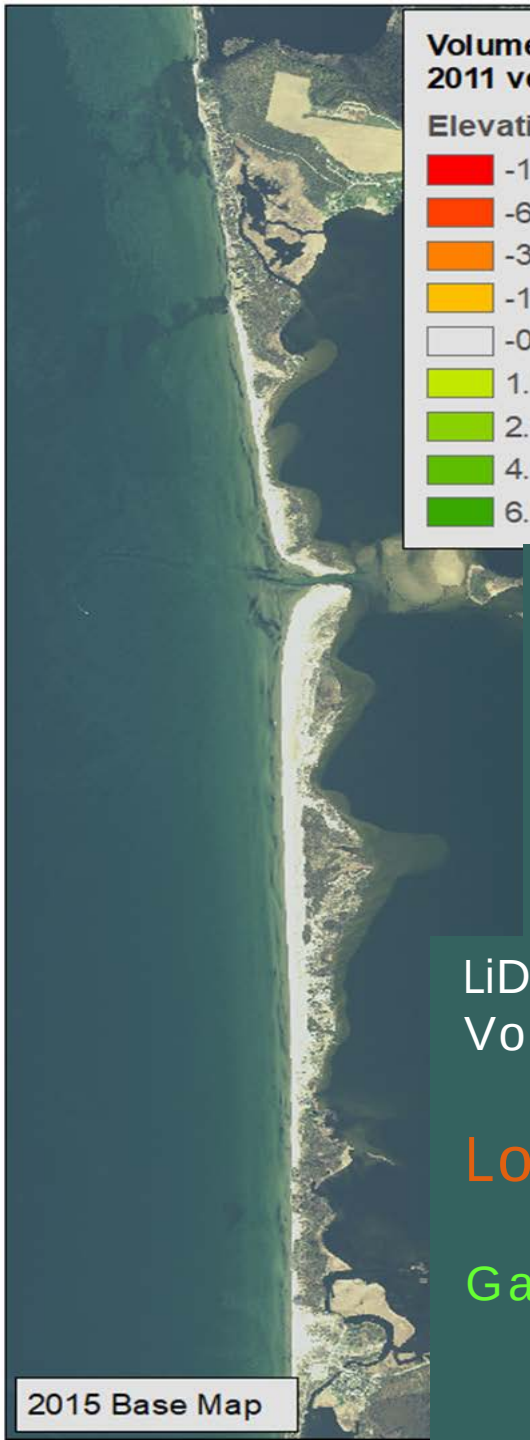




0 1,000 2,000 4,000 Feet



LiDAR-derived Elevation Surfaces



Volume Difference 2011 versus 2007

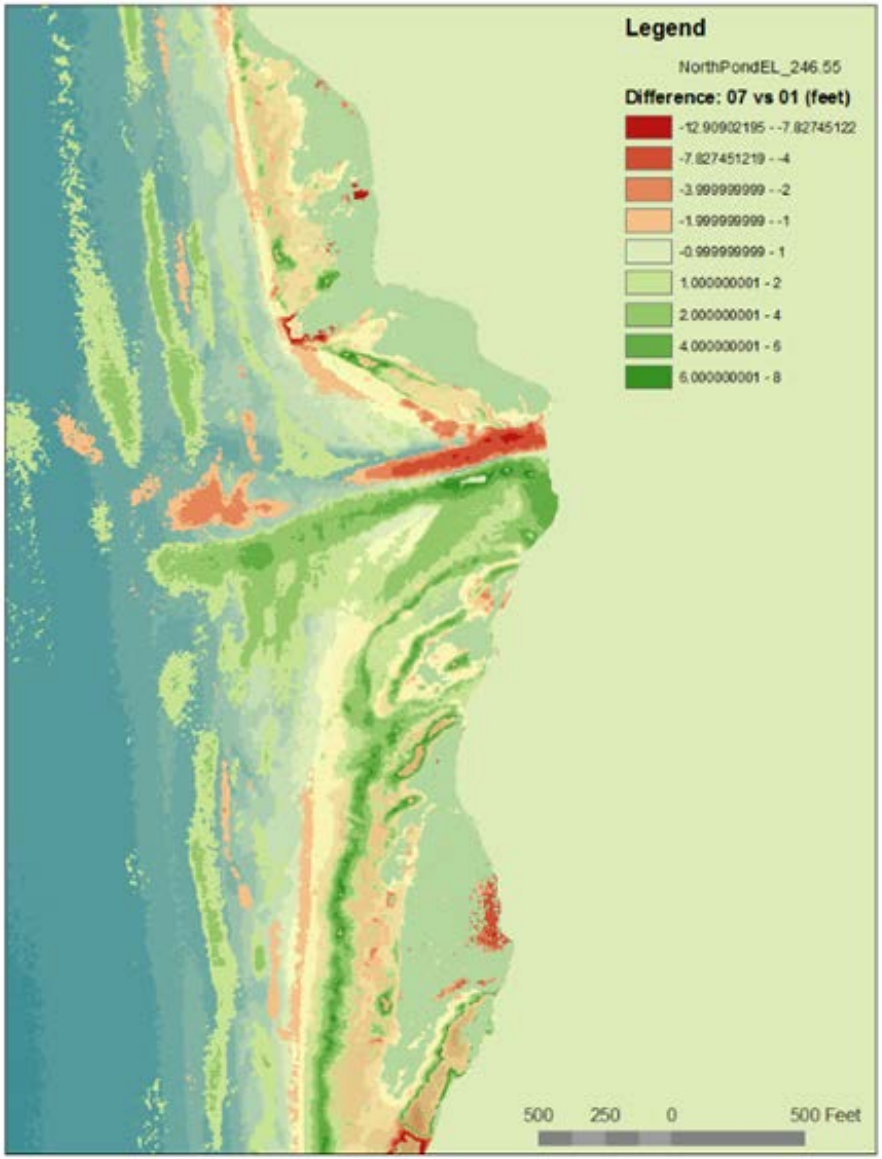
Elevation Change (ft)

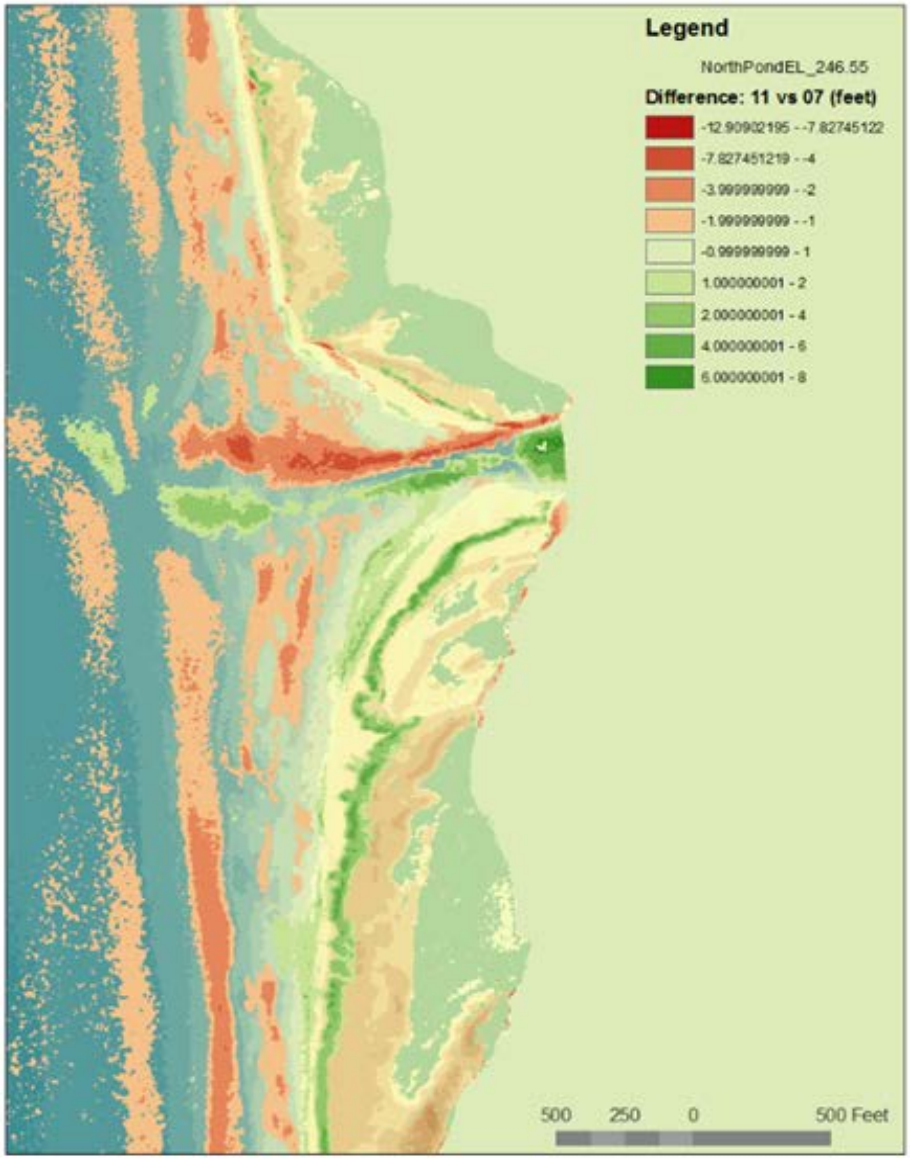
- -12.9 - -7
- -6.9 - -4
- -3.9 - -2
- -1.9 - -1
- -0.9 - 1
- 1.1 - 2
- 2.1 - 4
- 4.1 - 6
- 6.1 - 8

