Salinity Patterns and Trends in Western Biscayne Bay

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Greater Everglades Ecosystem
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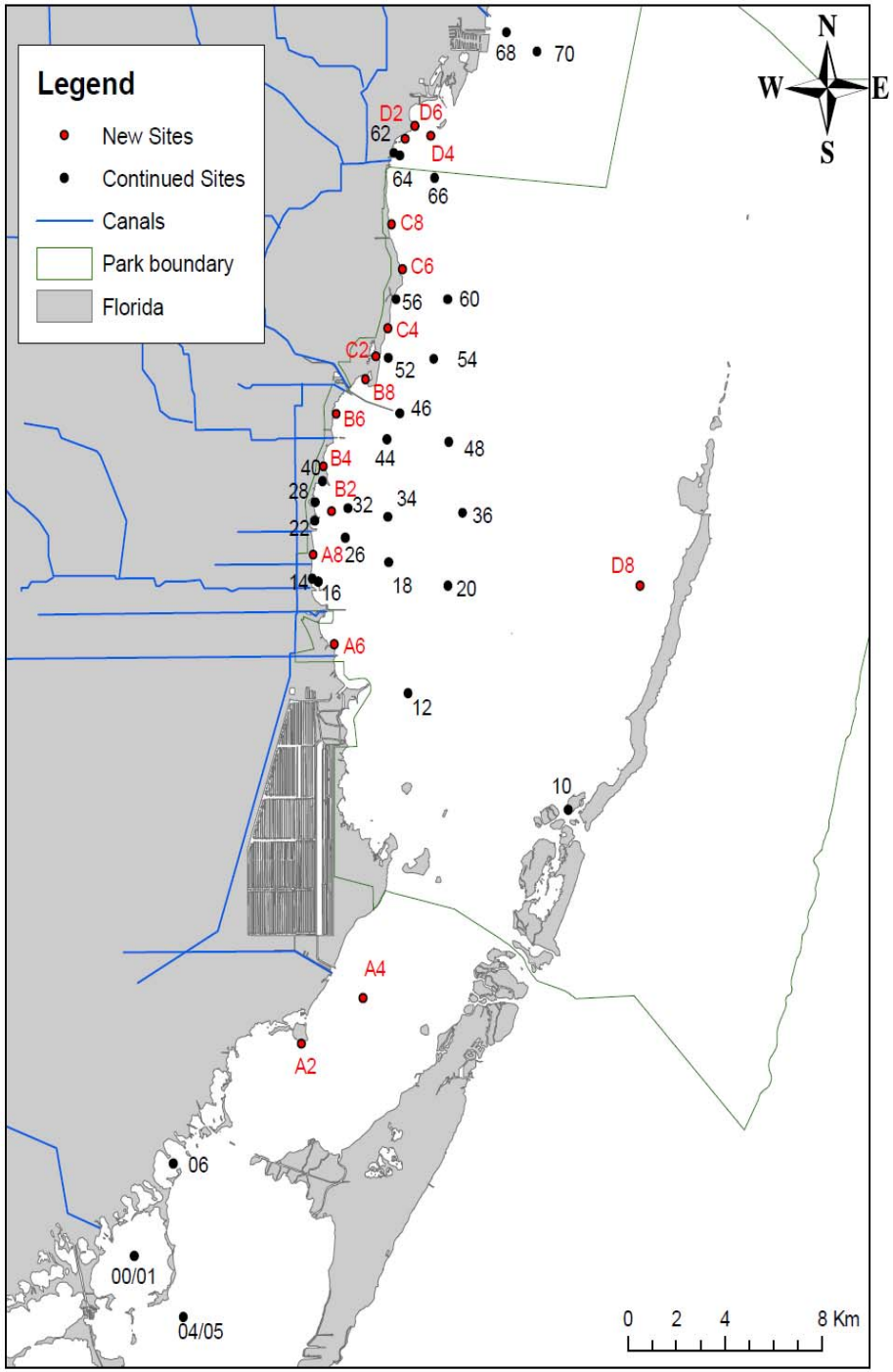
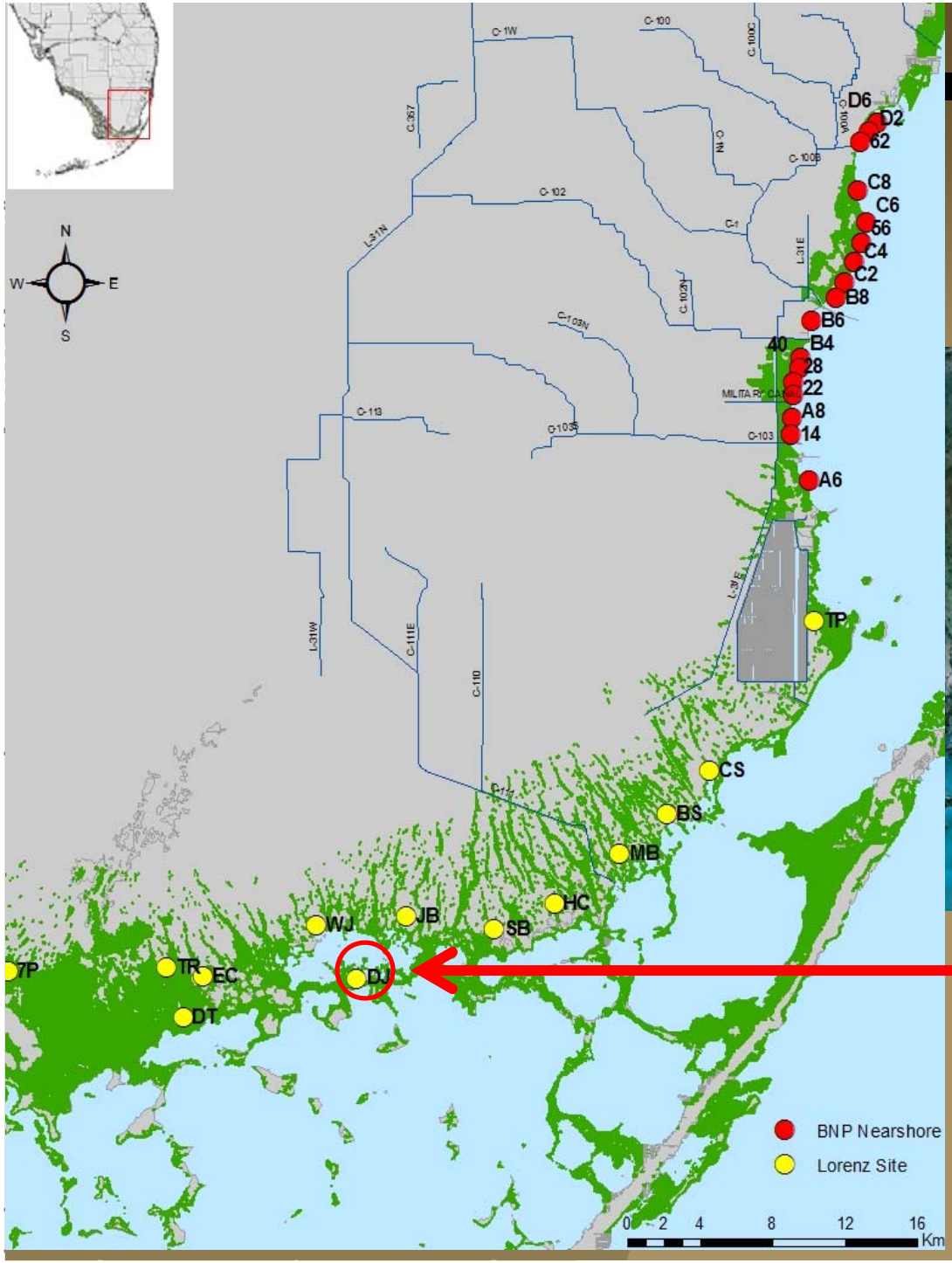
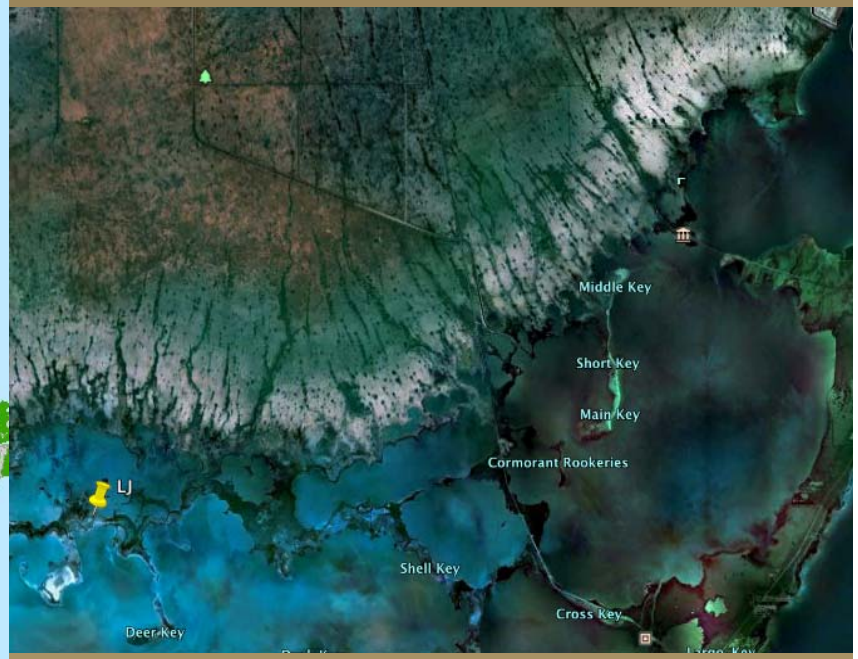
Original Network & Integrated Biscayne Bay Ecological Assessment Monitoring (IBBEAM)

