Regional Monitoring of Hardbottom Resources Under the BMA

Cheryl Miller, President, Coastal Eco-Group Inc.

Coastal Eco-Group Inc.

SEAL OF THE TOWN OF PALM BEACH FLORIDA
INCORPORATED APRIL 17, 1911

Florida Department of Environmental Protection

TETRA TECH

NSU
NOVA SOUTHEASTERN UNIVERSITY

Goals of the BMA cell-wide monitoring plan

- *1. provide reasonable assurance under State regulatory requirements (Chapter 161 and part IV of 373, F.S.) that approved projects will have no unanticipated impacts to nearshore hardbottom and their associated benthic communities; and*

- *2. Evaluate the variability of sand cover over ephemeral and persistent hardbottom, and resulting habitat functional shifts within this coastal cell.*

BMA cell-wide monitoring plan

Does beach nourishment have a greater effect on functions of nearshore hardbottom within the influence of the project than areas outside of the project influence?

Does nearshore hardbottom within the influence of beach project continue to exhibit the same variability in frequency of exposure and functions as nearshore hardbottom located outside the influence of beach nourishment in the BMA cell?

Creation of 2014 Baseline Benthic Habitat Map

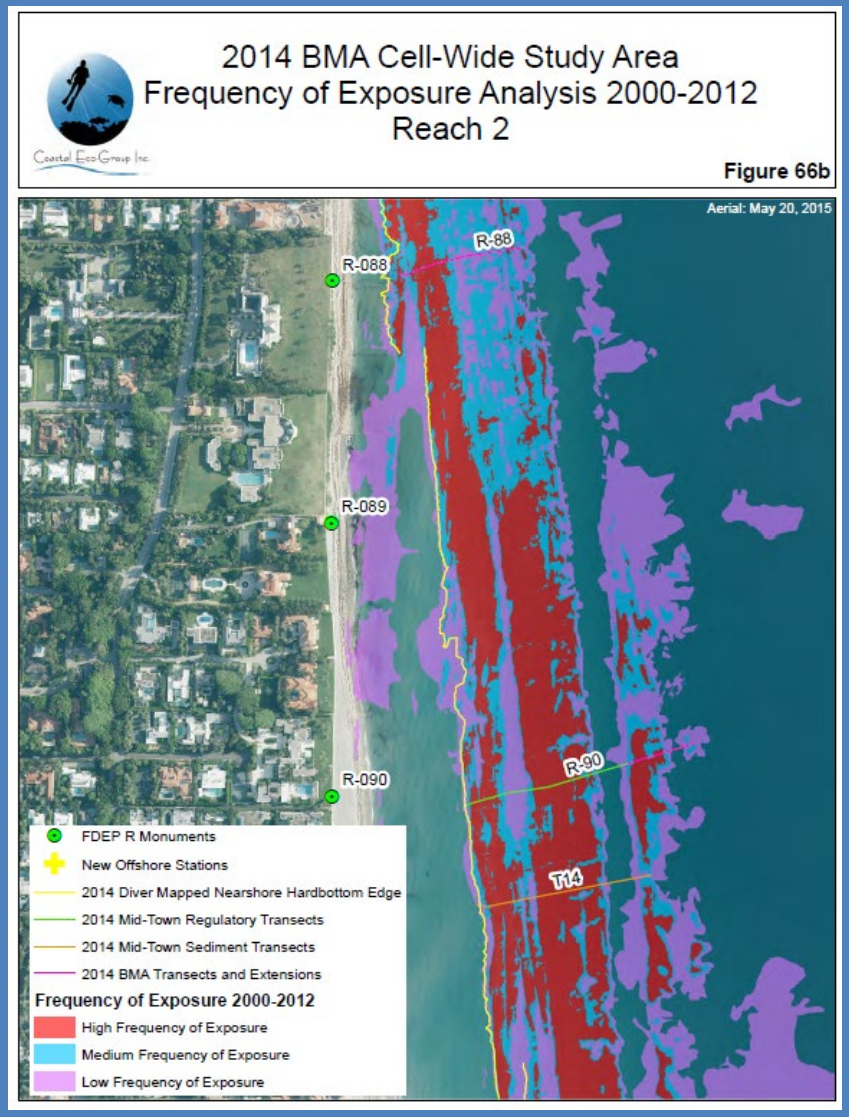
Persistence evaluated by frequency of exposure in aerial imagery: high, medium and low