LiDAR-derived Volumetric Change

Loss

Gain





2001 vs 2007

LiDAR-derived
Volumetric Change

Loss Gain

2007 vs 2011


LiDAR-derived
Volumetric measurements
Cut and Fill estimates
Loss Gain

Inlet formation:

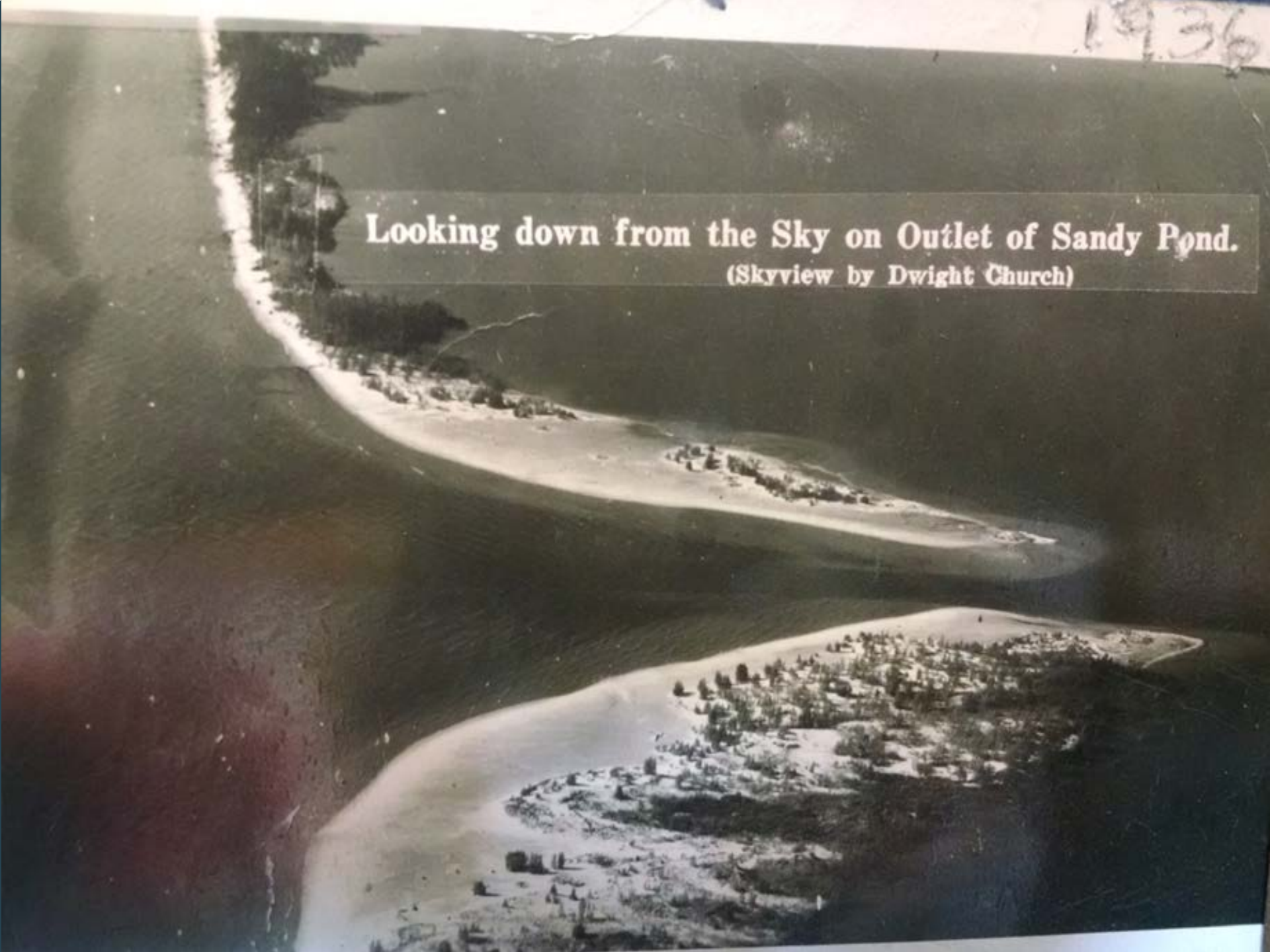
Major inlets

1895
1929
1955
1978

Minor Features

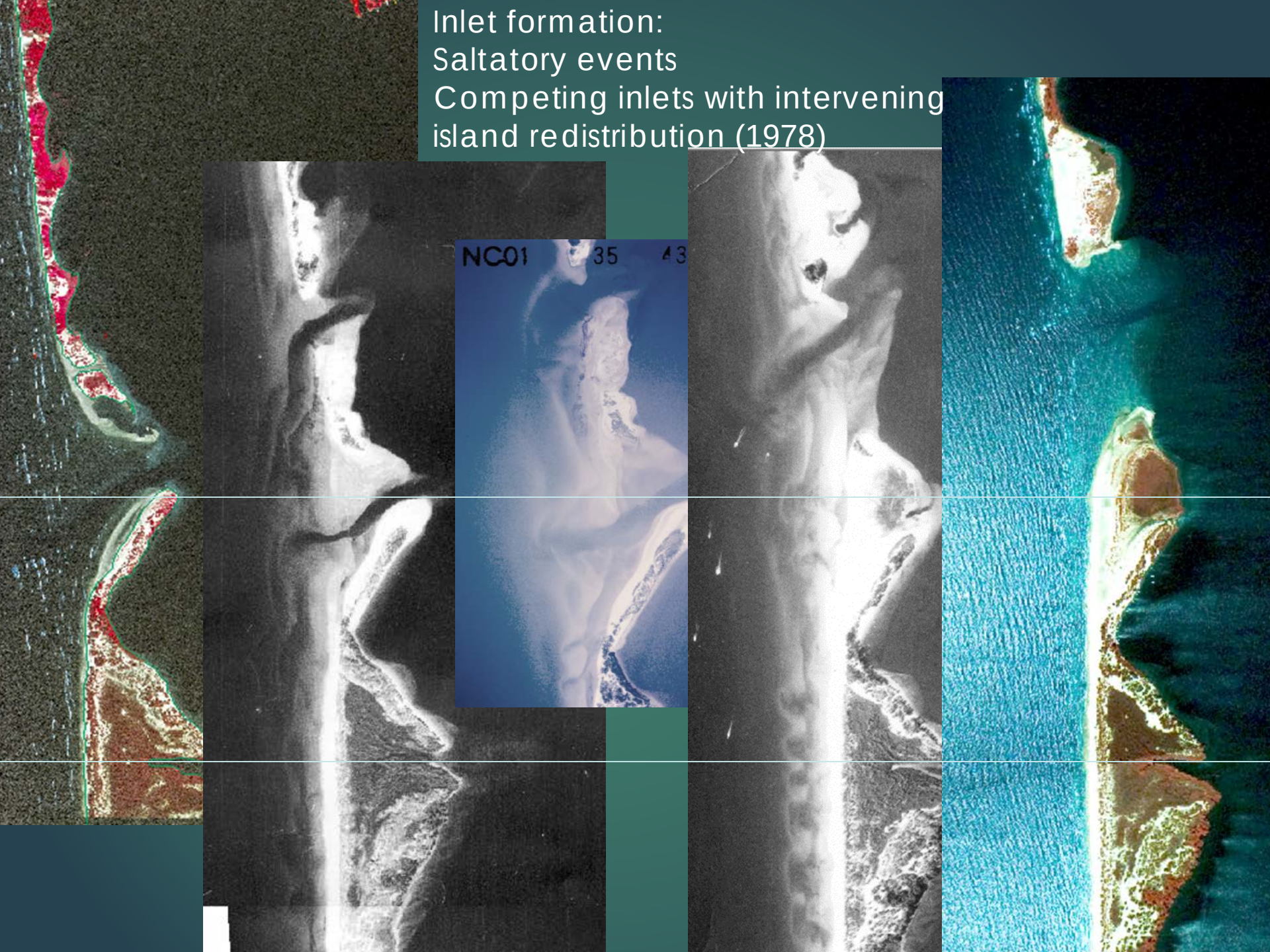
23 separate inlets and overwashes

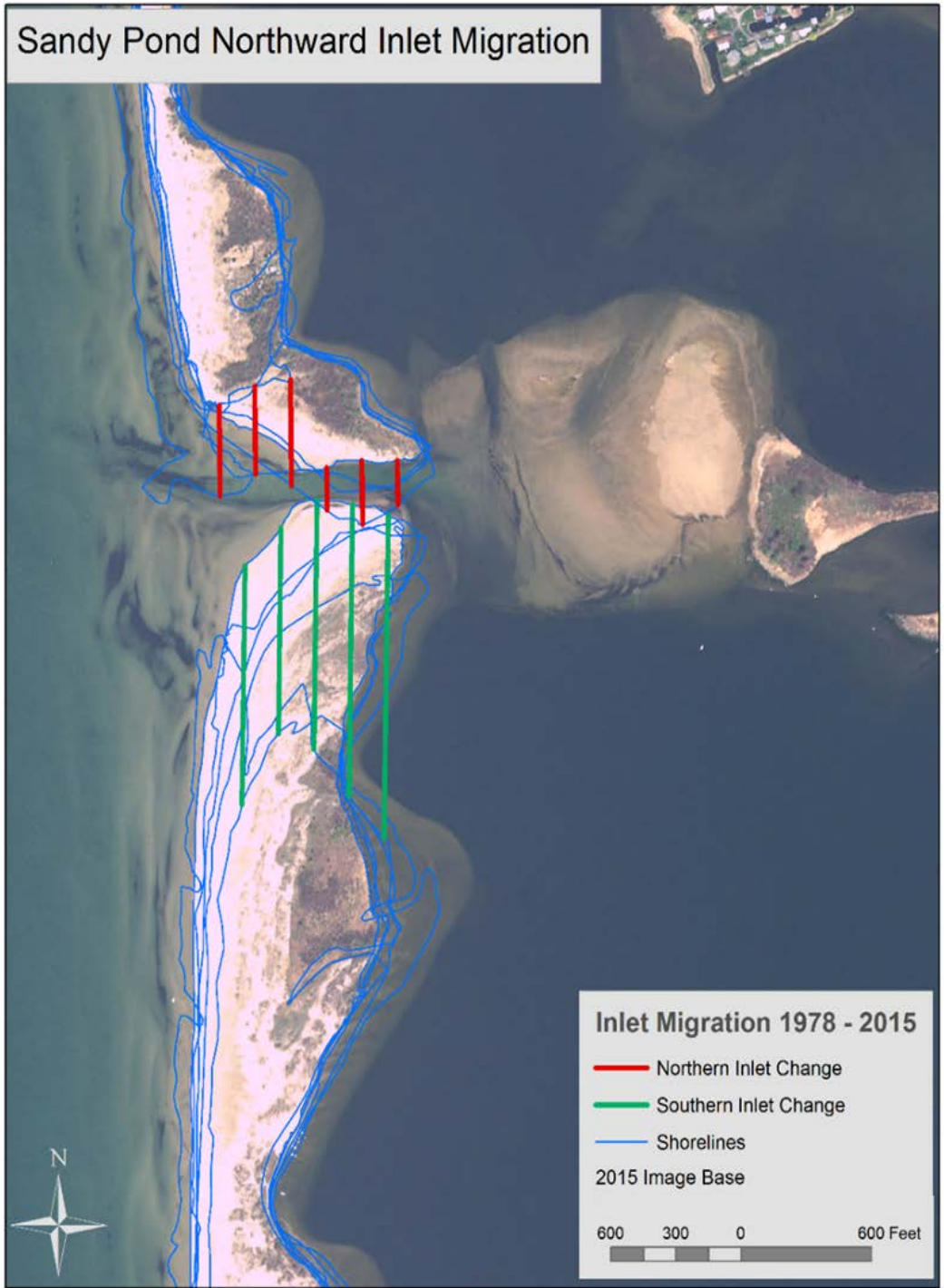
1936



Looking down from the Sky on Outlet of Sandy Pond.
(Skyview by Dwight Church)