- Designed in 2003-2004 by a multi-agency science team
- Compiled with embedded W-E transects and N-S transects
- Shoreline instruments within 100 meters
- Included paired surface and bottom instruments
- Designed to meet needs of modeling and collecting data as close as possible to the shoreline at specific features



Reference Site Location

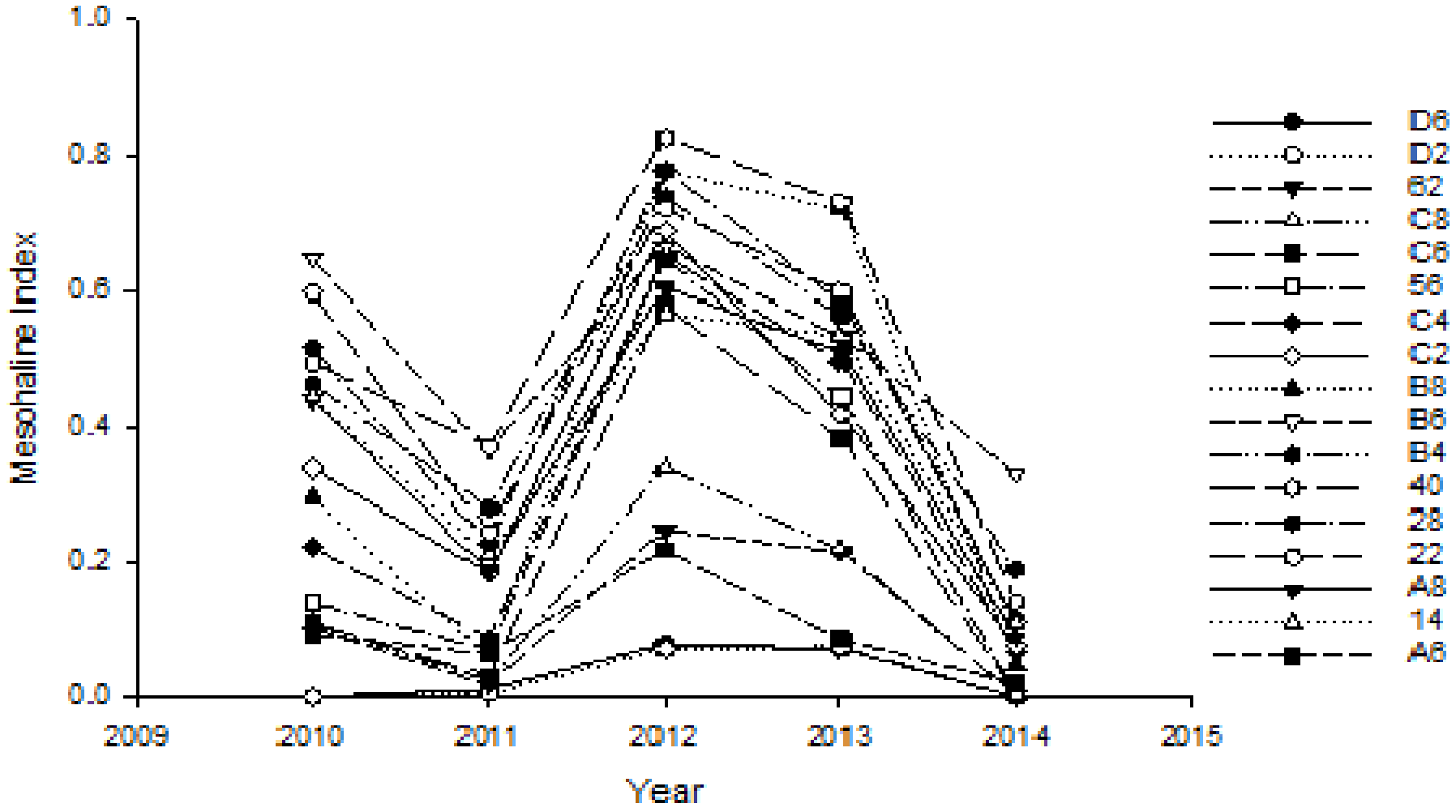


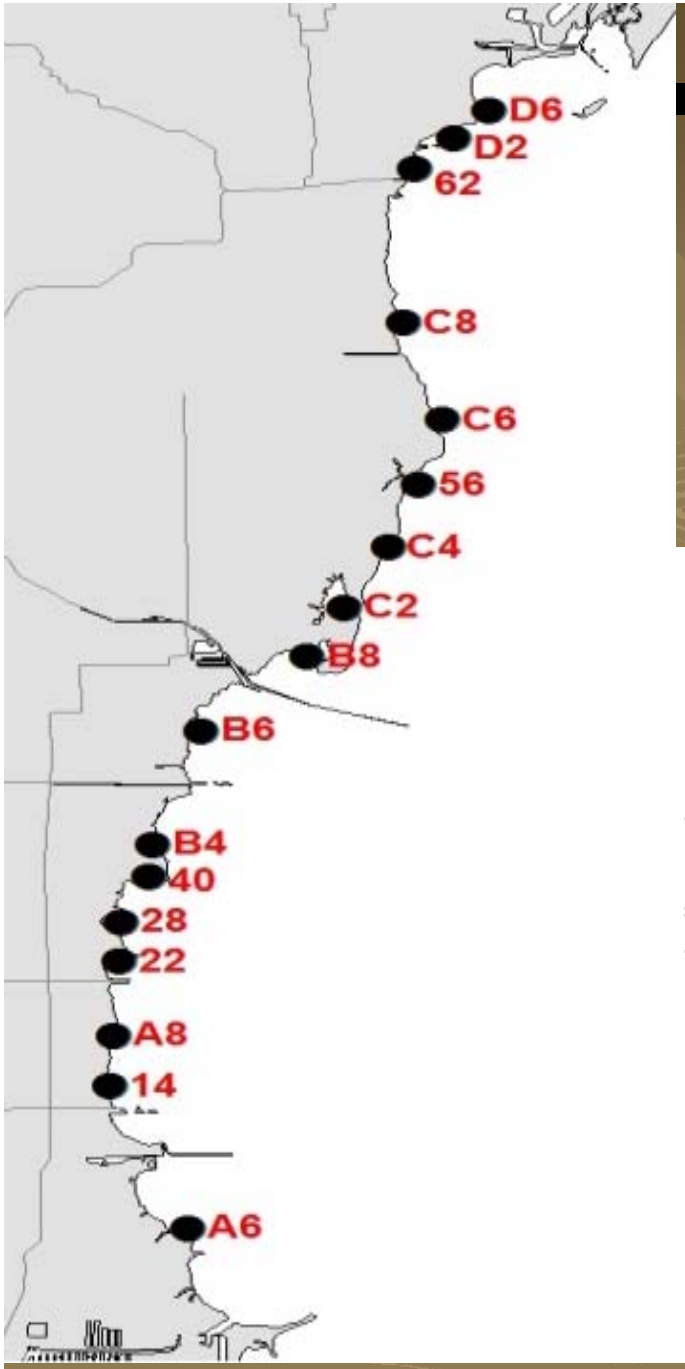


Jerry Lorenz'- Florida Bay Reference Site (DJ, Downstream Joe Bay)

