Development and Application of an Ocean Benthic Index for New Jersey Ocean Waters

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Background

- The New Jersey Ocean waters are listed as impaired based on using dissolved oxygen as a surrogate for biological impairment.
- Current NJ Surface Water Quality Standard is 5 mg/l
- Historical data from EPA dissolved oxygen transect helicopter flights showed low dissolved oxygen (<5mg/l) during the summer months.
- In 2007 sampling for the benthic community was initiated, to develop an index of biological health.
- Sampling was also conducted in 2009 and 2010.
- In 2012, a Rutgers report produced a Biological Index based on 2007 and 2009 data from 153 stations.
- Index was developed based on species tolerance groups.

Biotic Index

- A list of 218 species/taxa were assigned tolerance groups (GI – GV) by the Rutgers IMCS committee, and findings a National group of experts.
- A modified AMBI (European Index, Borja et al.) was used that calculates a biotic coefficient which is linked to a 0-7 scaled biotic index.

Biotic coefficient(BC)=(0 x %GI)+(1.5 x %G2)+(3 x %G3)+(4.5 x %GIV)+(6 x %GV)

Biotic coefficient (BC)	Biotic Index	Dominant ecological group (EG)	Ecological quality	Community health
0.0 < BC ≤ 0.2	0	I	unpolluted	normal
0.2 < BC ≤ 1.2	1		unpolluted	impoverished
1.2 < BC ≤ 3.3	2	III	slightly polluted	unbalanced
3.3 < BC ≤ 4.3	3		meanly polluted	transitional to pollution
4.3 < BC ≤ 5.0	4	IV-– V	meanly polluted	polluted
5.0 < BC ≤ 5.5	5		heavily polluted	transitional to heavily polluted
5.5 < BC ≤ 6.0	6	V	heavily polluted	heavily polluted
Azoic	7	Azoic	extremely polluted	azoic

Results

Biotic Index Results

	# of samples	Minimum	Maximum	Mean
Background stations	192	0	2	2
Discharge Mixing Zone stations	51	1	2	2
Impaired stations	10	2	2	2

Revisit Stations

Station	2007 BI	2009 BI	2010 BI
NJ07-0014	2	2	2
NJ07-0016	1	2	2
NJ07-0061	2	1	1
NJ07-0068	2	1	2
NJ07-0074	1	1	1
NJ07-0081	2	1	2
NJ07-0082	2	2	2
NJ07-0084	1	2	1
NJ07-0093	1	2	2
NJ07-0095	2	2	2

Station	DO min 2007	DO min 2009	DO min 2010
NJ07-0014	4.82	5.47	6.43
NJ07-0016	6.06	5.42	7.65
NJ07-0061	5.86	3.85	6.83
NJ07-0068	5.97	4.61	7.12
NJ07-0074	6.29	4.97	7.64
NJ07-0081	6.81	3.39	7.87
NJ07-0082	6.1	7.42	8.11
NJ07-0084	7.44	7.6	8.32
NJ07-0093	7.22	5.03	7.47
NJ07-0095	6.58	3.91	7.64

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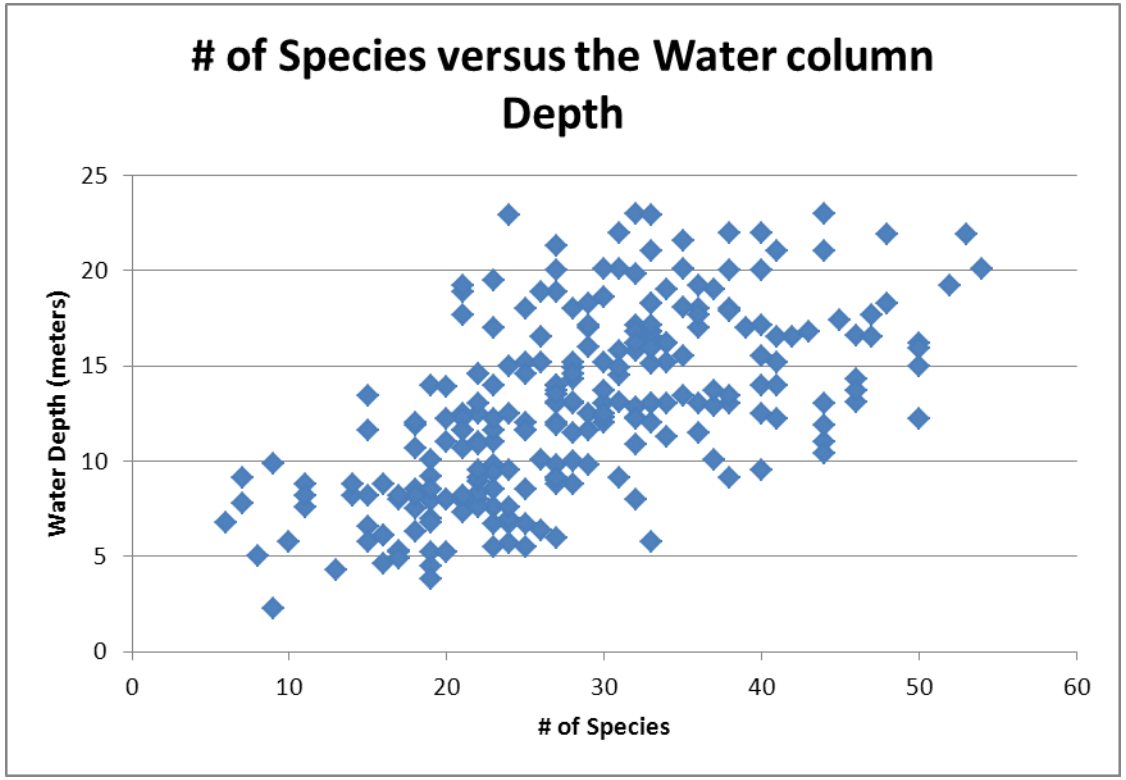
NJ07-0068	5.97	4.61	7.12
NJ07-0074	6.29	4.97	7.64
NJ07-0081	6.81	3.39	7.87
NJ07-0082	6.1	7.42	8.11
NJ07-0084	7.44	7.6	8.32
NJ07-0093	7.22	5.03	7.47
NJ07-0095	6.58	3.91	7.64