Inlet formation:
Saltatory events
Competing inlets with intervening island redistribution (1978)





1978 Inlet Analysis

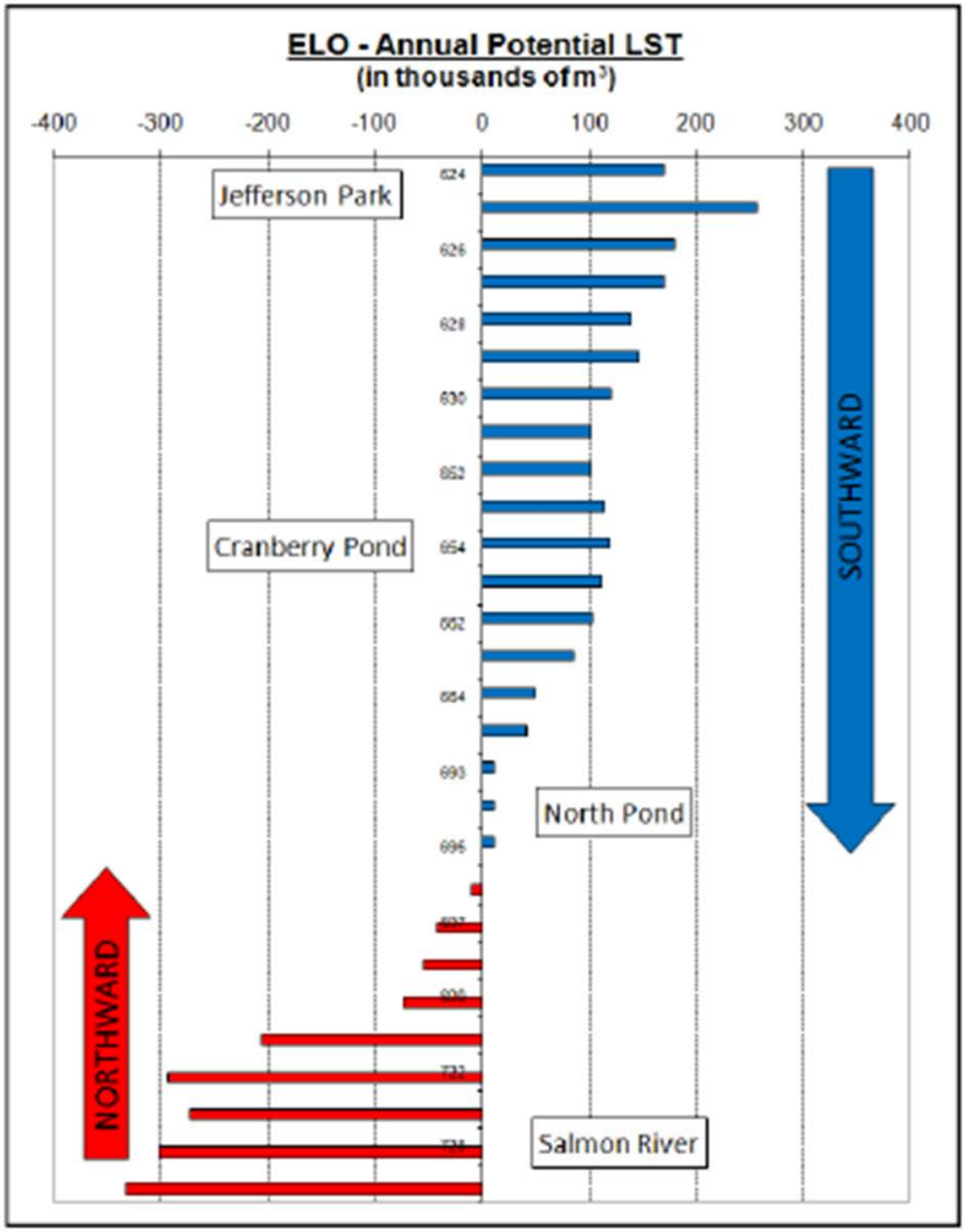
Current inlet

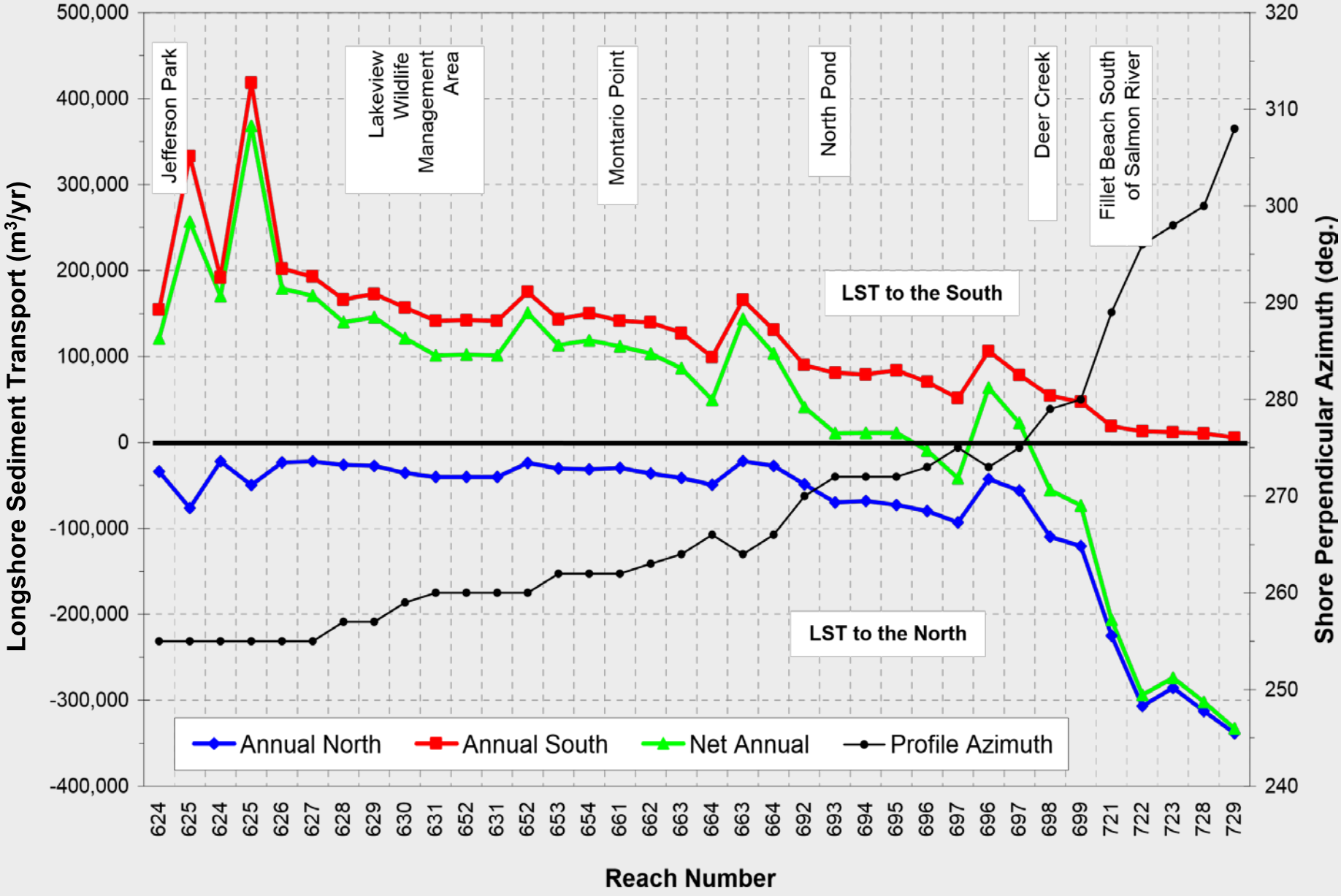
Processes differ from prior inlets

Northward migration

Formation of pond shoal

First inlet with dredging


ELO - Annual Potential LST
(in thousands of m³)
-400
-300
-200
-100
0
100
200
300
400
Jefferson Park
Cranberry Pond
North Pond
Salmon River
SOUTHWARD
NORTHWARD


