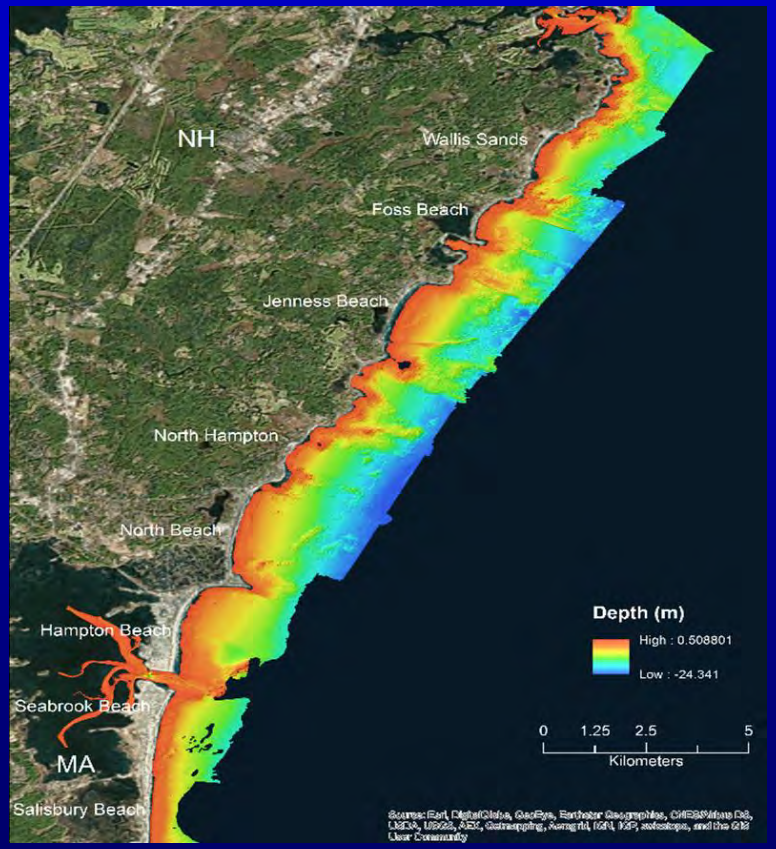
Assessing the Stability of New Hampshire Beaches: A Study Involving the University of New Hampshire, NH State Agencies and Citizen Scientists



Larry Ward, Rachel Morrison, and Zachary McAvoy

(UNH Center for Coastal and Ocean Mapping)

Alyson Eberhardt and Wellsley Costello

(New Hampshire Sea Grant and UNH Cooperative Extension)

Frederick Chormann

(New Hampshire Geological Survey)

Christian Williams

(New Hampshire Coastal Program)

NOAA National Oceanic and Atmospheric Administration, U.S. Department of Commerce

BOEM Bureau of Ocean Energy Management

NH

New Hampshire Geological Survey 1839 2001

CCOM JHC Center for Coastal & Ocean Mapping / Joint Hydrographic Center, University of New Hampshire

New Hampshire Coastal Program, Department of Environmental Services

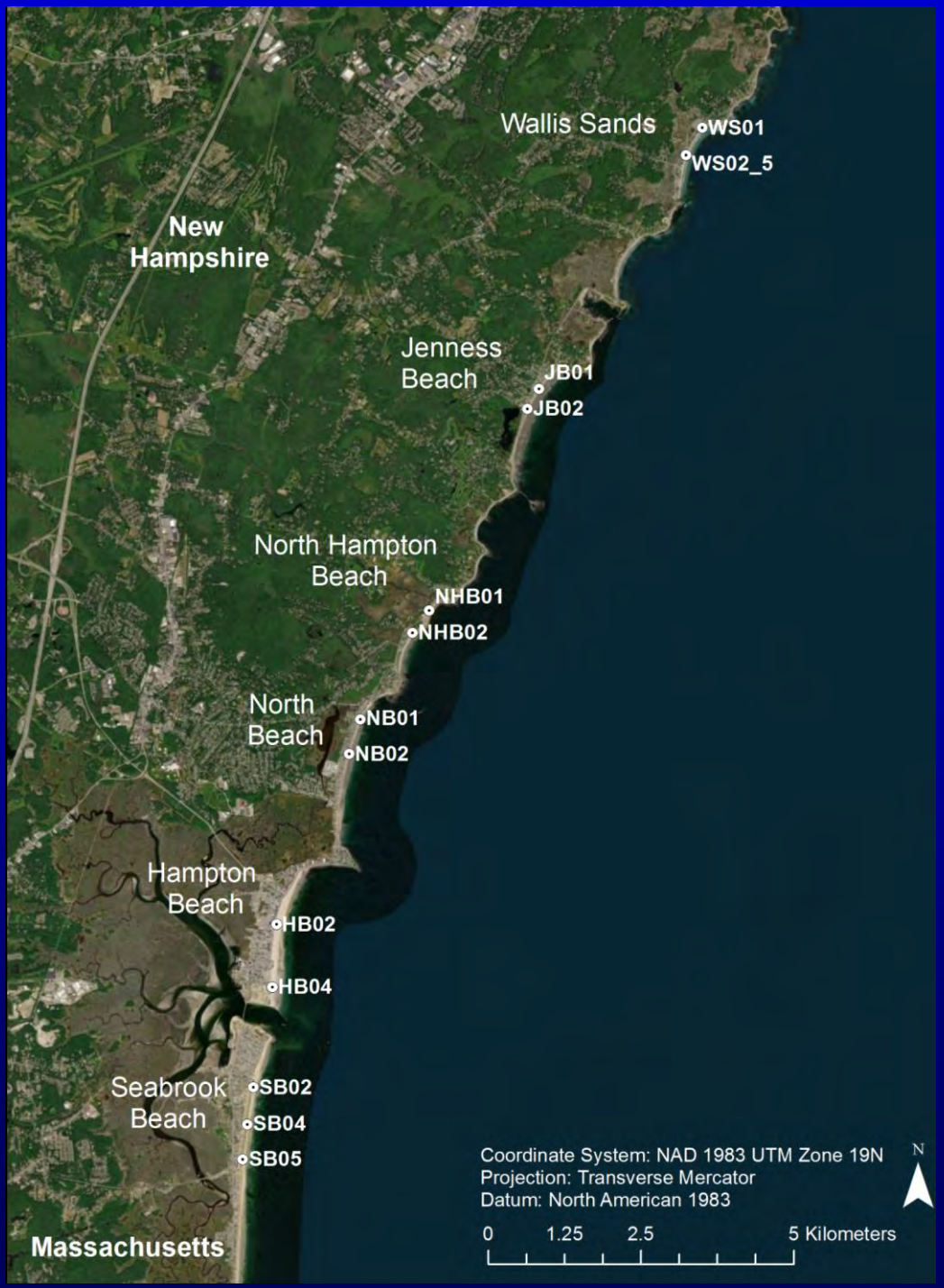
Why Are We Doing This?

- Due to Climate Change Many Coastal Areas Will Be Exposed to Increased Coastal Flooding and Erosion
  - Need to Increase Coastal Resiliency
- Need Scientific Input to Aid Management Decisions and Planning
- Therefore, Need to Understand:
  - How Beaches Change Seasonally
  - How Beaches React to Storm Events
  - Volumetric Changes in the Beaches
- No Long-term Study Has Been Done for New Hampshire!
  - Erosion or Accretion Trends
  - Sediments

For Example, What To Do With Dredged Sediment. Where To Put It

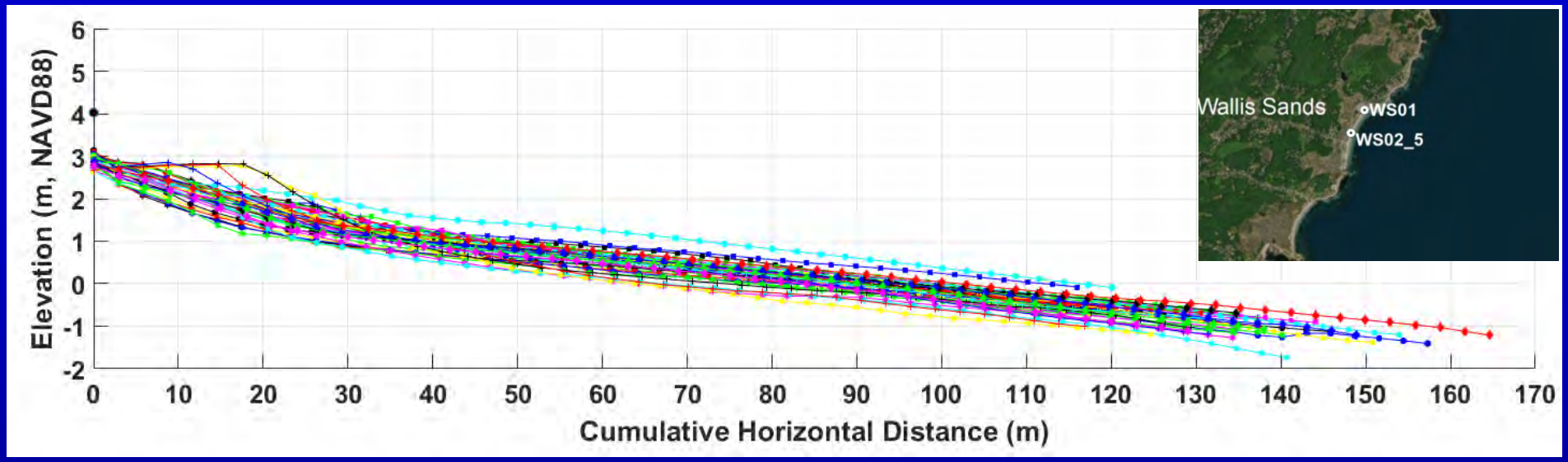
Volunteer Beach Profile Program

- Monitor Six of the Major Beaches for a Number of Years (> Five Years)
- Five-Year Plan to Develop, Year Four Starts July 2019
- Expanded to Thirteen Stations in January 2018
- Using Emery Method
- Overwhelming Amount of Data Accumulating Very Quickly
- Next Major Step Is Linking with NHGS for Web Serving



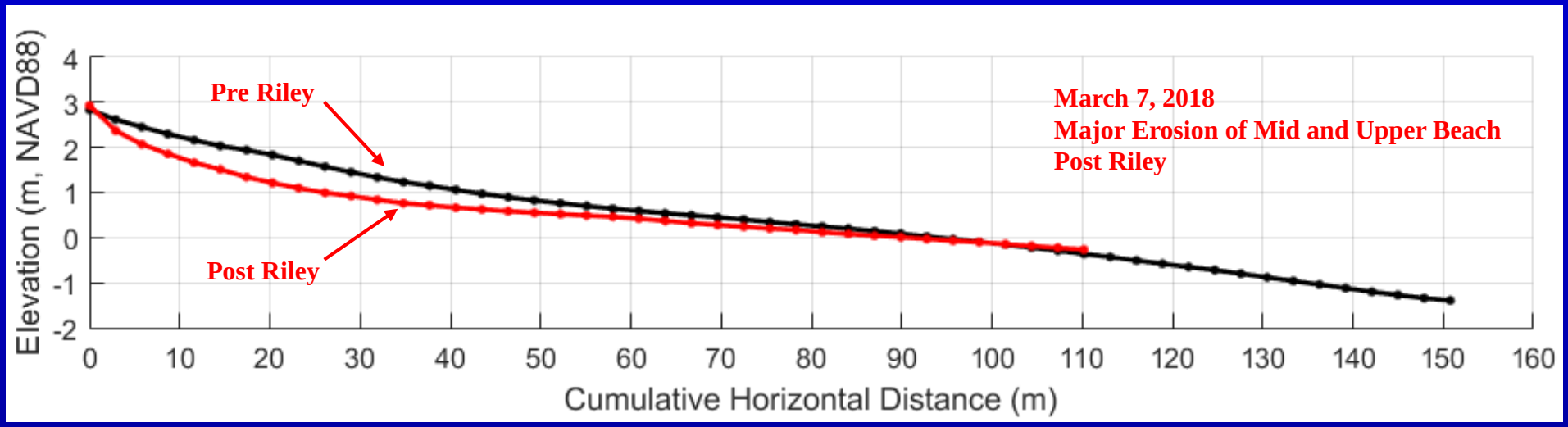
All Profiles at Wallis Sands State Park: WS01

December 9, 2016 to May 16, 2019 (39 Profiles)



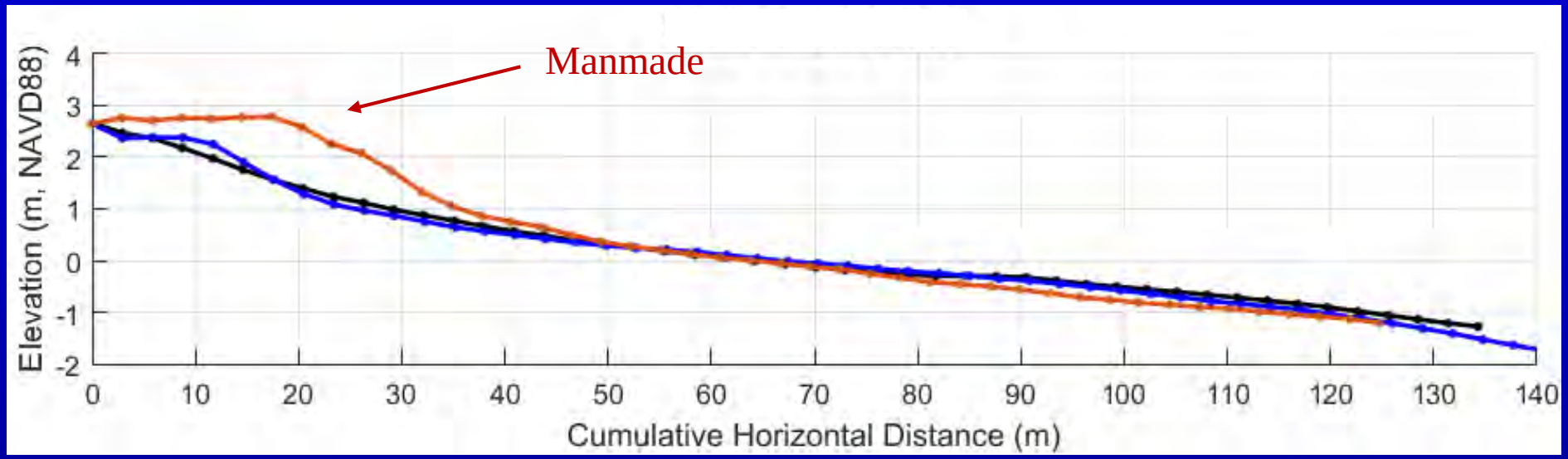
Wallis Sands State Park (WS01): Impact of Riley

February 27 and March 7, 2018



Building of a Man-Made Berm at Wallis Sands: WS01

May 21(Black), June 18 (Blue), and July 19 (Red), 2018

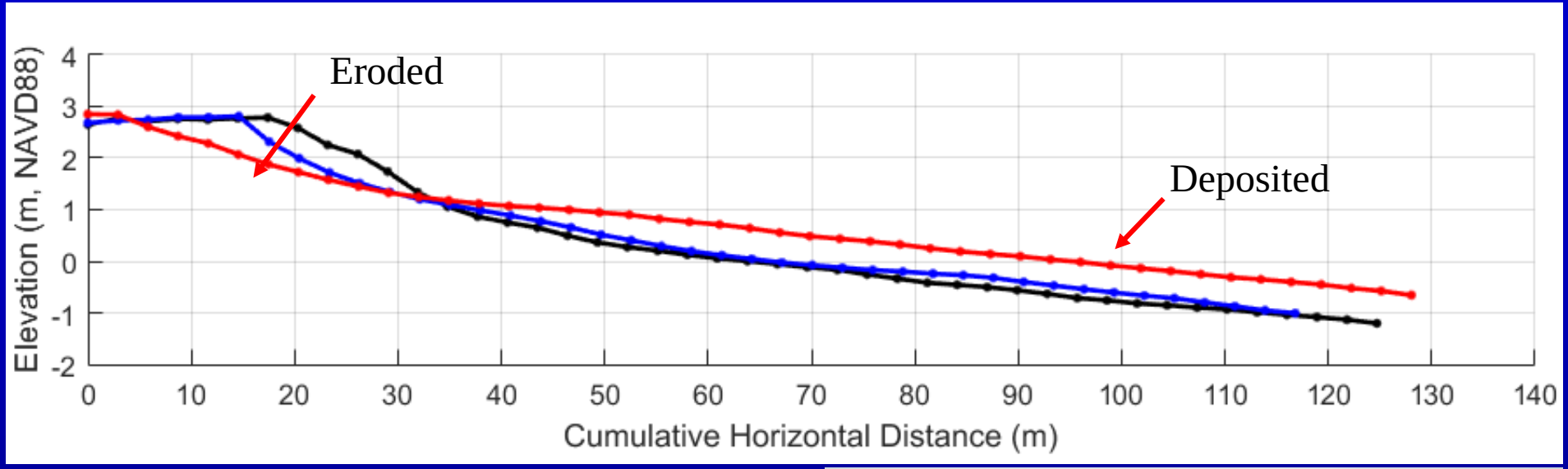


May 21, 2018

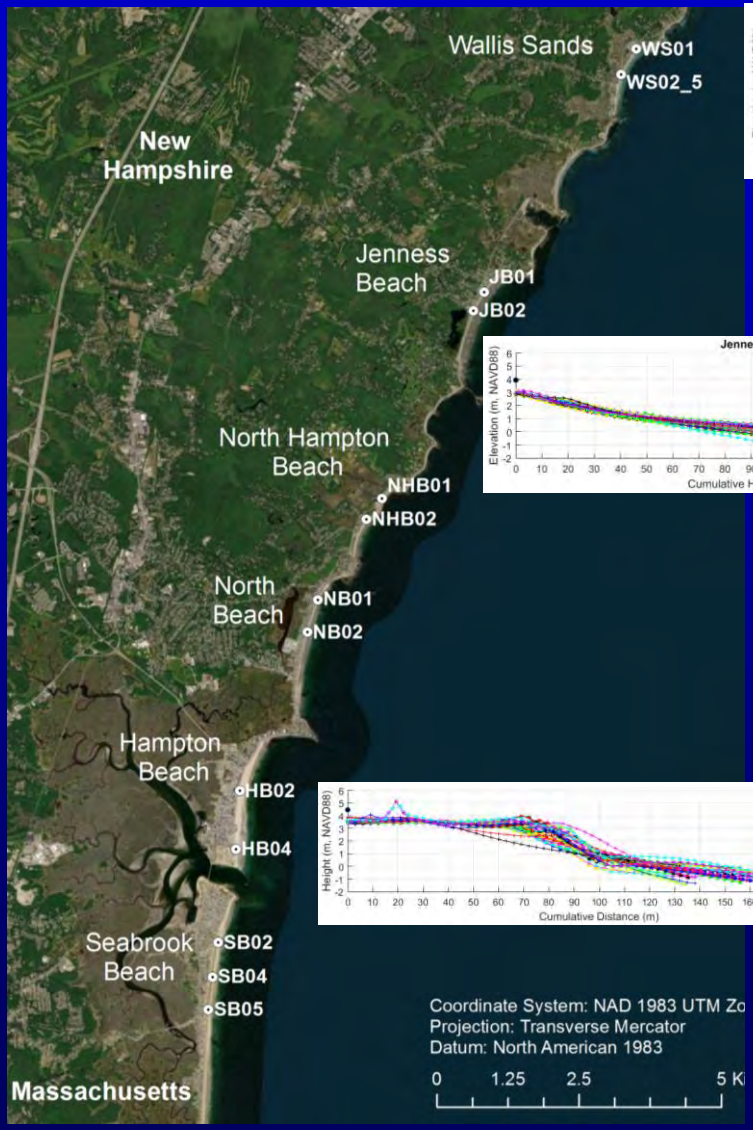
July 18, 2018

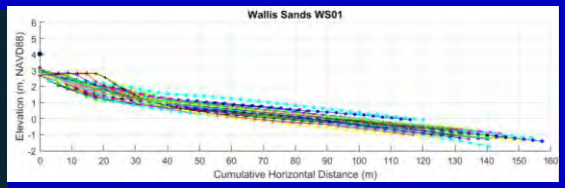
Natural Erosion of Man-Made Berm at Wallis Sands: WS01

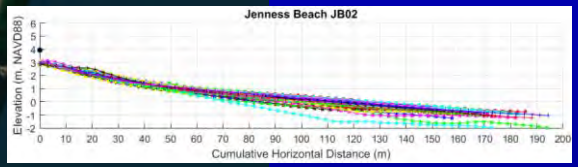
July 19 (Black), September 10 (Blue), and November 6 (Red), 2018