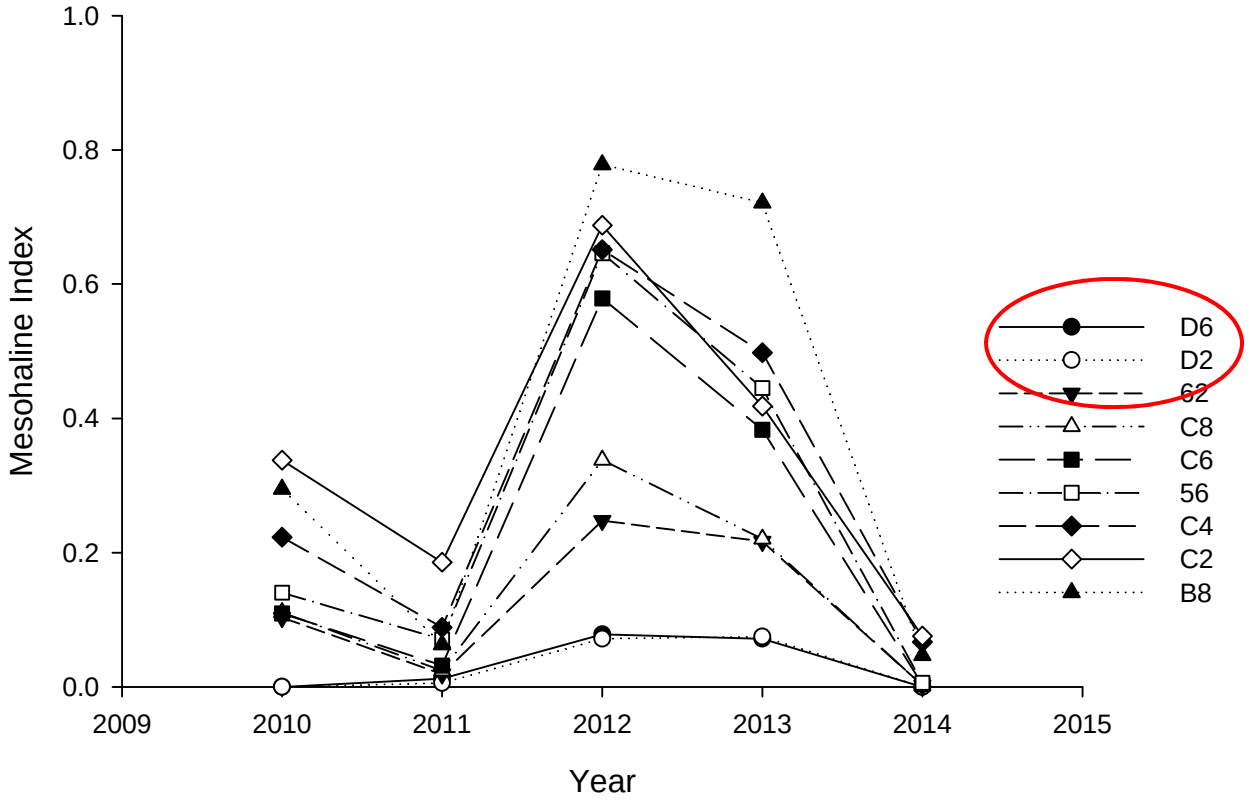
Salinity Patterns in Southern Biscayne Bay

- More persistent high salinity north of Black Point
- Stratification is a normal occurrence even in shallow water
- Hypersalinity along the western shoreline
- Three distinct areas of the Bay:
    1) Deering Estate to Black Point
    2) Black Point to Convoy Point
    3) Convoy Point to Manatee Bay
- Rapid Changes in salinity which return to pre-event levels over short periods of time
- Develops an estuarine zone every year which may be more or less persistent depending on operations

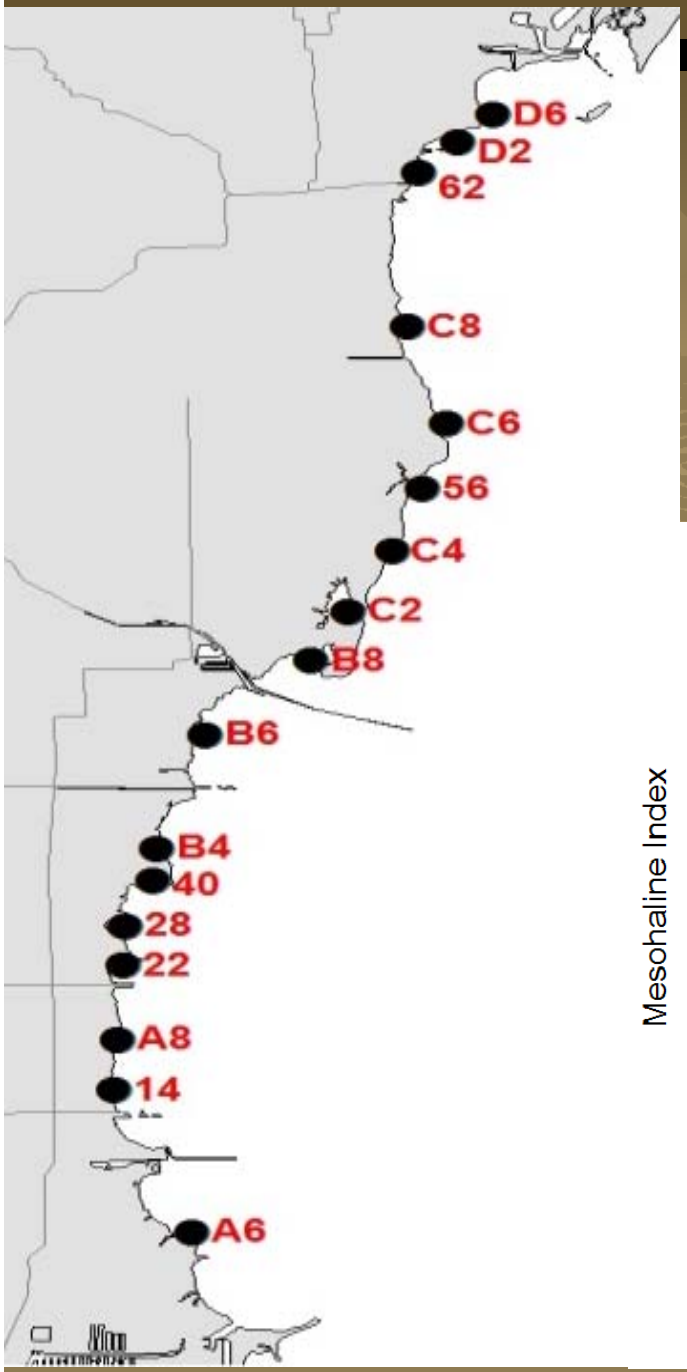

1.0
0.8
0.6
0.4
0.2
0.0
Mesohaline Index
2009
2010
2011
2012
2013
2014
2015
Year
D6
D2
62
C8
C6
56
C4
C2
B8
B6
B4
40
28
22
A8
14
A6

