

Florida Department of Environmental Protection



Standards and Assessment

New Numeric Criteria in Florida: Nutrients and Dissolved Oxygen

Russ Frydenborg
Standards and Assessment





Numeric Interpretation

- Paragraph 62-302.530(47)(b), F.A.C., states that
“in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.”
- Method for numerically interpreting this narrative nutrient criterion, on a site-specific basis, is provided in Rule 62-302.531, F.A.C



Hierarchical Approach

**Nutrient Total Maximum Daily Loads, Site Specific Alternative Criteria ,
Estuary-specific Criteria, and
Water Quality-Based Effluent Limitations**



Stressor-Response Relationships (lakes & springs)



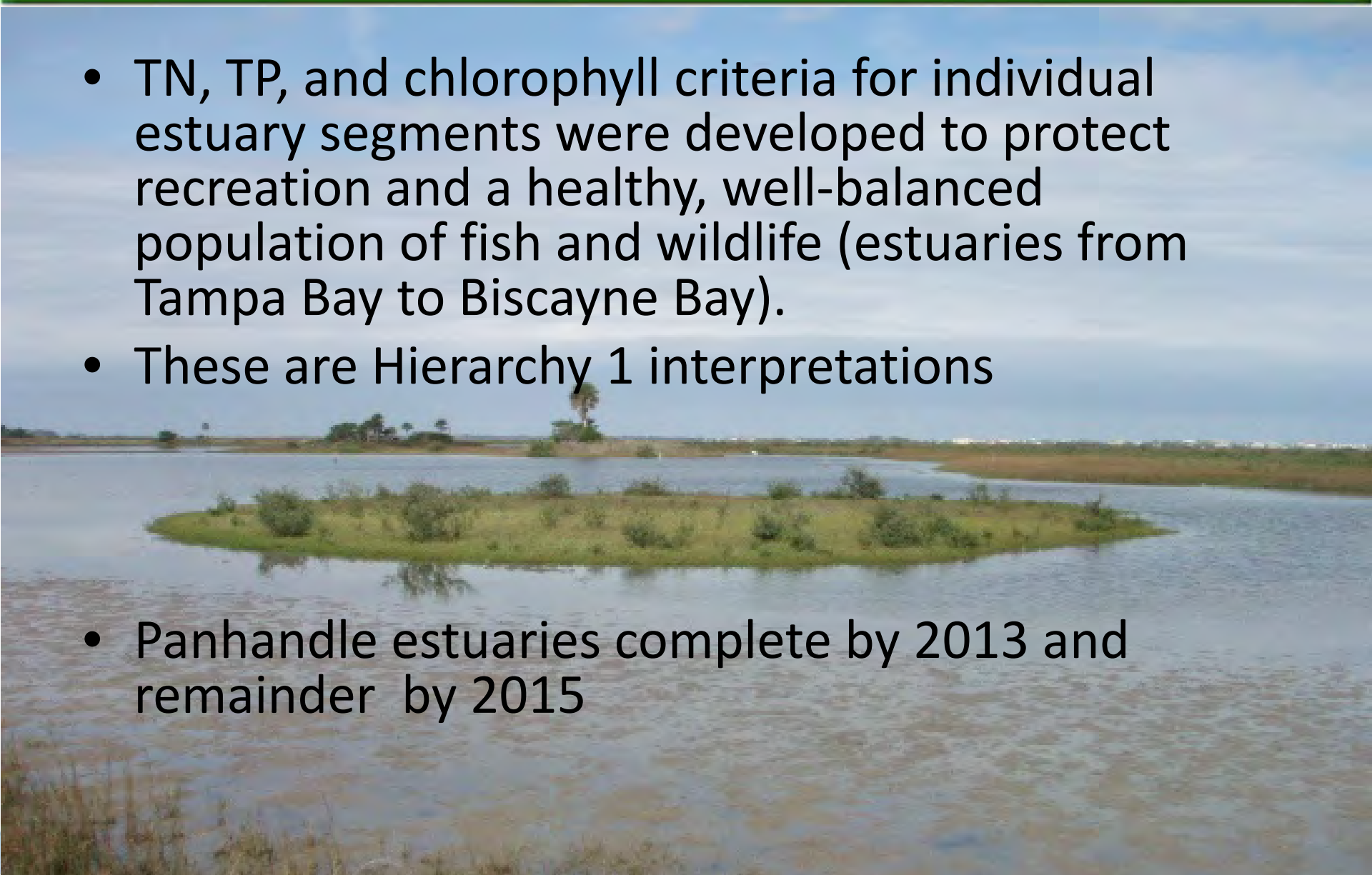
**Reference stream-based thresholds
combined with biological data (flora and fauna)**