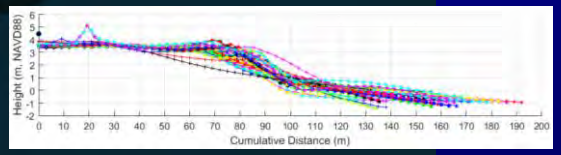


A Big Problem Is How Do We Deal with All of This Data in a Meaningful Way



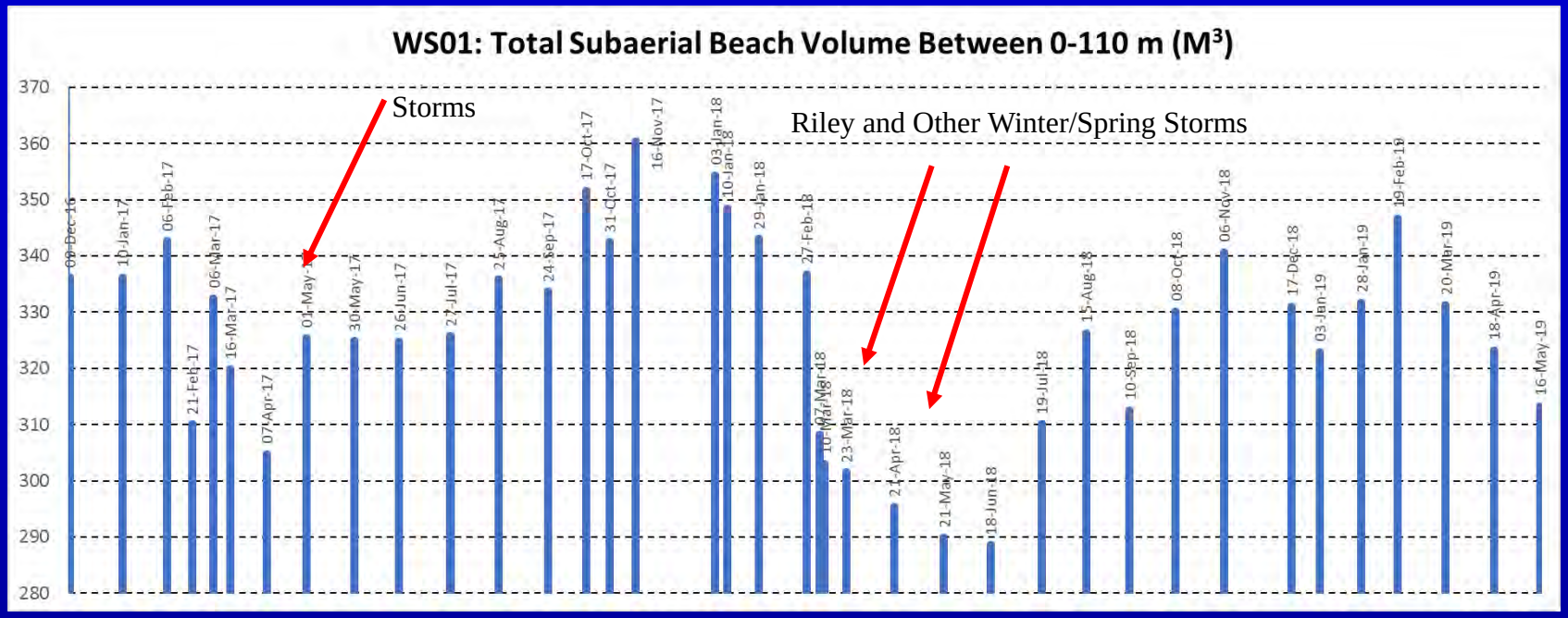


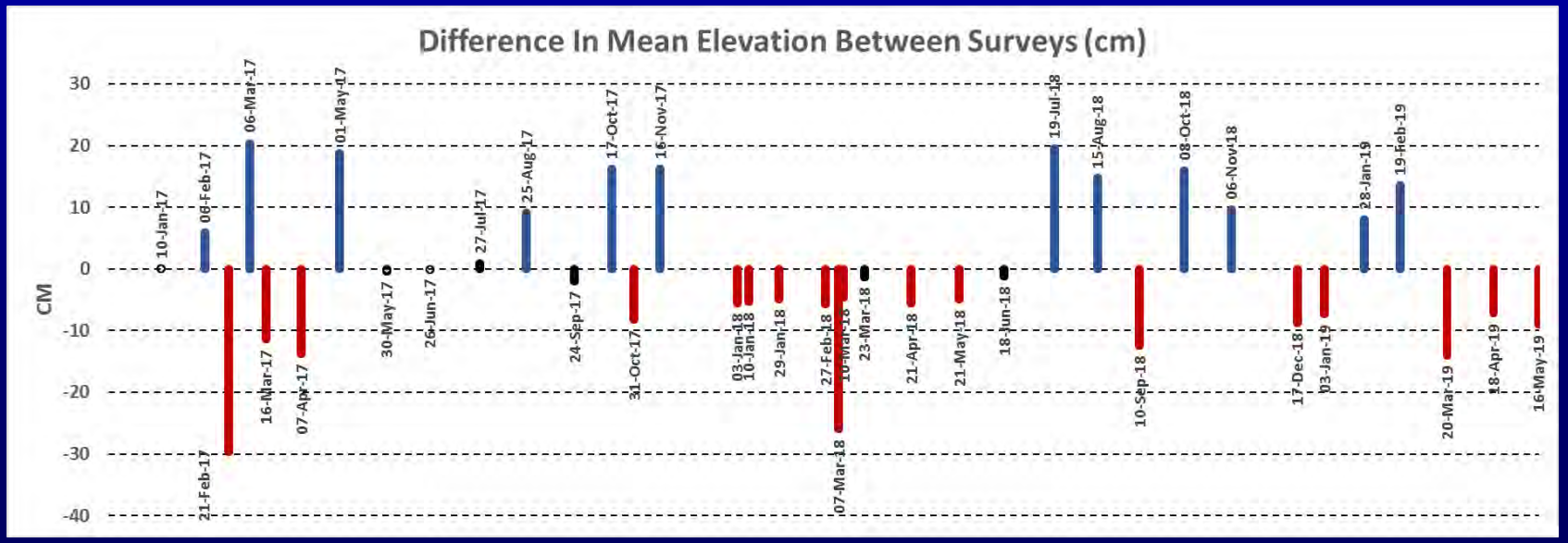




- Too Soon to Determine Long-Term Trends
- We Can and Are Assessing Events

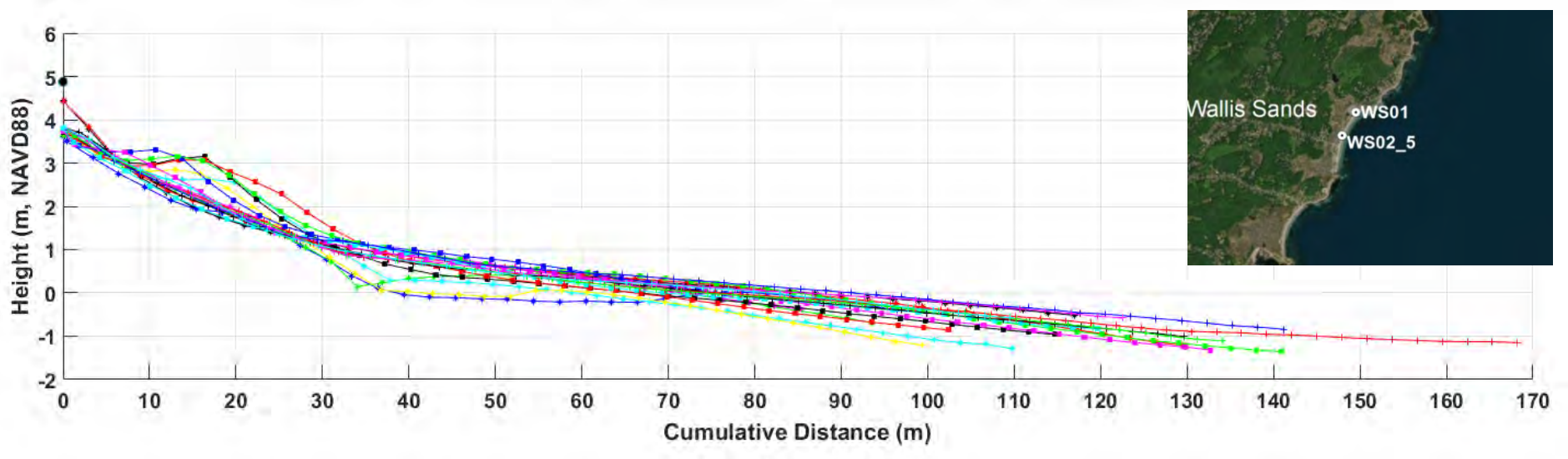
Convert to Volumetric Compaisons


WS01: Total Subaerial Beach Volume Between 0-110 m (M³)
Storms
Riley and Other Winter/Spring Storms
370
360
350
340
330
320
310
300
290
280
08-Dec-16
10-Jan-17
06-Feb-17
21-Feb-17
06-Mar-17
16-Mar-17
07-Apr-17
01-May-17
30-May-17
26-Jun-17
27-Jul-17
25-Aug-17
24-Sep-17
17-Oct-17
31-Oct-17
16-Nov-17
03-Jan-18
10-Jan-18
29-Jan-18
27-Feb-18
07-Mar-18
10-Mar-18
23-Mar-18
21-Apr-18
21-May-18
18-Jun-18
19-Jul-18
15-Aug-18
10-Sep-18
08-Oct-18
06-Nov-18
17-Dec-18
03-Jan-19
28-Jan-19
19-Feb-19
20-Mar-19
18-Apr-19
16-May-19

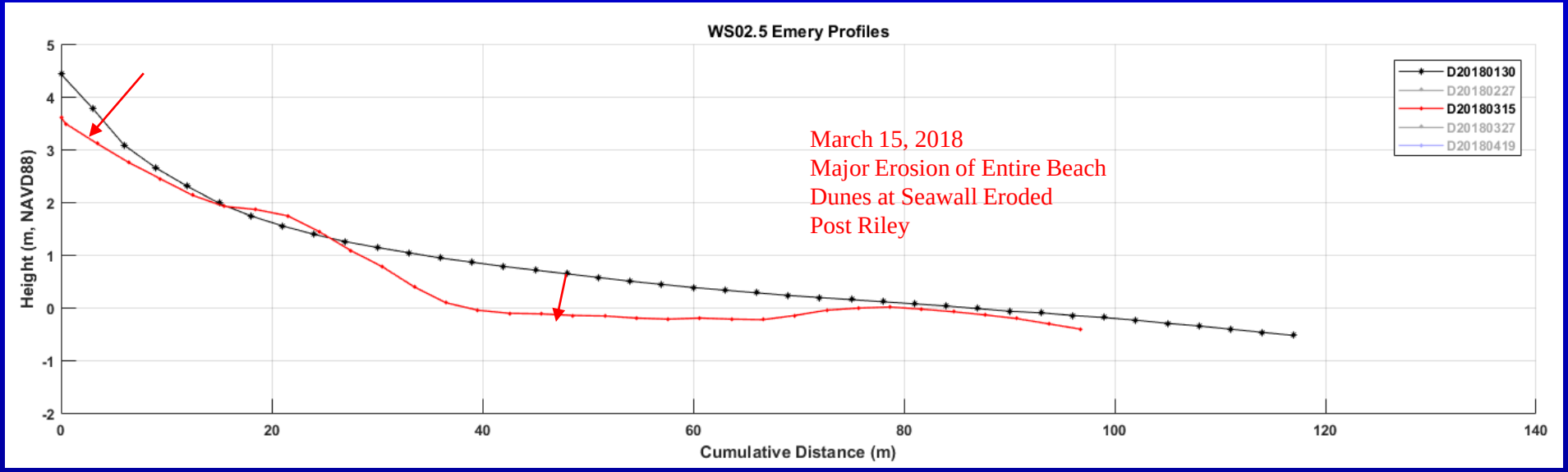

Difference In Mean Elevation Between Surveys (cm)
CM
30
20
10
0
-10
-20
-30
-40
10-Jan-17
08-Feb-17
21-Feb-17
06-Mar-17
16-Mar-17
07-Apr-17
01-May-17
30-May-17
26-Jun-17
27-Jul-17
25-Aug-17
24-Sep-17
17-Oct-17
31-Oct-17
16-Nov-17
03-Jan-18
10-Jan-18
29-Jan-18
27-Feb-18
07-Mar-18
10-Mar-18
23-Mar-18
21-Apr-18
21-May-18
18-Jun-18
19-Jul-18
15-Aug-18
10-Sep-18
08-Oct-18
06-Nov-18
17-Dec-18
03-Jan-19
28-Jan-19
19-Feb-19
20-Mar-19
18-Apr-19
16-May-19

All Profiles At Mid Wallis Sands: Station WS02.5

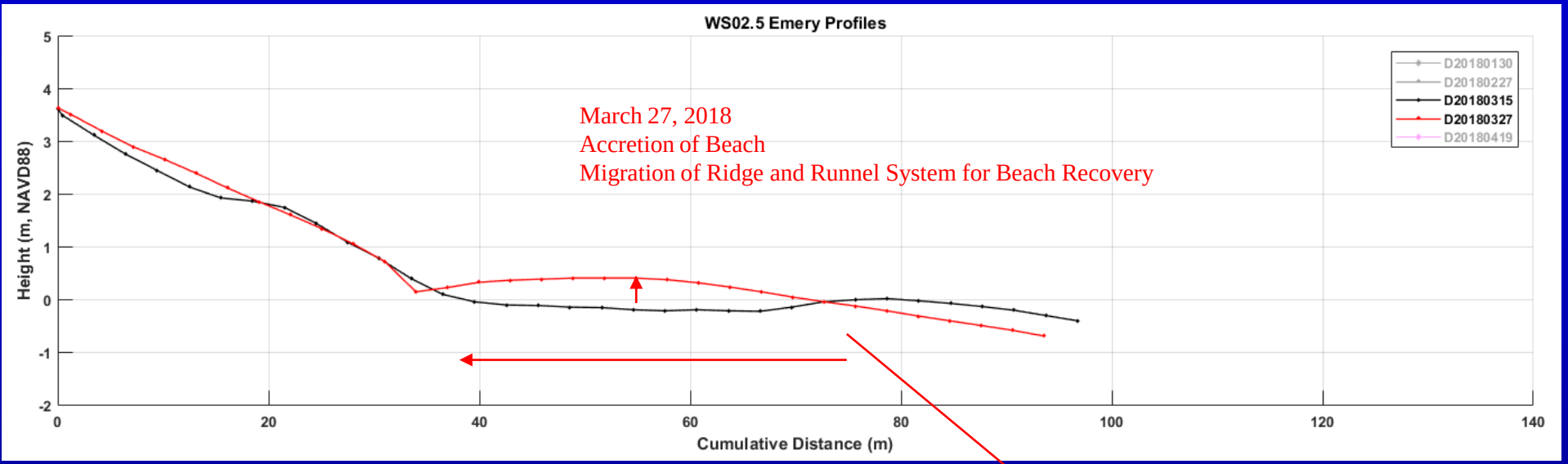
January 30, 2018 to June 6, 2019 (19 Profiles)

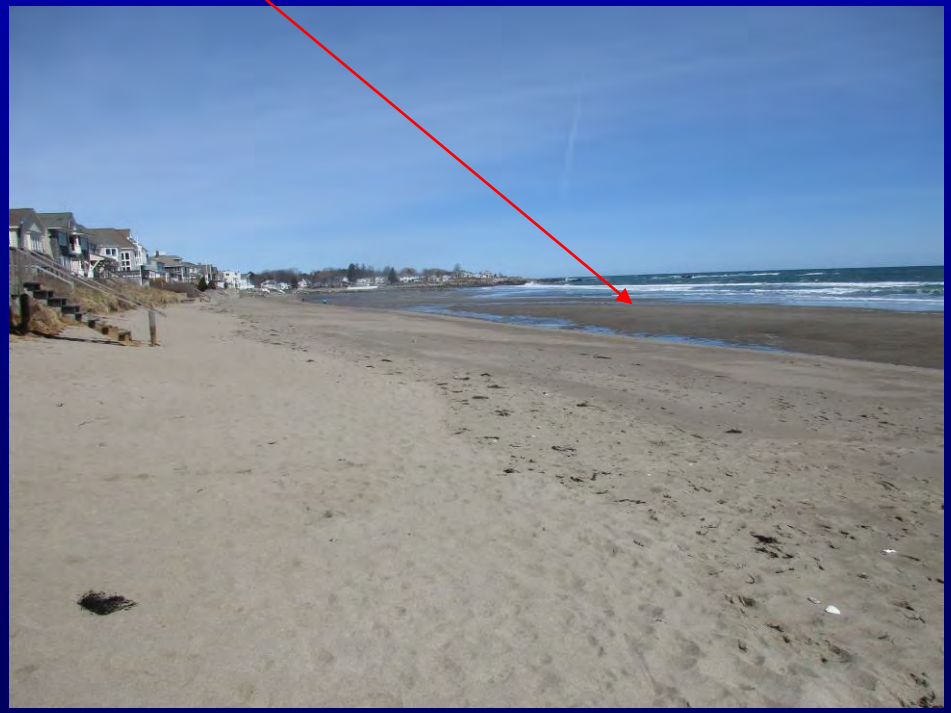


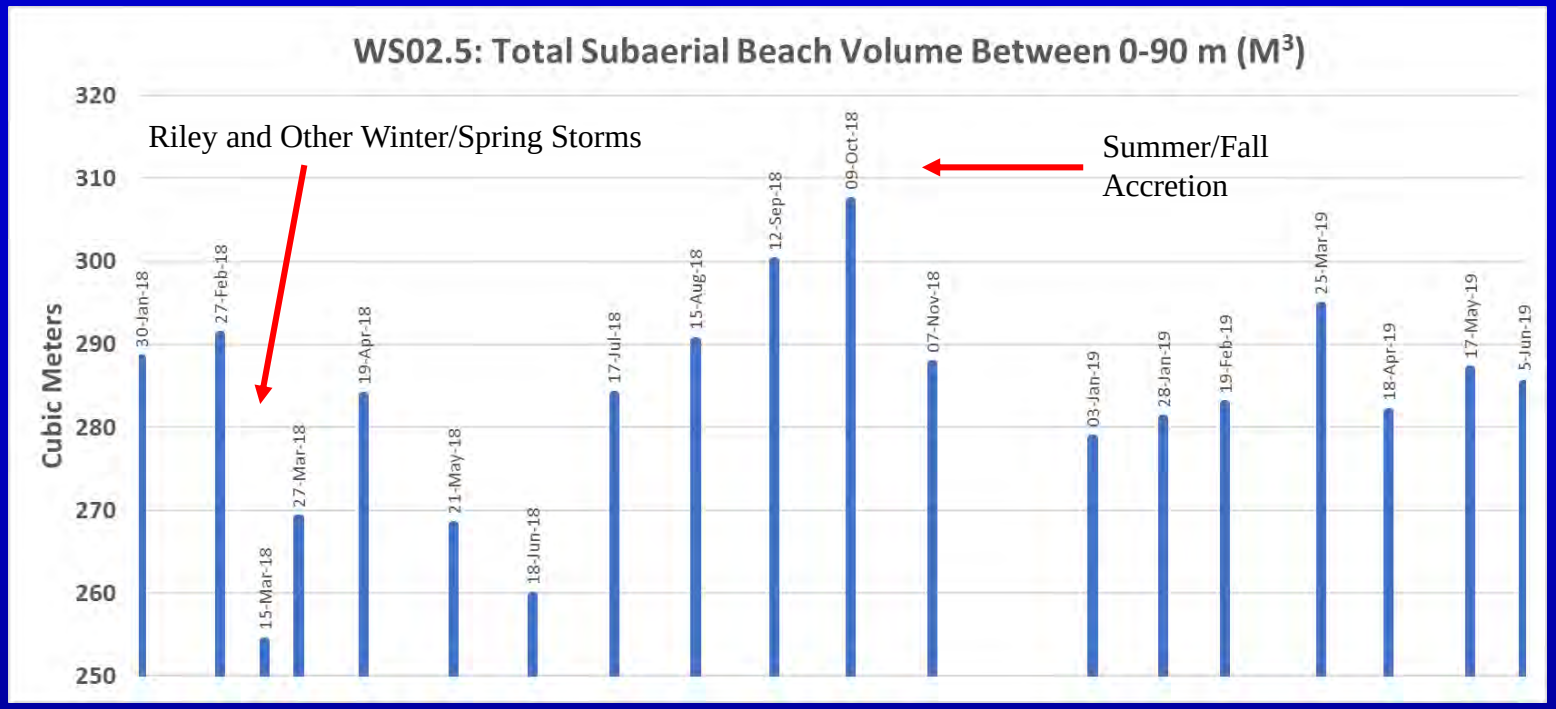
Mid Wallis Sands: WS02.5 Post-Riley
January 30 (Black) and March 15 (Red), 2018