Jefferson Park
Lakeview Wildlife Management Area
Montario Point
North Pond
Deer Creek
Fillet Beach South of Salmon River
LST to the South
LST to the North
Annual North
Annual South
Net Annual
Profile Azimuth
Longshore Sediment Transport (m³/yr)
Shore Perpendicular Azimuth (deg.)
Reach Number
500,000
400,000
300,000
200,000
100,000
0
-100,000
-200,000
-300,000
-400,000
320
310
300
290
280
270
260
250
240
624
625
624
625
626
627
628
629
630
631
652
631
652
653
654
661
662
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699
721
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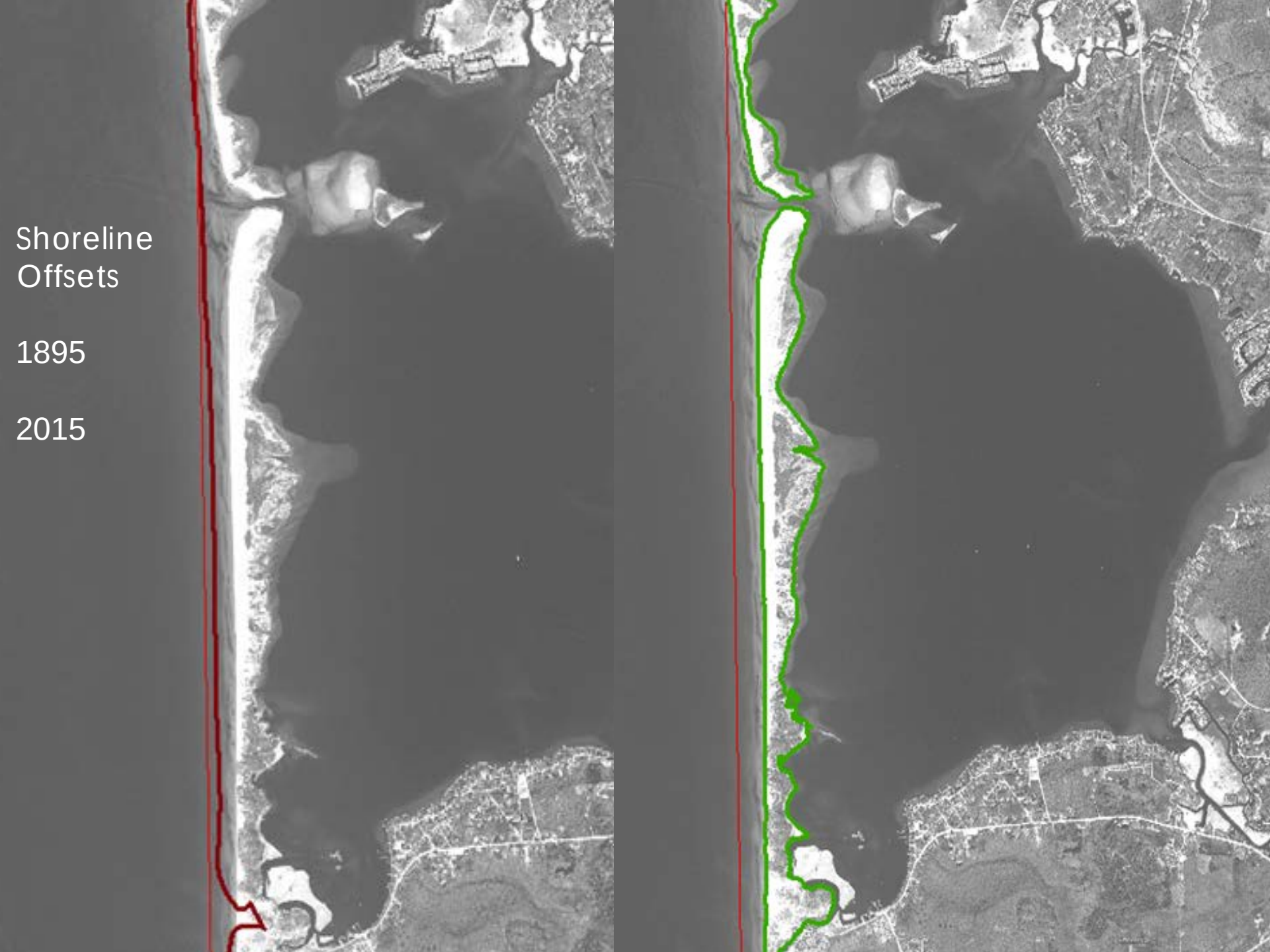
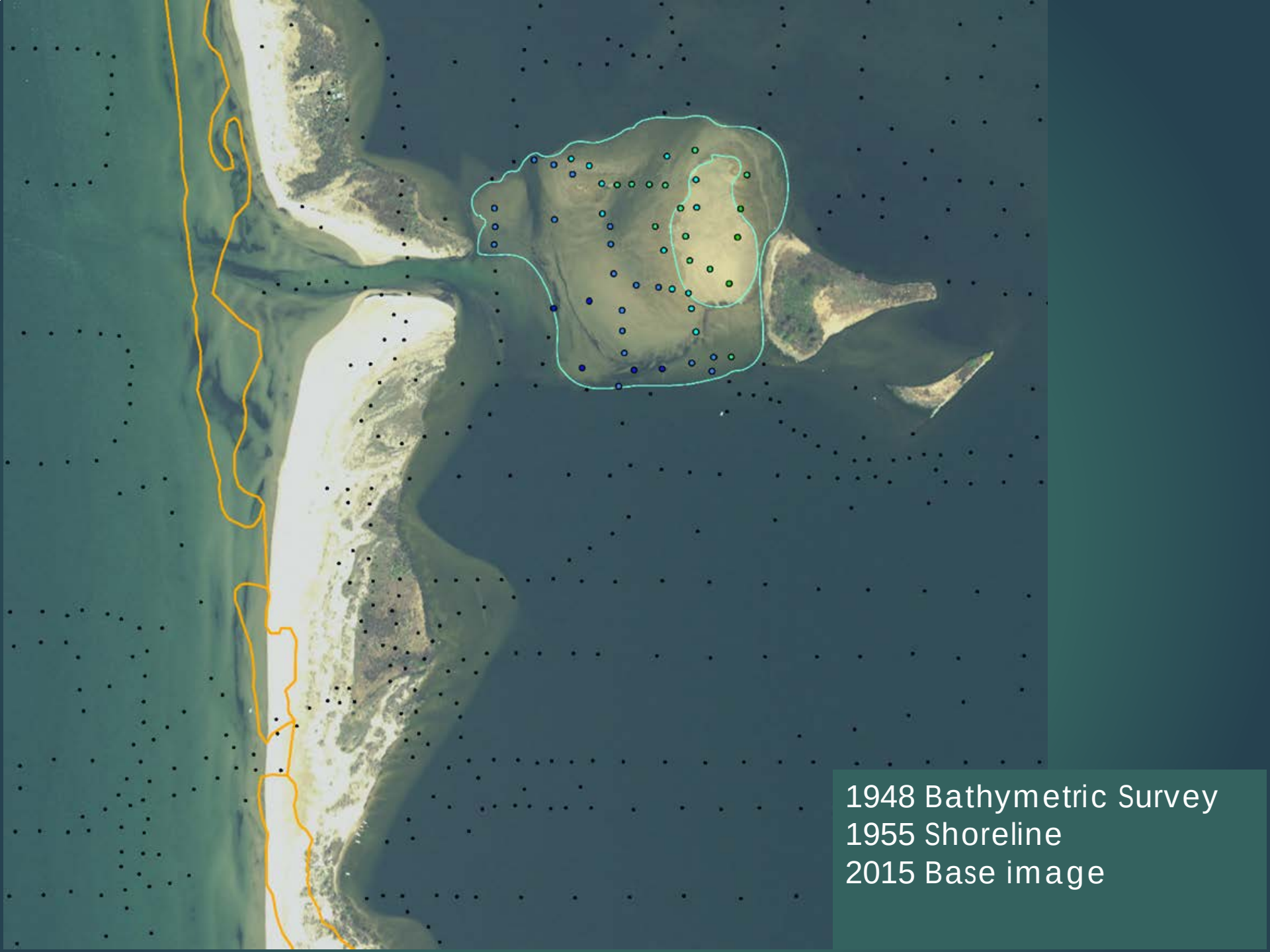
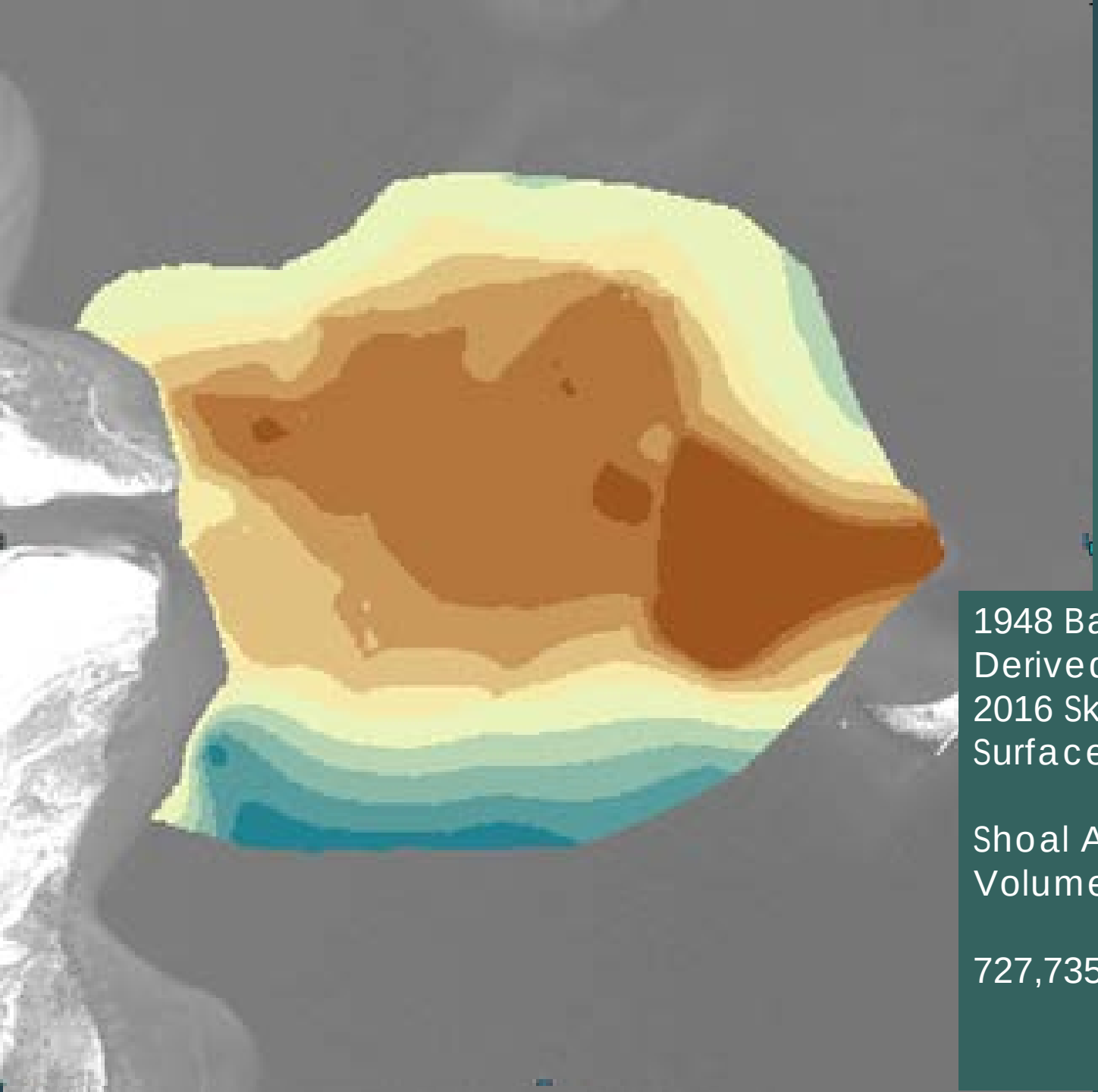
729