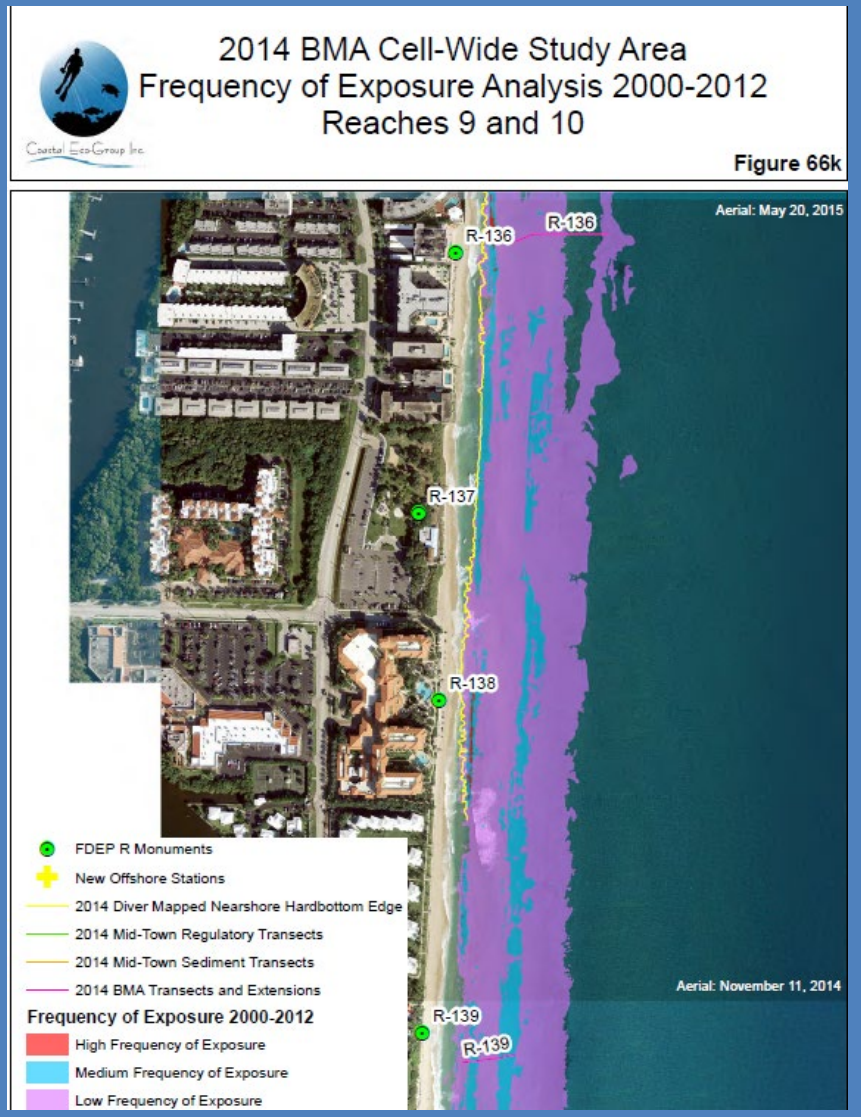
Distance/Depth categories in BMA monitoring plan

Nearshore hardbottom- < 4 m
Intermediate hardbottom- 4 to 8 m
Offshore hardbottom - > 8 m

115 groundtruthing sites randomly selected stratified by exposure frequency and distance/depth

Frequency of hardbottom exposure in aerial photography





BMA Benthic Habitat Study Results

Classification system should be updated using site specific data for the BMA cell

Accuracy of depth/distance categories in BMA - nearshore, intermediate, and offshore zones

Benthic habitat data shows that benthic community changes at 3 m water depth.

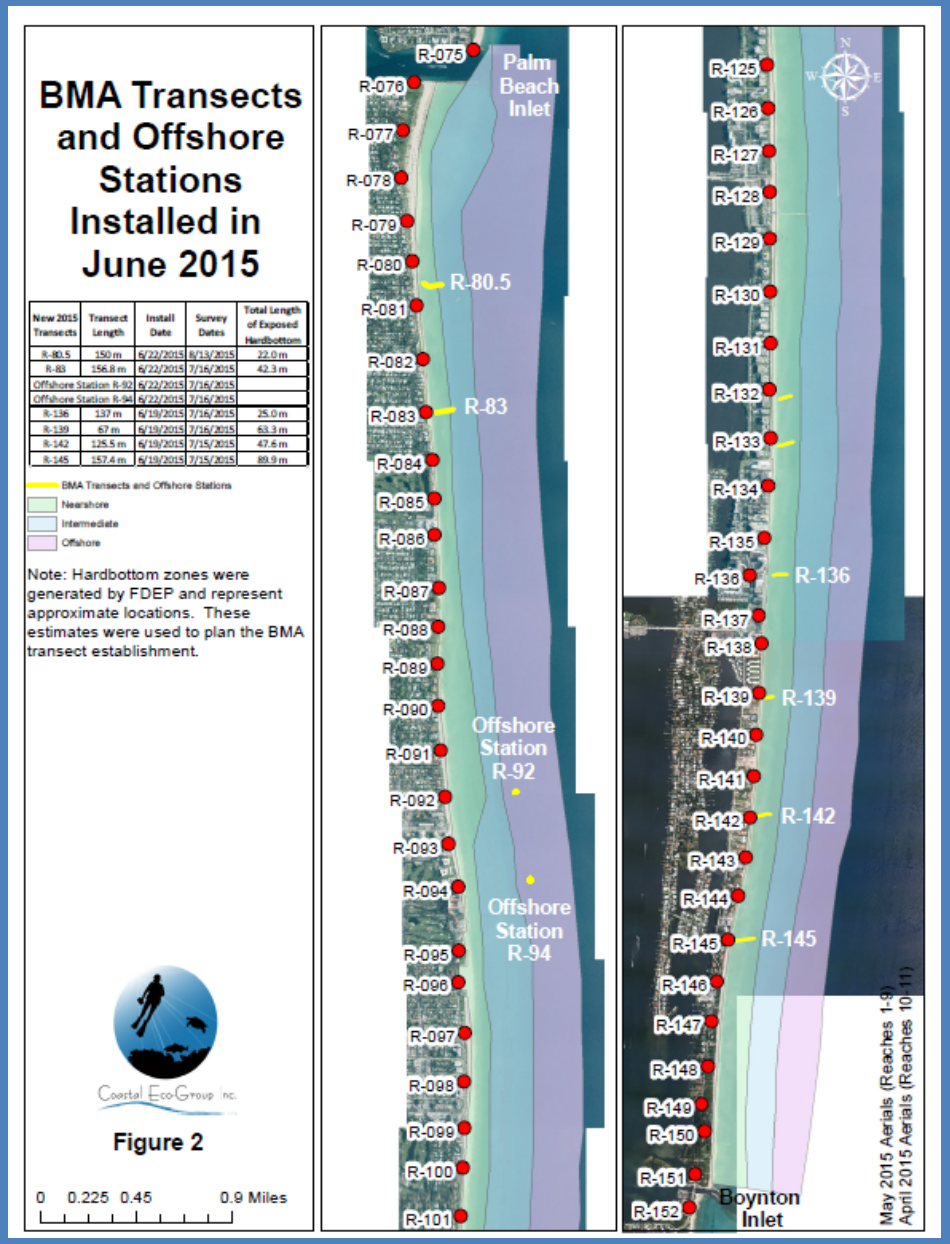
BMA Monitoring Network

17 regulatory transects in Mid-Town - 8 sediment and 9 benthic transects and one artificial reef transect