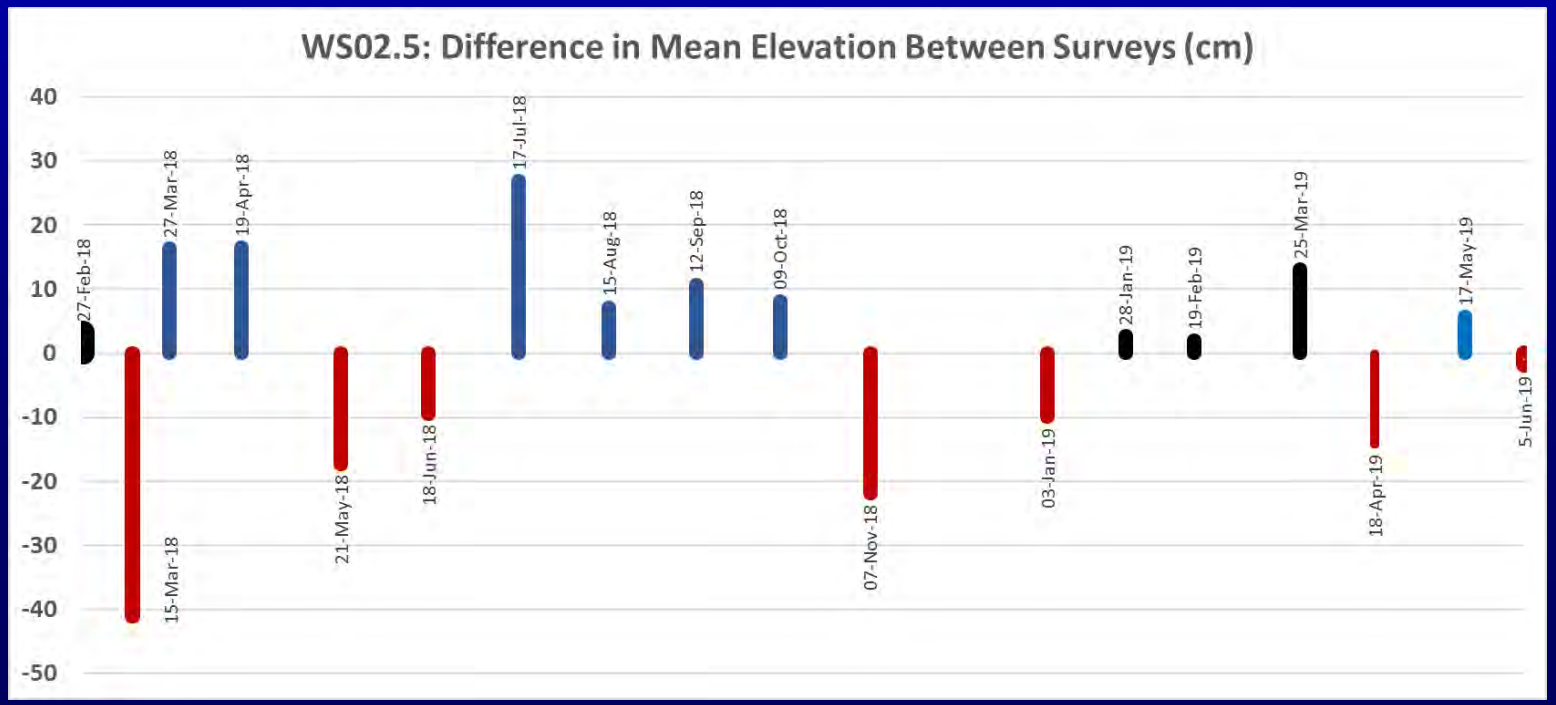


Mid Wallis Sands
March 15 (Black) and March 27 (Red), 2018



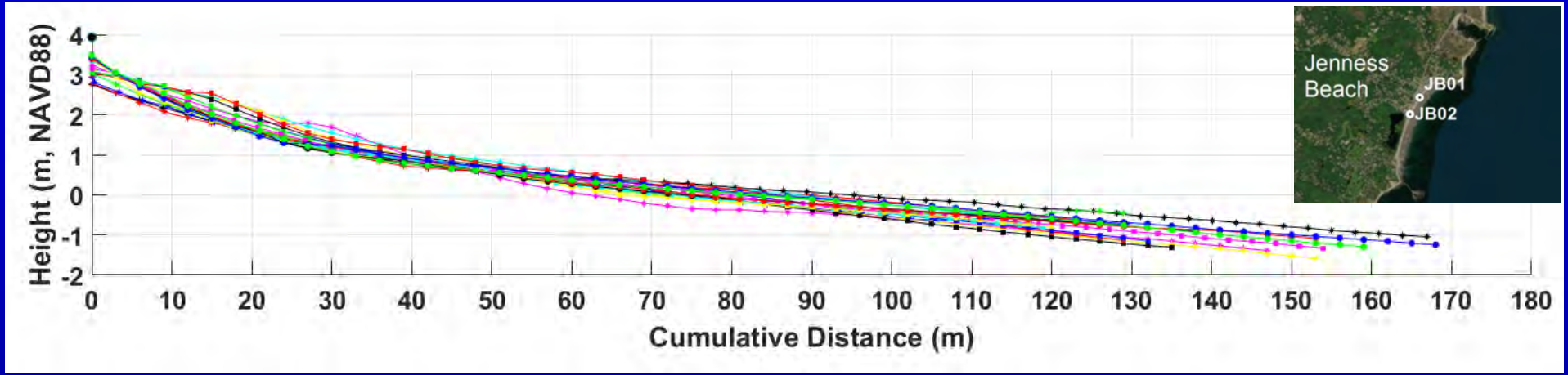



WS02.5: Total Subaerial Beach Volume Between 0-90 m (M³)
Riley and Other Winter/Spring Storms
Summer/Fall Accretion
Cubic Meters
320
310
300
290
280
270
260
250
30-Jan-18
27-Feb-18
15-Mar-18
27-Mar-18
19-Apr-18
21-May-18
18-Jun-18
17-Jul-18
15-Aug-18
12-Sep-18
09-Oct-18
07-Nov-18
03-Jan-19
28-Jan-19
19-Feb-19
25-Mar-19
18-Apr-19
17-May-19
5-Jun-19


WS02.5: Difference in Mean Elevation Between Surveys (cm)
40
30
20
10
0
-10
-20
-30
-40
-50
27-Feb-18
15-Mar-18
27-Mar-18
19-Apr-18
21-May-18
18-Jun-18
17-Jul-18
15-Aug-18
12-Sep-18
09-Oct-18
07-Nov-18
03-Jan-19
28-Jan-19
19-Feb-19
25-Mar-19
18-Apr-19
17-May-19
5-Jun-19

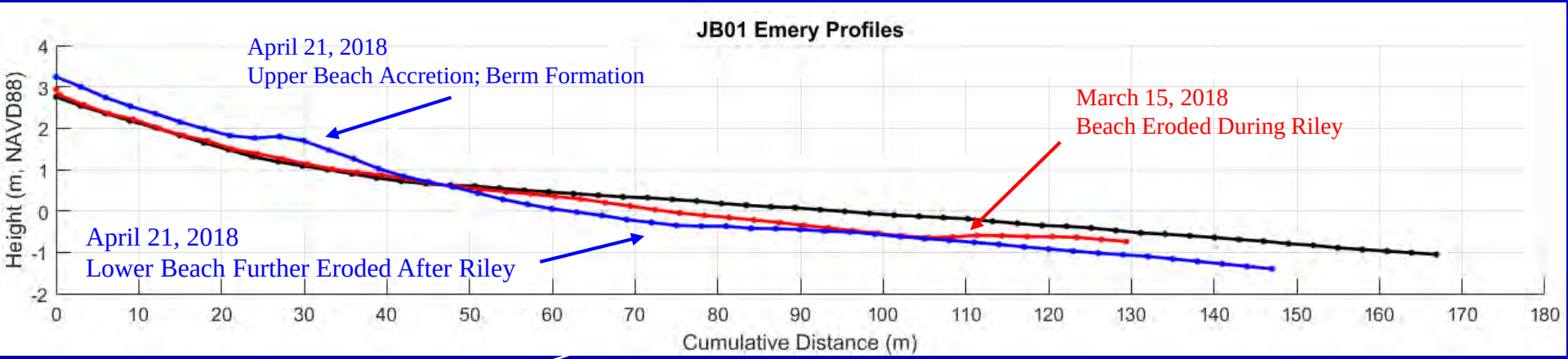
All Profiles at Jenness Beach: JB01 (Northern Station)

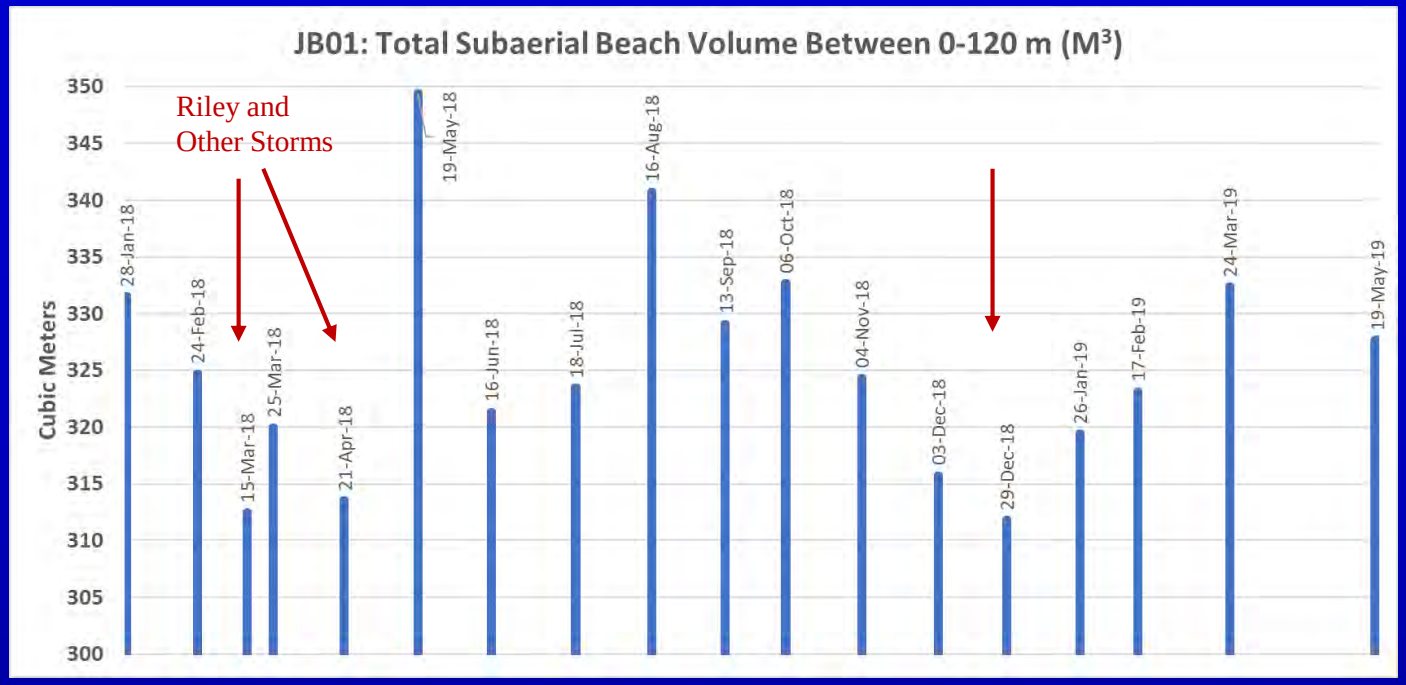
January 28, 2018 to May 19, 2019 (18 Profiles)

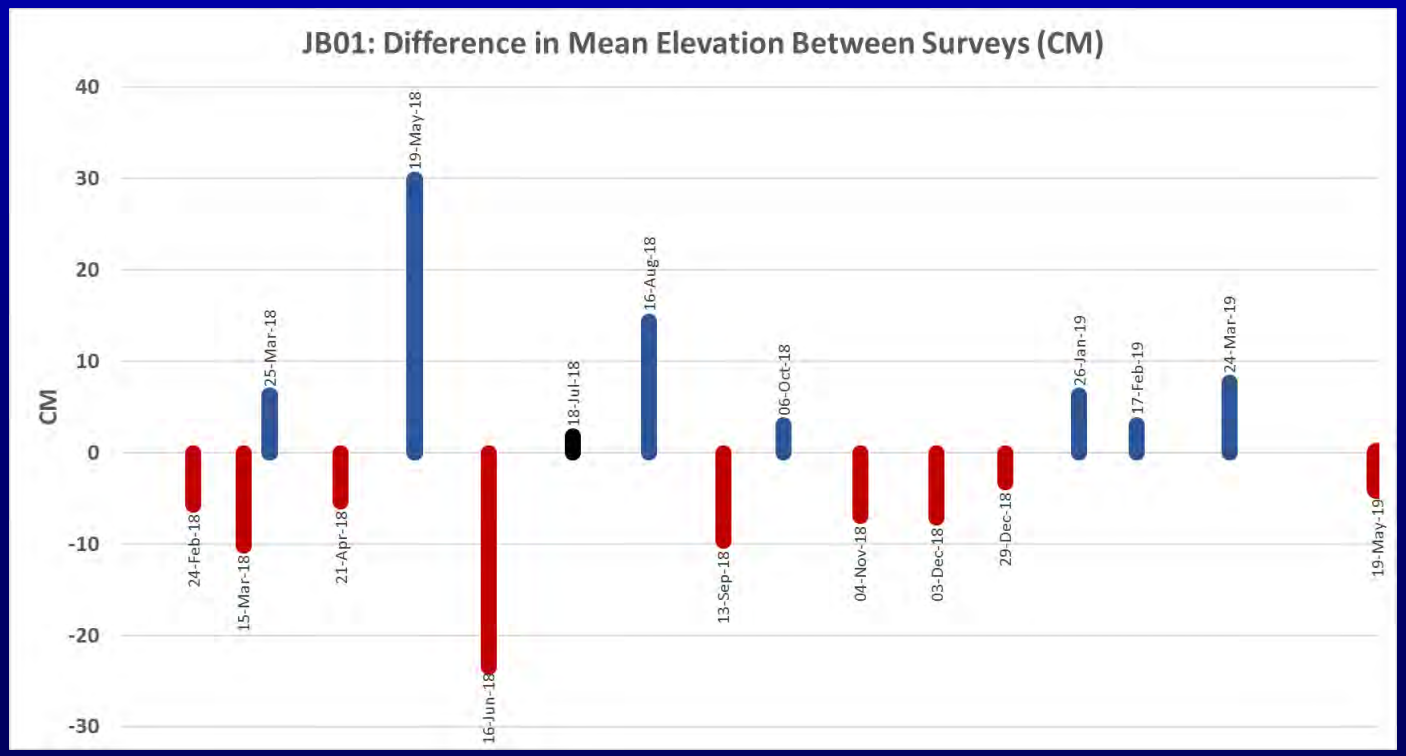


Jenness Beach (Northern Station): JB01

January 28, 2018 (Black), March 15, 2018 (Red), and April 21, 2018 (Blue)

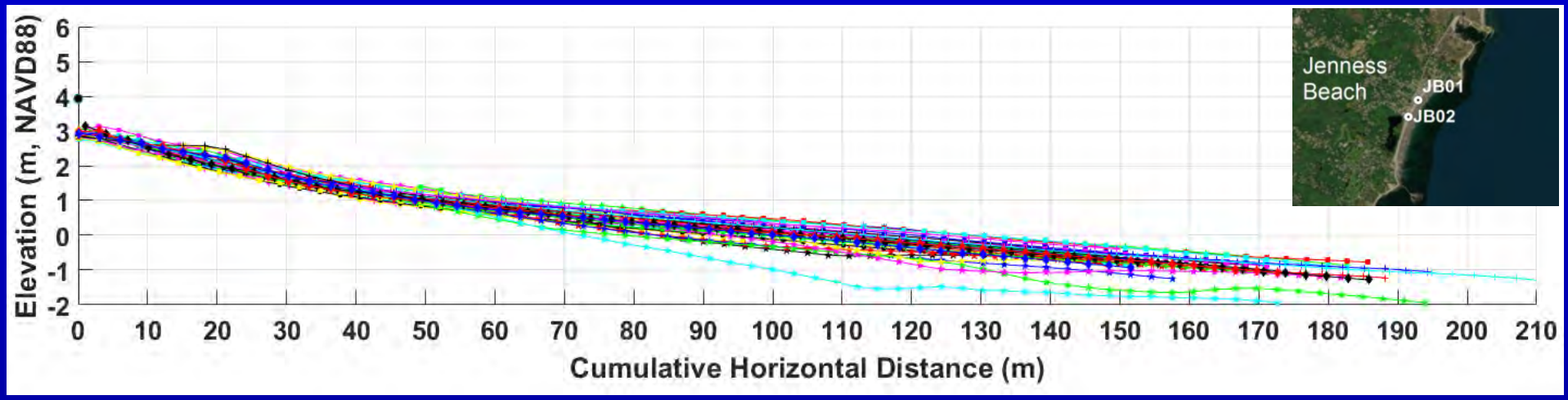



JB01: Total Subaerial Beach Volume Between 0-120 m (M³)
Riley and
Other Storms
Cubic Meters
350
345
340
335
330
325
320
315
310
305
300
28-Jan-18
24-Feb-18
15-Mar-18
25-Mar-18
21-Apr-18
19-May-18
16-Jun-18
18-Jul-18
16-Aug-18
13-Sep-18
06-Oct-18
04-Nov-18
03-Dec-18
29-Dec-18
26-Jan-19
17-Feb-19
24-Mar-19
19-May-19


JB01: Difference in Mean Elevation Between Surveys (CM)
CM
40
30
20
10
0
-10
-20
-30
24-Feb-18
15-Mar-18
25-Mar-18
21-Apr-18
19-May-18
16-Jun-18
18-Jul-18
16-Aug-18
13-Sep-18
06-Oct-18
04-Nov-18
03-Dec-18
29-Dec-18
26-Jan-19
17-Feb-19
24-Mar-19
19-May-19

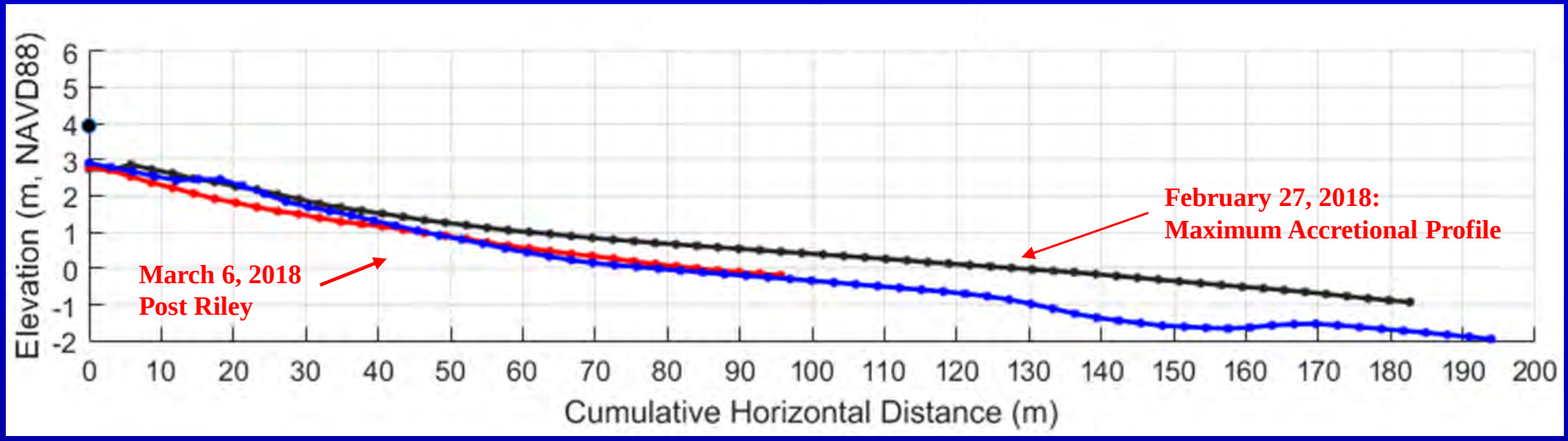
All Profiles at Jenness Beach State Park: JB02

December 8, 2016 to June 5, 2019 (36 Profiles)



Jenness Beach State Park (JB02): Maximum Profile and Riley

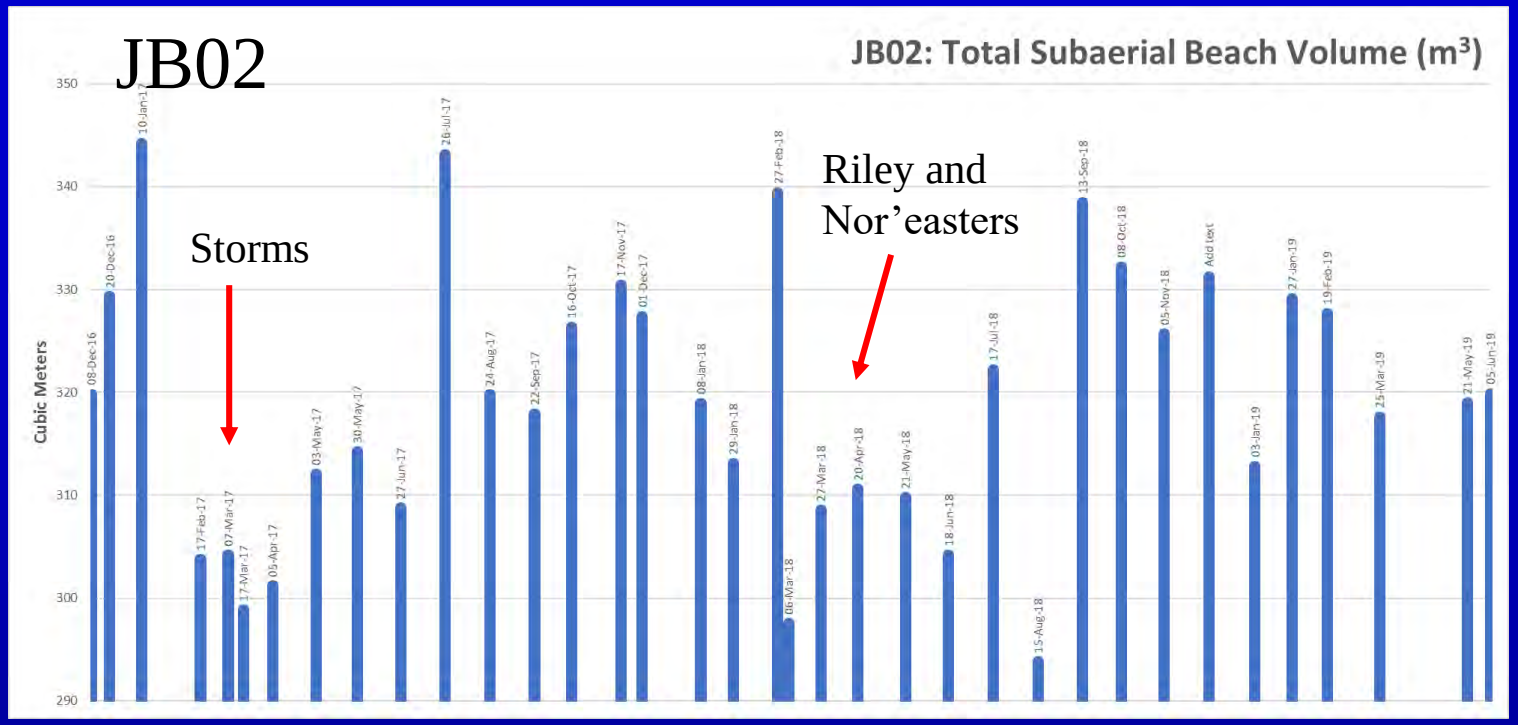
February 27 (Black), March 6 (Red), and June 18 (Blue), 2018