**Narrative (wetlands, intermittent streams,
South Florida flowing waters)**



Estuary Site-Specific Criteria

- TN, TP, and chlorophyll criteria for individual estuary segments were developed to protect recreation and a healthy, well-balanced population of fish and wildlife (estuaries from Tampa Bay to Biscayne Bay).
 - These are Hierarchy 1 interpretations
- 
- A wide-angle photograph of an estuary. In the foreground, there is a small, grassy island with some shrubs. The water is calm and reflects the sky. In the background, there is a line of trees and a distant shoreline under a clear blue sky.
- Panhandle estuaries complete by 2013 and remainder by 2015



NNC for Lakes

		Minimum calculated numeric interpretation		Maximum calculated numeric interpretation	
Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean Chlorophyll <i>a</i>	Annual Geometric Mean Total Phosphorus	Annual Geometric Mean Total Nitrogen	Annual Geometric Mean Total Phosphorus	Annual Geometric Mean Total Nitrogen
> 40 Platinum Cobalt Units	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L¹	2.23 mg/L
≤ 40 Platinum Cobalt Units and > 20 mg/L CaCO ₃	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L CaCO ₃	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93 mg/L

¹ For lakes with color > 40 PCU in the West Central Region, the maximum TP limit is 0.49 mg/L



Weeki Wachee, 1950s;
Nitrate < 0.1 mg/L, Eel grass



Weeki Wachee, 2001:
Nitrate ~ 0.7 mg/L, Lyngbya mats



Nuisance Algal Mats in Springs



Nitrate in Spring Vents

- Based on a stressor-response relationship between nitrate-nitrite and nuisance algal mats
- Applicable numeric interpretation of the narrative nutrient criterion is **0.35 mg/L** of nitrate-nitrite as an annual geometric mean
- Not to be exceeded more than once in any three consecutive calendar year period



Streams

- Stressor-response relationships between nutrients and biological effects were insufficient to develop criteria (for both flora and fauna)
- Therefore, a weight of evidence evaluation of flora and the Stream Condition Index (SCI) are used to determine if a stream's nutrient concentrations are protective of balanced flora and fauna
- Section 2.7 of SCI Primer has detailed discussion



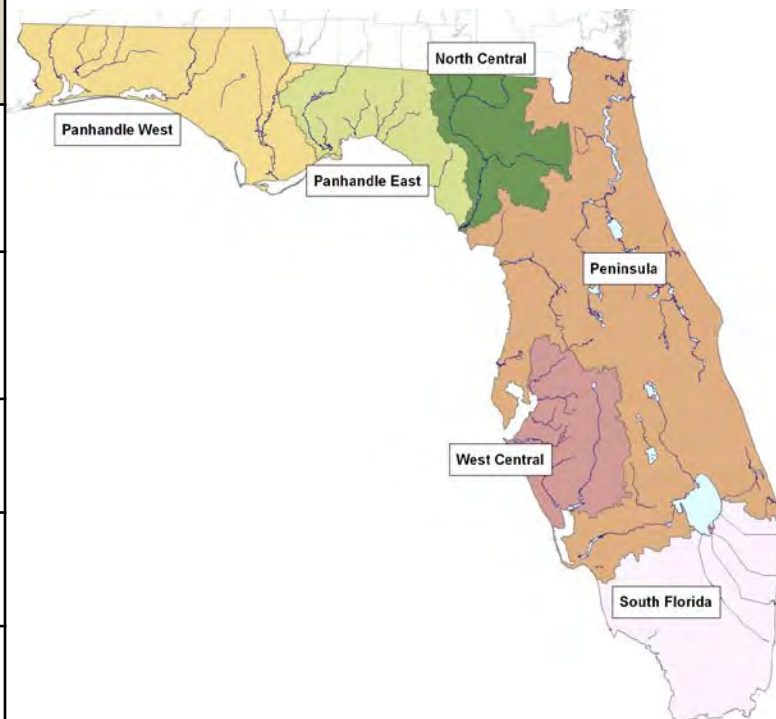
NNC in Streams Achieved IF:

- Information on chlorophyll *a* levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition do not indicate an imbalance in flora or fauna; AND EITHER
- The average score of at least two temporally independent SCIs is 40 or higher, with neither of the two most recent SCI scores less than 35, OR
- The Nutrient Thresholds (expressed as annual geometric means) are not exceeded more than once in a three year period



Streams Thresholds and Regions

Nutrient Region	Total Phosphorus Threshold	Total Nitrogen Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsula	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	





Floral Tools in Streams

- Linear Vegetation Survey
 - Coefficient of Conservatism, invasive exotics
- Rapid Periphyton Survey
 - Thickness and extent, autecology (interpreting species information)
- Phytoplankton chlorophyll a
- Habitat Assessment
 - Substrate type, availability, mapping, etc.

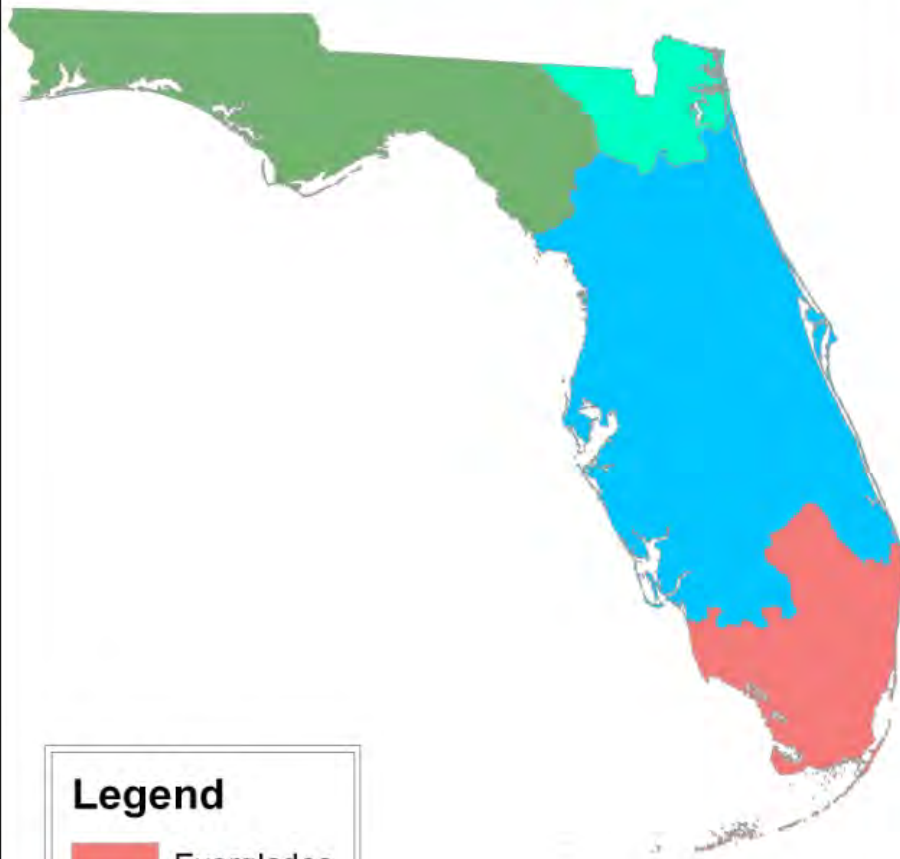


Fauna in Streams: SCI

- As part of DO criteria development QA Rule, DEP assessed the accuracy of the SCI regions
- Used non-metric multidimensional scaling analysis to explore community similarity in reference sites by region
- Found that formation of a new region, the Big Bend, was warranted, with minor adjustments to other borders to include watersheds boundaries