15 BMA transects to evaluate variability in hardbottom exposure including 2 BMA transects in Mid-Town

Four offshore extensions of Mid-Town transects

2 offshore stations in Mid-Town project area to capture offshore hardbottom



Hardbottom Exposure by Reach, 2014 through January 2020

BMA Reach Designation	FDEP Reference Monuments	July 3 & November 11-13, 2014	May 20 & April 1, 2015 (NSU&CEG)	February 26, 2016 Acreage (NSU & CEG)	July 9 & 16, 2016 Acreage (PBC)	January 9, 11, & 16 and July 19, 2017 Acreage (CEG)	August 9, 10, 11 and 15, 2018 Acreage (CEG)	January 8 and 13, 2020 Acreage (CEG)
Reach 1 (Palm Beach Inlet)	R-76 to R-78	0.0	0.0	0.0	0.0	0.0	0.0	N/Aˆ
Reach 2	R-78 to R-90+400	63.3	49.1	**64.3**	40.5	45.4	60.6	**39.0** ˆ
Reach 3	R-90+400 to R-95	53.1	51.8	**65.7**	49.4	51.5	**41.7**	46.7
Reach 4	R-95 to R-102+300	39.8	44.0	**51.5**	41.4	47.2	38.6	**36.1**
Reach 5	R-102+300 to R-110+100	18.5	18.1	**24.8**	15.4	21.3	19.8	**14.3**
Reach 6	R110+100 to R-116+500	2.3	2.0	2.1	1.4	0.2	3.8	2.8
Reach 7	R-116+500 to R-128+530	**10.1**	9.5	1.1	0.1	**0.0**	0.9	4.5
Reach 8	R128+530 to R-133+500	9.6	3.6	7.1	6.1	**3.1**	16.4	**16.5**
Reach 9	R-133+500 to R-137+400	15.5	10.9	14.2	9.7	**6.3**	**17.6**	13.4
Reach 10	R-137+400 to R-142	43.7	42.18*	1.47 (only to R-138)	**29.0**	23.80*	45.8	**46.7**
Reach 10	R-142 to R-145+740			N/A				
Reach 11 (Boynton Inlet)	R-145+740 to R-151+300	**3.7**	2.18*	N/A	**0.3**	1.89*	2.2	**3.7**
Total		**260*** **	**233***	***232****	**193**	**200***	**247**	**224**

*hybrid acreages from Town and County aerials- April and May 2015 and January and July 2017; delineations from Reaches 1-10 are from May 20, 2015 and July 19, 2017 aerials.

The 2015 and 2017 delineations are missing intermediate and offshore hardbottom from approximately R-146+320 ft south to Boynton Inlet in Reach 11. There were ~1.6 acres of exposed hardbottom in the November 2014 baseline aerial in this area.

**Total acreage does not include entire BMA cell-wide area.

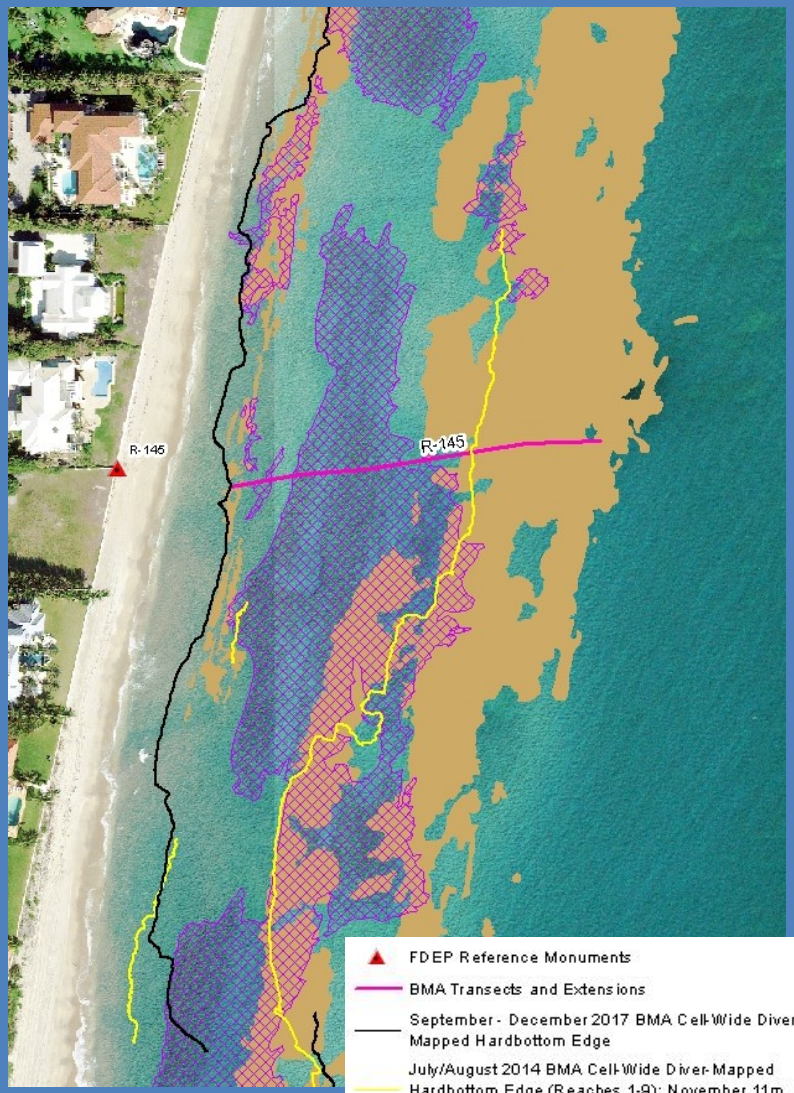
Hardbottom Distribution Analysis- 2000 through 2020

- Greatest overall exposure was July 2006 with 267 acres followed by July/November 2014 with 260 acres
- Exposure in Reaches 4 and 5 was higher in July 2017 than 2014. Highest exposure was in February 2016 aerial photography and lowest in January 2020.
- After all time lows in July 2017 aerial photography in Reaches 6 and 7, exposure in Reach 6 increased in 2018 to 1.5 acres higher than the 2014 baseline.
- Exposure in Reach 3 increased from July 2016 to July 2017, then decreased in August 2018 to low of about 42 acres. Exposure increased in January 2020 to about 47 acres.