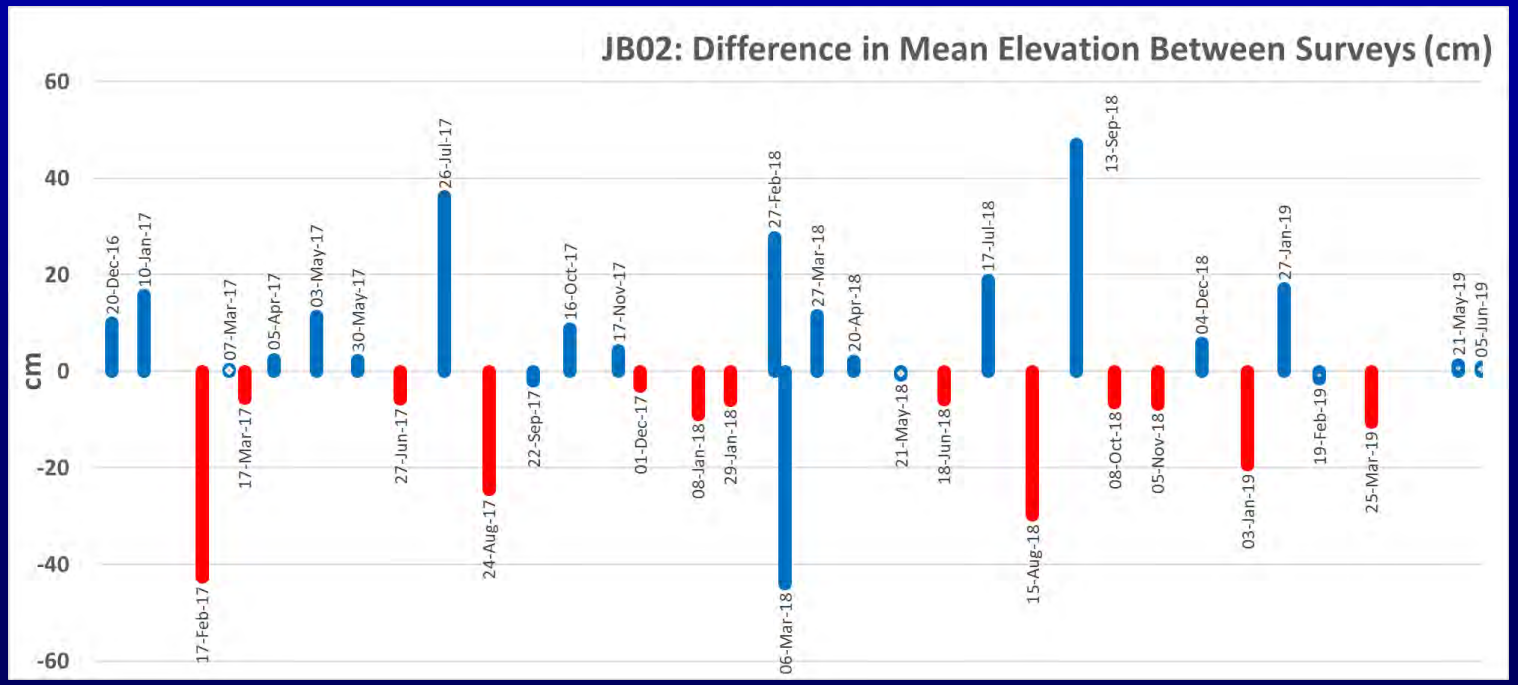




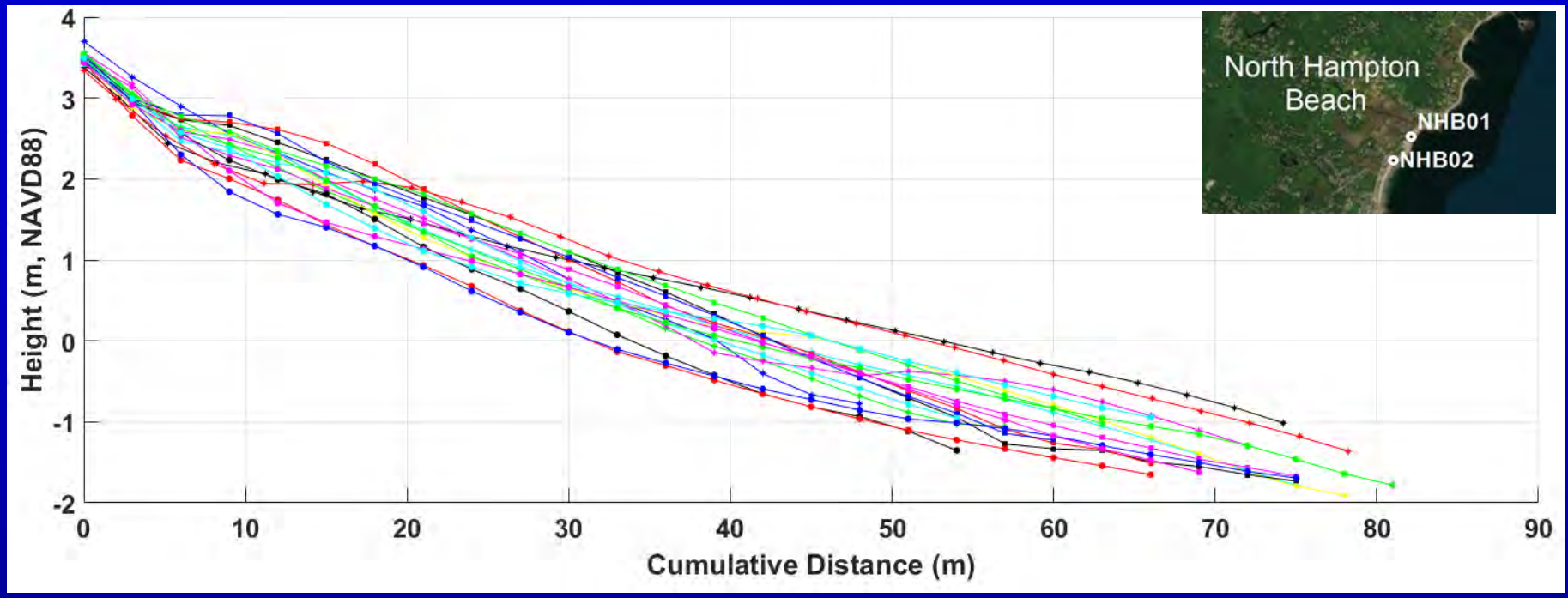
March 6, 2018: Post Riley

JB02

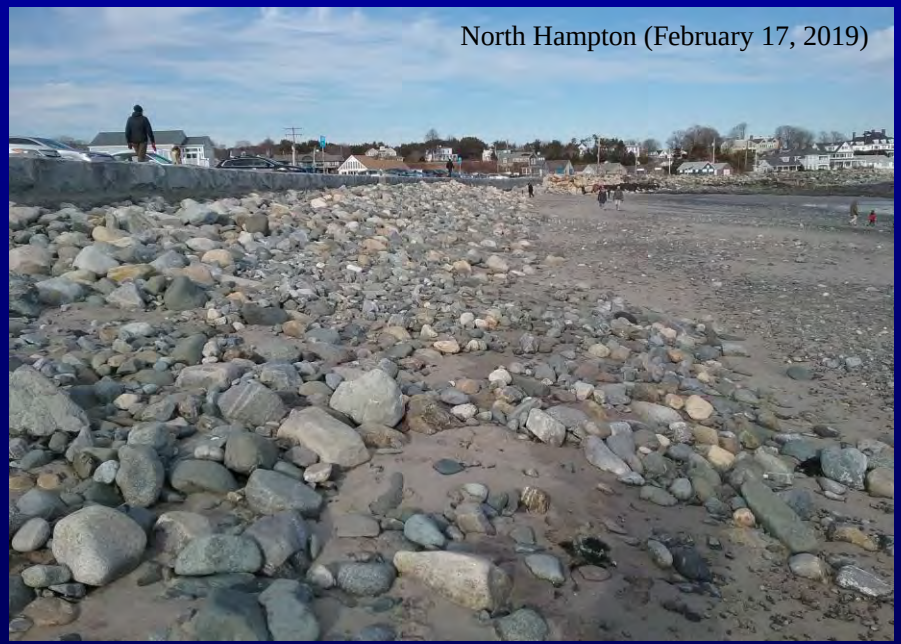

JB02: Total Subaerial Beach Volume (m³)
Cubic Meters
350
340
330
320
310
300
290
Storms
Riley and
Nor'easters
08-Dec-16
20-Dec-16
10-Jan-17
17-Feb-17
07-Mar-17
17-Mar-17
05-Apr-17
03-May-17
30-May-17
27-Jun-17
26-Jul-17
24-Aug-17
22-Sep-17
16-Oct-17
17-Nov-17
01-Dec-17
08-Jan-18
29-Jan-18
27-Feb-18
06-Mar-18
27-Mar-18
20-Apr-18
21-May-18
18-Jun-18
17-Jul-18
15-Aug-18
13-Sep-18
08-Oct-18
05-Nov-18
Add text
03-Jan-19
27-Jan-19
19-Feb-19
25-Mar-19
21-May-19
05-Jun-19


JB02: Difference in Mean Elevation Between Surveys (cm)
cm
60
40
20
0
-20
-40
-60
20-Dec-16
10-Jan-17
17-Feb-17
07-Mar-17
17-Mar-17
05-Apr-17
03-May-17
30-May-17
27-Jun-17
26-Jul-17
24-Aug-17
22-Sep-17
16-Oct-17
17-Nov-17
01-Dec-17
08-Jan-18
29-Jan-18
27-Feb-18
06-Mar-18
27-Mar-18
20-Apr-18
21-May-18
18-Jun-18
17-Jul-18
15-Aug-18
13-Sep-18
08-Oct-18
05-Nov-18
04-Dec-18
03-Jan-19
27-Jan-19
19-Feb-19
25-Mar-19
21-May-19
05-Jun-19

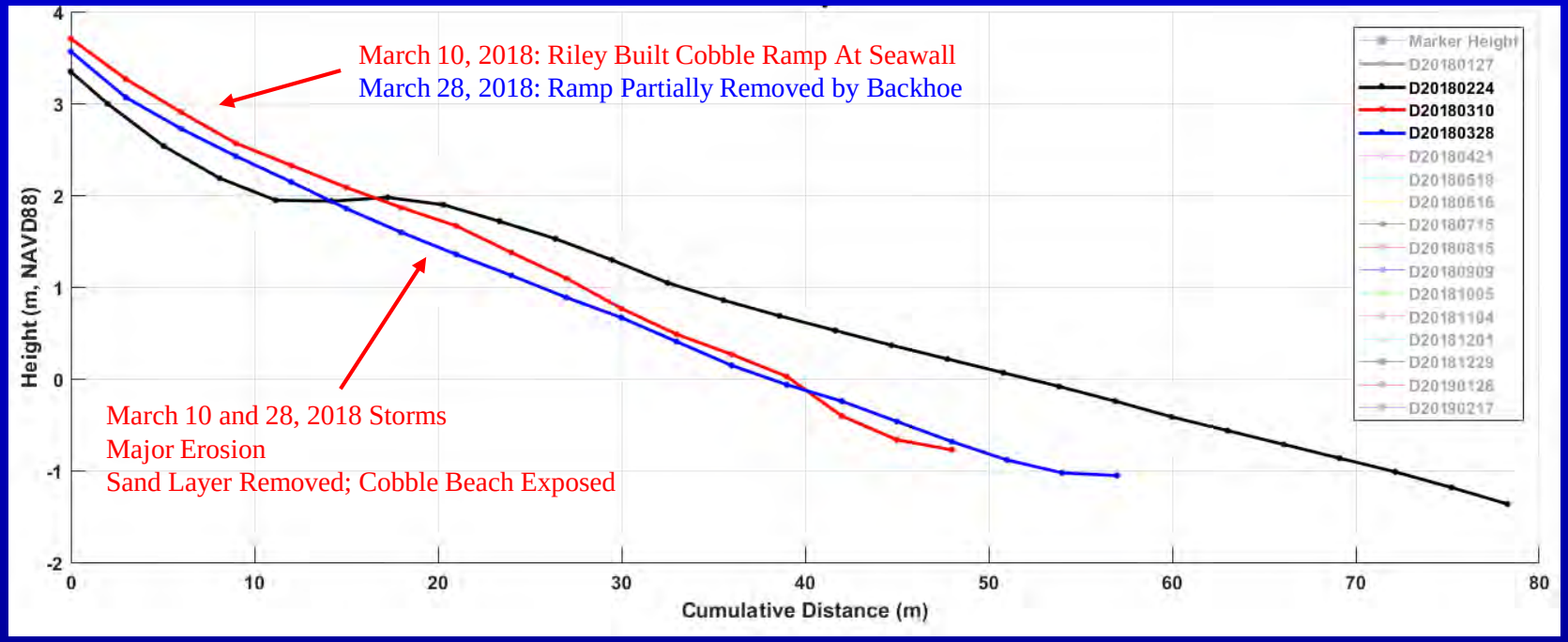
All Profiles at North Hampton State Park: January 27 to May 17, 2019 (19 Profiles)




North Hampton (March 10. 2018)


North Hampton (February 17, 2019)

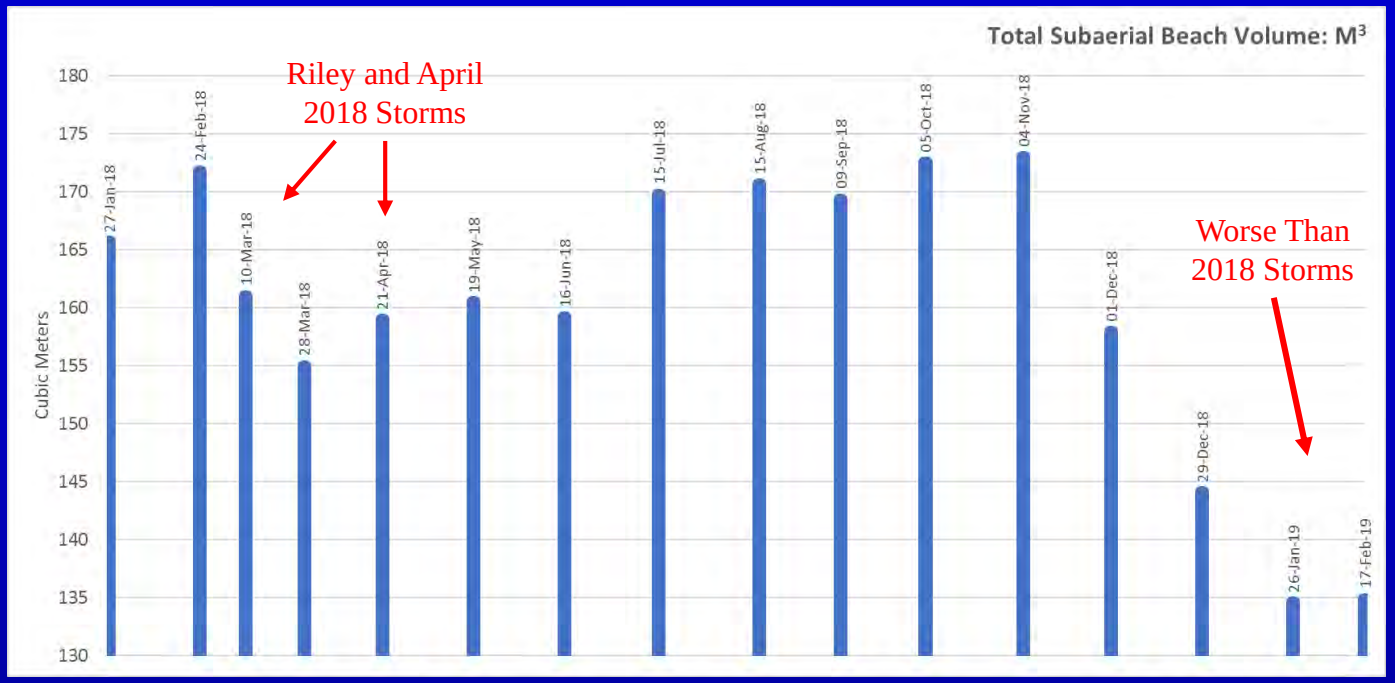
North Hampton (NHB01): February 24 (Black), March 10 (Red), and March 28 (Blue), 2018

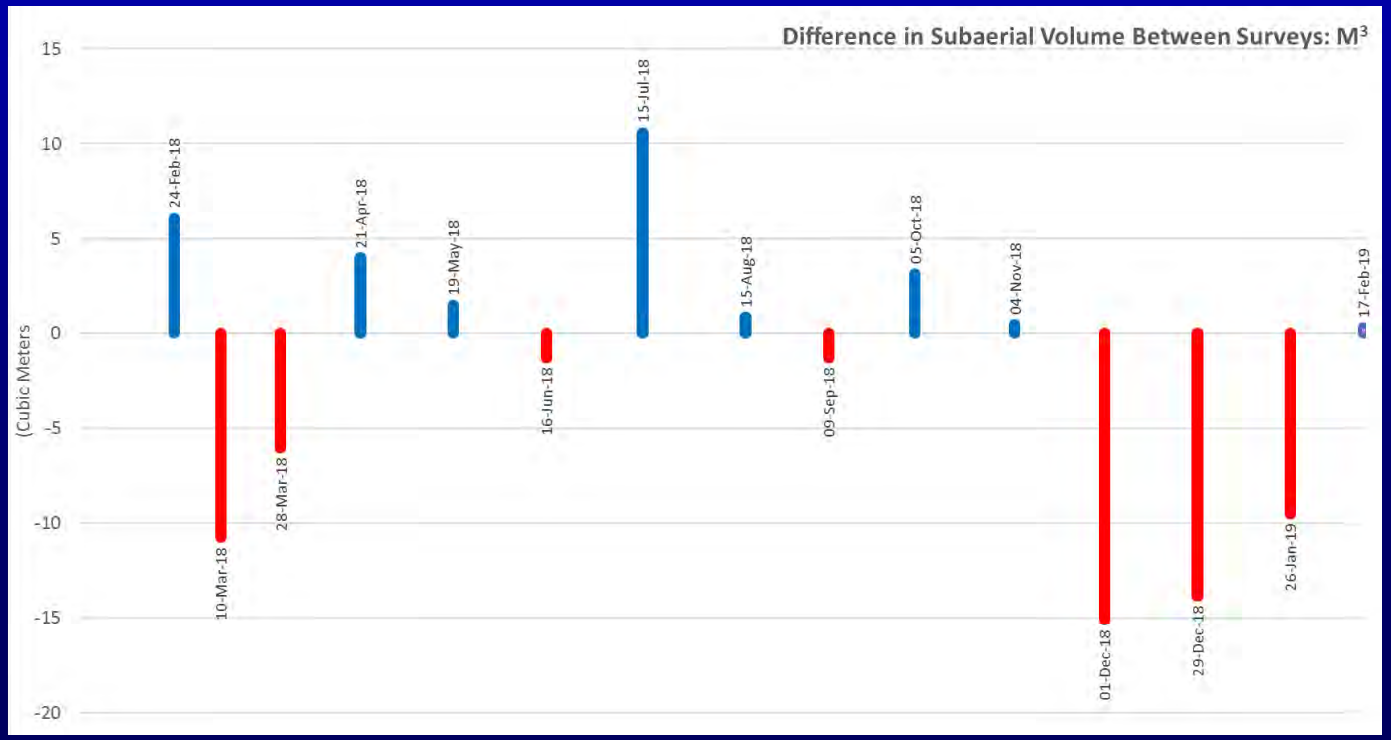


March 28, 2018

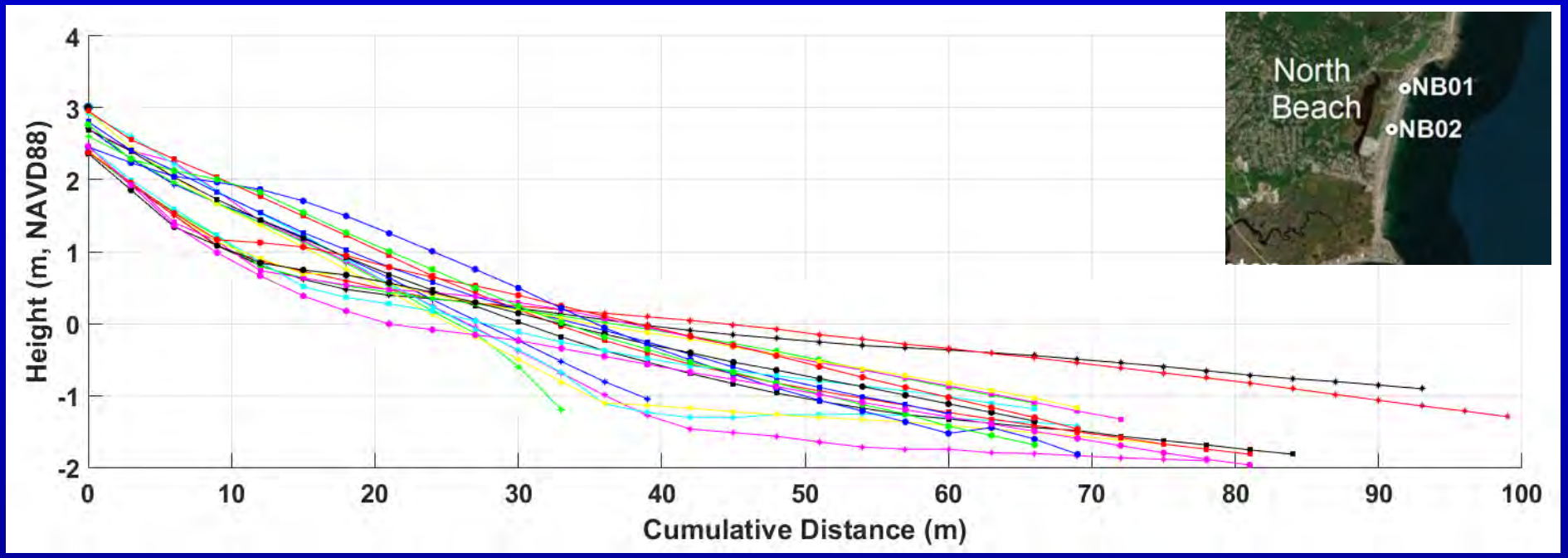
March 28, 2018

Post Riley
March 3, 2018


Total Subaerial Beach Volume: M³
Riley and April 2018 Storms
Worse Than 2018 Storms
Cubic Meters
180
175
170
165
160
155
150
145
140
135
130
27-Jan-18
24-Feb-18
10-Mar-18
28-Mar-18
21-Apr-18
19-May-18
16-Jun-18
15-Jul-18
15-Aug-18
09-Sep-18
05-Oct-18
04-Nov-18
01-Dec-18
29-Dec-18
26-Jan-19
17-Feb-19