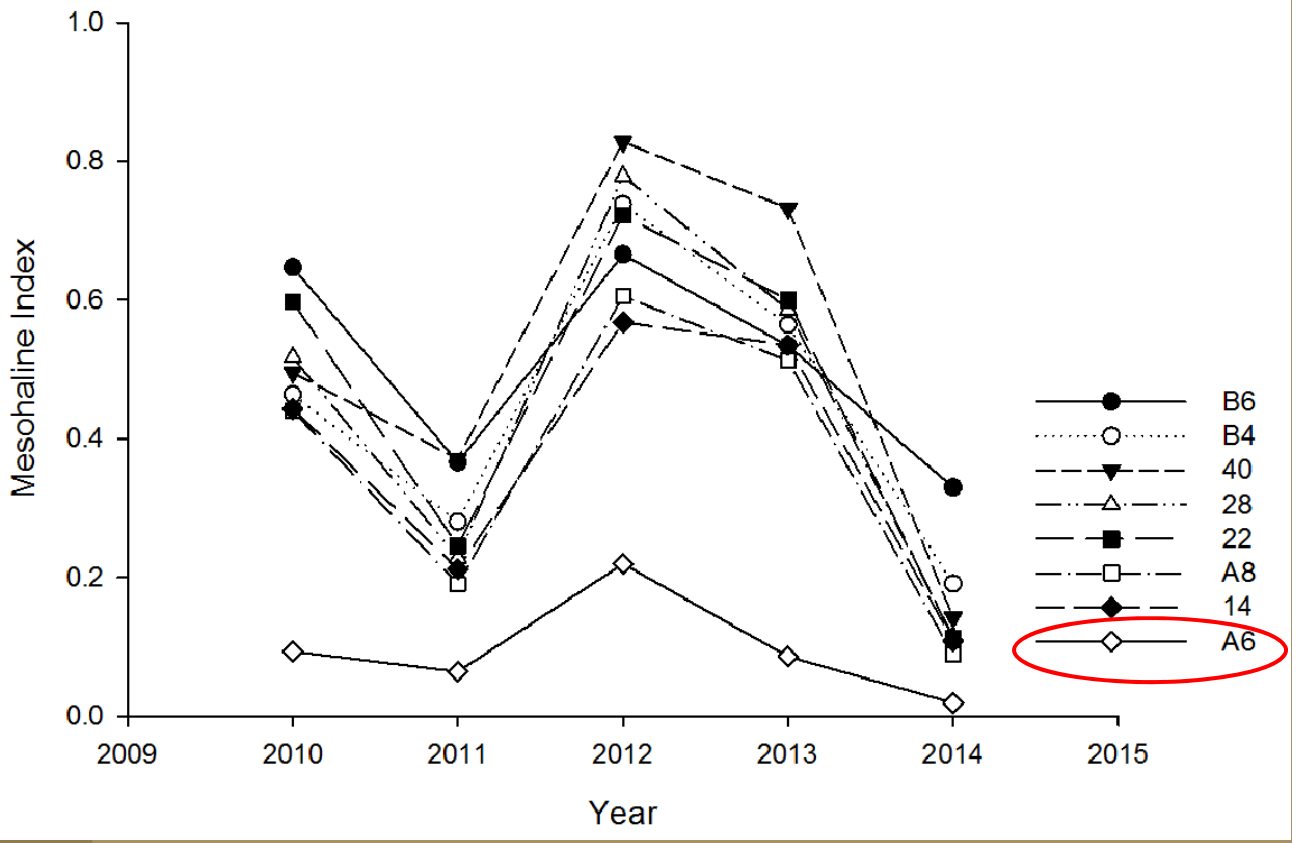


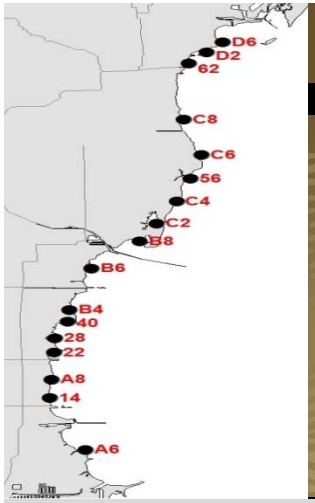
Mesohaline Response



Mesohaline Response



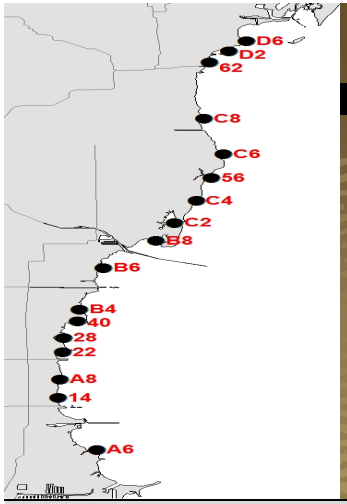




Mesohaline Index

WYR	2004	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Mean	
CYR	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014	2015		
Month	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr
Season	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
D6														0.000	0.000	0.012	0.003	0.078	0.000	0.072	0.000	0.000		0.040	0.001
D2														0.000	0.000	0.005	0.006	0.072	0.000	0.075	0.000	0.000		0.038	0.002
62	0.001	0.074	0.001	0.155	0.001	0.105	0.000	0.085	0.000	0.105	0.000	0.015	0.002	0.103	0.000	0.019	0.020	0.248	0.000	0.216	0.003	0.002		0.103	0.003
C8														0.111	0.000	0.024	0.032	0.338	0.000	0.220	0.008	0.002		0.146	0.010
C6														0.109	0.003	0.032	0.035	0.579	0.000	0.383	0.000	0.004		0.249	0.010
56	0.074	0.143	0.031	0.376	0.000	0.273	0.000	0.346	0.009	0.211	0.000	0.048	0.014	0.140	0.003	0.070	0.043	0.646	0.001	0.445	0.008	0.006		0.246	0.011
C4														0.223	0.002	0.088	0.054	0.651	0.000	0.498	0.014	0.067		0.305	0.017
C2														0.338	0.037	0.186	0.088	0.688	0.007	0.418	0.106	0.075		0.342	0.059
B8														0.295	0.047	0.063	0.135	0.778	0.011	0.721	0.168	0.047		0.402	0.090
B6														0.647	0.137	0.366	0.399	0.666	0.439	0.534	0.430	0.330		0.508	0.351
B4														0.464	0.137	0.280	0.541	0.738	0.202	0.564	0.420	0.191		0.443	0.325
40	0.186	0.243	0.230	0.538	0.287	0.434	0.212	0.404	0.194	0.422	0.262	0.291	0.222	0.495	0.135	0.371	0.532	0.827	0.172	0.732	0.398	0.142		0.453	0.264
28	0.104	0.209	0.252	0.475	0.281	0.407	0.172	0.351	0.162	0.393	0.199	0.155	0.168	0.517	0.108	0.228	0.432	0.778	0.116	0.586	0.335	0.114		0.383	0.222
22	0.000	0.215	0.213	0.408	0.245	0.348	0.188	0.348	0.175	0.486	0.147	0.238	0.159	0.598	0.115	0.246	0.455	0.722	0.110	0.600	0.294	0.113		0.393	0.210
A8														0.440	0.118	0.190	0.419	0.605	0.138	0.512	0.241	0.089		0.367	0.229
14	0.166	0.168	0.227	0.445	0.298	0.344	0.250	0.415	0.284	0.381	0.261	0.243	0.230	0.443	0.134	0.212	0.566	0.568	0.220	0.535	0.132	0.109		0.351	0.260
A6														0.093	0.036	0.064	0.180	0.219	0.008	0.086	0.028	0.019		0.097	0.063
DJ														0.818	0.299	0.564	0.223							0.691	0.261

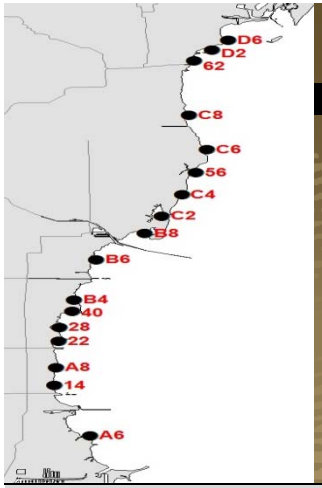
Mesohaline Index by water-year (WY), calendar-year (CY), and season (Wet=May-Oct; Dry=Nov-Apr). (MI=proportion of salinity observations ≥5-<18).



Variability Index

WYR	2004	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Mean	
CYR	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014			
Month	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	May-Oct	Nov-Apr
Season	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Wet	Dry
D6														0.000	0.011	0.043	0.060	0.163	0.072	0.103	0.033	0.000	0.077	0.044
D2														0.000	0.006	0.027	0.055	0.120	0.039	0.060	0.077	0.043	0.063	0.044
62	0.188	0.293	0.089	0.332	0.188	0.281	0.227	0.266	0.033	0.174	0.105	0.234	0.127	0.408	0.177	0.130	0.082	0.359	0.033	0.190	0.039	0.092	0.251	0.110
C8														0.116	0.000	0.049	0.088	0.174	0.011	0.087	0.022	0.011	0.080	0.030
C6														0.137	0.077	0.103	0.071	0.377	0.022	0.185	0.055	0.043	0.177	0.057
56	0.057	0.147	0.055	0.223	0.033	0.060	0.083	0.179	0.022	0.179	0.033	0.022	0.066	0.163	0.056	0.125	0.071	0.239	0.039	0.098	0.116	0.071	0.137	0.057
C4														0.072	0.000	0.087	0.044	0.076	0.011	0.033	0.028	0.054	0.064	0.021
C2														0.532	0.188	0.402	0.253	0.435	0.138	0.257	0.182	0.315	0.352	0.190
B8														0.168	0.238	0.209	0.231	0.288	0.227	0.087	0.050	0.043	0.157	0.186
B6														0.287	0.028	0.239	0.170	0.353	0.072	0.315	0.144	0.402	0.319	0.103
B4														0.290	0.081	0.212	0.209	0.207	0.105	0.288	0.249	0.185	0.223	0.161
40	0.014	0.087	0.024	0.109	0.011	0.095	0.006	0.049	0.022	0.114	0.022	0.078	0.033	0.082	0.022	0.102	0.176	0.082	0.133	0.087	0.105	0.060	0.084	0.055
28	0.014	0.076	0.127	0.196	0.043	0.070	0.061	0.082	0.038	0.136	0.055	0.038	0.088	0.207	0.387	0.484	0.082	0.103	0.055	0.136	0.116	0.027	0.141	0.105
22	0.067	0.120	0.114	0.152	0.061	0.130	0.055	0.098	0.093	0.231	0.061	0.130	0.072	0.473	0.193	0.190	0.121	0.212	0.101	0.163	0.017	0.098	0.182	0.089
A8														0.268	0.072	0.228	0.214	0.299	0.182	0.277	0.177	0.283	0.271	0.161
14	0.239	0.310	0.239	0.416	0.503	0.554	0.326	0.565	0.610	0.543	0.344	0.467	0.436	0.567	0.232	0.413	0.408	0.620	0.564	0.593	0.378	0.478	0.502	0.404
A6														0.120	0.077	0.098	0.055	0.190	0.122	0.272	0.060	0.179	0.185	0.078
DJ														0.021	0.011	0.000	0.011						0.010	0.011

Variablity Index by water-year (WY), calendar-year (CY), and season (Wet=May-Oct; Dry=Nov-Apr). (Variability proportion of observations where daily salinity range >5).