Comparing Regions

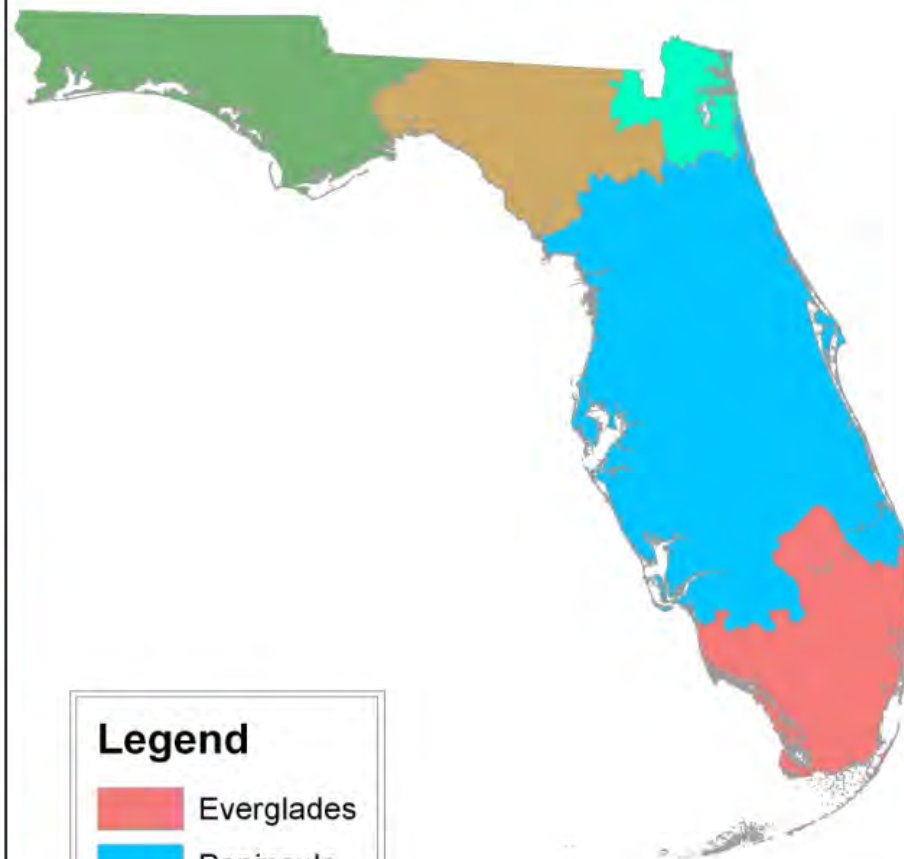
SCI 2007 Bioregions



Legend

- Everglades
- Northeast
- Panhandle
- Peninsula

SCI 2012 Bioregions



Legend

- Everglades
- Peninsula
- Northeast
- Big Bend
- Panhandle



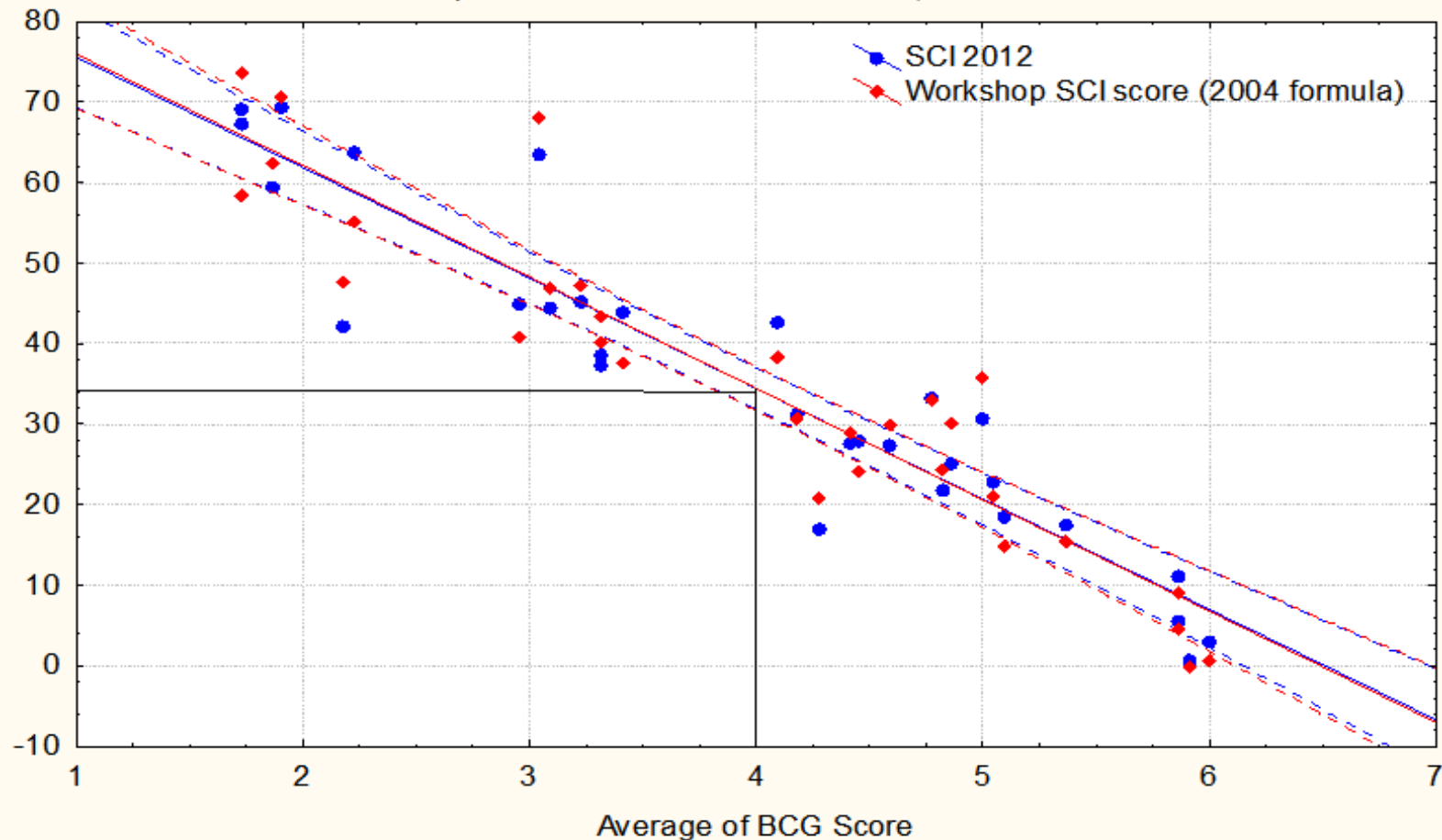
New Scoring and the Biological Condition Gradient: No Change

Scatterplot of multiple variables against Average of BCG Score

ReconstructBCG_SCIplot in ReconstructBCG_SCI.stw 8v*30c

SCI_2012 = $89.3218 - 13.7218 * x$; 0.95 Conf.Int.

Workshop SCI score = $89.8201 - 13.8409 * x$; 0.95 Conf.Int.





New Scoring and the Reference Site Distribution: 40 Remains the Threshold

Parameter	Original 55 Reference Sites Using 2007 Regions	Original 55 Reference Sites Recalculated Using New 2012 Regions	Reference Sites with Most Recent Data (n = 51) Calculated Using New 2012 Regions
Mean	65	67	66
2.5 th percentile of reference (Lowest Acceptable Average SCI Value)	40	42	35



SCI Regionalization Conclusions

- Four regions (new Big Bend)
- Adjustments to metric scoring were minor except for Big Bend
- New scoring did not change BCG results
- New scoring did not substantially change lower reference site distribution (2 points higher)
- New reference site data had a lower percentile distribution that was slightly (5 points) less than previous
- Score of 40 bracketed these results: No change to threshold