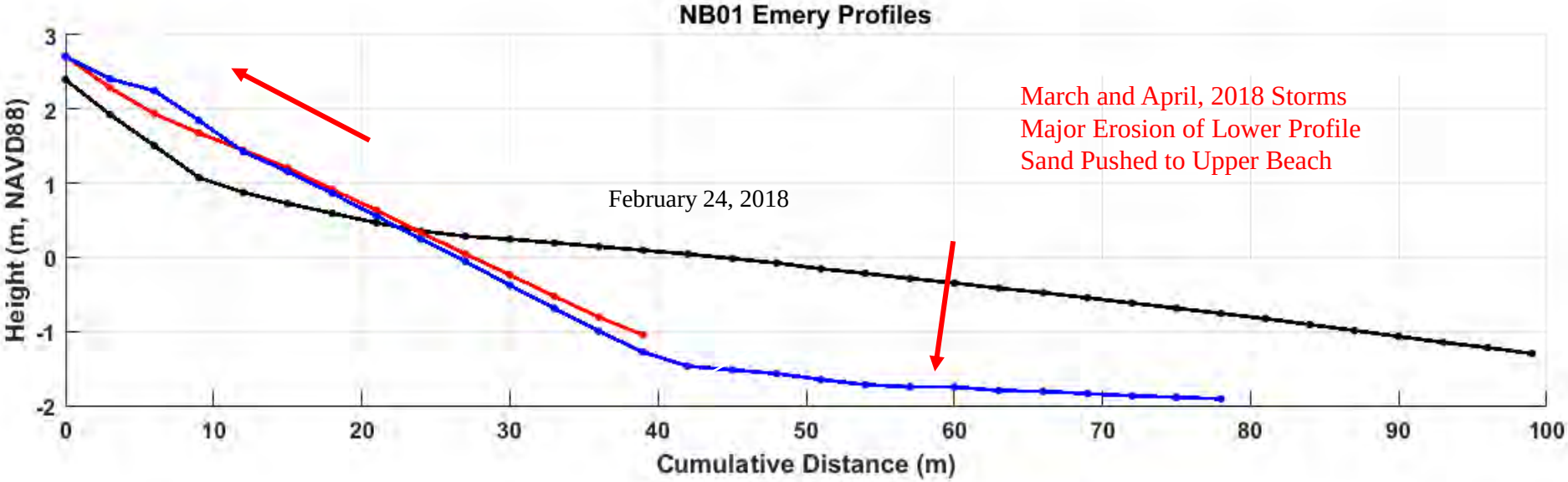

Difference in Subaerial Volume Between Surveys: M³
(Cubic Meters
15
10
5
0
-5
-10
-15
-20
24-Feb-18
10-Mar-18
28-Mar-18
21-Apr-18
19-May-18
16-Jun-18
15-Jul-18
15-Aug-18
09-Sep-18
05-Oct-18
04-Nov-18
01-Dec-18
29-Dec-18
26-Jan-19
17-Feb-19

North Beach (NB01): January 27, 2018 to May 16, 2019 (19 Profiles)

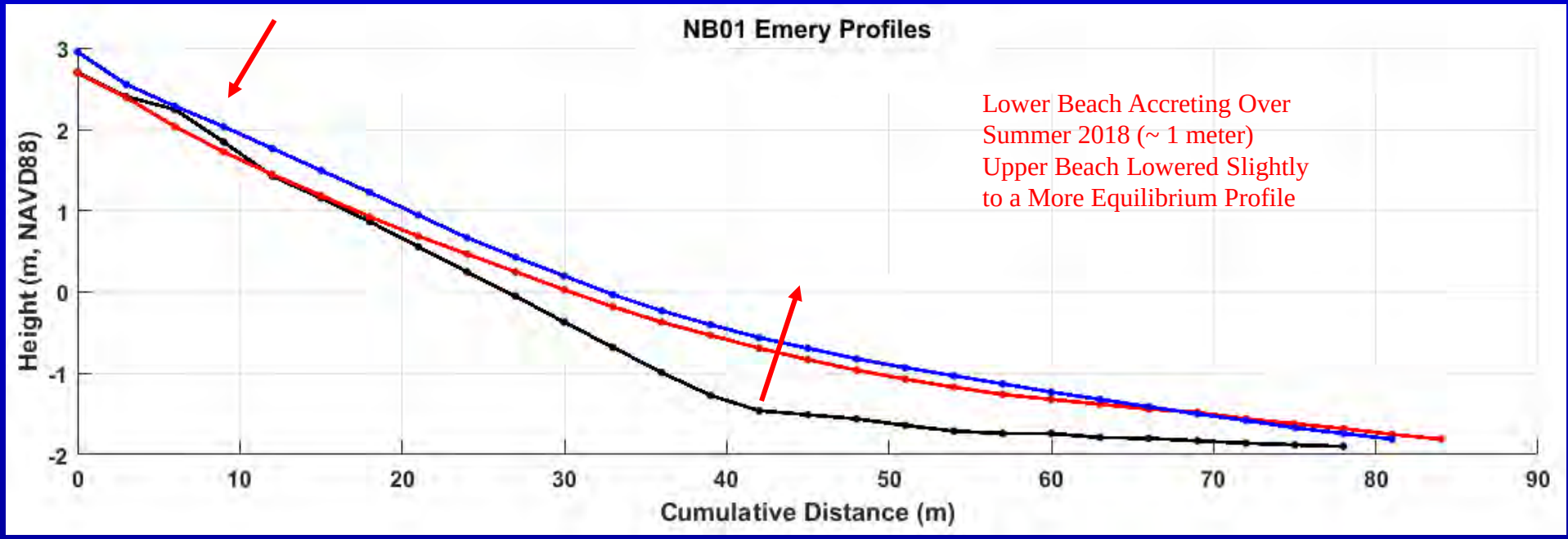


March 3, 2018:
Riley

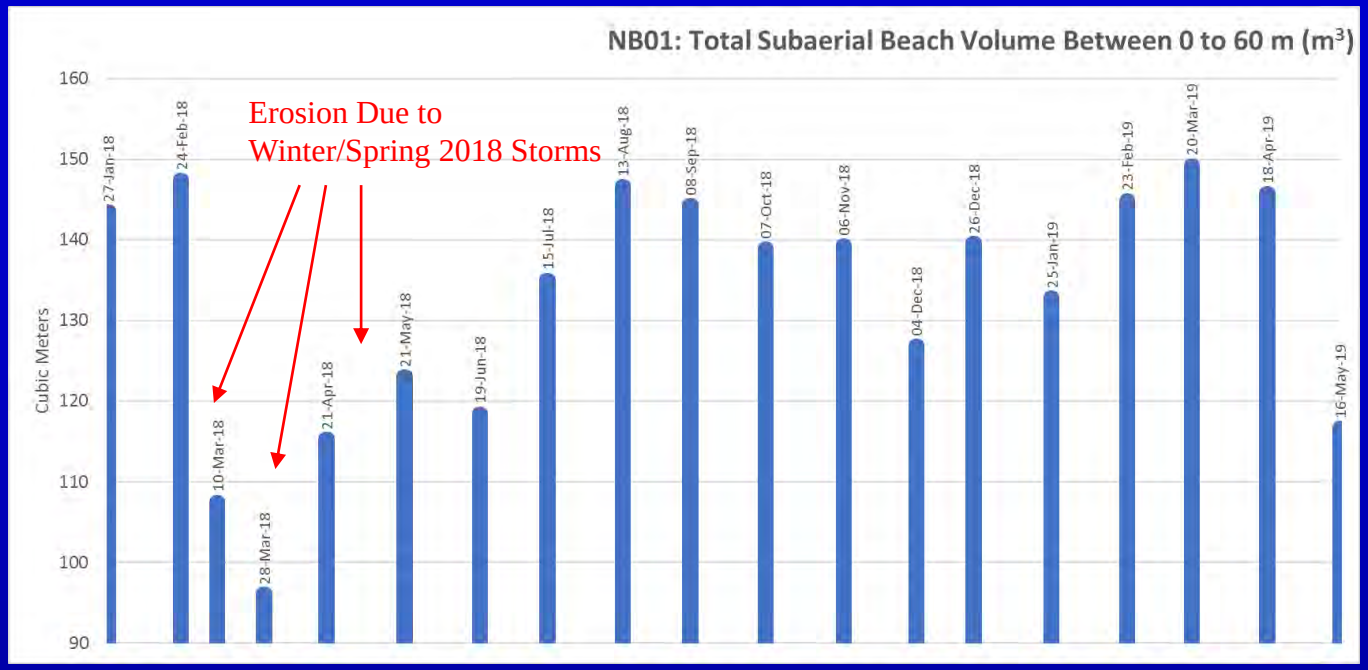
North Beach (NB01): February 24 (Black), March 10 (Red), and April 21 (Blue), 2018

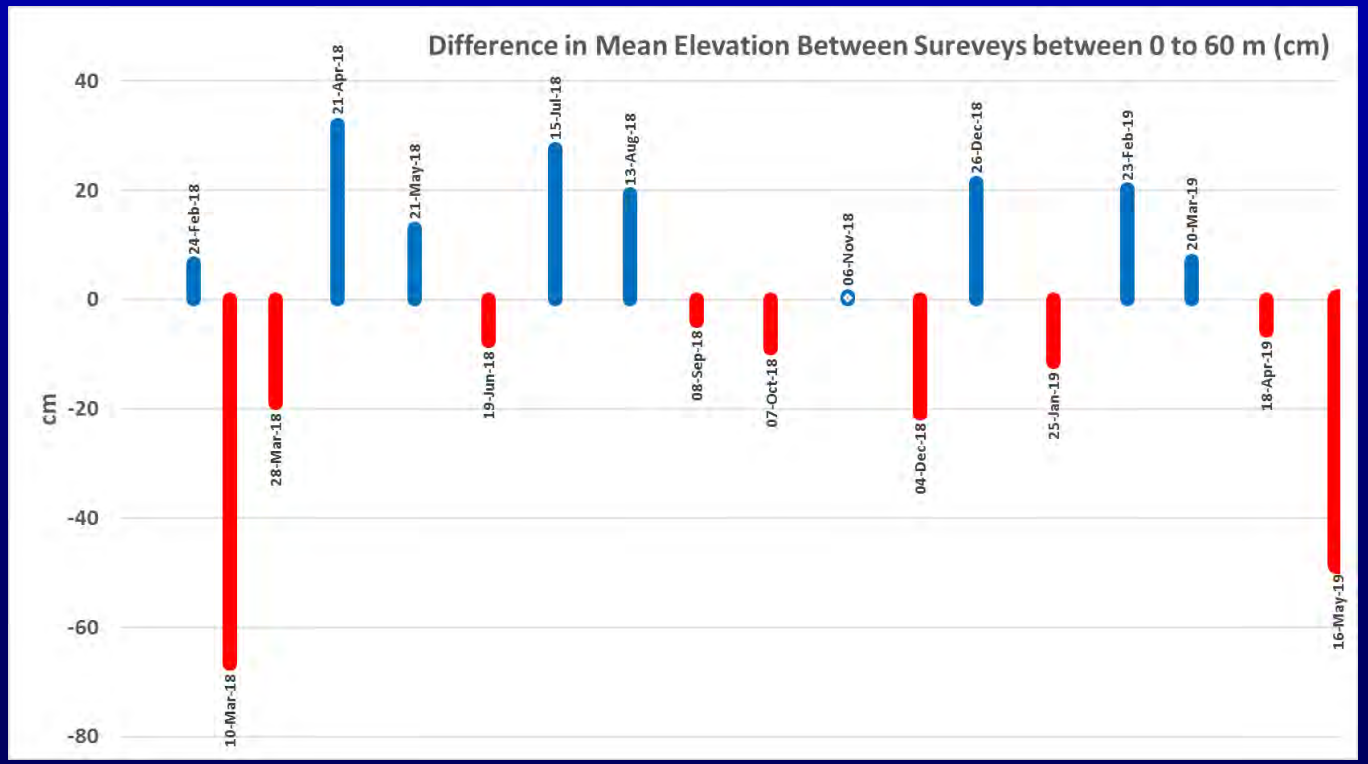


North Beach (NB01): April 21 (Black), July 15 (Red) and September 8 (Blue), 2018

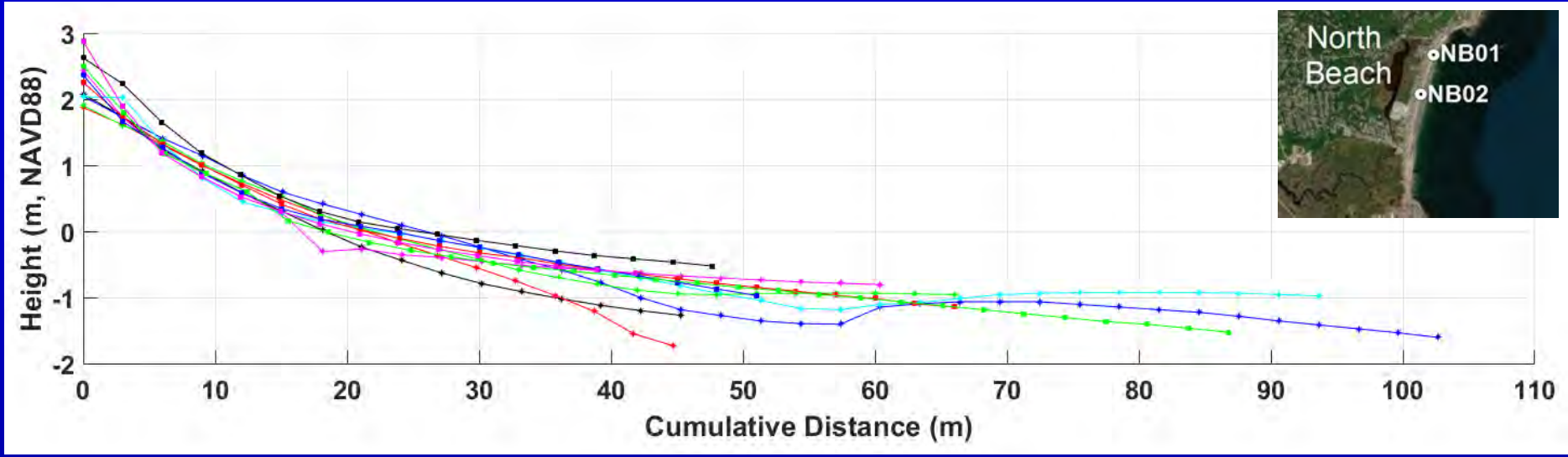



Peat


NB01: Total Subaerial Beach Volume Between 0 to 60 m (m³)
Erosion Due to
Winter/Spring 2018 Storms
Cubic Meters
160
150
140
130
120
110
100
90
27-Jan-18
24-Feb-18
10-Mar-18
28-Mar-18
21-Apr-18
21-May-18
19-Jun-18
15-Jul-18
13-Aug-18
08-Sep-18
07-Oct-18
06-Nov-18
04-Dec-18
26-Dec-18
25-Jan-19
23-Feb-19
20-Mar-19
18-Apr-19
16-May-19


Difference in Mean Elevation Between Sureveys between 0 to 60 m (cm)
cm
40
20
0
-20
-40
-60
-80
24-Feb-18
10-Mar-18
28-Mar-18
21-Apr-18
21-May-18
19-Jun-18
15-Jul-18
13-Aug-18
08-Sep-18
07-Oct-18
06-Nov-18
04-Dec-18
26-Dec-18
25-Jan-19
23-Feb-19
20-Mar-19
18-Apr-19
16-May-19

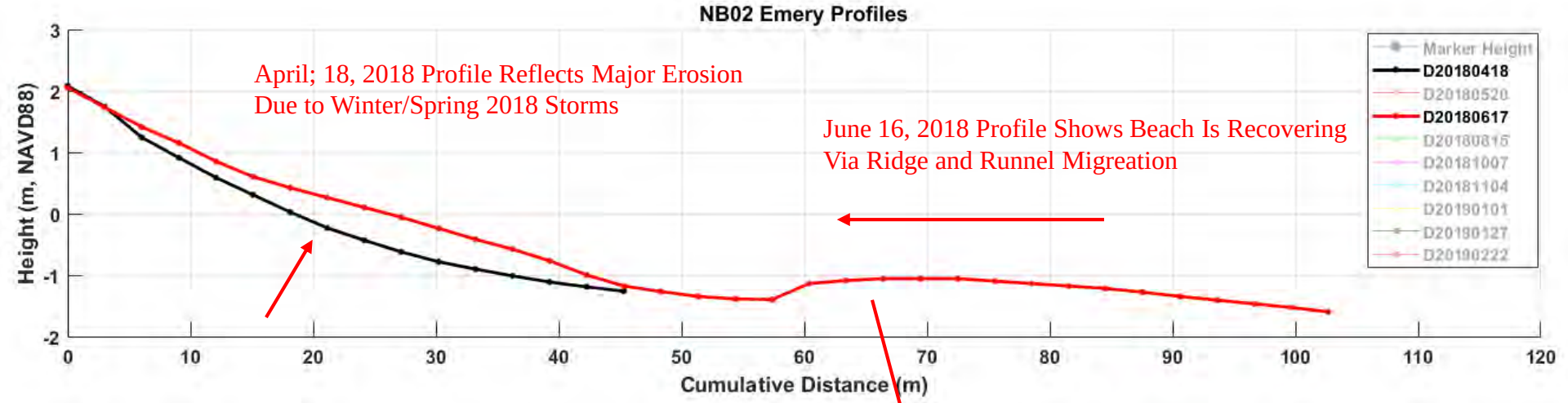
All Profiles At North Beach (NB02): April 8, 2018 to May 16, 2019 (11 Profiles)