Shoreline
Offsets
1895
2015


1948 Bathymetric Survey
1955 Shoreline
2015 Base image



1948 Bathymetric Survey
Derived surface
2016 Skidmore GPS
Surface

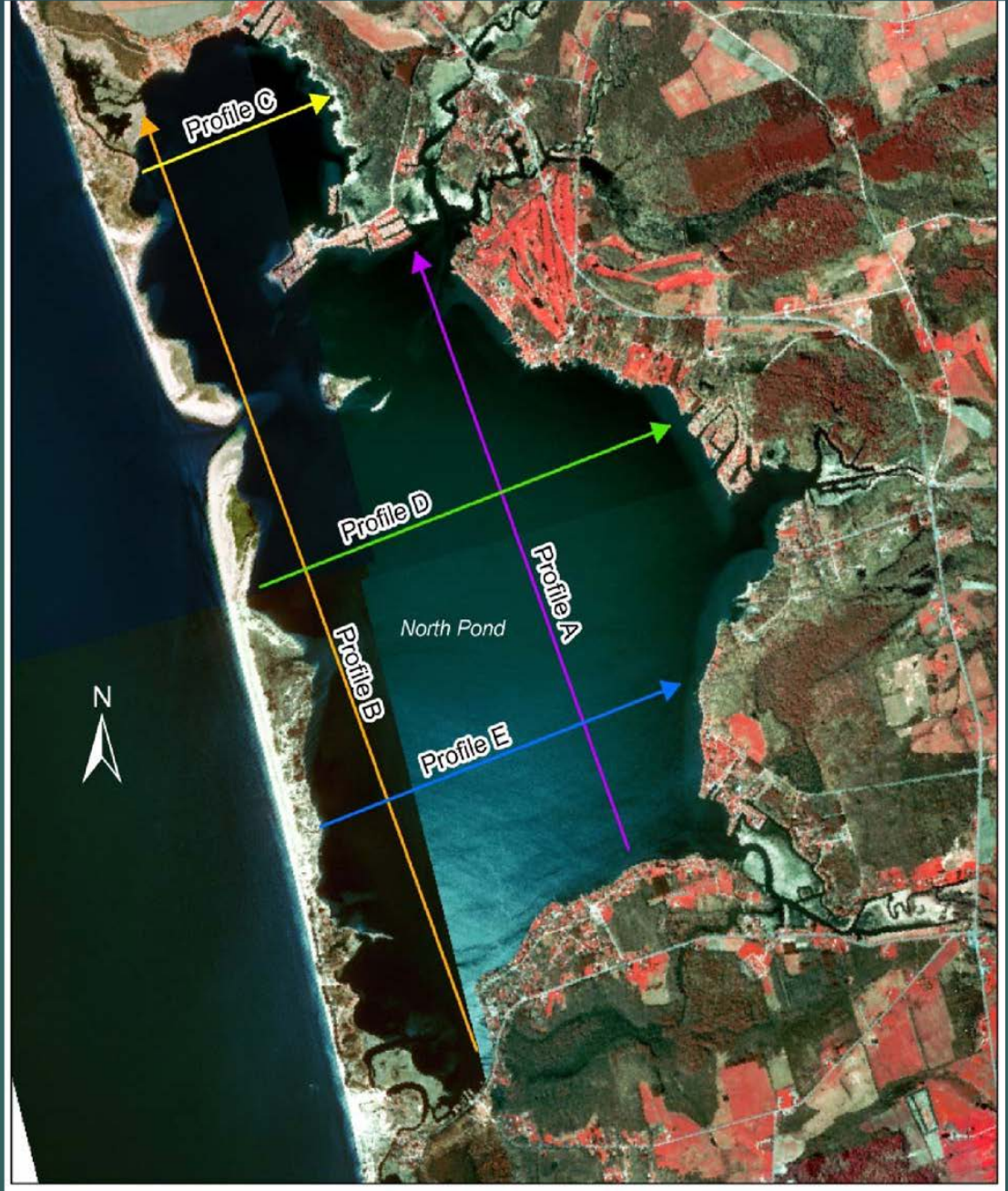
Shoal Accumulation
Volume from 1978 to 2016

727,735 cubic yards

1948 Bathymetric Survey
2001 USACE JABL LiDAR
2016 Skidmore GPS

80 percent deposited in 23 years

20 percent in later 15 years.