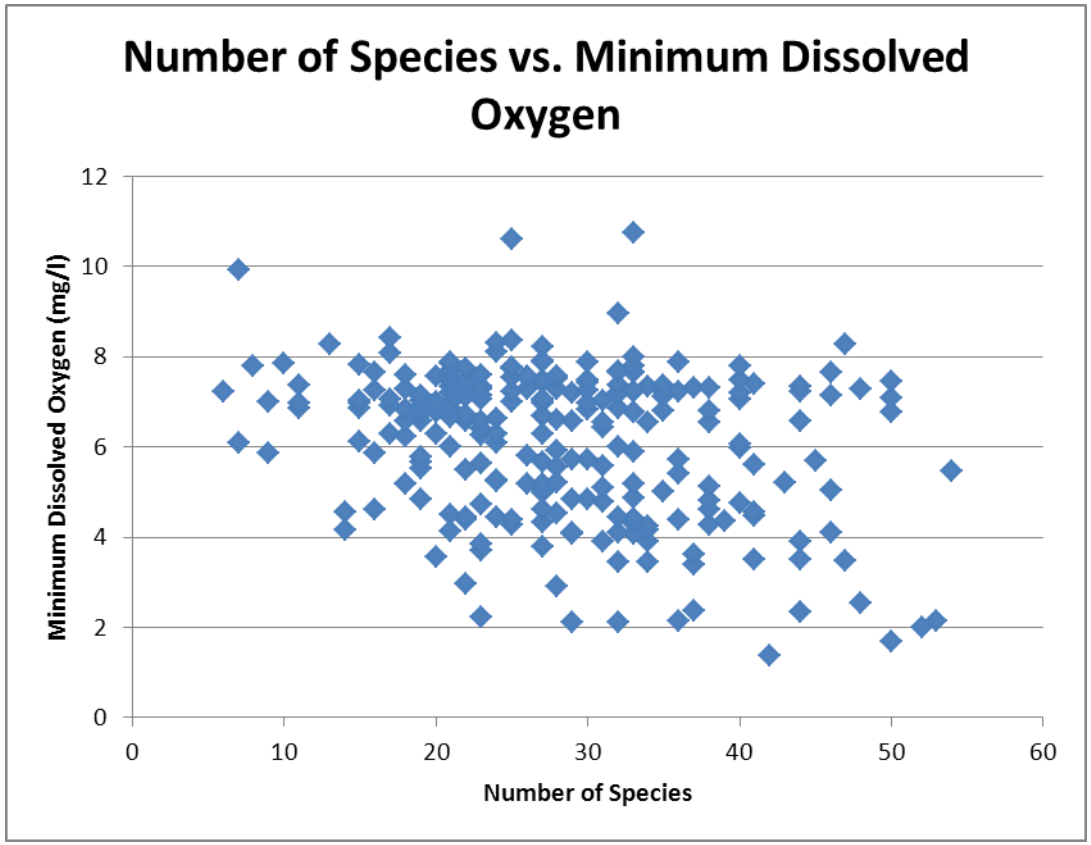
Sampling Results (Species Richness)



Results Species Richness by Location Type

	# of samples	Minimum	Maximum	Mean
Background stations	192	6	54	28
Discharge Mixing Zone stations	51	11	52	29
Impaired stations	10	18	46	27

Richness vs. Dissolved Oxygen



Diversity

Shannon Diversity Index

	# of samples	Minimum	Maximum	Mean
Background stations	192	0.2	3.2	1.9
Discharge Mixing Zone stations	51	0.3	2.6	1.9
Impaired stations	10	0.6	2.7	1.7

Simpson Index of Diversity

	# of samples	Minimum	Maximum	Mean
Background stations	192	0.1	0.9	0.7
Discharge Mixing Zone stations	51	0.1	0.9	0.7
Impaired stations	10	0.2	0.9	0.6

Pielou Evenness Index

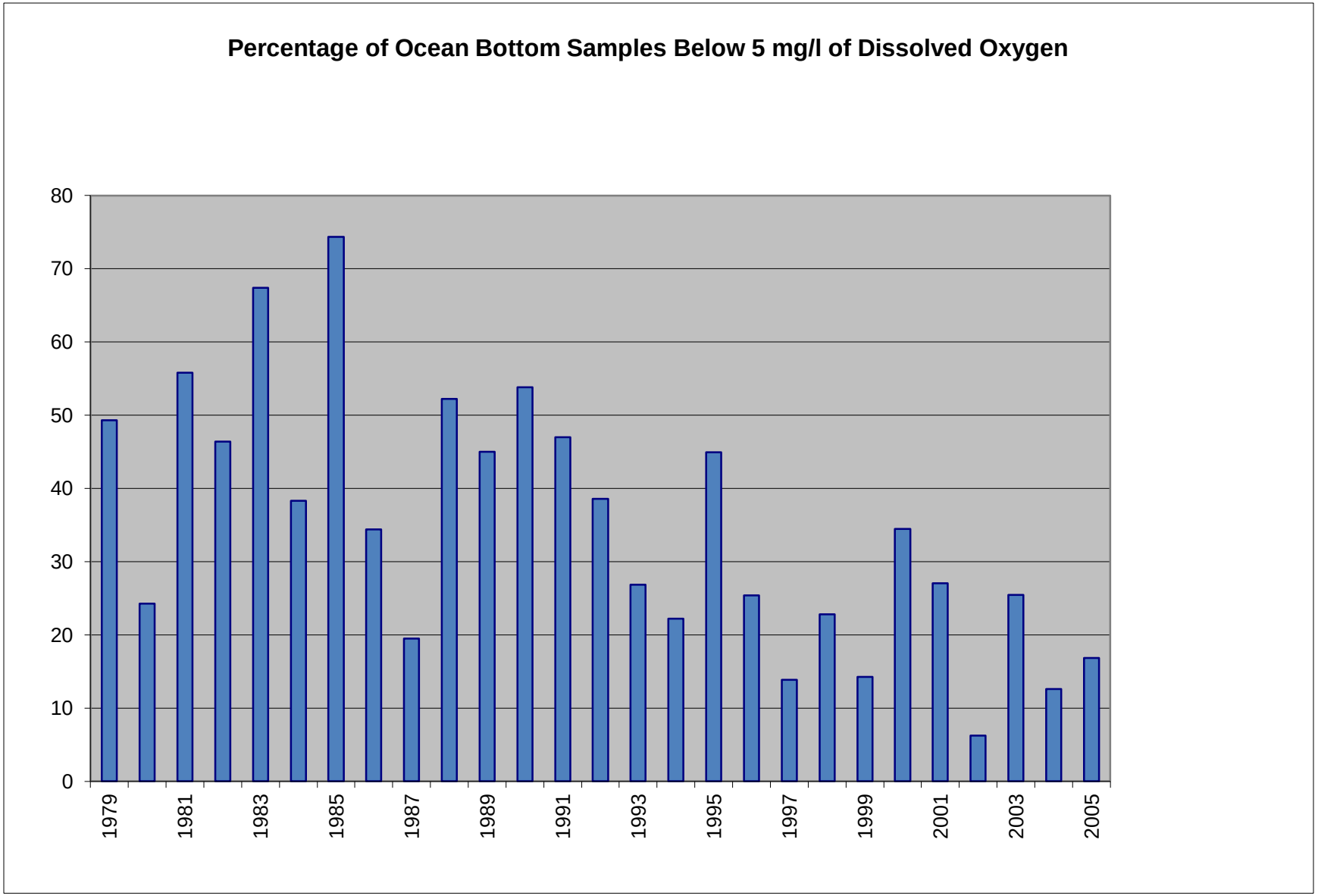
	# of samples	Minimum	Maximum	Mean
Background stations	192	0.1	0.9	0.6
Discharge Mixing Zone stations	51	0.1	0.8	0.6
Impaired stations	10	0.2	0.8	0.5