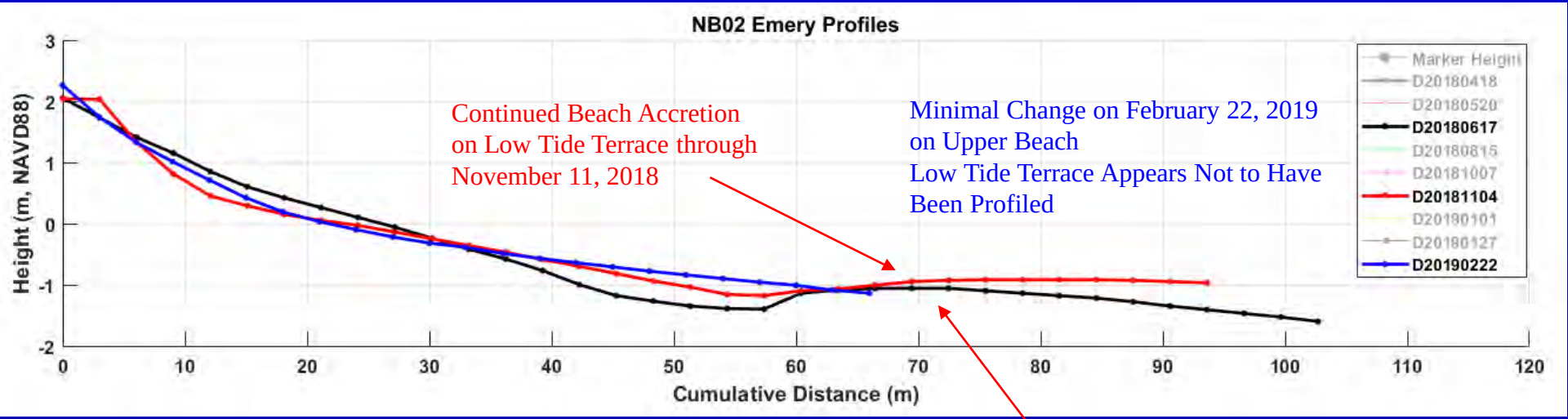
April 18, 2018

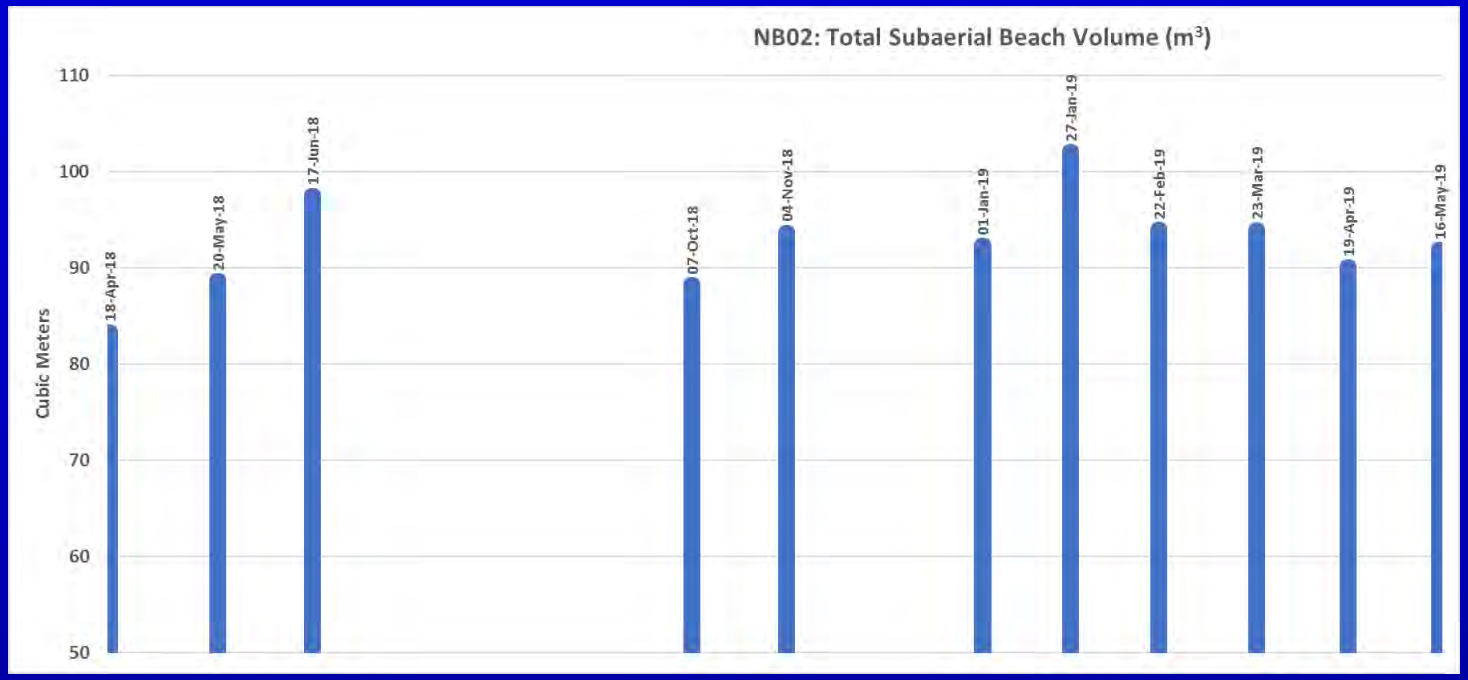
June 17, 2018

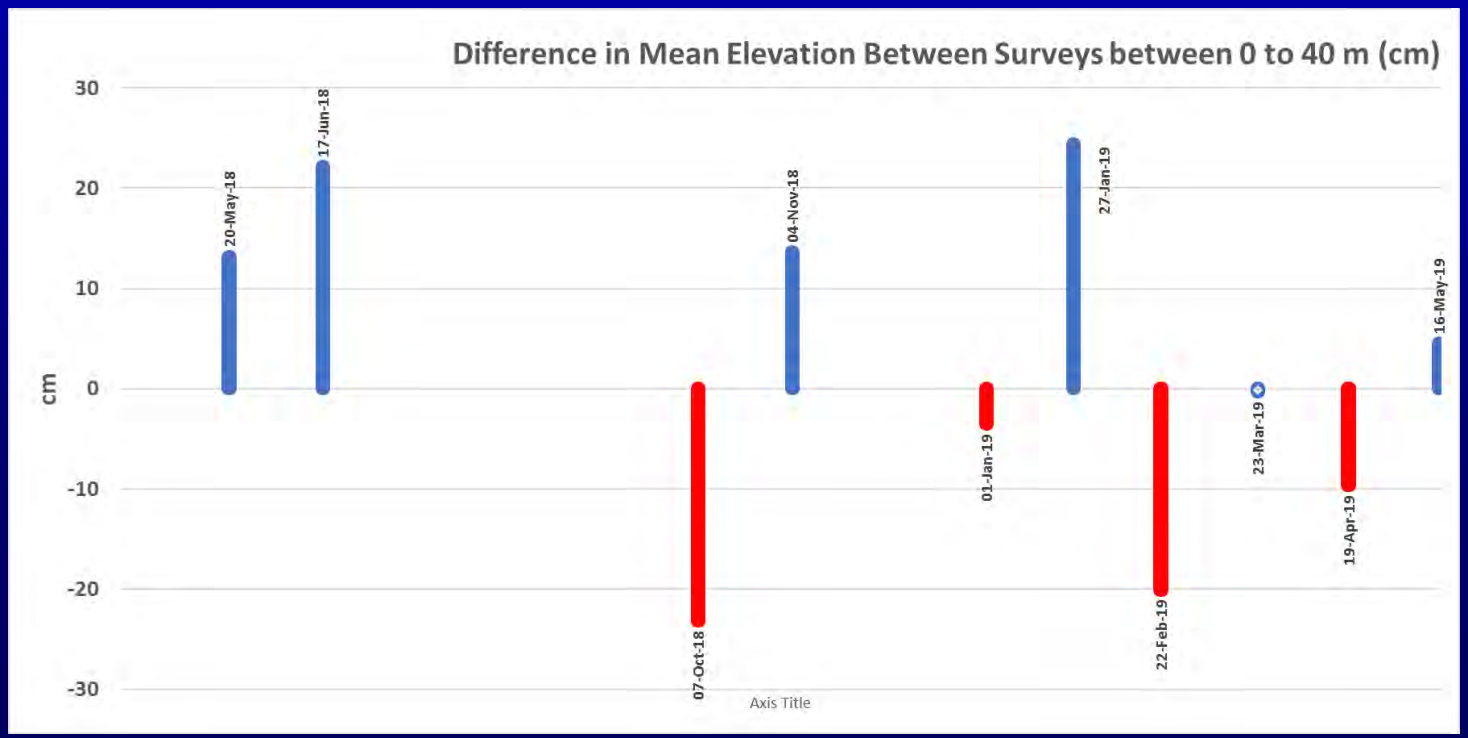
North Beach (NB02): April 18 (Black) and June 16 (Red), 2018



North Beach (NB02): June 16 (Black) and November 4 (Red), 2018 and February 22 (Blue), 2019

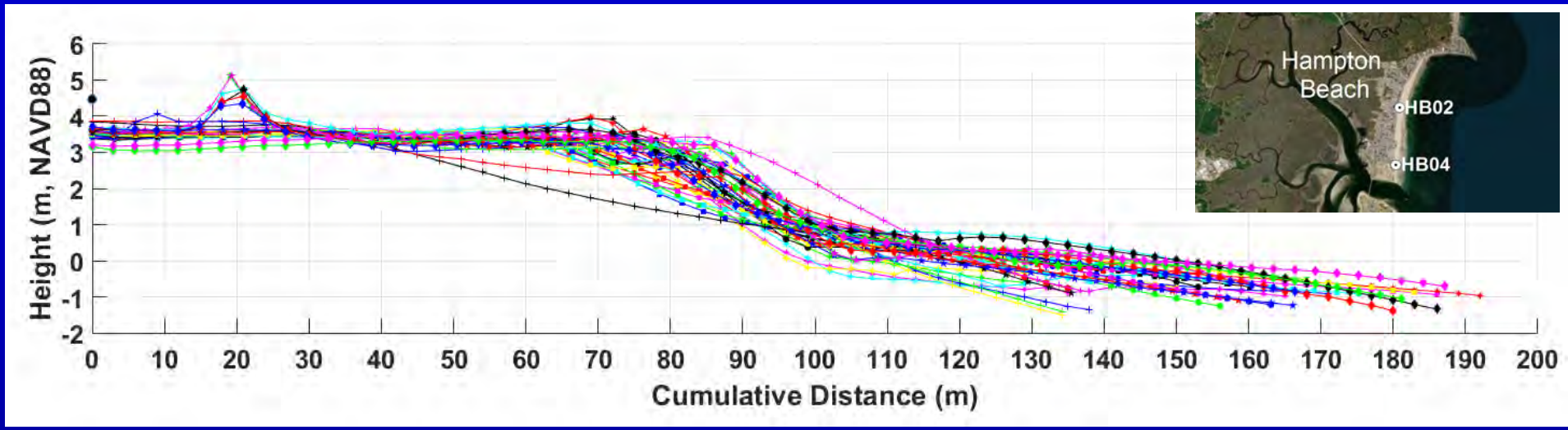



NB02: Total Subaerial Beach Volume (m³)
Cubic Meters
110
100
90
80
70
60
50
18-Apr-18
20-May-18
17-Jun-18
07-Oct-18
04-Nov-18
01-Jan-19
27-Jan-19
22-Feb-19
23-Mar-19
19-Apr-19
16-May-19


Difference in Mean Elevation Between Surveys between 0 to 40 m (cm)
cm
30
20
10
0
-10
-20
-30
20-May-18
17-Jun-18
07-Oct-18
04-Nov-18
01-Jan-19
27-Jan-19
22-Feb-19
23-Mar-19
19-Apr-19
16-May-19
Axis Title

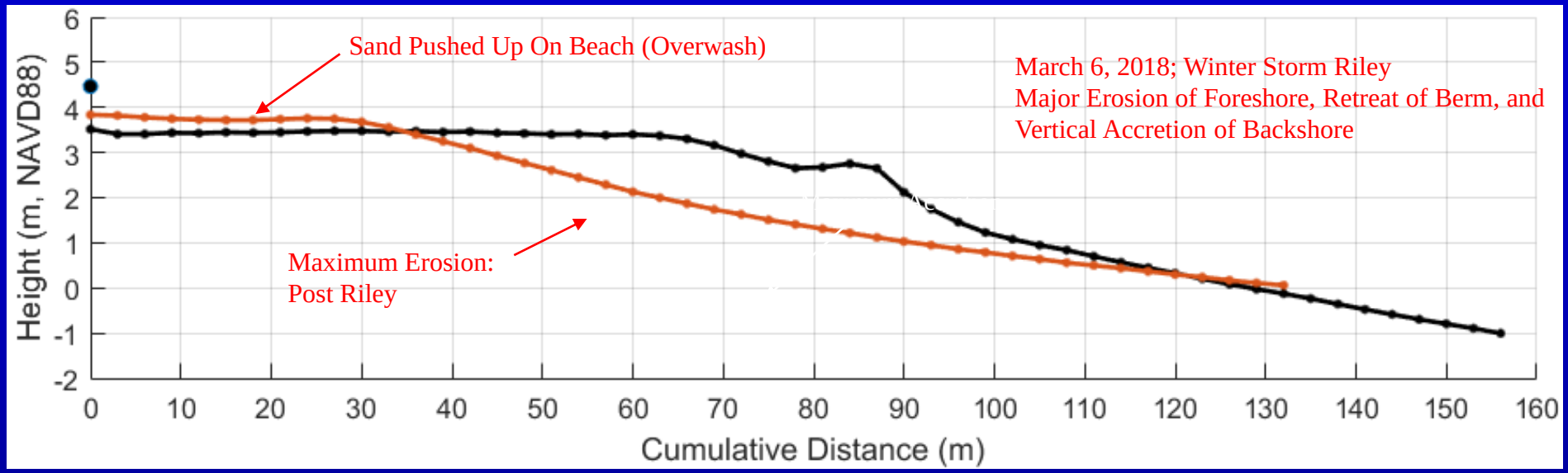
All Profiles at Mid-Hampton Beach : HB02

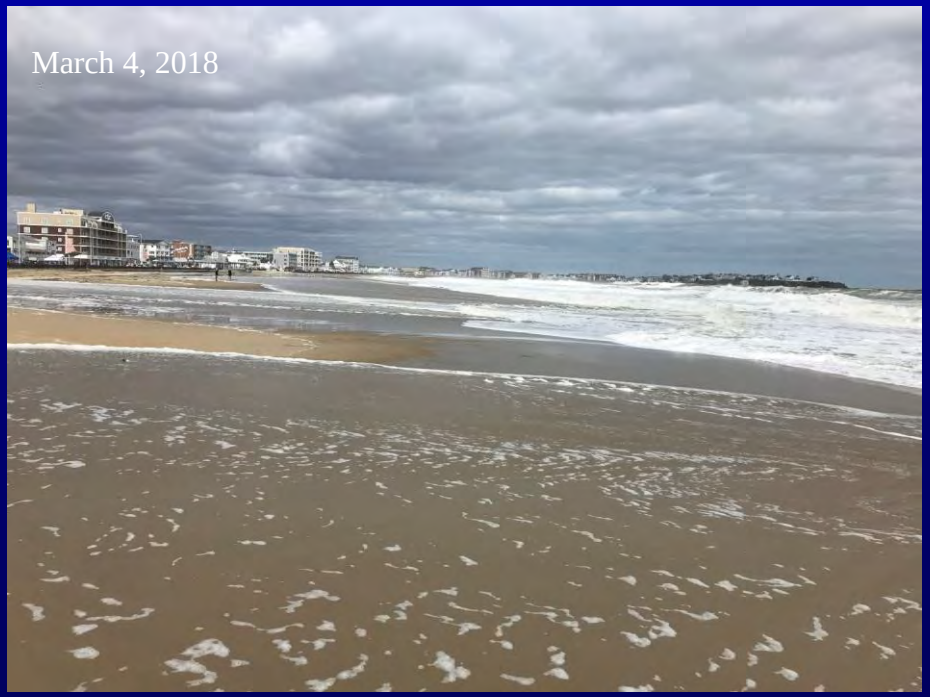
Dec 9, 2016 to June 4, 2019 (39 Profiles)



Maximum Summer Accretion and Maximum Erosion at Mid-Hampton Beach: HB02

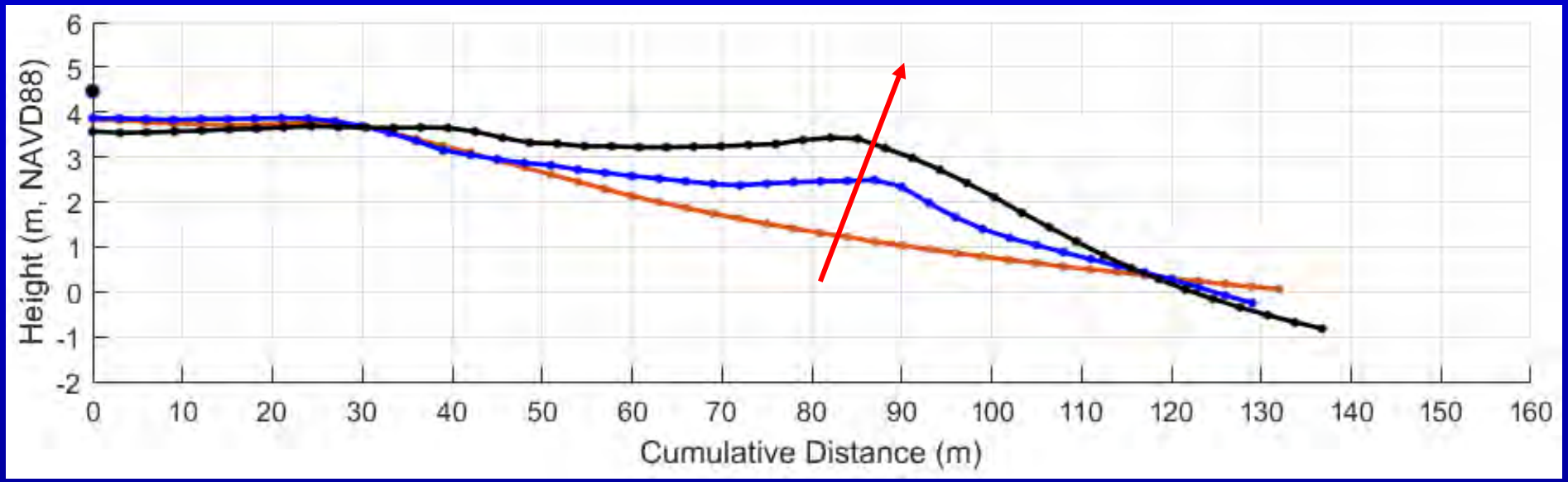
August 23 (Black), 2017 and March 6, 2018 (Red)





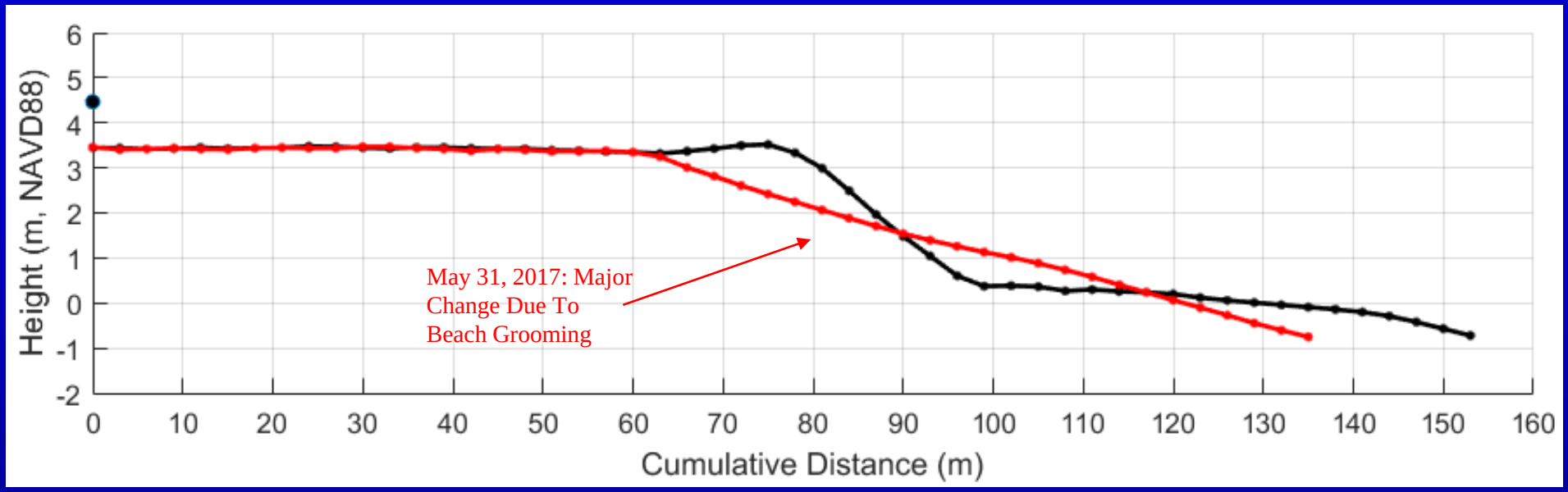
Recovery form Winter Storm Riley at Mid-Hampton Beach: HB02