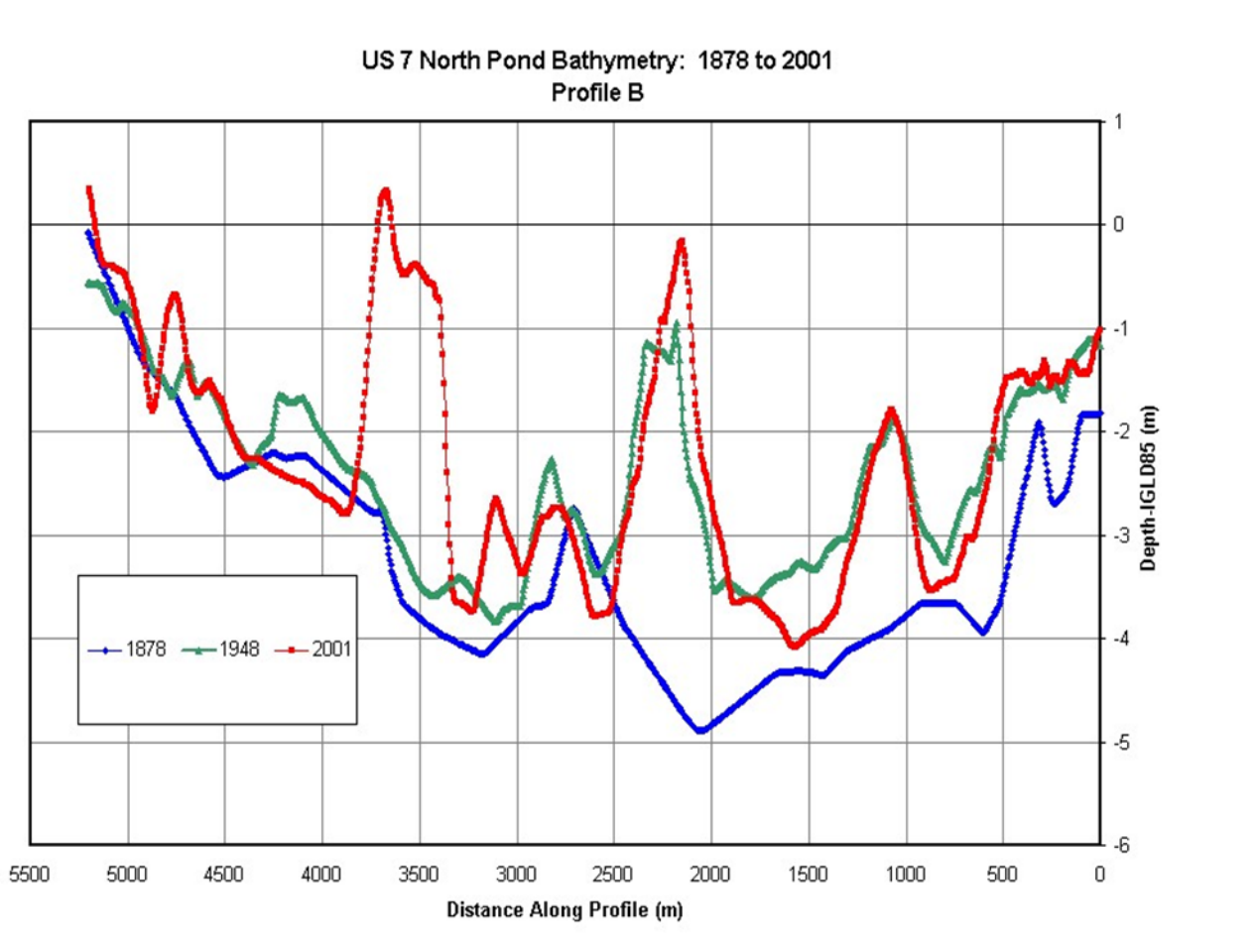
US7 North Pond Profile Locations

1878-1948-2001 Bathymetry

0 0.5 1 2 km

NB: Arrowheads on profiles indicate the direction in which the profile was taken.
For example, profile 'A' was taken in a south to north direction.

Baird

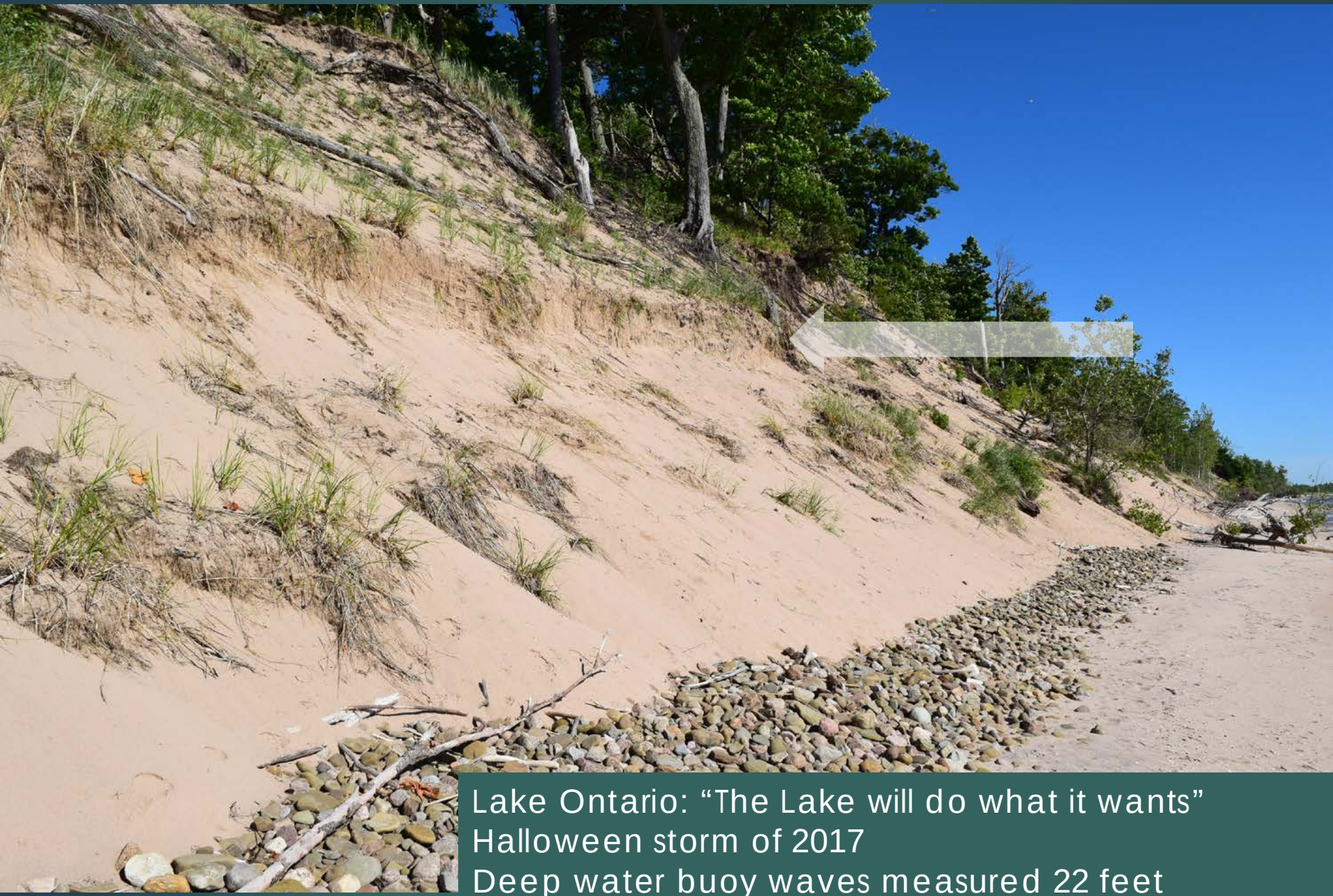

US 7 North Pond Bathymetry: 1878 to 2001
Profile B
1878
1948
2001
1
0
-1
-2
-3
-4
-5
-6
Depth-IGLD85 (m)
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Distance Along Profile (m)

Estimated deposition of the 1938 (759,000 cy) and 1955 (327,000 cy) filled inlets combined with the estimated volume of the Inlet Shoal (728,000 cy) account for 1.8 million cy of sand (inlet fill volumes were calculated in Mattheus; Inlet Shoal volume was calculated for this Project).

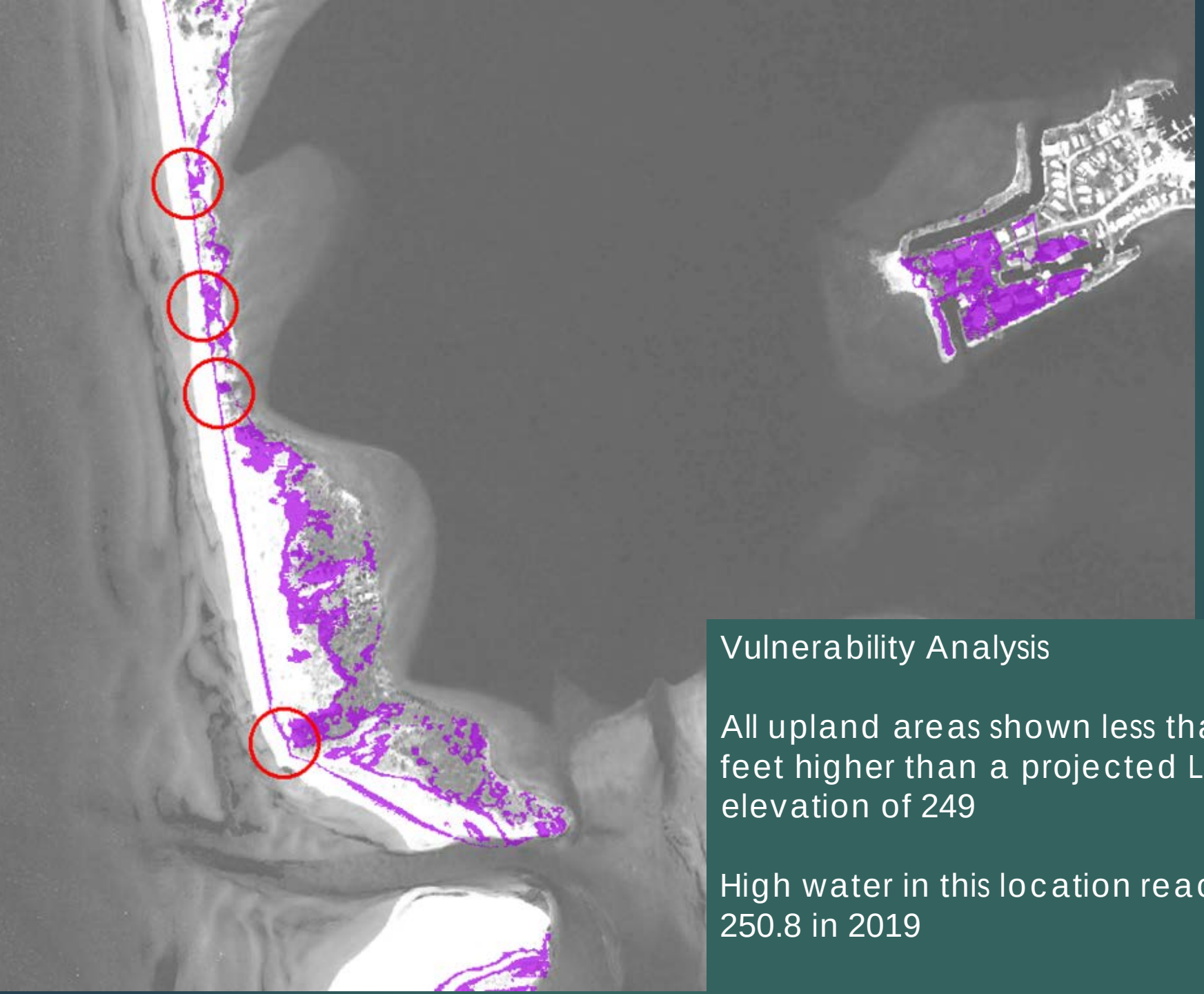
Subsequent dune growth, barrier widening, and development of the recurved spits at the current inlet have increased this volume, probably substantially.