%TOC

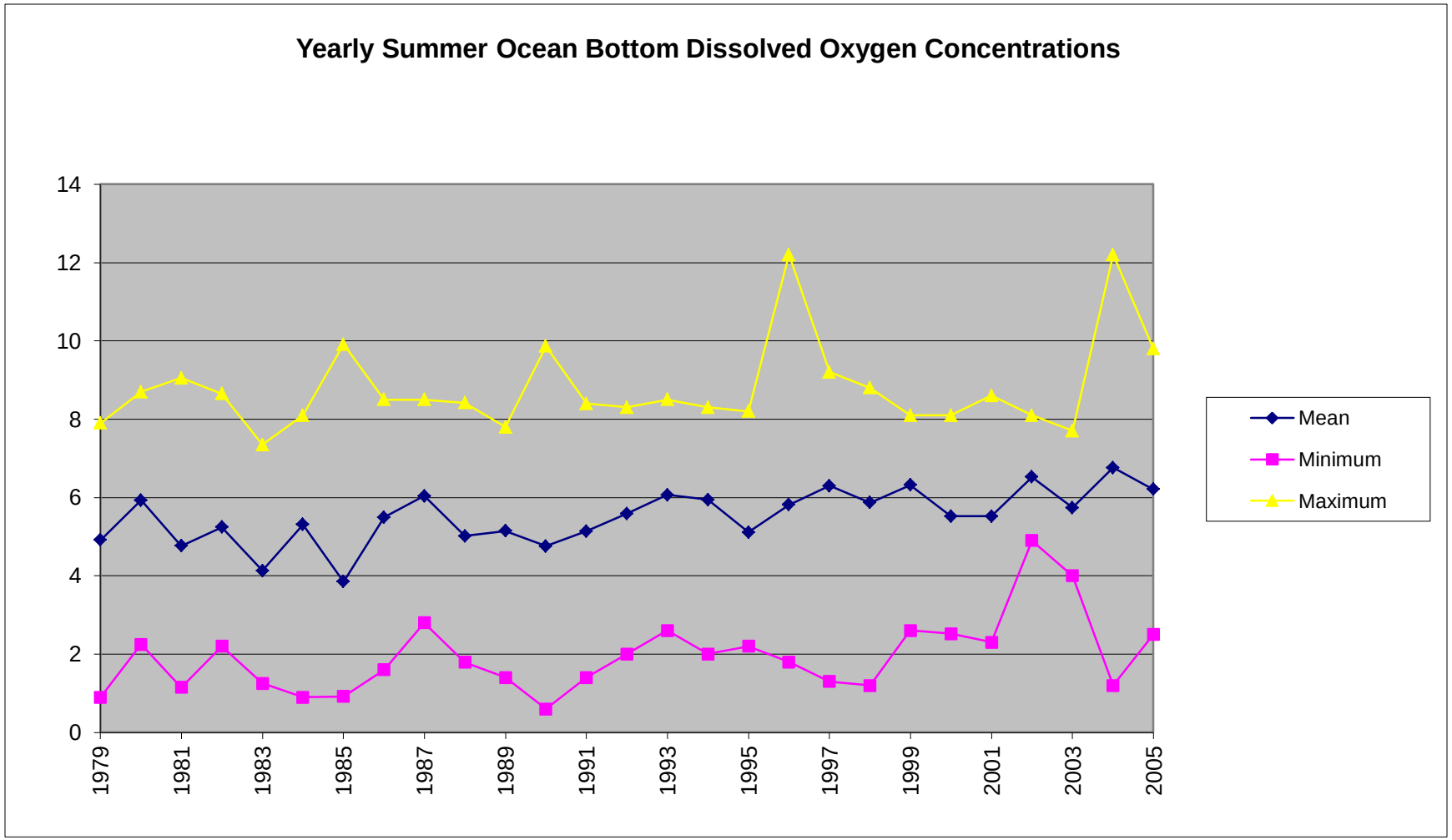
	# of samples	Minimum	Maximum	Mean
Background stations	192	0.13	5.67	0.58
Discharge Mixing Zone stations	51	0.13	9.49	1.43
Impaired stations	10	0.24	3.73	1.37