Salinity Regime Suitability Index

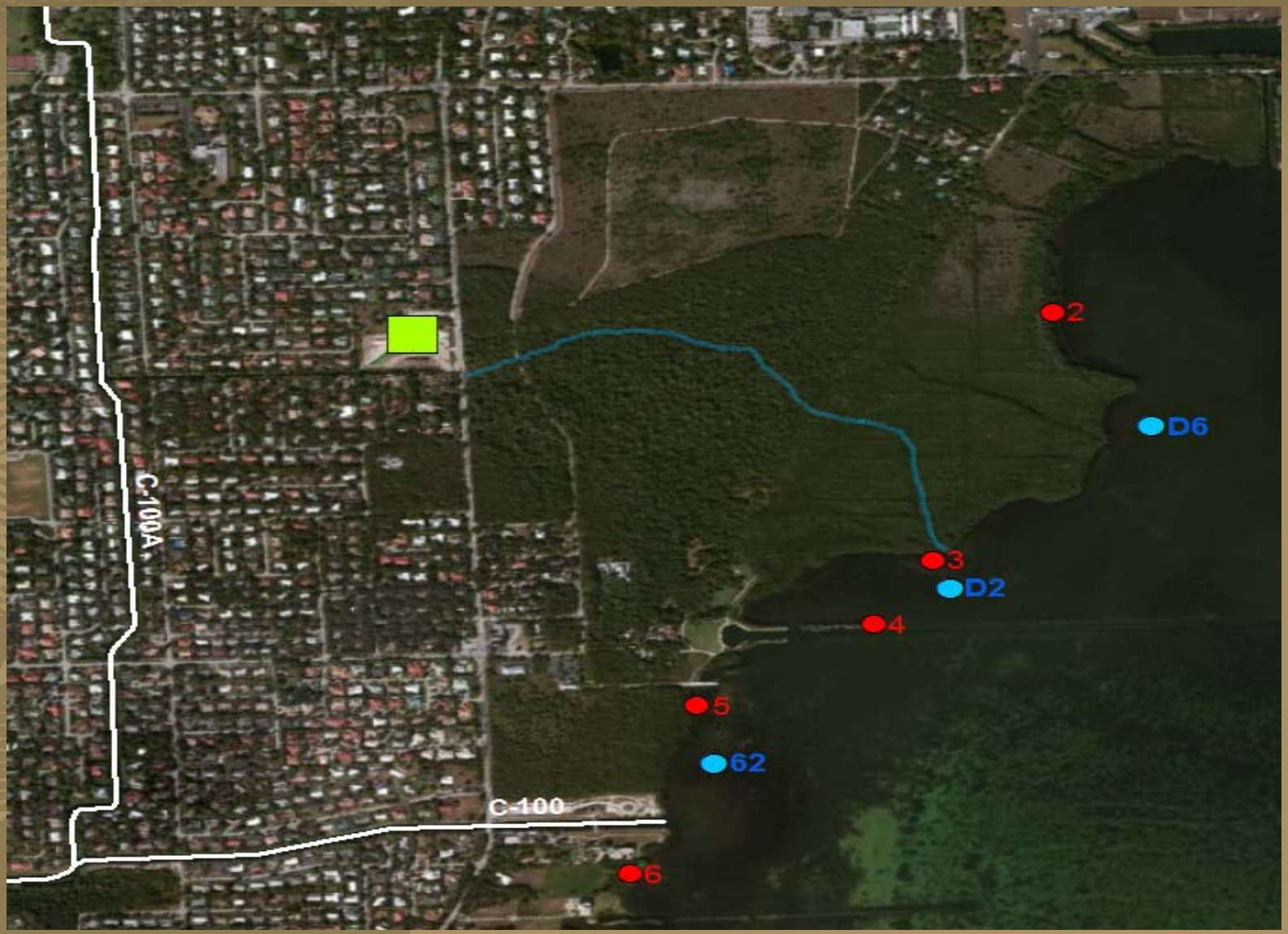
WYR	2004	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Mean	
CYR	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014			
Month	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct		May-Oct	Nov-Apr
Season	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet		Wet	Dry
D6														0.000	0.000	0.226	0.134	0.403	0.000	0.400	0.000	0.000		0.257	0.034
D2														0.000	0.000	0.163	0.181	0.398	0.055	0.413	0.000	0.000		0.244	0.059
62	0.086	0.368	0.085	0.470	0.091	0.422	0.059	0.397	0.059	0.443	0.000	0.221	0.112	0.394	0.046	0.253	0.266	0.542	0.000	0.560	0.138	0.125		0.381	0.086
C8														0.461	0.000	0.270	0.308	0.653	0.000	0.586	0.199	0.118		0.407	0.127
C6														0.455	0.145	0.284	0.319	0.712	0.000	0.678	0.069	0.146		0.455	0.133
56	0.412	0.443	0.308	0.663	0.038	0.635	0.000	0.657	0.203	0.557	0.000	0.349	0.236	0.489	0.146	0.371	0.342	0.789	0.094	0.738	0.195	0.171		0.533	0.156
C4														0.592	0.126	0.419	0.373	0.844	0.000	0.784	0.237	0.386		0.605	0.184
C2														0.541	0.311	0.464	0.403	0.730	0.182	0.677	0.443	0.359		0.557	0.335
B8														0.626	0.329	0.345	0.470	0.821	0.206	0.870	0.542	0.354		0.598	0.387
B6														0.773	0.509	0.608	0.692	0.755	0.741	0.715	0.716	0.582		0.687	0.665
B4														0.690	0.501	0.540	0.753	0.837	0.565	0.738	0.681	0.538		0.663	0.625
40	0.568	0.565	0.607	0.783	0.657	0.732	0.595	0.727	0.575	0.720	0.635	0.623	0.599	0.769	0.510	0.664	0.760	0.913	0.530	0.874	0.709	0.508		0.721	0.618
28	0.468	0.534	0.604	0.726	0.645	0.723	0.545	0.685	0.538	0.698	0.572	0.522	0.535	0.743	0.405	0.454	0.735	0.887	0.478	0.797	0.666	0.481		0.659	0.572
22	0.000	0.535	0.574	0.702	0.613	0.671	0.562	0.680	0.541	0.720	0.516	0.582	0.528	0.680	0.453	0.528	0.737	0.829	0.462	0.795	0.661	0.467		0.654	0.565
A8														0.686	0.479	0.487	0.691	0.751	0.483	0.718	0.583	0.395		0.607	0.559
14	0.502	0.446	0.557	0.638	0.529	0.535	0.553	0.565	0.480	0.558	0.555	0.493	0.506	0.577	0.468	0.440	0.694	0.600	0.458	0.601	0.435	0.383		0.531	0.524
A6														0.434	0.319	0.334	0.554	0.562	0.192	0.597	0.296	0.236		0.432	0.340
DJ														0.929	0.666	0.826	0.591							0.878	0.629

Salinity Regime Suitability Index by water-year(WY), calendar-year (CY), and season (Wet=May-Oct; Dry=Nov-Apr). This index is a composite of the mesohaline, hypersaline and variability indices

Benefits of Water Delivery ….. Resulting Downstream Response

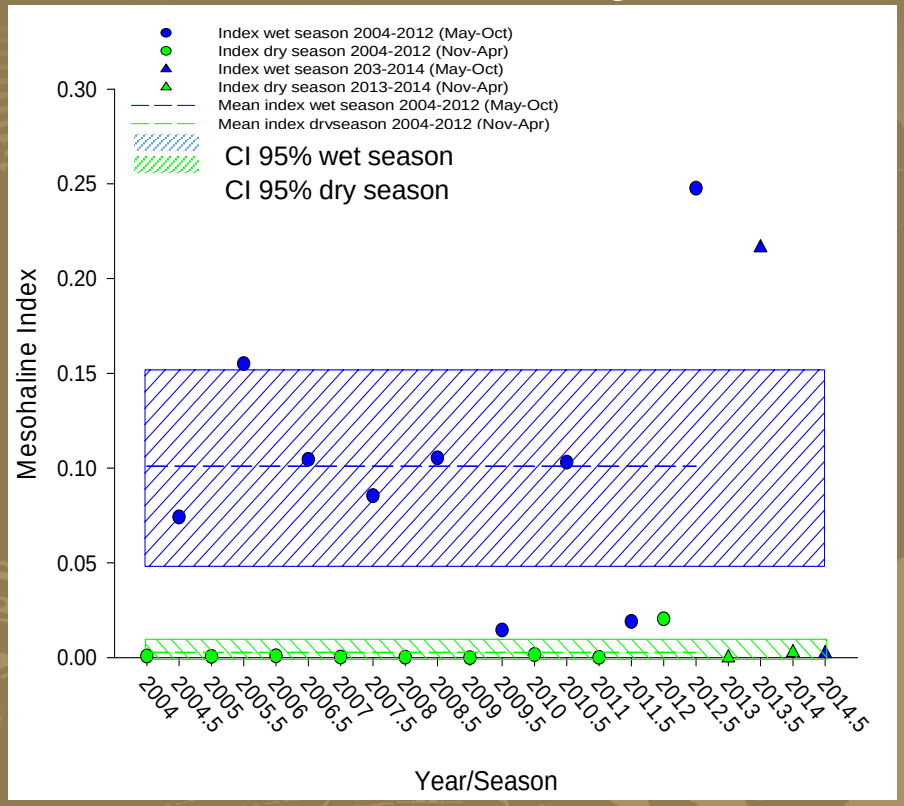
- Two test action water deliveries to Biscayne Bay during dry season…small amounts of water was delivered to Biscayne Bay through canals not involved in the Seasonal Agricultural Drawdown.
- Tests were in 2009 (first informal test) and a formal study in 2011-12.
- Delivery was through the C-1 and C-100.
- Resulted in measurable downstream changes in benthic salinity patterns and responses.
- Structure S-700 was installed and began operating at Deering Estate in stable operations late 2012.