Even with increased sediment availability from the off-shore sand plain due to glacial rebound as suggested by Baird, the inlet is likely to continue to act as a sand sink.

To appreciate the amount of sand lost from the beach and nearshore area over this period, it is useful to visualize that a container four yards deep, 100 yards wide and almost three miles long would be needed to contain the two million cubic yards of sand deposited in shoals, the inlet, and on the barrier.



Lake Ontario: “The Lake will do what it wants”
Halloween storm of 2017
Deep water buoy waves measured 22 feet
Onshore wave height estimates are 17 feet

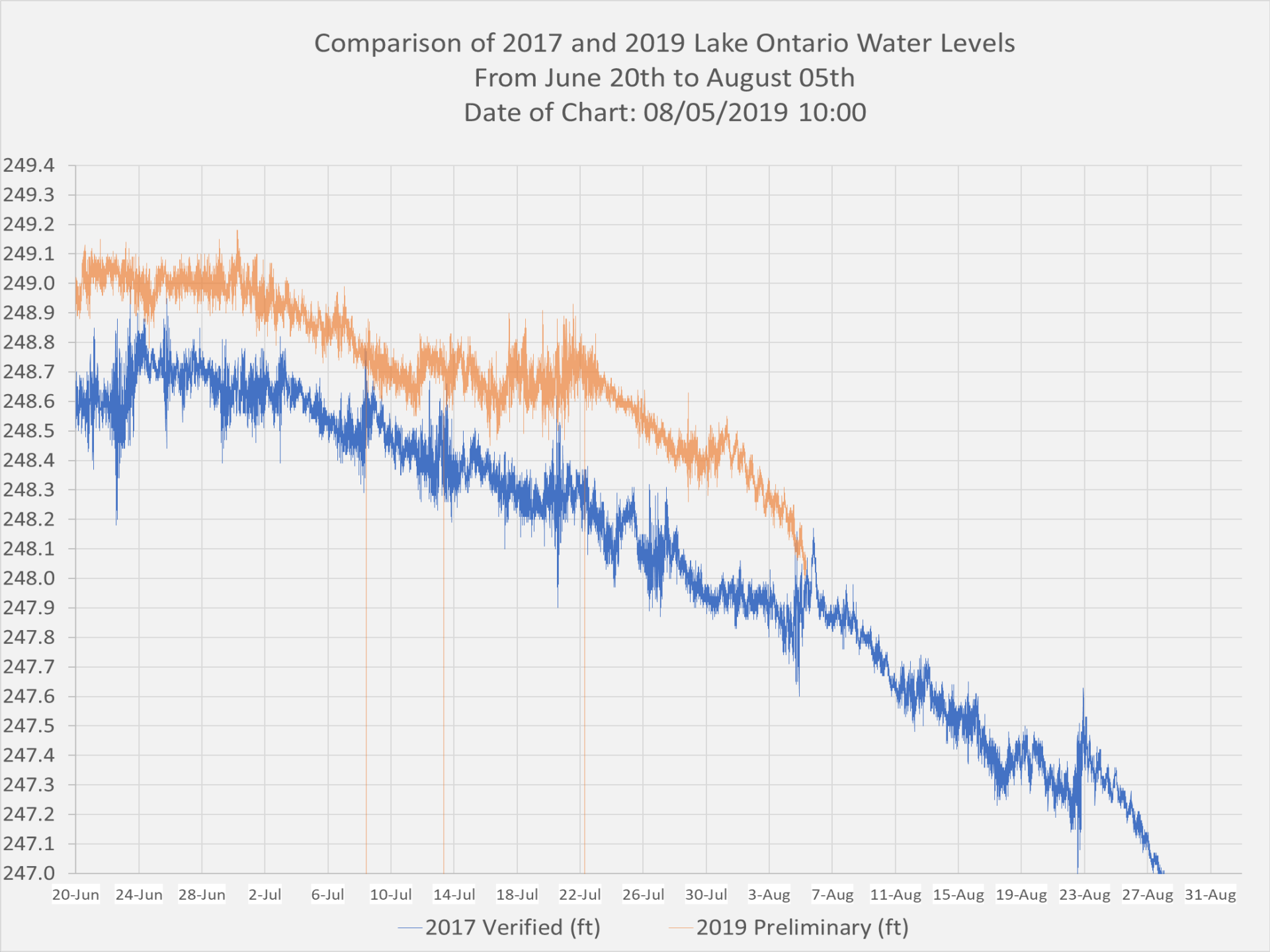


Vulnerability Analysis

All upland areas shown less than 2 feet higher than a projected Lake elevation of 249

High water in this location reached 250.8 in 2019

2019


Comparison of 2017 and 2019 Lake Ontario Water Levels
From June 20th to August 05th
Date of Chart: 08/05/2019 10:00
249.4
249.3
249.2
249.1
249.0
248.9
248.8
248.7
248.6
248.5
248.4
248.3
248.2
248.1
248.0
247.9
247.8
247.7
247.6
247.5
247.4
247.3
247.2
247.1
247.0
20-Jun
24-Jun
28-Jun
2-Jul
6-Jul
10-Jul
14-Jul
18-Jul
22-Jul
26-Jul
30-Jul
3-Aug
7-Aug
11-Aug
15-Aug
19-Aug
23-Aug
27-Aug
31-Aug
2017 Verified (ft)
2019 Preliminary (ft)


2018


June 2019


July 2019

September 2019


PRIVATE
PROPERTY
NO TRESPASSING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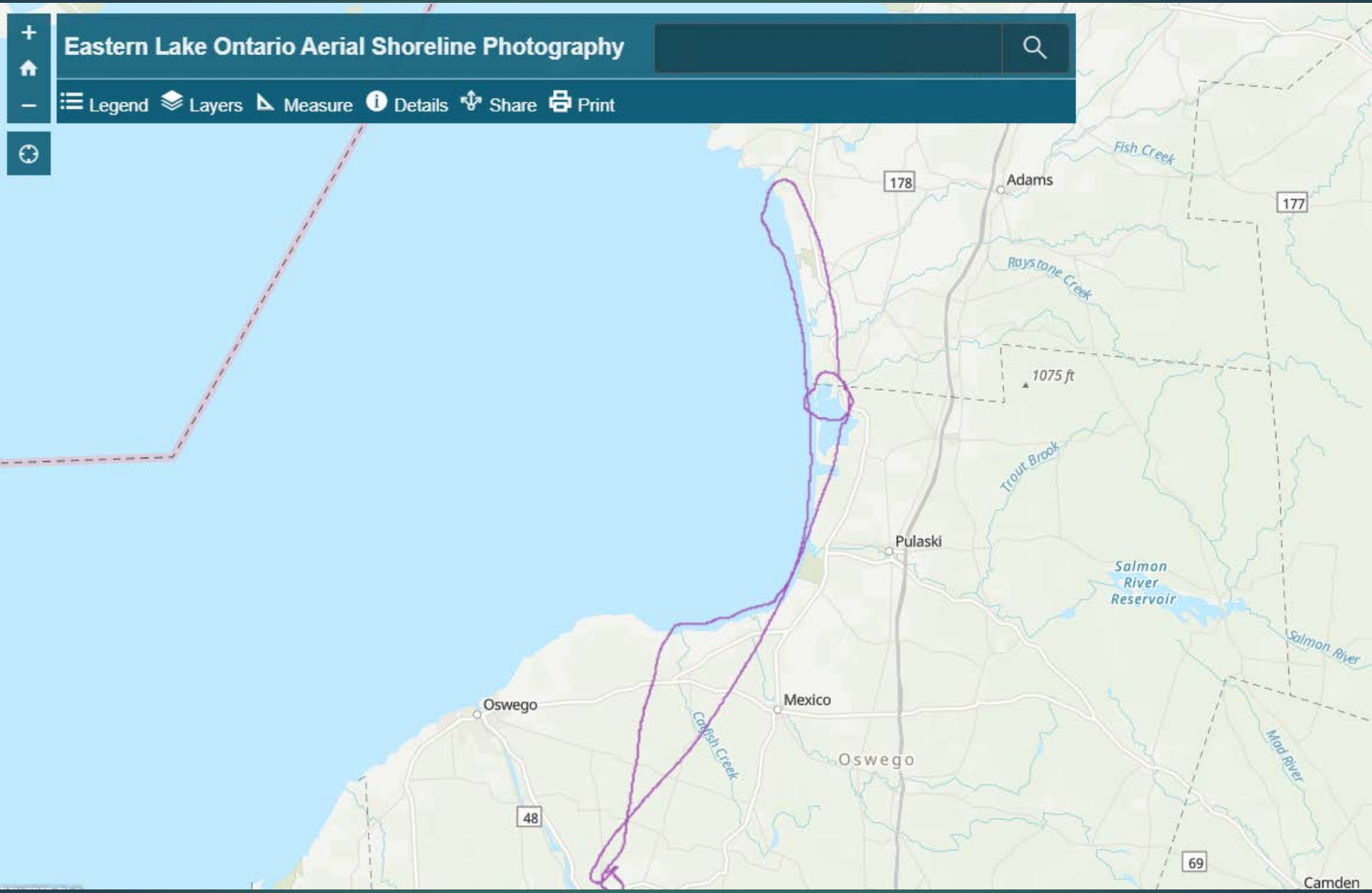