Dissolved Oxygen

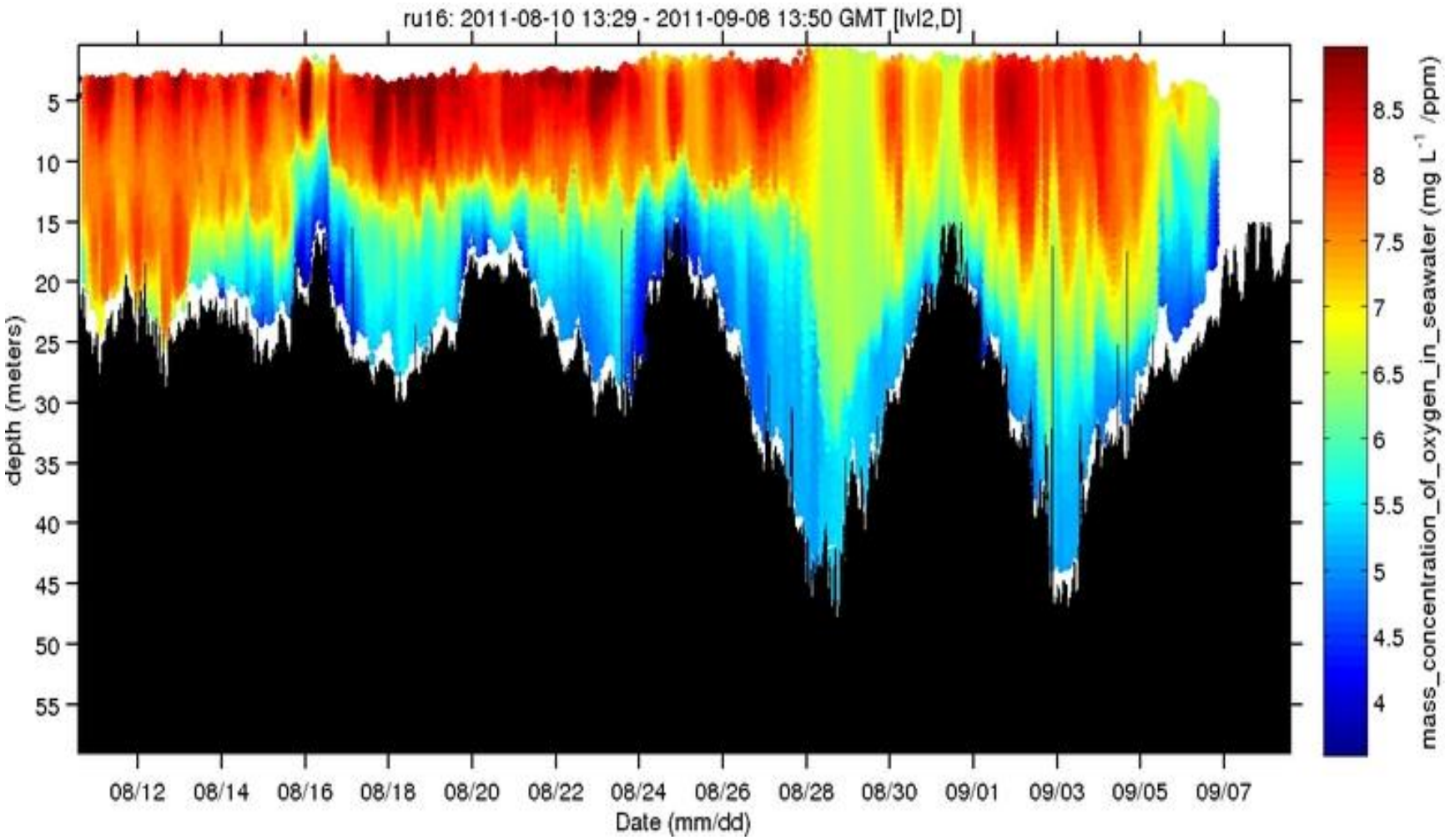
- Dissolved Oxygen concentration of 5 mg/l is above the concentration expected to have an impact on the Benthic Community, studies have suggested that 3 mg/l defines the hypoxia line, and that duration of the low concentration plays a roll.
- Slocum gliders with dissolved oxygen sensors are being used to better understand the oxygen conditions in New Jersey's Coastal Waters.
- Historical data shows low conditions during the summer months.


Percentage of Ocean Bottom Samples Below 5 mg/l of Dissolved Oxygen
80
70
60
50
40
30
20
10
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