Variability in nearshore exposure in Reach 2 – 2014 versus 2020

Reach 2 experienced the greatest decrease in exposed hardbottom between July 2014 and January 2020 with nearly 15 acres of burial between R-83 and R-90+400 ft

Shifting of intertidal and nearshore hardbottom exposure in Reach 10, R-145 2014 versus 2017 (L) and 2014 versus January 2020 (R)



FDEP Reference Monuments
BMA Transects and Extensions
September - December 2017 BMA Cell-Wide Diver-Mapped Hardbottom Edge
July/August 2014 BMA Cell-Wide Diver-Mapped Hardbottom Edge (Reaches 1-9); November 11m 2014 (Reaches 10 & 11)
DRAFT July 19, 2017 Aerial Delineated Hardbottom (Reaches 1-9); January 20, 2017 (Reaches 10 & 11)
July 3, 2014 Aerial Delineated Hardbottom (Reaches 1-9); November 11, 2014 (Reaches 10 & 11)

0 25 50 Meters

July 3 & November 11, 2014 Aerial Delineated Hardbottom
January 8 & 13, 2020 Aerial Delineated Hardbottom

0 20 40 80 120 Meters

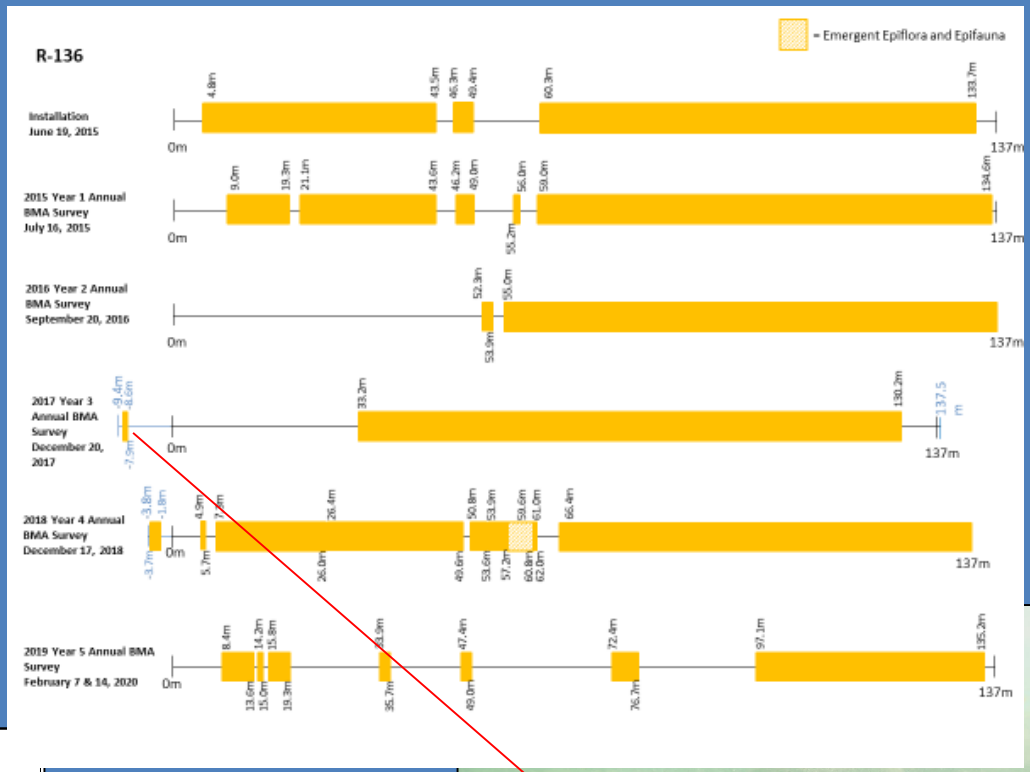
January 20, 2017 Aerials

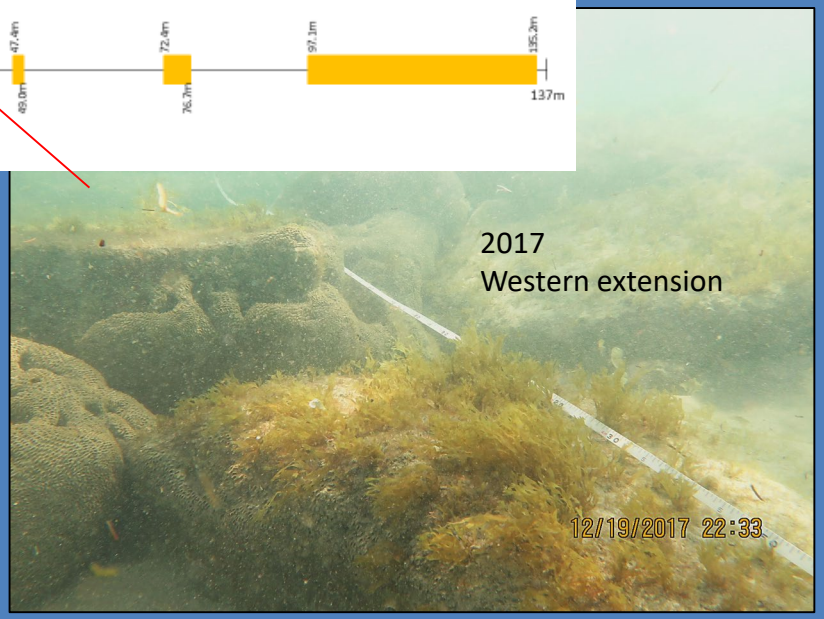
BMA surveys track new hardbottom exposure at landward and seaward ends of transects 2014 through 2019