Deering Estate

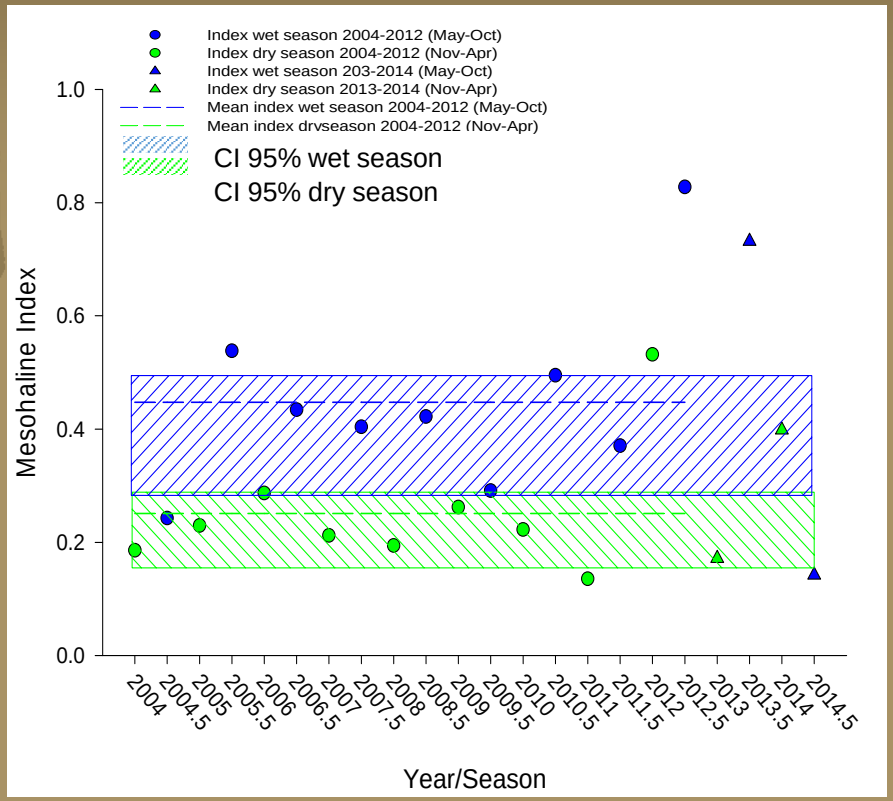


Mesohaline Index Values

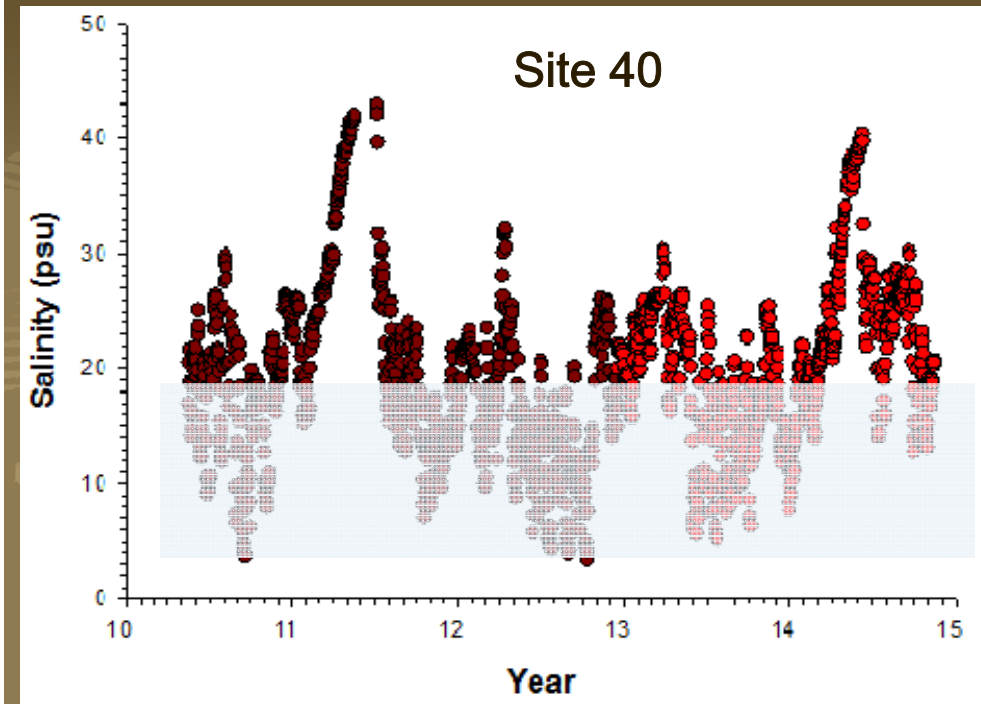
Site 62 off of Deering Estate

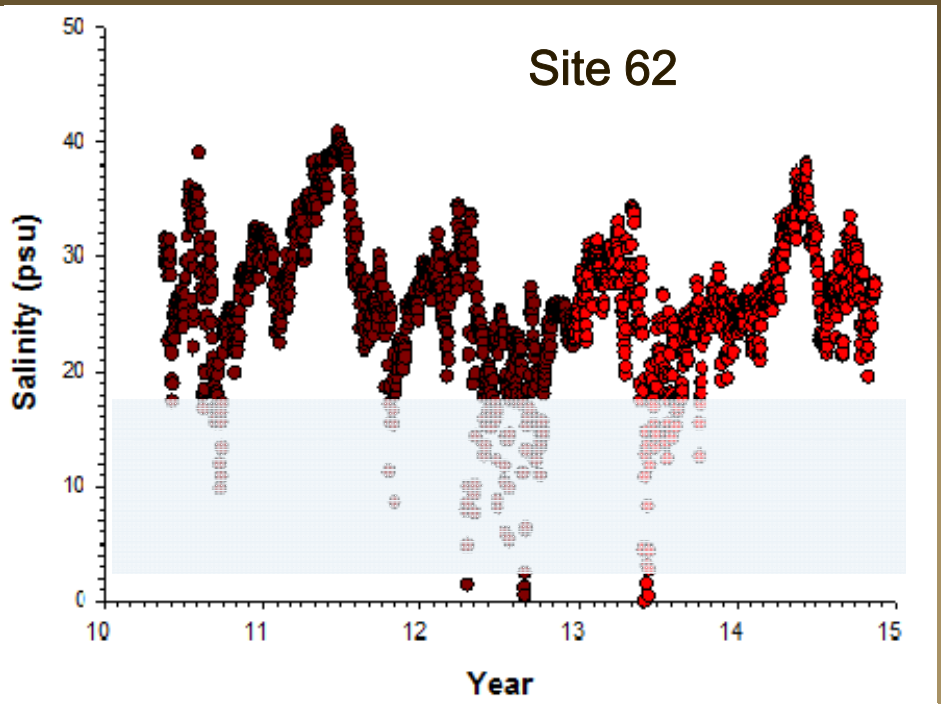


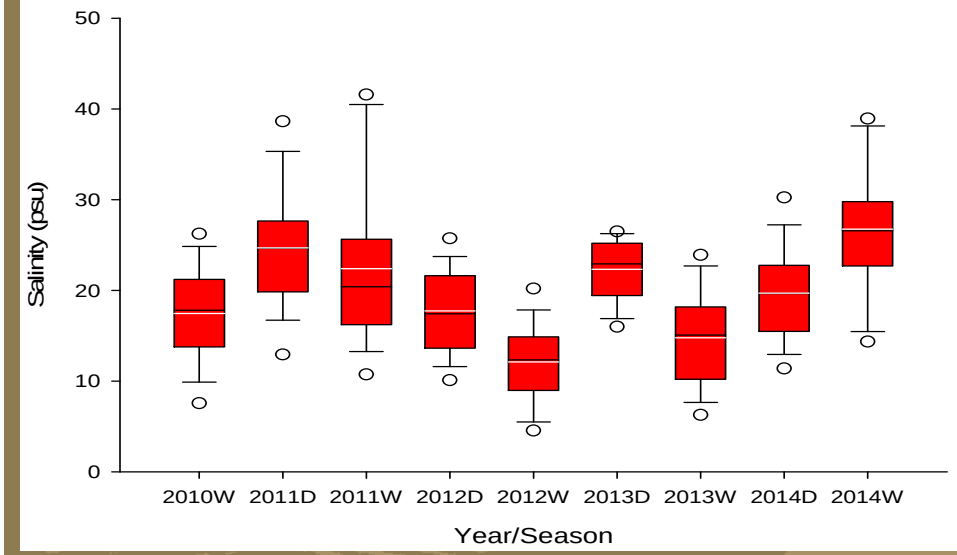
Site 40 South of Fender Point

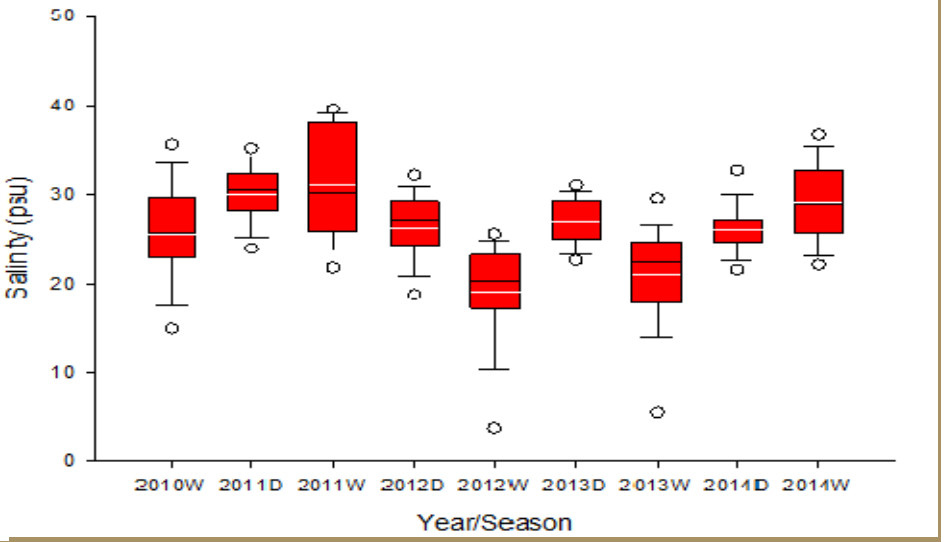


Mesohaline Index Value, including the 2004-2012 wet and dry season means and their 95% confidence intervals. Year values without added .5 represent dry season and those with added .5 represent wet season.