EPA Helicopter Transect Data



Aug. 2011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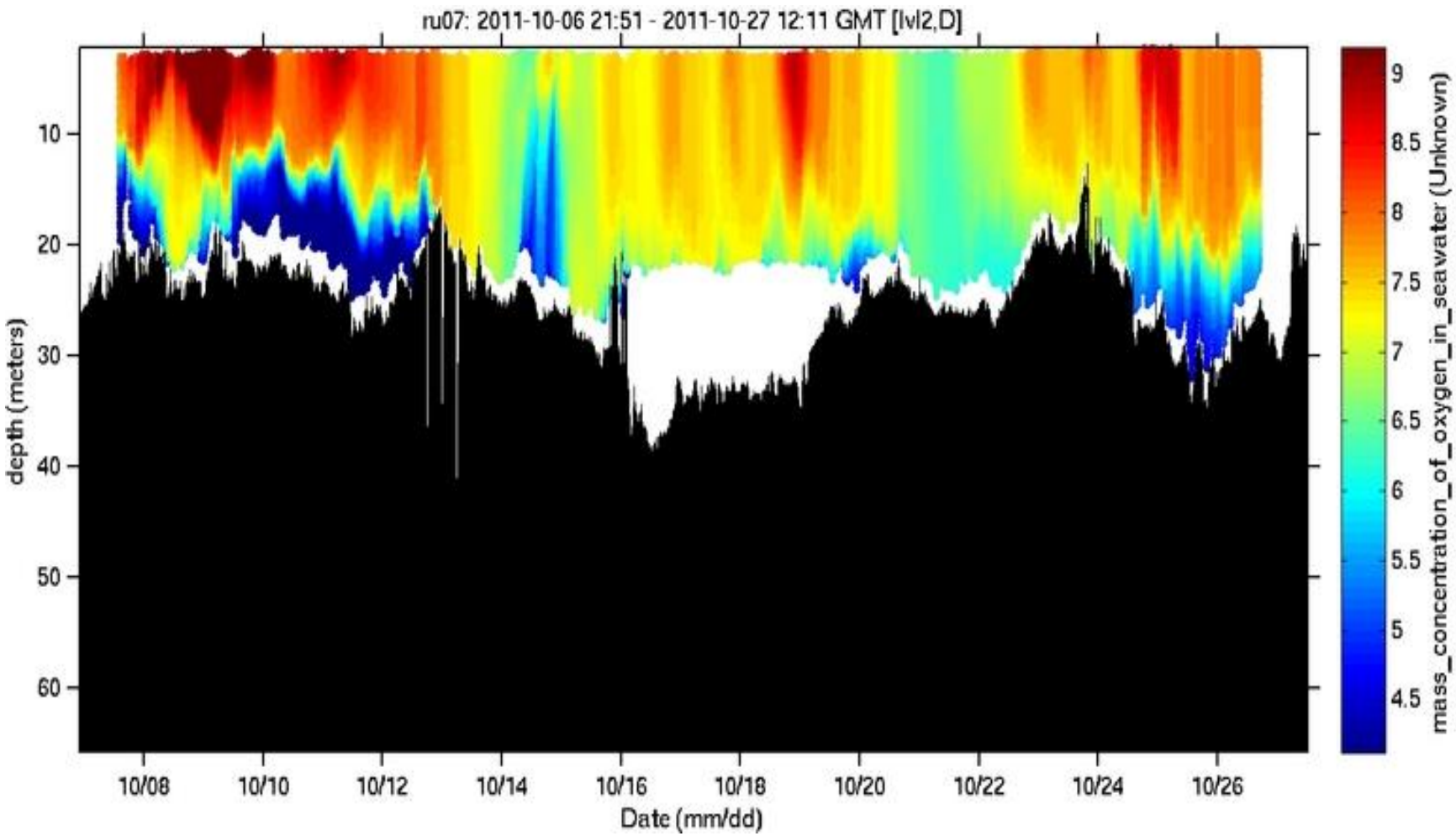
depth (meters)
5
10
15
20
25
30
35
40
45
50
55
08/12
08/14
08/16
08/18
08/20
08/22
08/24
08/26
08/28
08/30
09/01
09/03
09/05
09/07
Date (mm/dd)
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
mass_concentration_of_oxygen_in_seawater (mg L-1 /ppm)

Oct. 2011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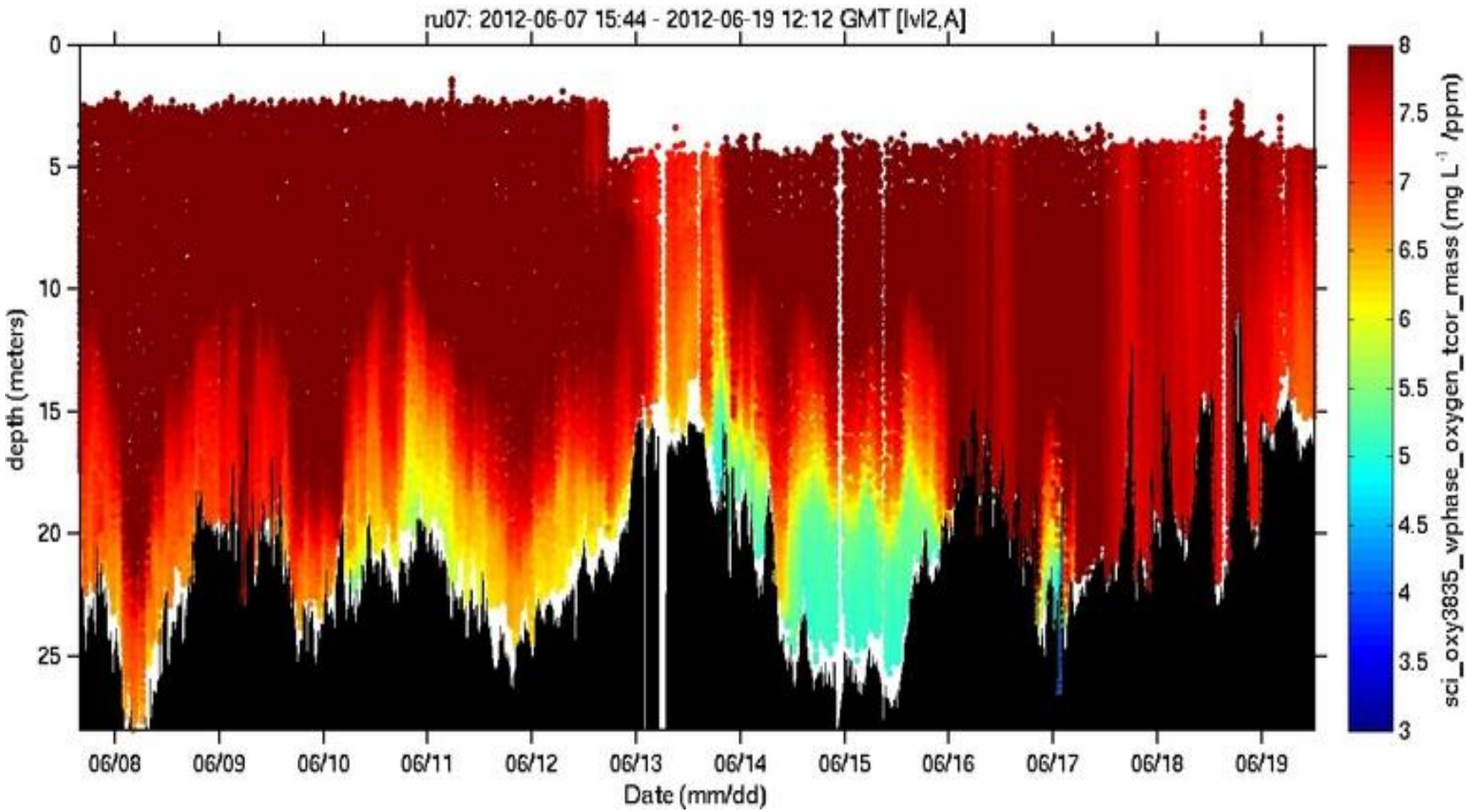
depth (meters)
10
20
30
40
50
60
10/08
10/10
10/12
10/14
10/16
10/18
10/20
10/22
10/24
10/26
Date (mm/dd)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
mass_concentration_of_oxygen_in_seawater (Unknown)