Transect	Total length of transect (m)					2015 Extension		2016 Extension		2017 Extension			2018 Extension			2019 Extension		
	Installation/ Baseline	2015 Year 1 Survey	2016 Year 2 Survey	2017 Year 3 Survey	2018 Year 4 Survey	Length (m)	Location of Tranesct	Length (m)	Location of Tranesct	Length (m)	Location of Tranesct	*Length of Exposed HB Along Extension	Length (m)	Location of Tranesct	*Length of Exposed HB Along Extension	Length (m)	Location of Tranesct	*Length of Exposed HB Along Extension
R-80.5	150.0	150.0	150.0	150.0	151.8	-	-	-	-	2.0	West	-	1.8	West	-	-	-	-
R-83	156.8	156.8	156.4	156.8	173.2	-	-	1.6	West	-	-	-	16.4*	West	3.6	-	-	-
R-103	151.0	151.0	151.0	173.0	151.0	-	-	-	-	23.0*	East	21.0	-	-	-	-	-	-
R-115	15.5	15.5	15.5	17.5	15.5	-	-	-	-	2.0	East	-	-	-	-	-	-	-
R-132	117.0	117.0	123.0	117.0	117.0	-	-	6.0	West	-	-	-	-	-	-	10.2	East	-
R-133	143.0	143.0	149.2	146.0	150.1	-	-	7.2	West	3.0	West	-	7.1	West	-	-	-	-
R-136	137.0	137.0	137.0	146.9	140.8	-	-	-	-	9.4*/0.5*	West/East	8.7 / 0.5	3.8*	West	1.9	-	-	-
R-139	67.0	67.0	73.9	138.6	67.0	-	-	6.9	West	14.4*/57.2*	West/East	6.1 / 43.2	-	-	-	17.9	East	-
R-142	125.5	126.3	130.9	132.7	134.7	0.8	East	5.4	West	7.2	West	-	9.2*	West	7.6	-	-	-
R-145	157.4	157.4	157.4	158.0	157.4	-	-	-	-	0.6	West	-	-	-	-	18.5*	West	15.8
R-94	281.0	281.0	281.0	287.3	281.0	-	-	-	-	6.3*	East	1.4	-	-	-	6.3*	East	1.9
R-95 Breakers Natural	60.0	62.0	60.0	62.0	60.0	2.0	East	NA	East	2.0	East	-	NA	East	-	6.0	East	-
R-91 ext	108.0	108.0	108.0	122.0	108.0	-	-	-	-	14.0*	East	9.0	-	-	-	-	-	-
R-92 ext	125.6	127.6	125.6	125.6	125.6	2.0	East	-	-	-	-	-	-	-	-	1.2	East	-

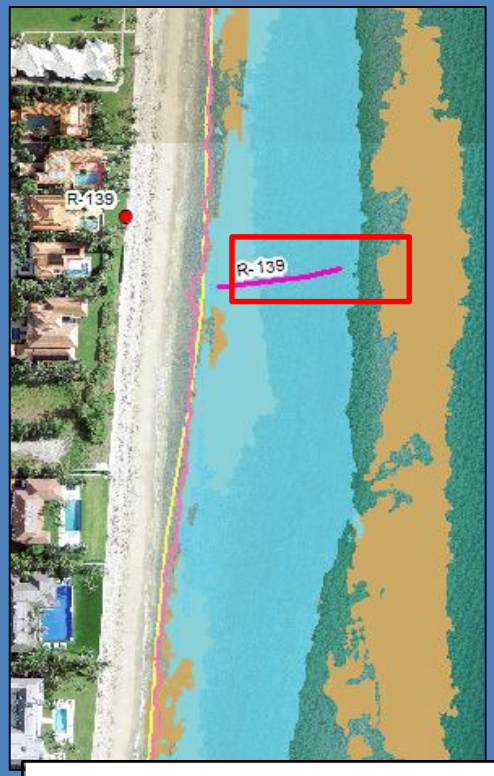
Transect R-136- New Hardbottom at West End in 2017, Remained Exposed in 2018, Buried in 2019

July 2016 Aerials



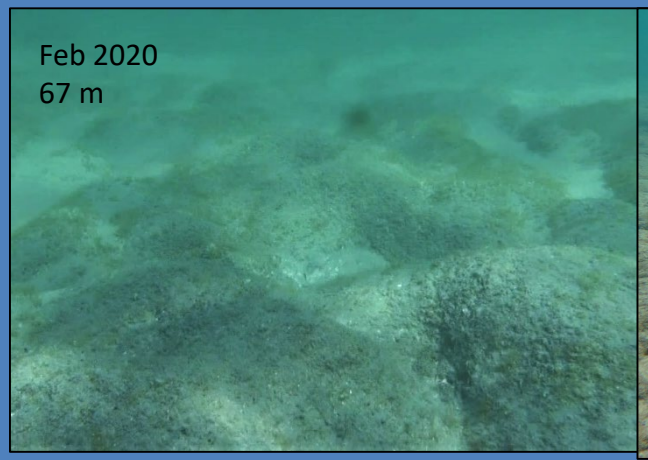


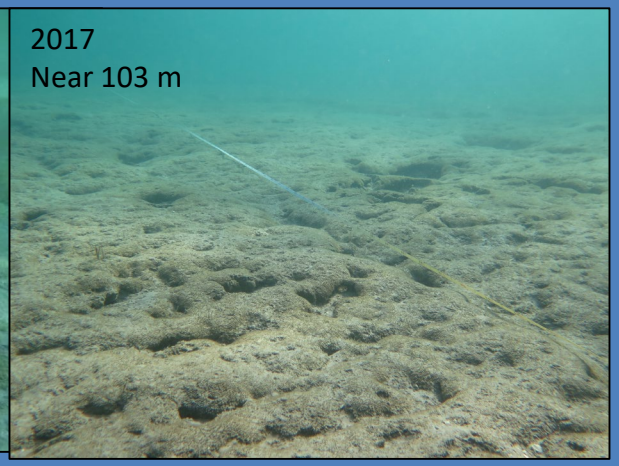
Reach 9 Transect R-139- New exposure of east end in 2017; Buried in 2018, and Re-exposed in Year 5 survey