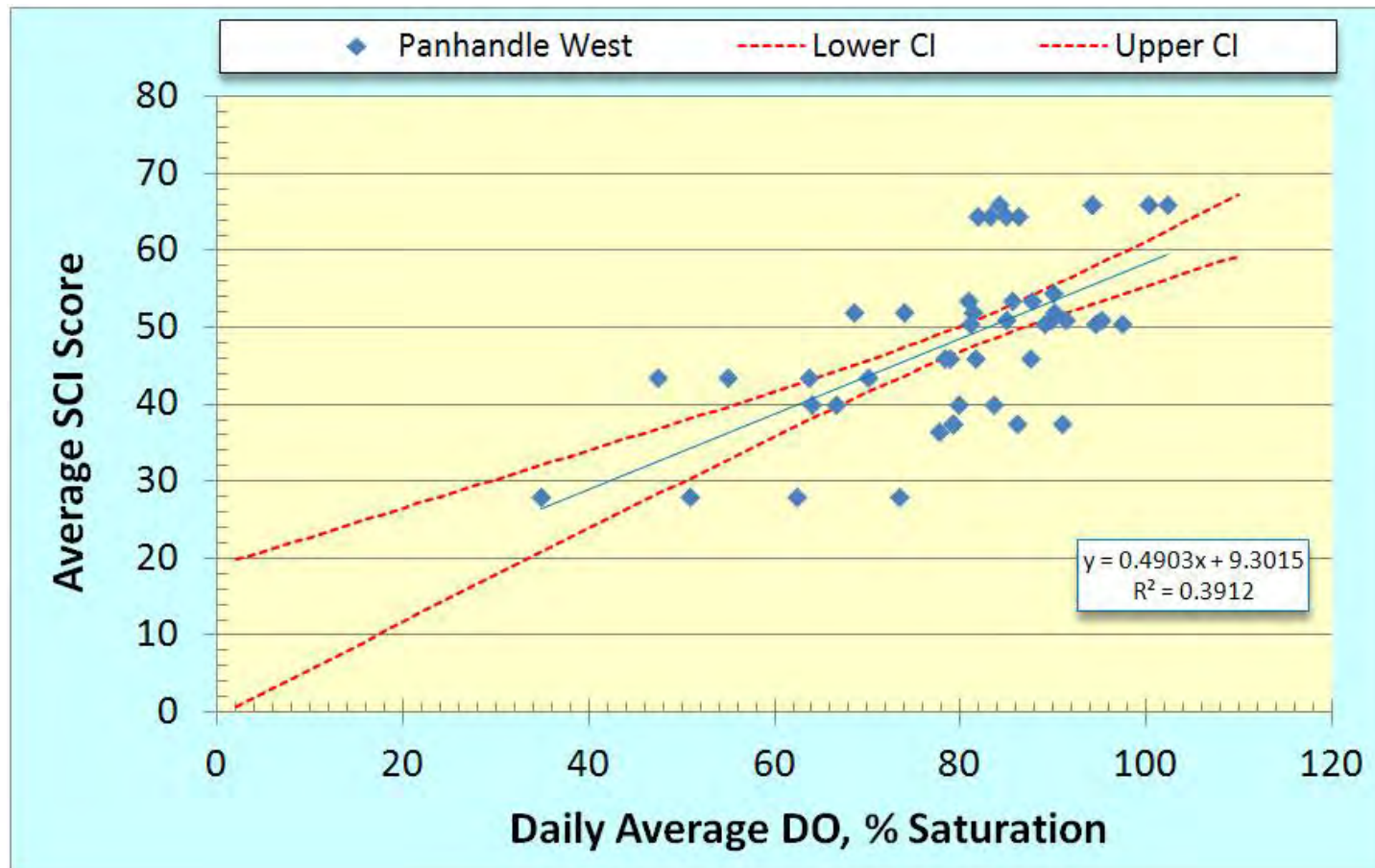
Dissolved Oxygen

- Current criteria based on 1970s (outdated) science
- Proposed revisions based on:
 - DO vs. SCI relationship (applied to streams and lakes)
 - DO vs. laboratory toxicity tests for marine waters (EPA Virginian Province approach)



Panhandle West SCI = 40 Thresholds (Daily Average DO)