June 2012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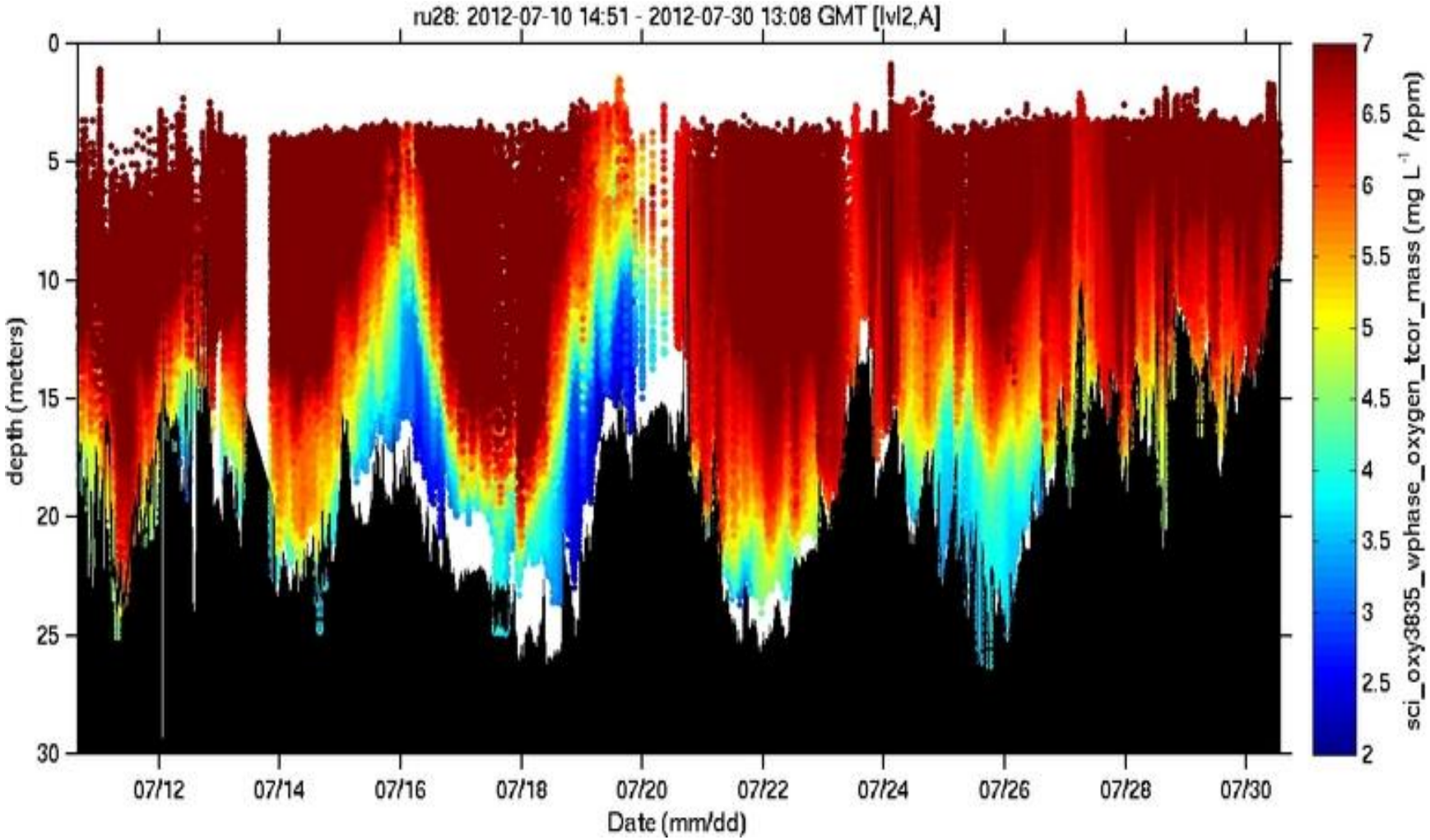
depth (meters)
0
5
10
15
20
25
06/08
06/09
06/10
06/11
06/12
06/13
06/14
06/15
06/16
06/17
06/18
06/19
Date (mm/dd)
sci_oxy3835_vphase_oxygen_tcor_mass (mg L⁻¹ /ppm)
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3