July 2016 Aerial

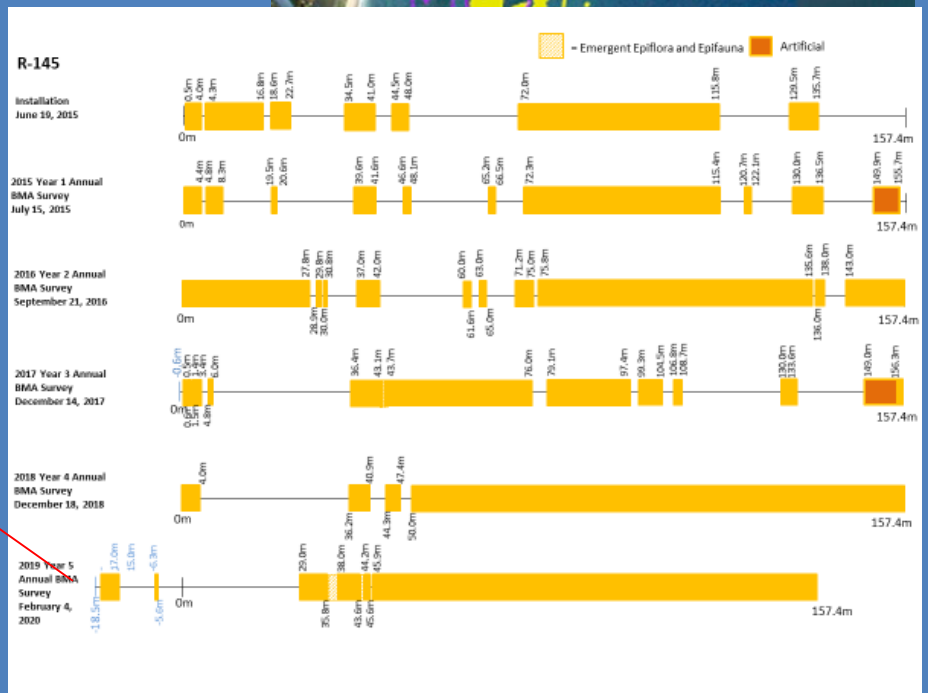
- July-September 2016 BMA Cell-Wide Diver-Mapped Hardbottom Edge
- August/September 2015 BMA Cell-Wide Diver-Mapped Hardbottom Edge
- July/August 2014 BMA Cell-Wide Diver-Mapped Hardbottom Edge
- July 2016 Aerial Delineated
- July 3, 2014 Aerial Delineated Hardbottom (Reaches 1-9); November 11, 2014 (Reaches 10 & 11)






R-145
R-145
Aerial Date: January 8 & 13, 2020


R-144
R-145
R-145


R-145
= Emergent Epiflora and Epifauna
Artificial
Installation
June 19, 2015
2015 Year 1 Annual
BMA Survey
July 15, 2015
2016 Year 2 Annual
BMA Survey
September 21, 2016
2017 Year 3 Annual
BMA Survey
December 14, 2017
2018 Year 4 Annual
BMA Survey
December 18, 2018
2019 Year 5
Annual BMA
Survey
February 4,
2020
0m
157.4m

Diver-Mapped Hardbottom Edges- 2014 , 2017 and 2018 (L) and 2019 (R)