March 6 (Red), March 27 (Blue), and June 15 (Black), 2018



Beach Grooming of Mid-Hampton Profile: HB02

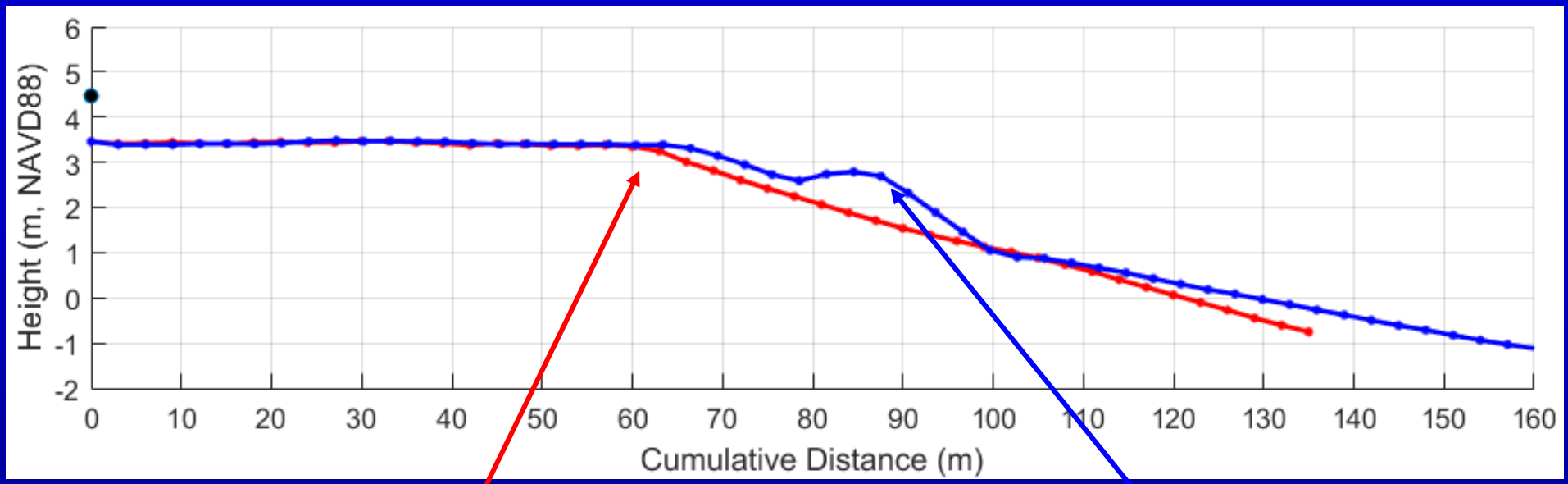
May 3 (Black) and May 31 (Red), 2017

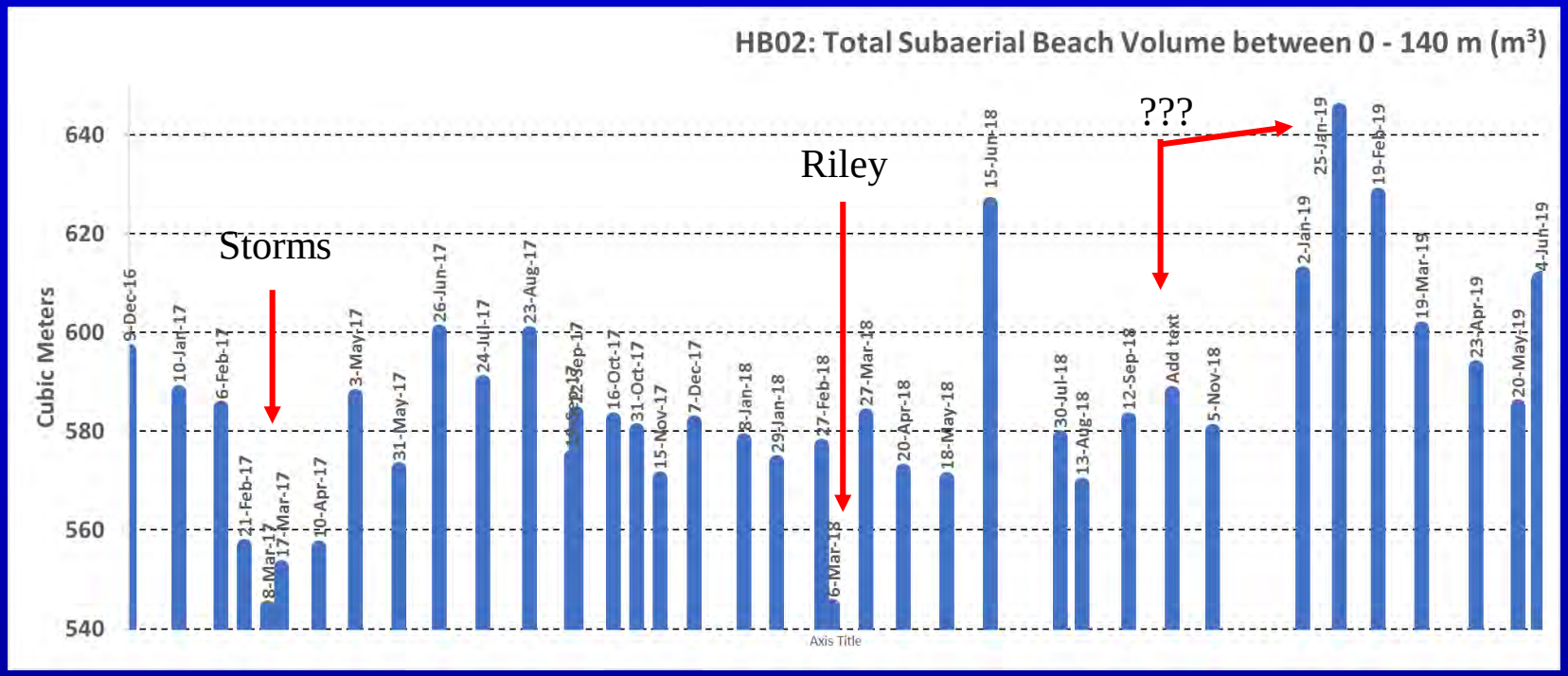


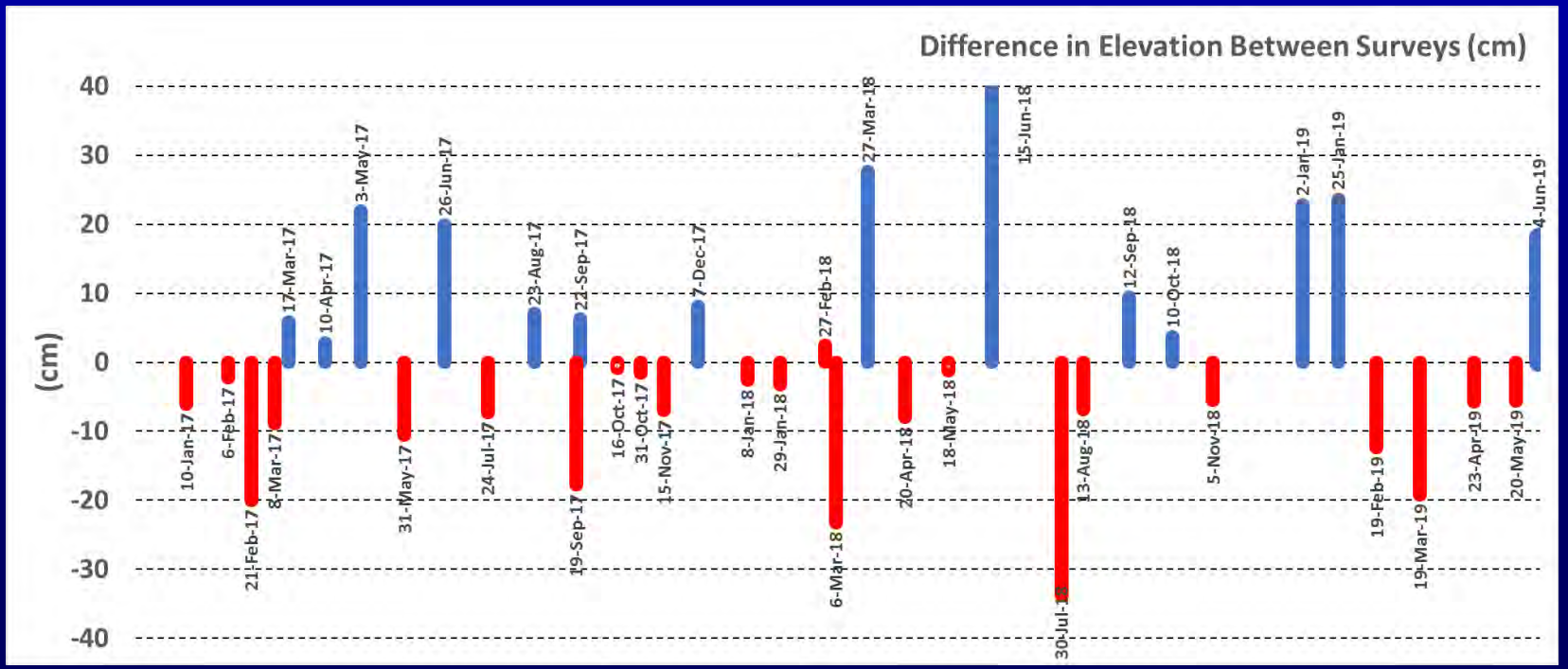
Beech Grooming at Mid-Hampton Beach: May 3, 2017

Beach Grooming and Recovery of Mid-Hampton Profile: HB02

May 31 (Red) and June 26 (Blue), 2017

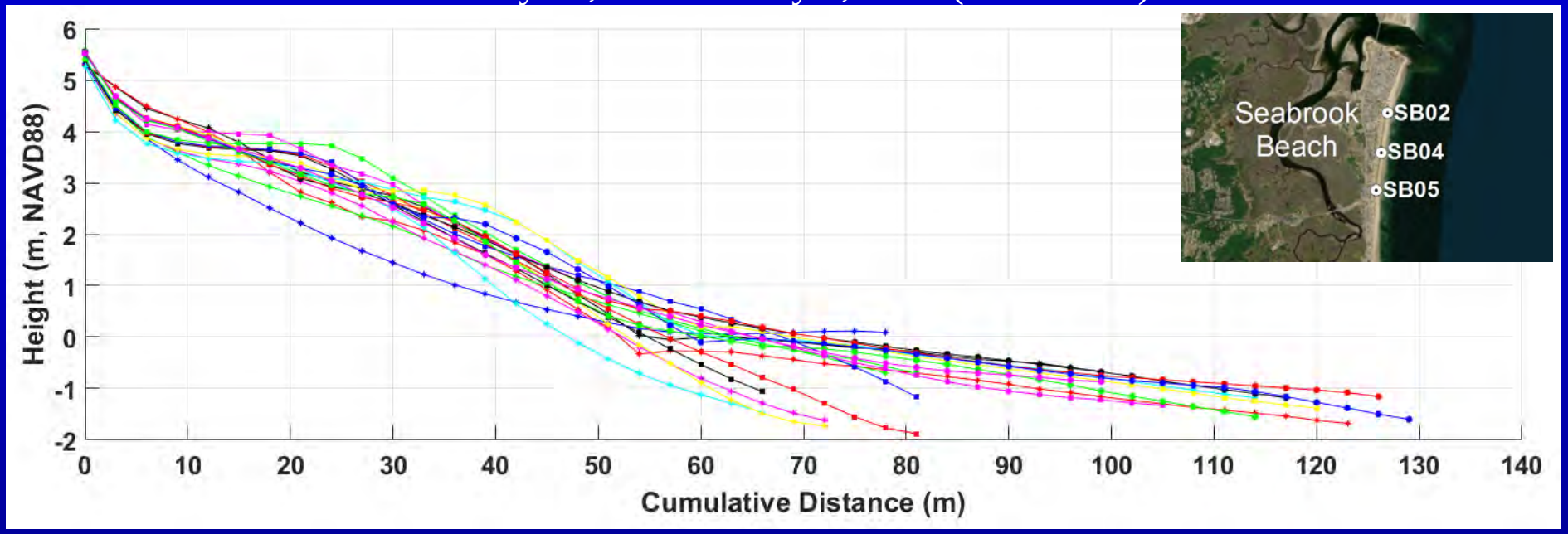



HB02: Total Subaerial Beach Volume between 0 - 140 m (m³)
Cubic Meters
640
620
600
580
560
540
Storms
Riley
???
9-Dec-16
10-Jan-17
6-Feb-17
21-Feb-17
8-Mar-17
17-Mar-17
10-Apr-17
3-May-17
31-May-17
26-Jun-17
24-Jul-17
23-Aug-17
16-Oct-17
31-Oct-17
15-Nov-17
7-Dec-17
8-Jan-18
29-Jan-18
27-Feb-18
6-Mar-18
27-Mar-18
20-Apr-18
18-May-18
15-Jun-18
30-Jul-18
13-Aug-18
12-Sep-18
Add text
5-Nov-18
2-Jan-19
25-Jan-19
19-Feb-19
19-Mar-19
23-Apr-19
20-May-19
4-Jun-19
Axis Title


Difference in Elevation Between Surveys (cm)
(cm)
40
30
20
10
0
-10
-20
-30
-40
10-Jan-17
6-Feb-17
21-Feb-17
8-Mar-17
17-Mar-17
10-Apr-17
3-May-17
31-May-17
26-Jun-17
24-Jul-17
23-Aug-17
19-Sep-17
21-Sep-17
16-Oct-17
31-Oct-17
15-Nov-17
7-Dec-17
8-Jan-18
29-Jan-18
27-Feb-18
6-Mar-18
27-Mar-18
20-Apr-18
18-May-18
15-Jun-18
30-Jul-18
13-Aug-18
12-Sep-18
10-Oct-18
5-Nov-18
2-Jan-19
25-Jan-19
19-Feb-19
19-Mar-19
23-Apr-19
20-May-19
4-Jun-19

All Profiles at Seabrook Beach: SB02

January 29, 2018 to May 5, 2019 (19 Profiles)