July 2012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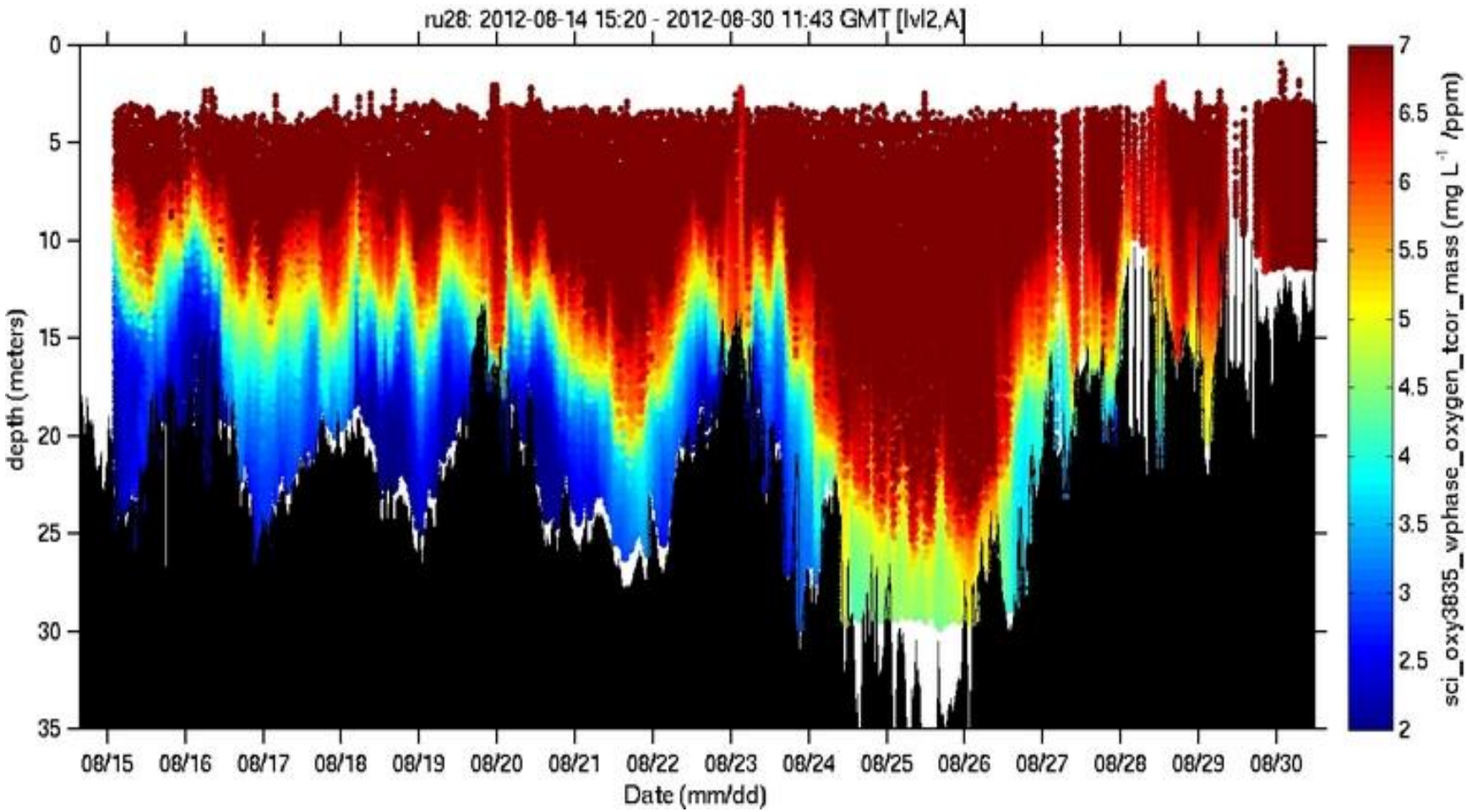
depth (meters)
0
5
10
15
20
25
30
07/12
07/14
07/16
07/18
07/20
07/22
07/24
07/26
07/28
07/30
Date (mm/dd)
sci_oxy3835_wphase_oxygen_tcor_mass (mg L-1 /ppm)
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2

Aug. 2012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depth (meters)
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5
10
15
20
25
30
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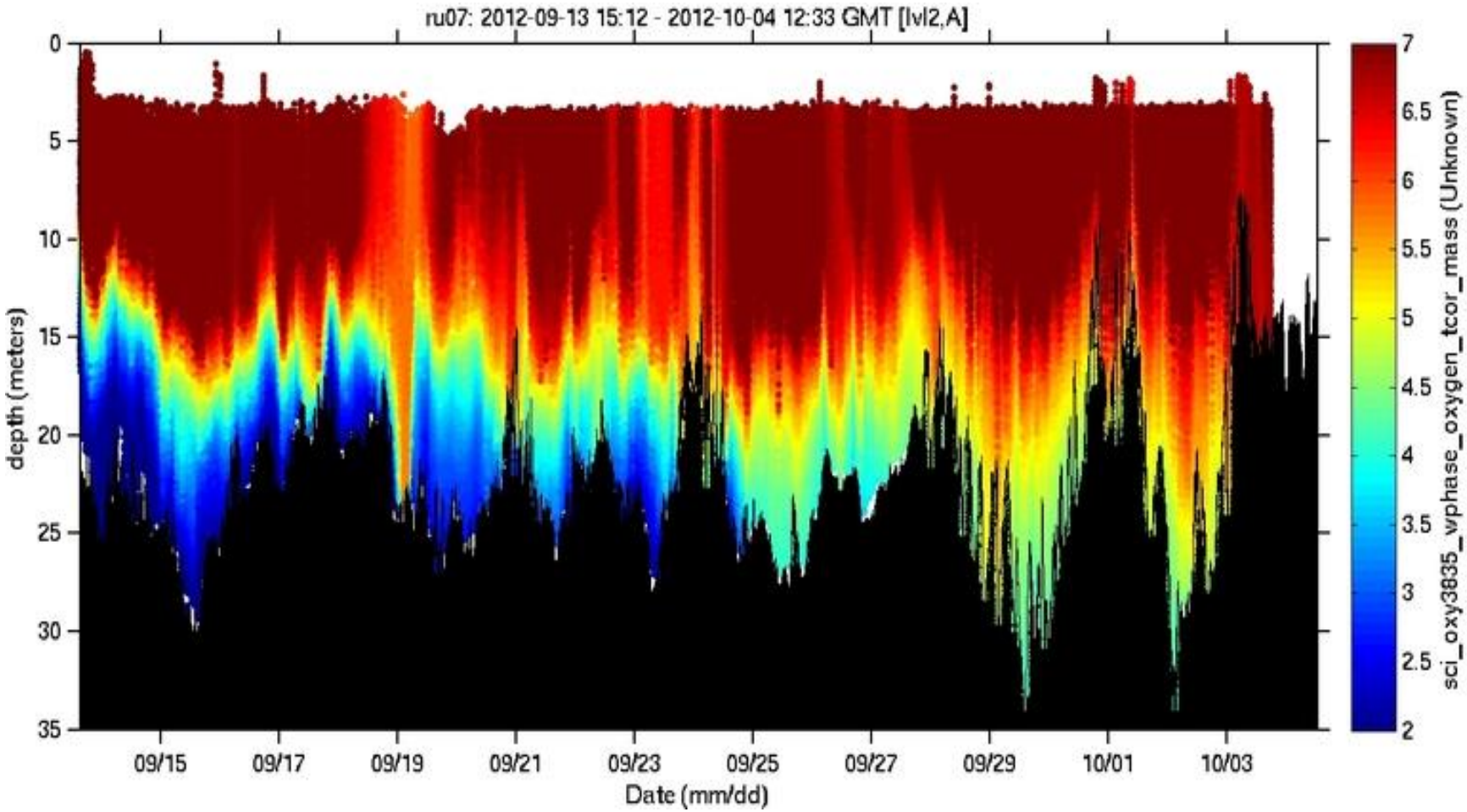
08/15
08/16
08/17
08/18
08/19
08/20
08/21
08/22
08/23
08/24
08/25
08/26
08/27
08/28
08/29
08/30
Date (mm/dd)
sci_oxy3835_vphase_oxygen_tcor_mass (mg L-1 /ppm)
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2