Shoreline Areas Exhibiting Minimal Variability in Hardbottom Edge

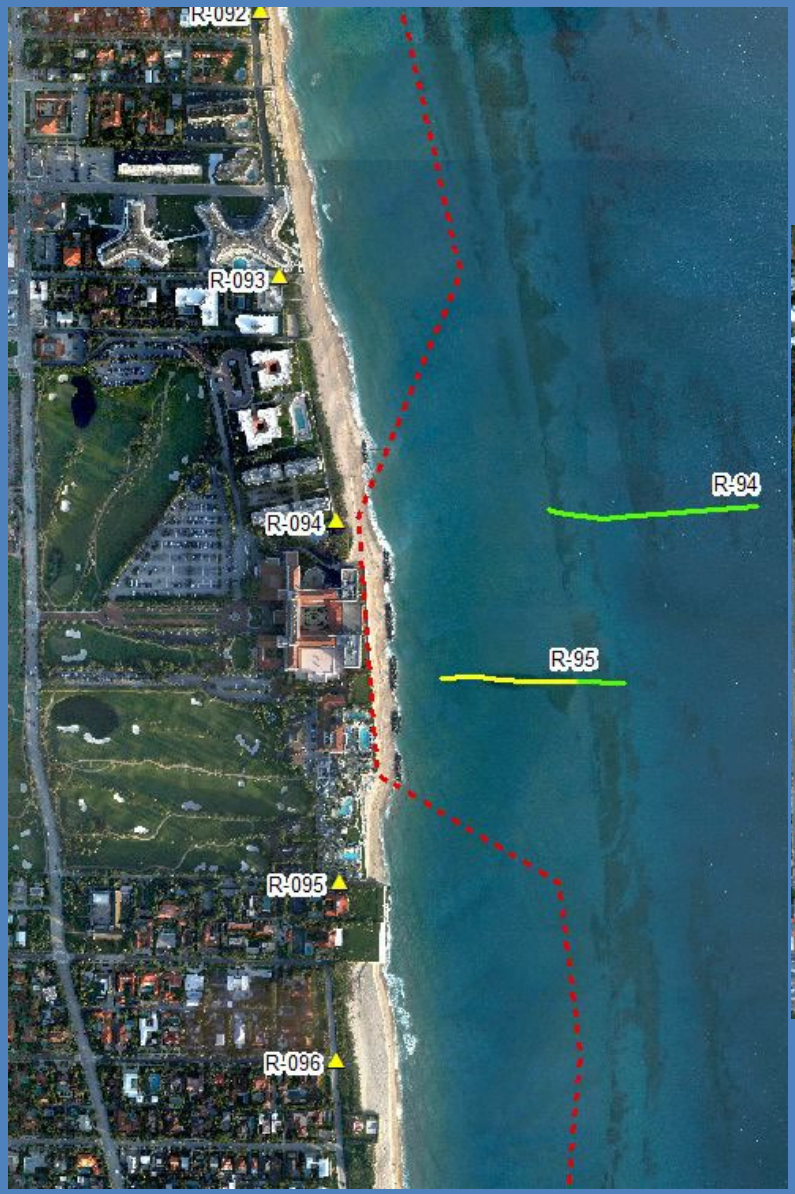
Reach 2- R-87 to R-88

Five groupings of BMA transects (based on distance from shore, habitat type, and relation to Mid-Town project area)

- Intertidal transects- R-113, R-115, and R-116
- Nearshore transects- R-80.5, R-83, R-132, R-133, R-136, R-139, R-142, and R-145
- Updrift/Downdrift transects- R-88 and R-103
- Project Area transects- R-94 and R-95 natural
- Offshore extensions- R-90, R-91, R-92 and R-93

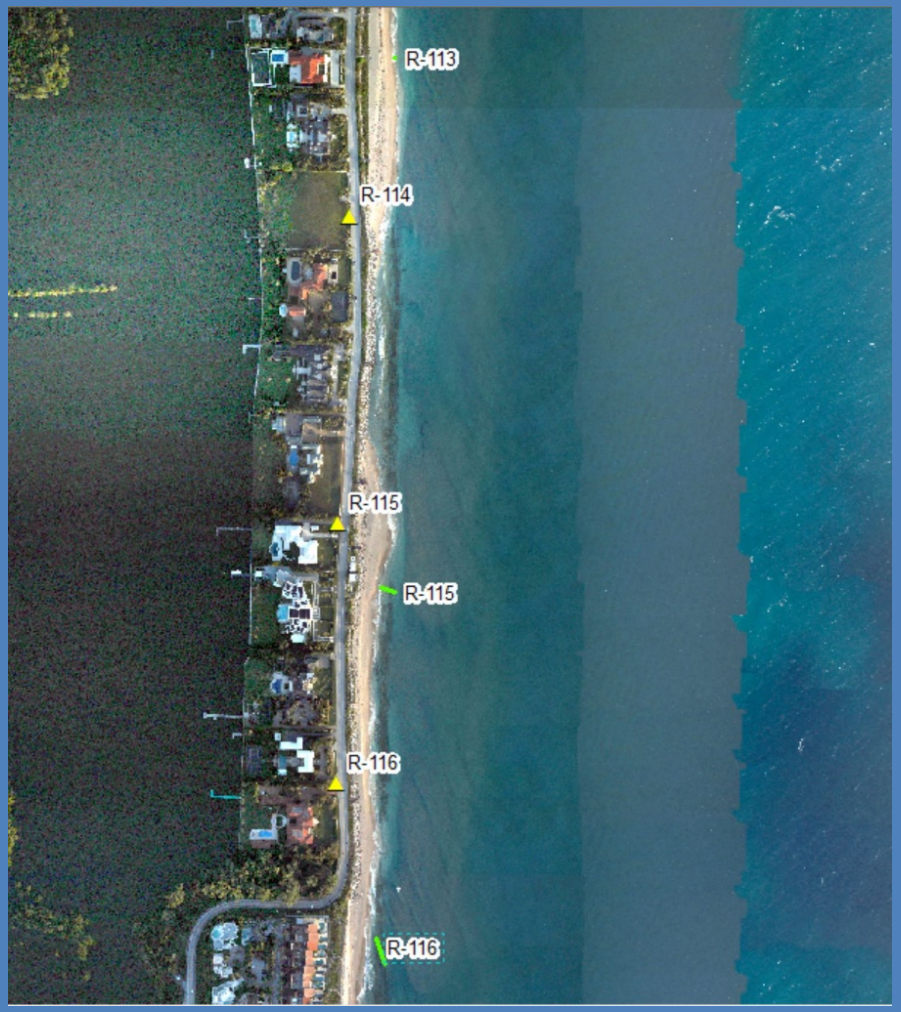
Updrift/downdrift

Project Area



MidTown extensions

Three intertidal transects



Nearshore transects

Changes in linear extent and percent cover of sand along the BMA permanent transects, 2014 Baseline versus 2019 Year 5