March 3, 2018

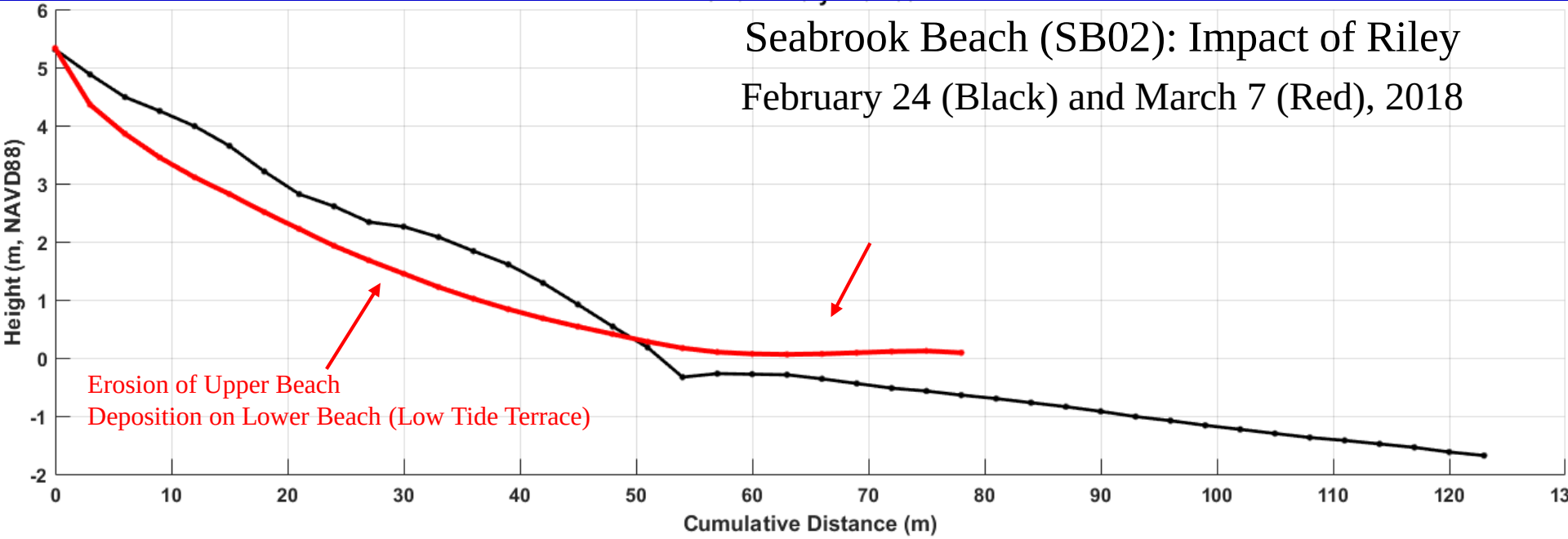

March 3, 2018
Note Extensive
Overwash from Storms


March 28, 2018
Note Scarp in Dunes
Eroded by Storms


March 28, 2018

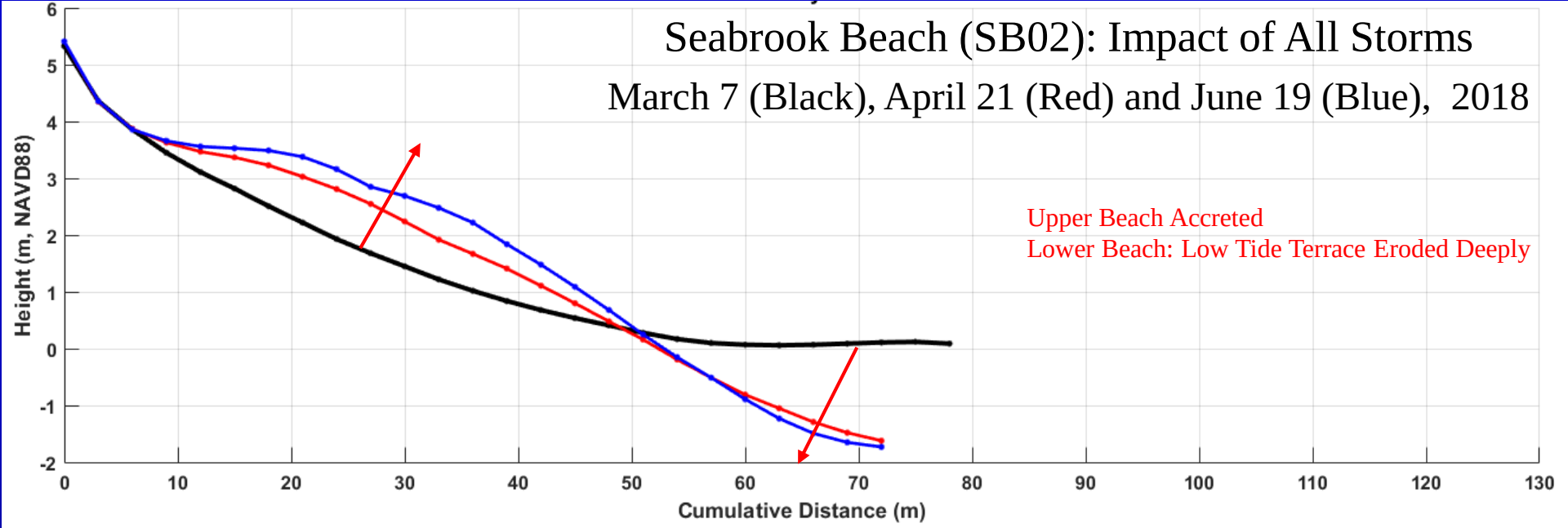
Seabrook Beach (SB02): Impact of Riley

February 24 (Black) and March 7 (Red), 2018

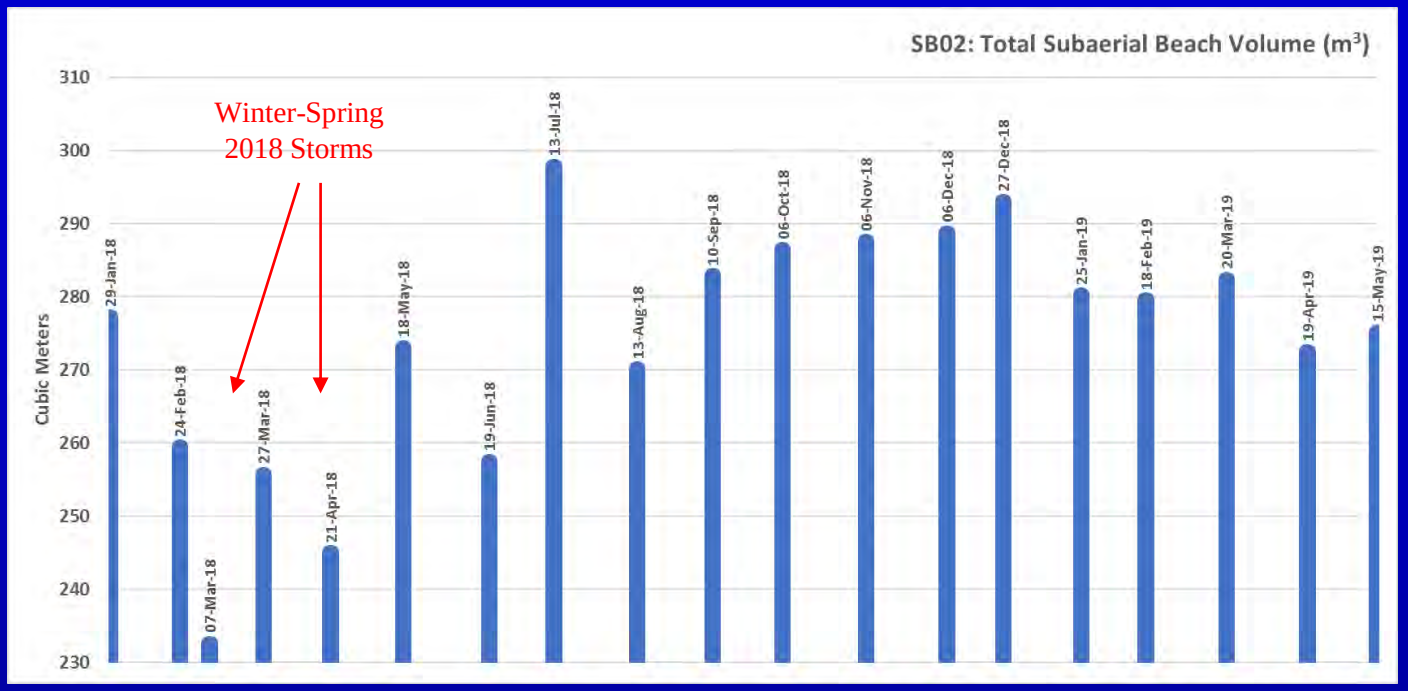


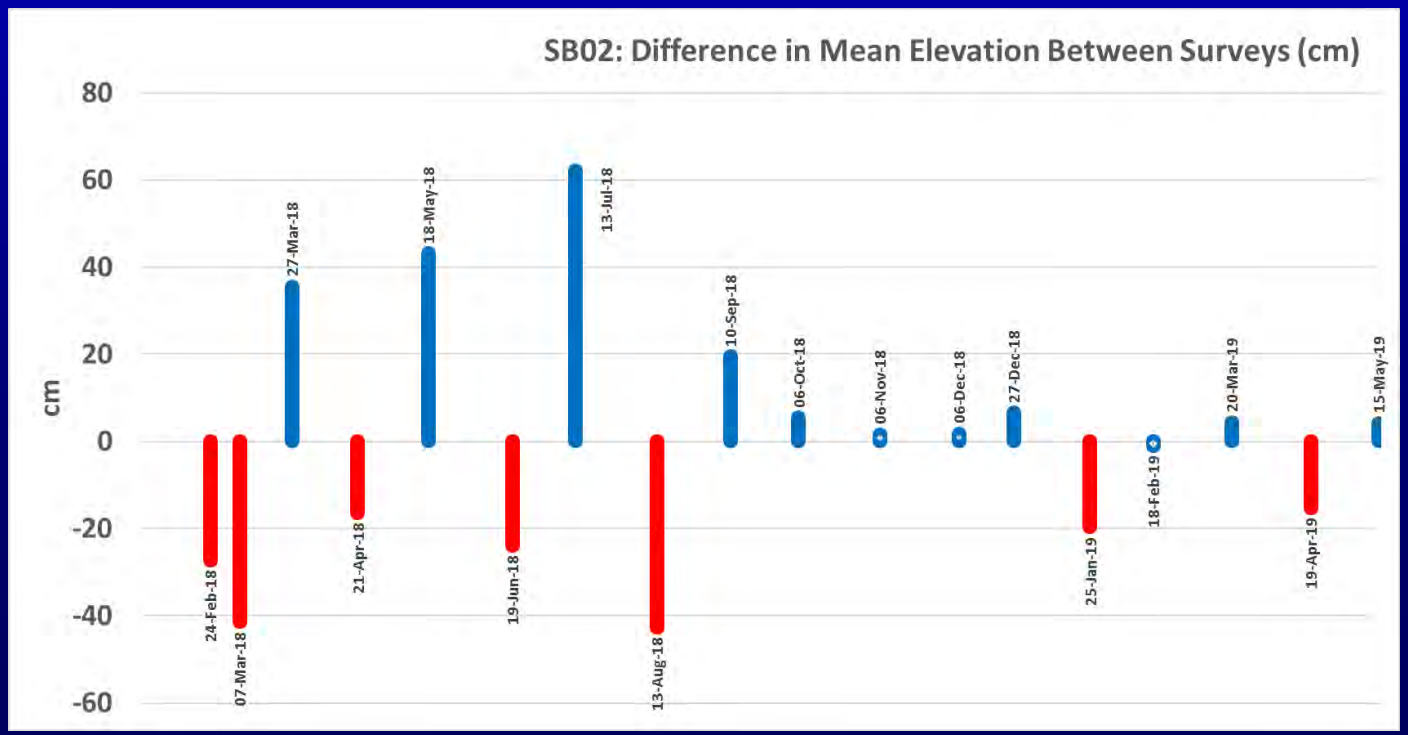
Seabrook Beach (SB02): Impact of All Storms

March 7 (Black), April 21 (Red) and June 19 (Blue), 2018



Upper Beach Accreted
Lower Beach: Low Tide Terrace Eroded Deeply


SB02: Total Subaerial Beach Volume (m³)
Winter-Spring
2018 Storms
Cubic Meters
310
300
290
280
270
260
250
240
230
29-Jan-18
24-Feb-18
07-Mar-18
27-Mar-18
21-Apr-18
18-May-18
19-Jun-18
13-Jul-18
13-Aug-18
10-Sep-18
06-Oct-18
06-Nov-18
06-Dec-18
27-Dec-18
25-Jan-19
18-Feb-19
20-Mar-19
19-Apr-19
15-May-19


SB02: Difference in Mean Elevation Between Surveys (cm)
cm
80
60
40
20
0
-20
-40
-60
24-Feb-18
07-Mar-18
27-Mar-18
21-Apr-18
18-May-18
19-Jun-18
13-Jul-18
13-Aug-18
10-Sep-18
06-Oct-18
06-Nov-18
06-Dec-18
27-Dec-18
25-Jan-19
18-Feb-19
20-Mar-19
19-Apr-19
15-May-19

All Profiles at Seabrook Beach: SB05

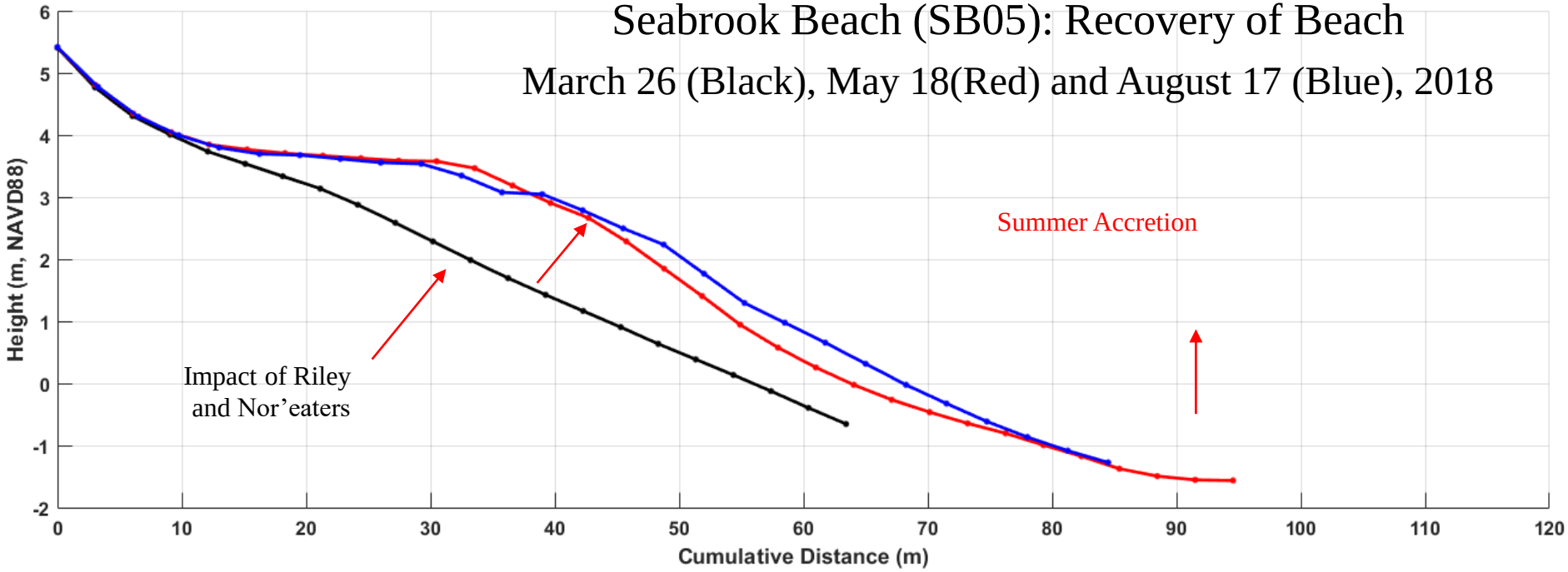
January 29, 2018 to May 18, 2019 (19 Profiles)

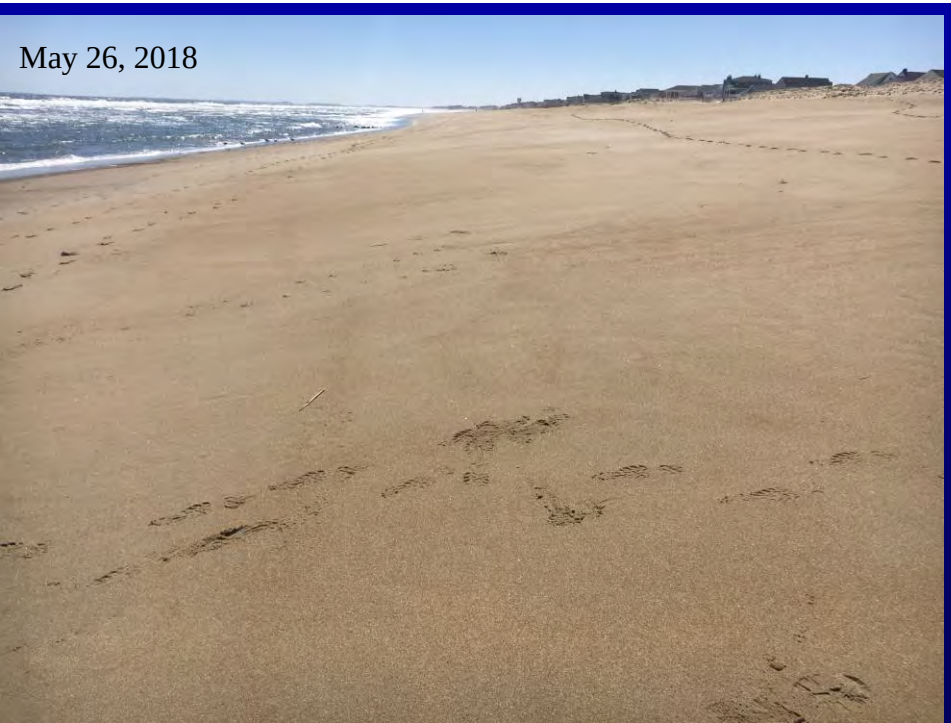
Height (m, NAVD88)

Cumulative Distance (m)

Seabrook Beach (SB05): Recovery of Beach

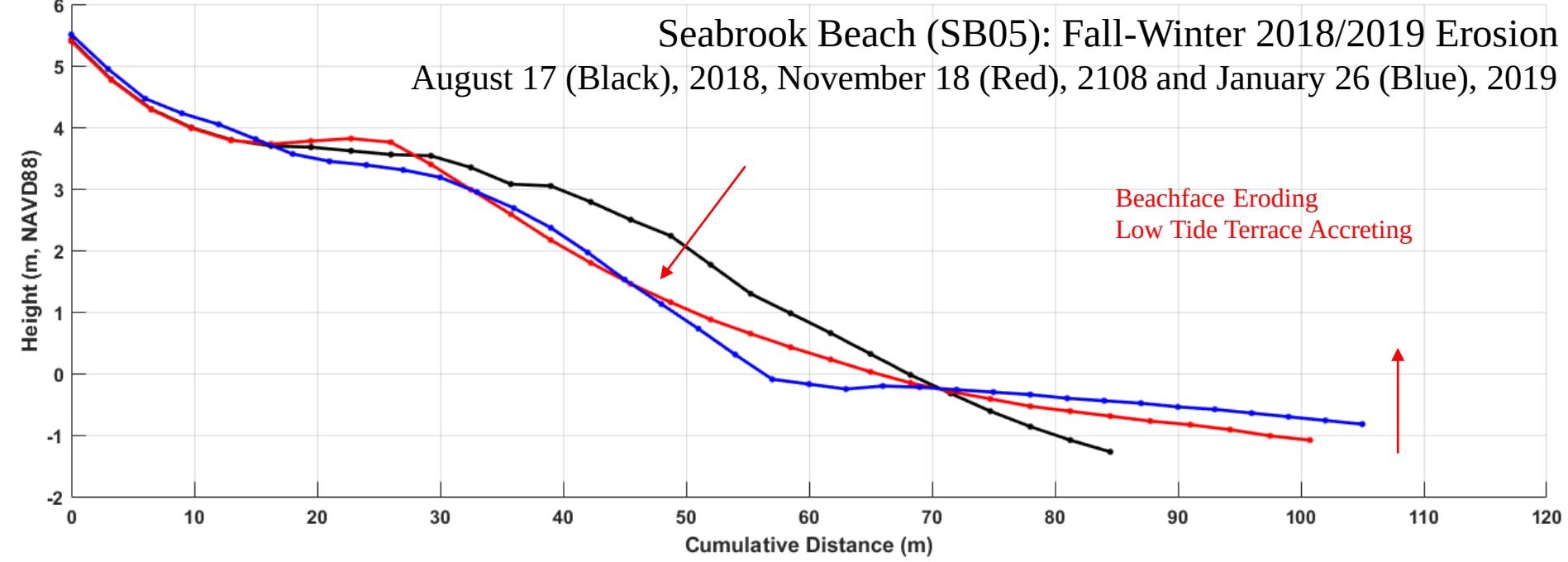
March 26 (Black), May 18(Red) and August 17 (Blue), 2018

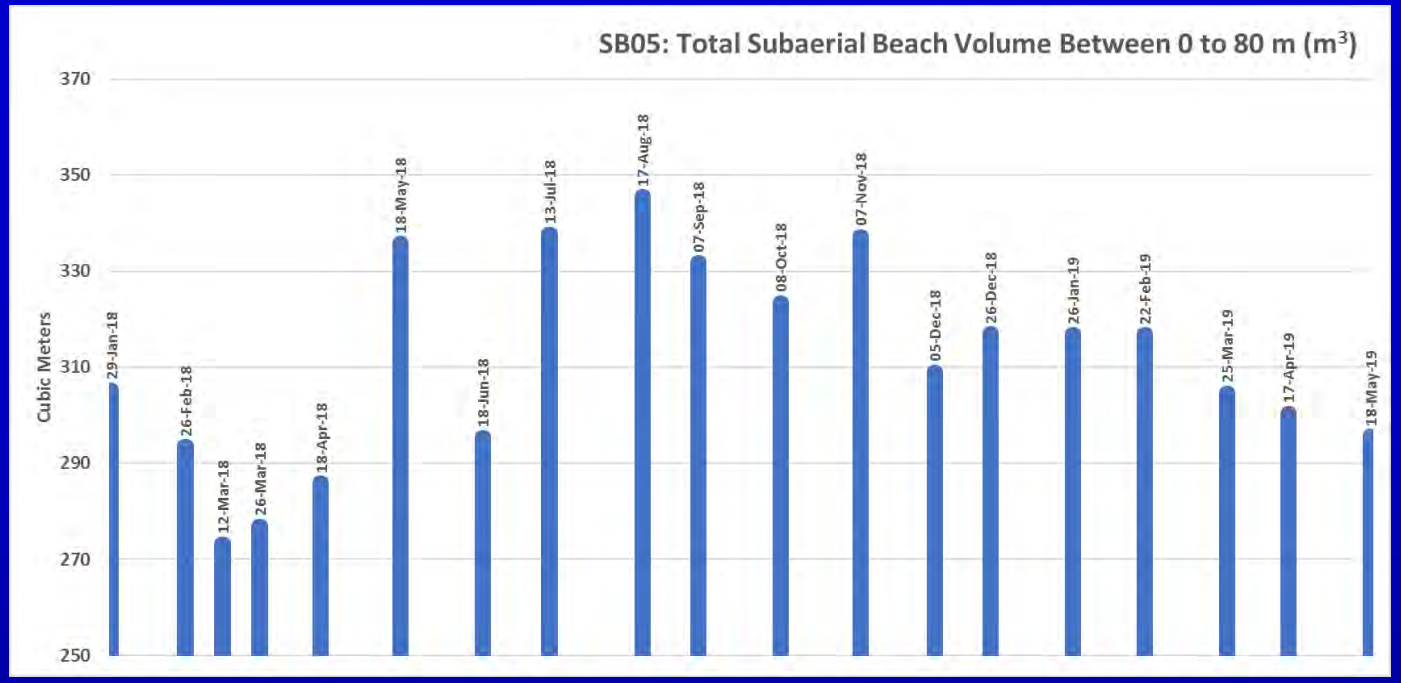


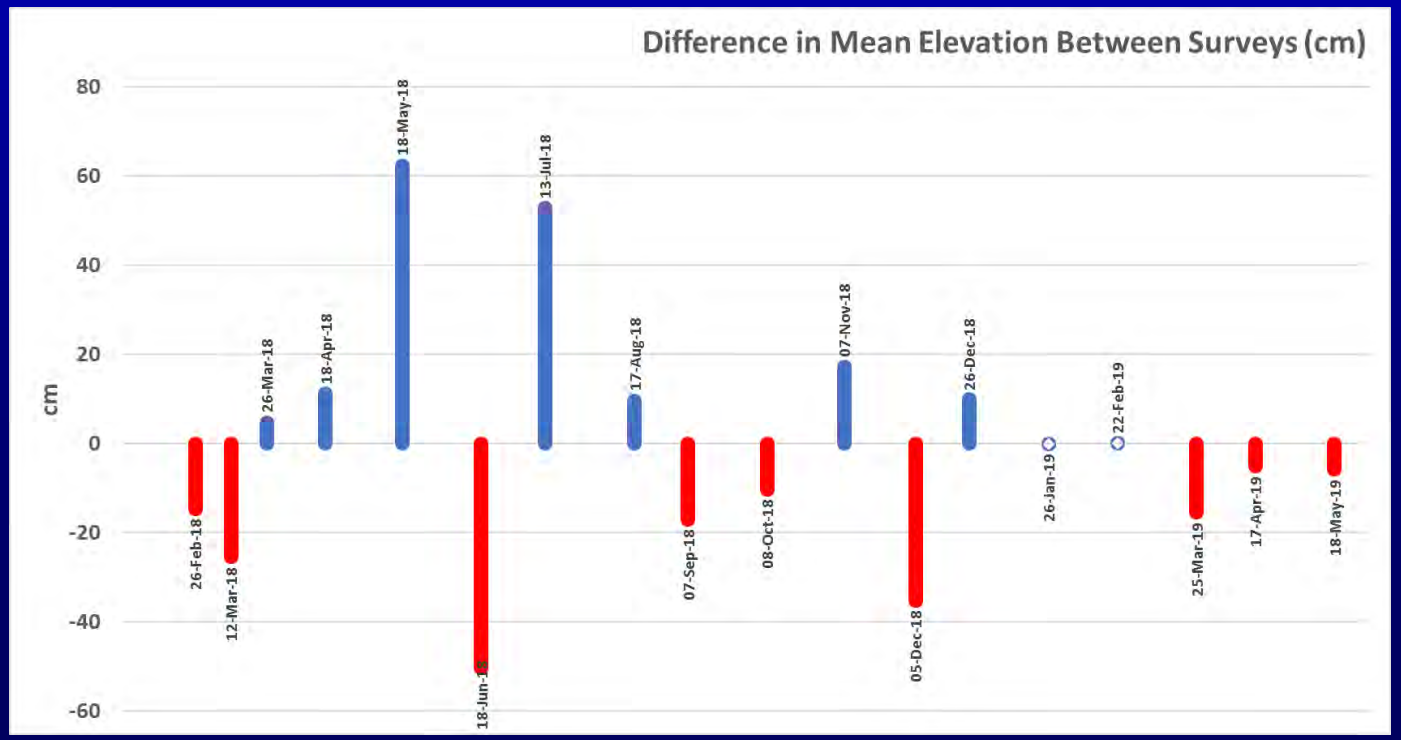


Seabrook Beach (SB05): Fall-Winter 2018/2019 Erosion

August 17 (Black), 2018, November 18 (Red), 2108 and January 26 (Blue), 2019




SB05: Total Subaerial Beach Volume Between 0 to 80 m (m3)
Cubic Meters
370
350
330
310
290
270
250
29-Jan-18
26-Feb-18
12-Mar-18
26-Mar-18
18-Apr-18
18-May-18
18-Jun-18
13-Jul-18
17-Aug-18
07-Sep-18
08-Oct-18
07-Nov-18
05-Dec-18
26-Dec-18
26-Jan-19
22-Feb-19
25-Mar-19
17-Apr-19
18-May-19


Difference in Mean Elevation Between Surveys (cm)
cm
80
60
40
20
0
-20
-40
-60
26-Feb-18
12-Mar-18
26-Mar-18
18-Apr-18
18-May-18
18-Jun-18
13-Jul-18
17-Aug-18
07-Sep-18
08-Oct-18
07-Nov-18
05-Dec-18
26-Dec-18
26-Jan-19
22-Feb-19
25-Mar-19
17-Apr-19
18-May-19

Summary

- The Volunteer Beach Profiling Program is Providing a Cost-Effective Approach to Monitoring NH Beaches
- The Database Being Developed Will Help Guide Future Management Decisions Such As:
  - Which Are Our Most Vulnerable Beaches
  - Where Should Dredge Material Be Placed
  - Which Beaches Are the Best Candidates for Beach Nourishment
- The Database Is Growing Extremely Fast and We Have to Determine How Best to Analyze, Archive, and Present the Results
- Next Step is to Complete Analysis and Synthesis of Present Database
- And Link with the NHGS to Develop Web Site
- And Finally, We Should Monitor the Beach Nourishments at Seabrook This Winter

Acknowledgements

- New Hampshire Coastal Program
- BOEM – New Hampshire Cooperative Agreement
- UNH/NOAA Joint Hydrographic Center
  - (Award NA10NOS4000073)
- University of New Hampshire Department of Earth Sciences

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