Sept. 2012


ru07: 2012-09-13 15:12 - 2012-10-04 12:33 GMT [lvl2,A]
depth (meters)
0
5
10
15
20
25
30
35
09/15
09/17
09/19
09/21
09/23
09/25
09/27
09/29
10/01
10/03
Date (mm/dd)
sci_oxy3835_wphase_oxygen_tcor_mass (Unknown)
7
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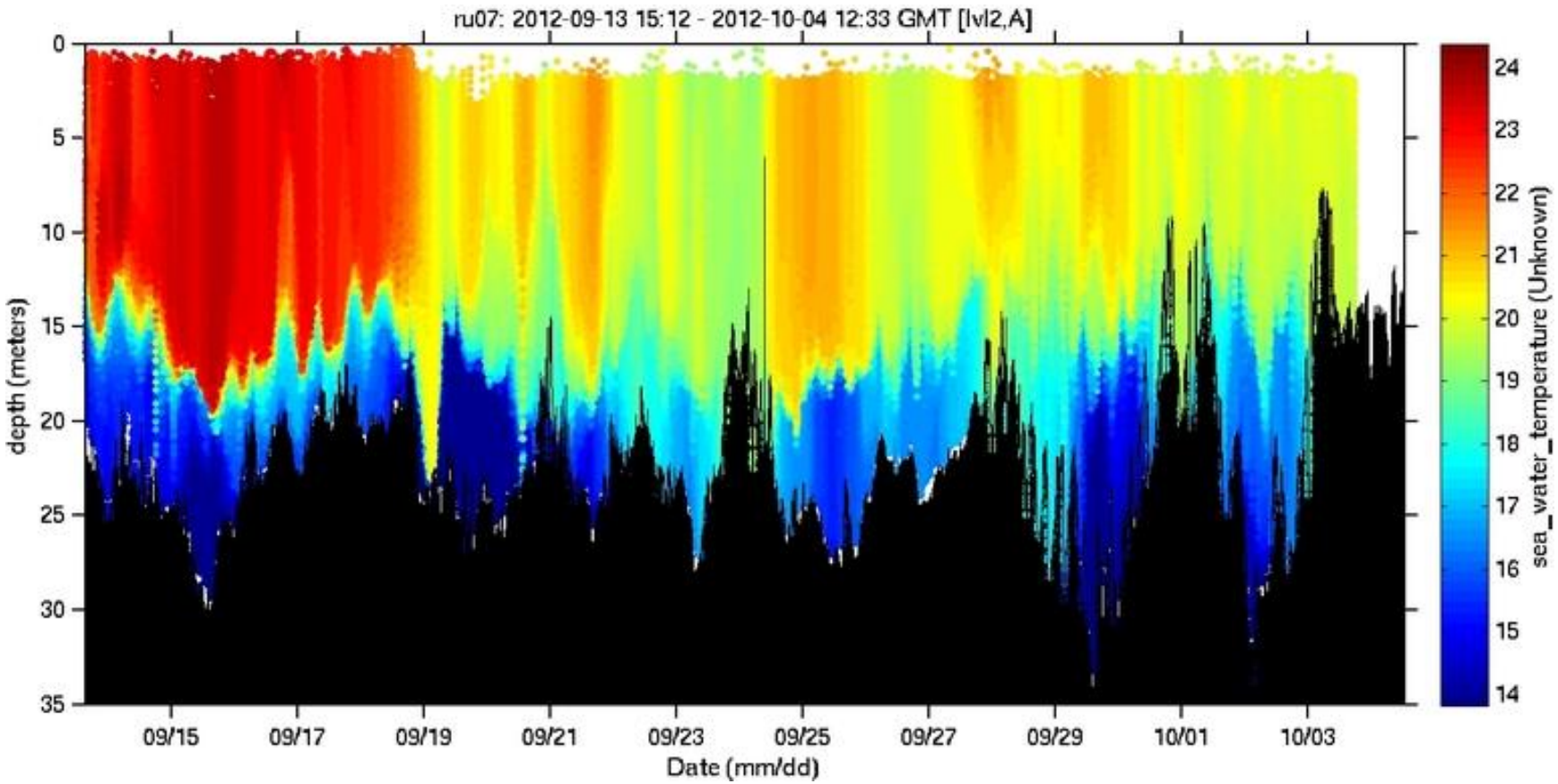
6
5.5
5
4.5
4
3.5
3
2.5
2

Temp


ru07: 2012-09-13 15:12 - 2012-10-04 12:33 GMT [lvl2,A]
depth (meters)
0
5
10
15
20
25
30
35
09/15
09/17
09/19
09/21
09/23
09/25
09/27
09/29
10/01
10/03
Date (mm/dd)
sea_water_temperature (Unknown)
24
23
22
21
20
19
18
17
16
15
14

Conclusions

- Benthic Index values for all years did not have any samples exceed a BI of 2, including by ocean discharges.
- Low oxygen concentrations based on the revisit station data, does not determine the biotic index classification.
- Overall, no correlation between dissolved oxygen and the BI.
- Overall results do not support the current classification of the NJ Ocean waters as Impaired, based on dissolved oxygen.
- Low dissolved oxygen off the coast is a yearly occurrence when the Ocean waters stratify.
- Glider data shows the stratification and the mixing of the water column due to varying intensities of wind events.

Future Work

- Continue the assessment of current data, mapping of individual parameters by station.
- Sample 50 stations off the coast on NJ in the summer of 2013, to monitor conditions and assess post Superstorm Sandy.