Zones	Transect	Total Length of Transect (m)	Total Linear Sand (m)								Percent of Transect		
			Installation (Oct 2014/ Jun 2015)	2014 Baseline BMA Survey (Dec 2014)	2015 Year 1 Annual BMA Survey (Jul-Dec 2015)	2016 Year 2 Annual BMA Survey (Sep-Dec 2016)	2017 Year 3 Annual BMA Survey (Jul-Dec 2017)	2018 Year 4 Annual BMA Survey (Oct 2018 - Feb 2019)	2019 Year 5 Annual BMA Survey (Jan 2020 - Feb 2020)	Change in Linear Cover (m) Year 4 - Baseline	Baseline BMA Survey (Dec 2014/ Jul 2015)	2019 Year 5 Annual BMA Survey (Jan 2020 - Feb 2020)	Change in Linear Cover (%) Year 5 - Baseline
Intertidal Transects	R-113	2.2	0.0	2.2	2.2	2.2	2.2	2.2	2.2	0.0	100%	100.0%	0.0%
	R-115	15.5	0.0	0.0	15.5	1.1	7.8	4.3	9.3	9.3	0%	60.0%	60.0%
	R-116	29.5	5.4	0.0	29.5	29.5	3.2	0.0	3.4	3.4	0%	11.5%	11.5%
	Total	**47.2**	**5.4**	**2.2**	**47.2**	**32.8**	**13.2**	**6.5**	**14.9**	**12.7**	**4.7%**	**31.6%**	**26.9%**
Nearshore Transects	R-80.5*	150	129.3	-	128.0	132.0	121.5	134.2	122.5	-5.5	85.3%	81.7%	-3.7%
	R-83*	156.8	116.4	-	114.5	122.4	112.4	149.2	156.8	42.3	73.0%	100.0%	27.0%
	R-132	117	98.1	80.1	117.0	116.6	106.0	63.1	41.3	-38.8	68.5%	35.3%	-33.2%
	R-133	143	62.9	58.0	86.5	87.2	94.8	74.6	86.2	28.2	40.6%	60.3%	19.7%
	R-136*	137	115.2	-	112.0	83.6	97.0	121.6	55.3	-56.7	81.8%	40.4%	-41.4%
	R-139*	67	2.6	-	3.7	1.6	33.8	29.7	20.0	16.3	5.5%	29.9%	24.3%
	R-142*	126.3	74.8	-	77.9	101.6	71.8	99.0	46.4	-31.5	61.7%	36.7%	-24.9%
	R-145*	157.4	80.1	-	67.5	118.1	73.5	119.2	125.3	57.8	42.9%	79.6%	36.7%
	2014 Total	**260**	**161.0**	**138.1**	**203.5**	**203.8**	**200.8**	**137.7**	**127.5**	**-10.6**	**53.1%**	**49.0%**	**-4.1%**
	2015 Total*	**794.5**	**518.4**	-	503.6	**559.3**	**510.0**	**652.9**	**526.3**	**22.7**	**63.4%**	**66.2%**	**2.9%**
Updrift/Downdrift Transects	R-88	172	64.0	97.8	101.9	117.6	30.7	78.3	91.8	-6.0	56.9%	53.4%	-3.5%
	R-103	151	98.8	21.6	15.6	48.2	15.5	17.7	75.2	53.6	14.3%	49.8%	35.5%
	Total	**323**	**162.8**	**119.4**	**117.5**	**165.8**	**46.2**	**96.0**	**167.0**	**47.6**	**37.0%**	**51.7%**	**14.7%**
Project Area Transects	R-94	281	152.9	157.3	167.0	140.0	159.0	175.0	190.9	33.6	56.0%	67.9%	12.0%
	R-95 Natural	60	12.8	5.9	15.8	11.5	10.7	11.7	18.5	12.6	9.8%	30.8%	21.0%
	Total	**341**	**165.7**	**163.2**	**182.8**	**151.5**	**169.7**	**186.7**	**209.4**	**46.2**	**47.9%**	**61.4%**	**13.5%**
Offshore Extensions	R-90 ext.	82.0	31.0	47.6	39.1	37.2	38.9	43.9	46.7	-0.9	58.0%	57.0%	-1.1%
	R-91 ext.	108.0	86.0	86.9	87.9	85.7	75.5	86.1	99.8	12.9	80.5%	92.4%	11.9%
	R-92 ext.	125.6	91.9	90.0	95.6	105.6	108.0	122.8	123.7	33.7	71.7%	98.5%	26.8%
	R-93 ext.	3.0	3.0	3.0	2.0	0.0	3.0	3.0	3.0	0.0	100.0%	100.0%	0.0%
	Total	**318.6**	**211.9**	**227.5**	**224.6**	**228.5**	**225.4**	**255.8**	**273.2**	**45.7**	**71.4%**	**85.8%**	**14.3%**

Red highlights indicate increases in sand cover, green indicates decreases. Greatest decreases were recorded at the nearshore transects in southern reaches

Summary of 2019 Year 5 survey results

Comparison of the baseline condition and the 2019 Year 5 survey revealed distinct differences between the BMA groups.

Nearshore transects are characterized by a significantly higher percent cover of sediment

Intertidal transects have significantly higher overall percent cover of bare hard substrate.

Transects located further offshore are characterized by higher overall relative percent cover of biotic functional groups typical of rapid colonization including turf algae, macroalgae, sponges, hydroid, and wormrock

Summary of 2019 Year 5 survey results

- Linear sand cover, mean sediment depth, and mean percent sand cover in quadrats increased at the BMA transects between the 2014 Baseline and 2019 Year 5 surveys.

- Considerable increases (>20%) were noted at transects within all five transect groupings (intertidal, nearshore, updrift/downdrift, project area, and offshore) with the greatest overall increases noted in the intertidal zone.

- Reach 8 showed the greatest increase in hardbottom exposure between 2014 Baseline and Year 5 with 8 acres exposed between R-131 and R-133

Summary

- The greatest decreases in linear sand cover were recorded at the nearshore transects due to shifts in hardbottom exposure.

- Significant increases in overall standing sediment depth were detected in all five BMA groups with the greatest increases recorded in the intertidal (R-113), nearshore (R-145) and offshore (R-91 ext) zones.

- BMA Transects R-94 and R-95 Breakers Natural are located within the 2015 Mid-Town project area. Linear sand cover increased and mean standing sediment depth, quadrat maximum sand depth and percent cover of sediment in quadrats significantly increased at both transects between 2014 and 2019.

- Hardbottom exposure was greatest in the BMA monitoring period in January 2020 aerial photography in Reaches 8 and 10