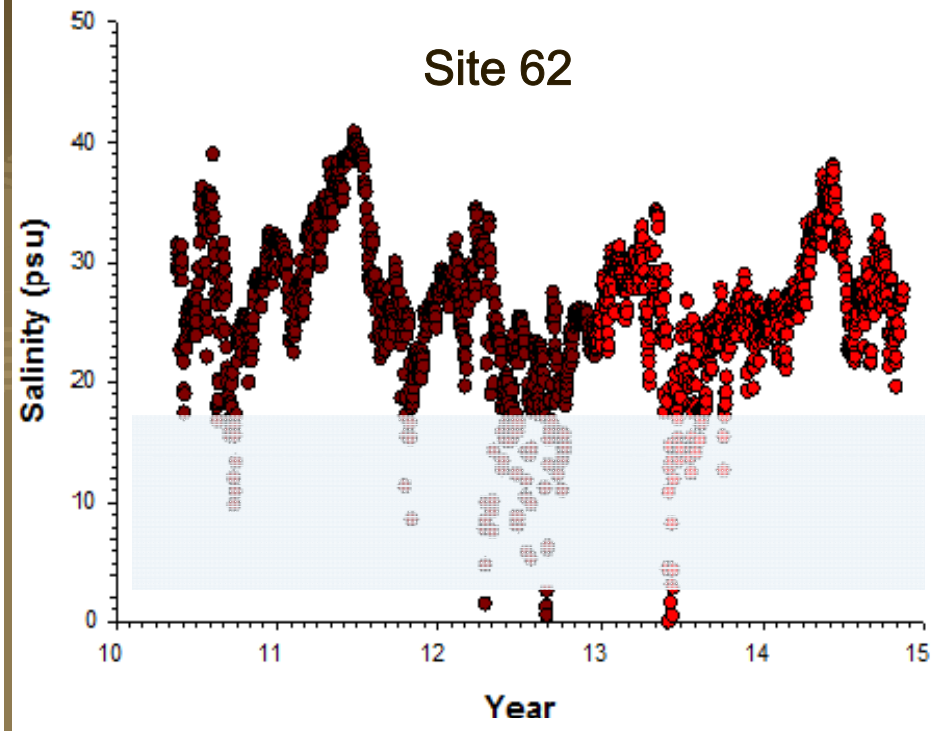


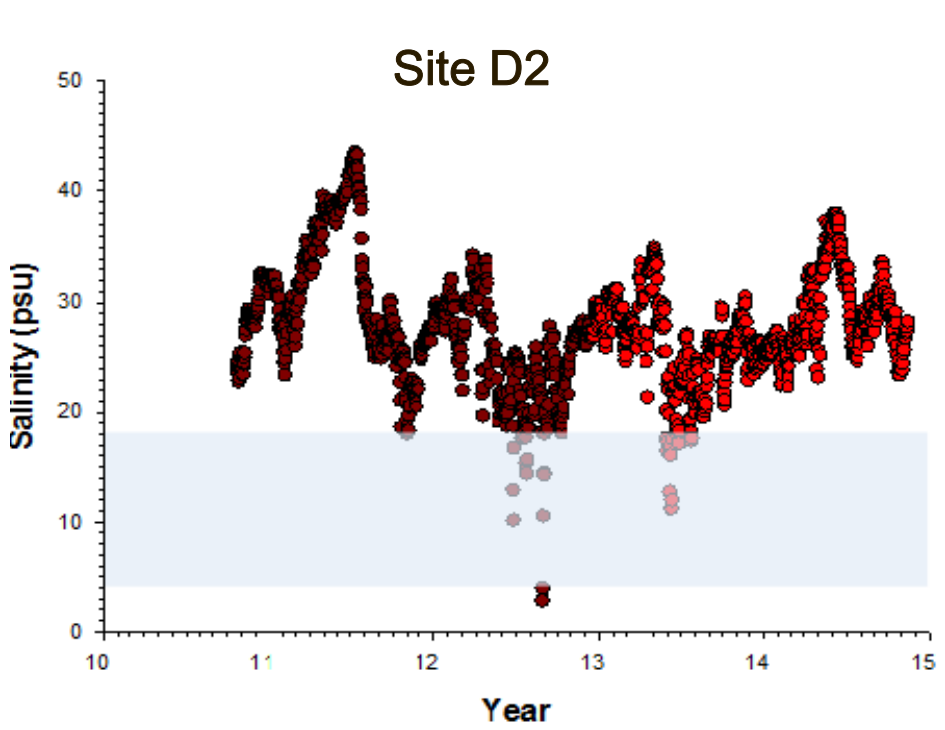


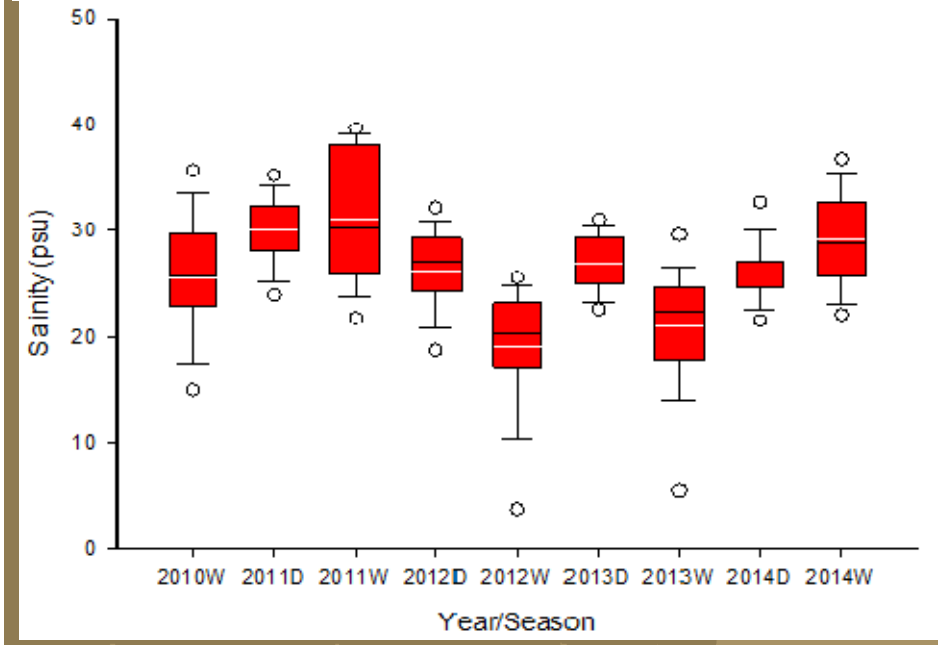


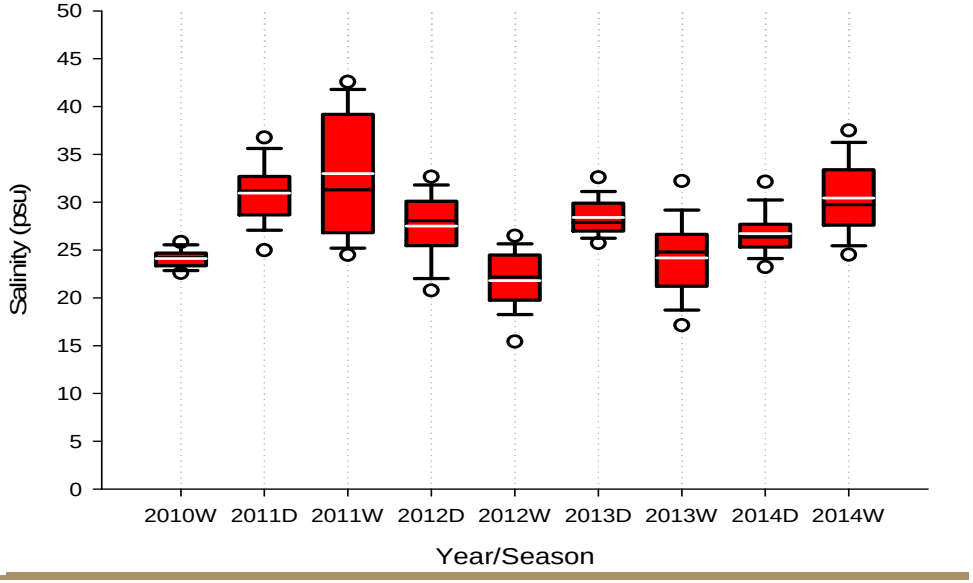


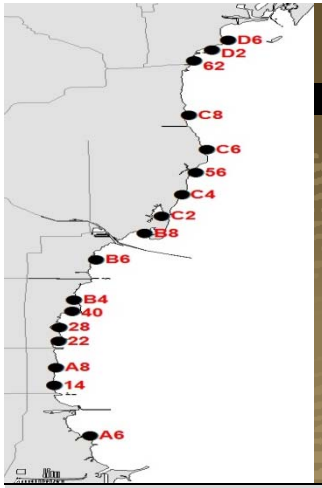
white line = mean, black line = median, black circles =5th/95th percentile, red box 25th/75th percentile, black vertical lines = min/max.