Eastern Lake Ontario Aerial Shoreline Photography
Legend
Layers
Measure
Details
Share
Print
178
Adams
177
Fish Creek
Roystone Creek
1075 ft
Trout Brook
Pulaski
Salmon River Reservoir
Salmon River
Oswego
Mexico
Catfish Creek
Oswego
Mad River
48
69
Camden

Eastern Lake Ontario Aerial Shoreline Photography

Legend Layers Measure Details Share Print

(1 of 2)

Sandy Pond Photo Point

Link to photo: More info

Zoom to

Renshaw Bay

318 ft

Carter Rd

Henderson Rd

Weaver Rd

Scott Rd

The Elms

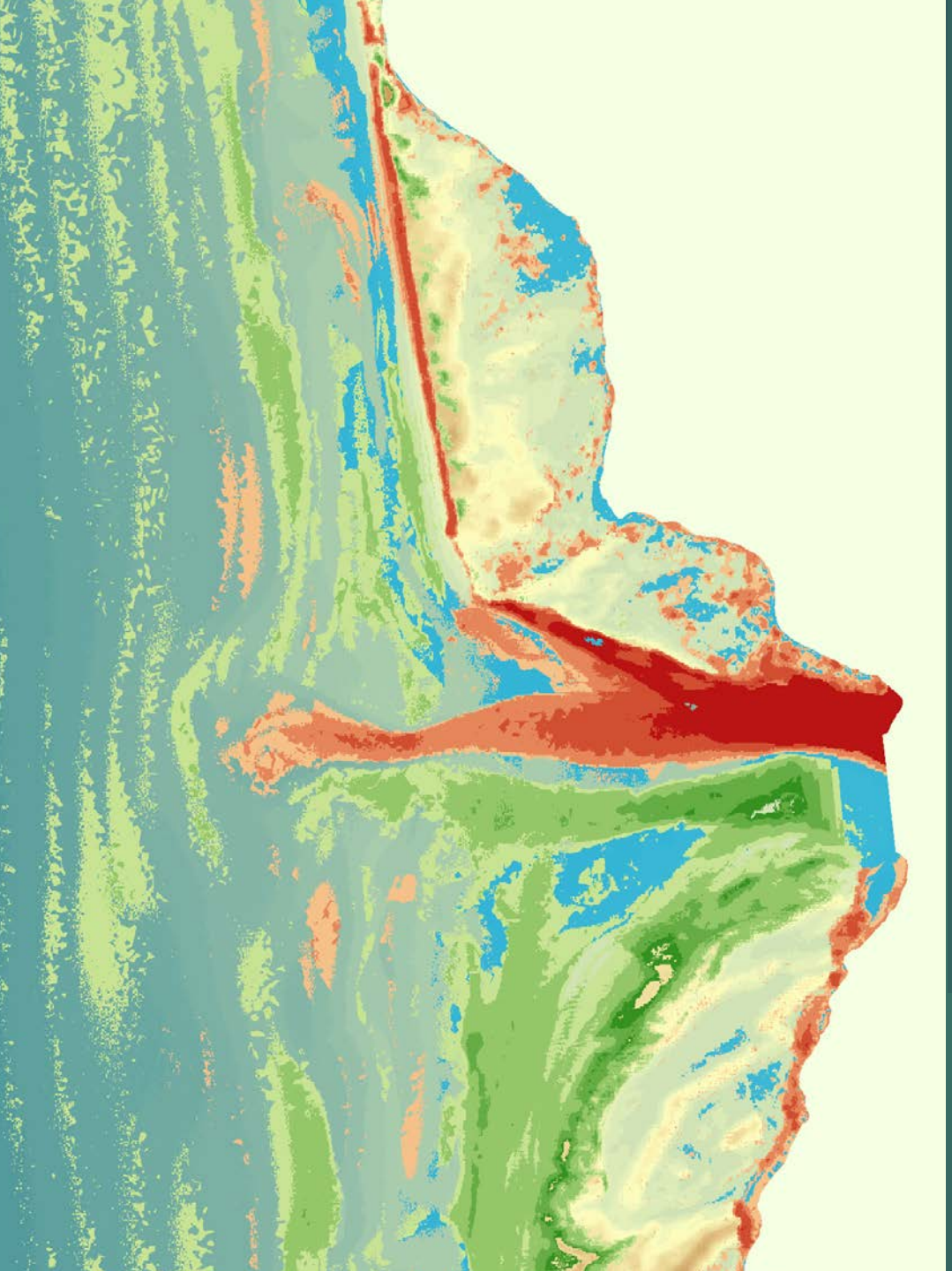
Elms Golf Club

Elms Rd

Stanley Dr

Groman Dr

County Route 121



Inlet Change Dynamics

2001 DEM
nearshore between 245 and OHW

2007

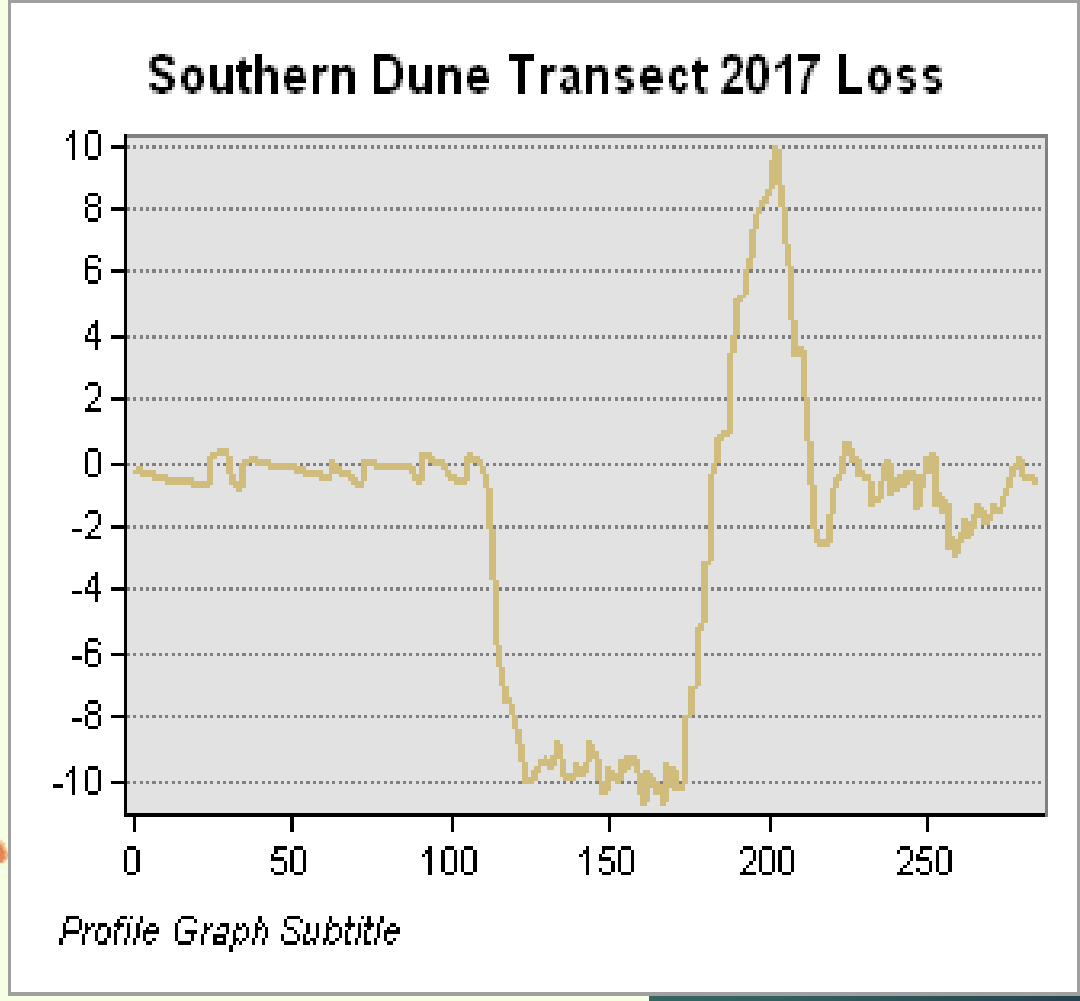
2007 vs 2001 Change

2011

2011 vs 2007 Change

2018

2018 vs 2011 Change



2019 Losses

As of 18 September 2019, an additional 3 – 8 feet of vertical loss occurred along the three transects shown when compared to the 2018 DEM. Fall storms would add losses.

Recommendations from 2017 Plan

Included a process for developing inlet management strategies

Led by TNC, the process considered several alternatives:

- Allow natural processes to proceed, including inlet formation
- Continue to maintain channel with sand placed to the south
- Restore north barrier resiliency using nature-based shoreline design
- Harden shorelines and channel against change

Nature-based shoreline restoration strategy adopted

- Town of Sandy Creek funded under NYS DEC EPF
- $320,000 plus local match of $140,000
- Designed to address 2017 losses
  - Proposed Hydraulic Dredging to by-pass sand from
    - channel area
    - Shoal
  - 18,000 cubic yards of sand to be used to
    - Restore dune and beach over wash areas
    - ~800 feet of shoreline
- Scheduled for October 2019
- Proposed for expansion under REDI to address additional 2019 losses
  - Volume increase to 30,000 cubic yards
  - Add funds to cover 4,000 feet of shoreline

Sandy Pond Resiliency Project

A project by the Town of Sandy Creek, New York

Acknowledgments

Eastern Lake Ontario Dune Coalition and its member agencies, organizations, and individuals.

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Geoffrey Steadman, photography and 2017 report co-author. Storm photo by N. Stowell.

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Marie Rosenblatt, for missing some of the fun things we would be doing if not for this.