Site 62
Salinity (psu)
Year


Site D2
Salinity (psu)
Year


Salinity (psu)
2010W
2011D
2011W
2012D
2012W
2013D
2013W
2014D
2014W
Year/Season

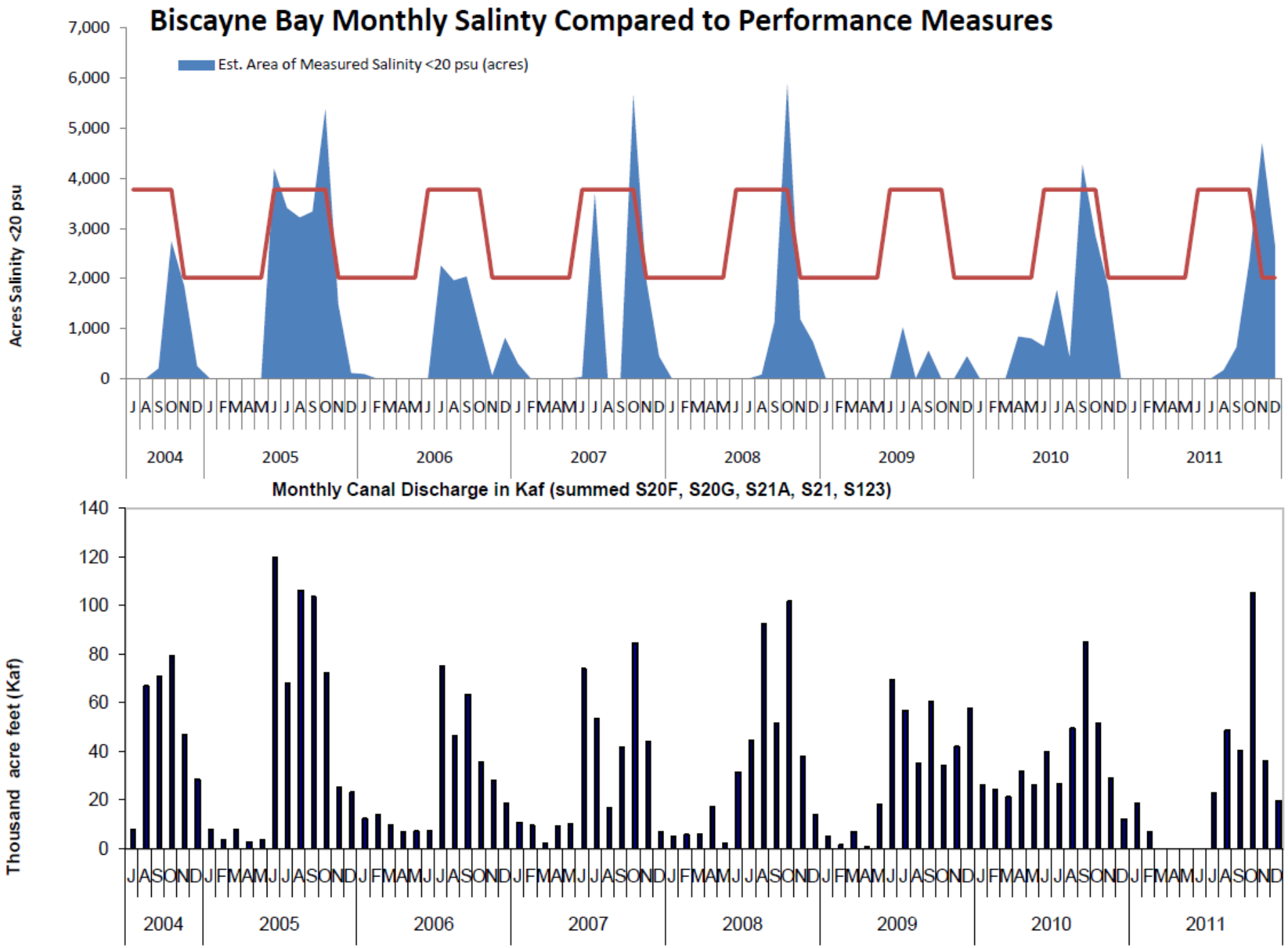

Salinity (psu)
2010W
2011D
2011W
2012D
2012W
2013D
2013W
2014D
2014W
Year/Season



Salinity Regime Suitability Index

WYR	2004	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Mean	
CYR	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014			
Month	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct		May-Oct	Nov-Apr
Season	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet		Wet	Dry
D6														0.000	0.000	0.226	0.134	0.403	0.000	0.400	0.000	0.000		0.257	0.034
D2														0.000	0.000	0.163	0.181	0.398	0.055	0.413	0.000	0.000		0.244	0.059
62	0.086	0.368	0.085	0.470	0.091	0.422	0.059	0.397	0.059	0.443	0.000	0.221	0.112	0.394	0.046	0.253	0.266	0.542	0.000	0.560	0.138	0.125		0.381	0.086
C8														0.461	0.000	0.270	0.308	0.653	0.000	0.586	0.199	0.118		0.407	0.127
C6														0.455	0.145	0.284	0.319	0.712	0.000	0.678	0.069	0.146		0.455	0.133
56	0.412	0.443	0.308	0.663	0.038	0.635	0.000	0.657	0.203	0.557	0.000	0.349	0.236	0.489	0.146	0.371	0.342	0.789	0.094	0.738	0.195	0.171		0.533	0.156
C4														0.592	0.126	0.419	0.373	0.844	0.000	0.784	0.237	0.386		0.605	0.184
C2														0.541	0.311	0.464	0.403	0.730	0.182	0.677	0.443	0.359		0.557	0.335
B8														0.626	0.329	0.345	0.470	0.821	0.206	0.870	0.542	0.354		0.598	0.387
B6														0.773	0.509	0.608	0.692	0.755	0.741	0.715	0.716	0.582		0.687	0.665
B4														0.690	0.501	0.540	0.753	0.837	0.565	0.738	0.681	0.538		0.663	0.625
40	0.568	0.565	0.607	0.783	0.657	0.732	0.595	0.727	0.575	0.720	0.635	0.623	0.599	0.769	0.510	0.664	0.760	0.913	0.530	0.874	0.709	0.508		0.721	0.618
28	0.468	0.534	0.604	0.726	0.645	0.723	0.545	0.685	0.538	0.698	0.572	0.522	0.535	0.743	0.405	0.454	0.735	0.887	0.478	0.797	0.666	0.481		0.659	0.572
22	0.000	0.535	0.574	0.702	0.613	0.671	0.562	0.680	0.541	0.720	0.516	0.582	0.528	0.680	0.453	0.528	0.737	0.829	0.462	0.795	0.661	0.467		0.654	0.565
A8														0.686	0.479	0.487	0.691	0.751	0.483	0.718	0.583	0.395		0.607	0.559
14	0.502	0.446	0.557	0.638	0.529	0.535	0.553	0.565	0.480	0.558	0.555	0.493	0.506	0.577	0.468	0.440	0.694	0.600	0.458	0.601	0.435	0.383		0.531	0.524
A6														0.434	0.319	0.334	0.554	0.562	0.192	0.597	0.296	0.236		0.432	0.340
DJ														0.929	0.666	0.826	0.591							0.878	0.629

Salinity Regime Suitability Index by water-year(WY), calendar-year (CY), and season (Wet=May-Oct; Dry=Nov-Apr). This index is a composite of the mesohaline, hypersaline and variability indices


Biscayne Bay Monthly Salinty Compared to Performance Measures
Est. Area of Measured Salinity <20 psu (acres)
Acres Salinity <20 psu
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
2004
2005
2006
2007
2008
2009
2010
2011
Monthly Canal Discharge in Kaf (summed S20F, S20G, S21A, S21, S123)
Thousand acre feet (Kaf)
140
120
100
80
60
40
20
0
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
2004
2005
2006
2007
2008
2009
2010
2011

Conclusions

- Water provided during the initial operations of the structure for the Deering Estate portion of the Biscayne Bay Coastal Wetlands showed downstream improvement.
- 2014 was a bad year for estuarine zones off of Deering Estate and north of Black Point.
- Additional freshwater delivered through the canal system to Biscayne Bay in the dry season improved the salinity conditions in the late wet season and early dry season.
- Even small amounts of water delivered to the Biscayne Bay benefit the bay salinity conditions.
- Operational changes can benefit the bay when made in conjunction with downstream salinity conditions.

Recommendations……Next Steps

- Investigate why there was so little downstream mesohaline zone in 2014 off of Deering Estate.
- Revisit delivery schedules to Biscayne Bay to provide freshwater during the dry season when possible.
- Revisit the Everglades Restoration Transitional Plan (ERTP) to accommodate routing water to central and southern Biscayne Bay when not needed by the Everglades System.
- As operational plans are developed add dry season needs for Biscayne Bay to all operational plans.
- Evaluate the impacts of removal of water for the Florida Power and Light Turkey Point Plant from coastal Miami-Dade County and the C&SF system


Questions ?
Assistance and Special Thanks :
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