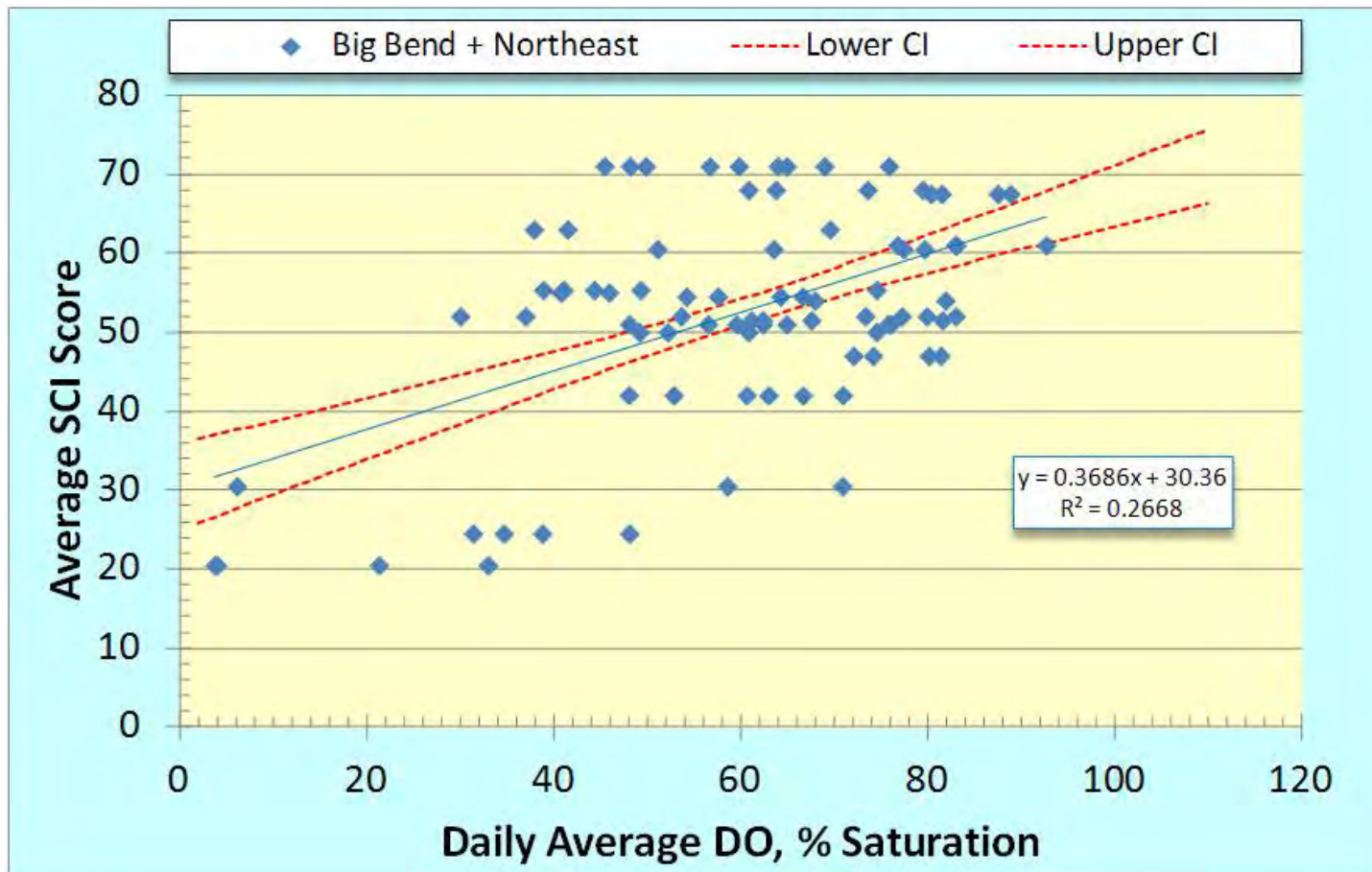
- Regression line = 62 % Saturation
- Lower Confidence Limit = 67 % Saturation





Big Bend and Northeast SCI = 40 Thresholds (Daily Average DO)

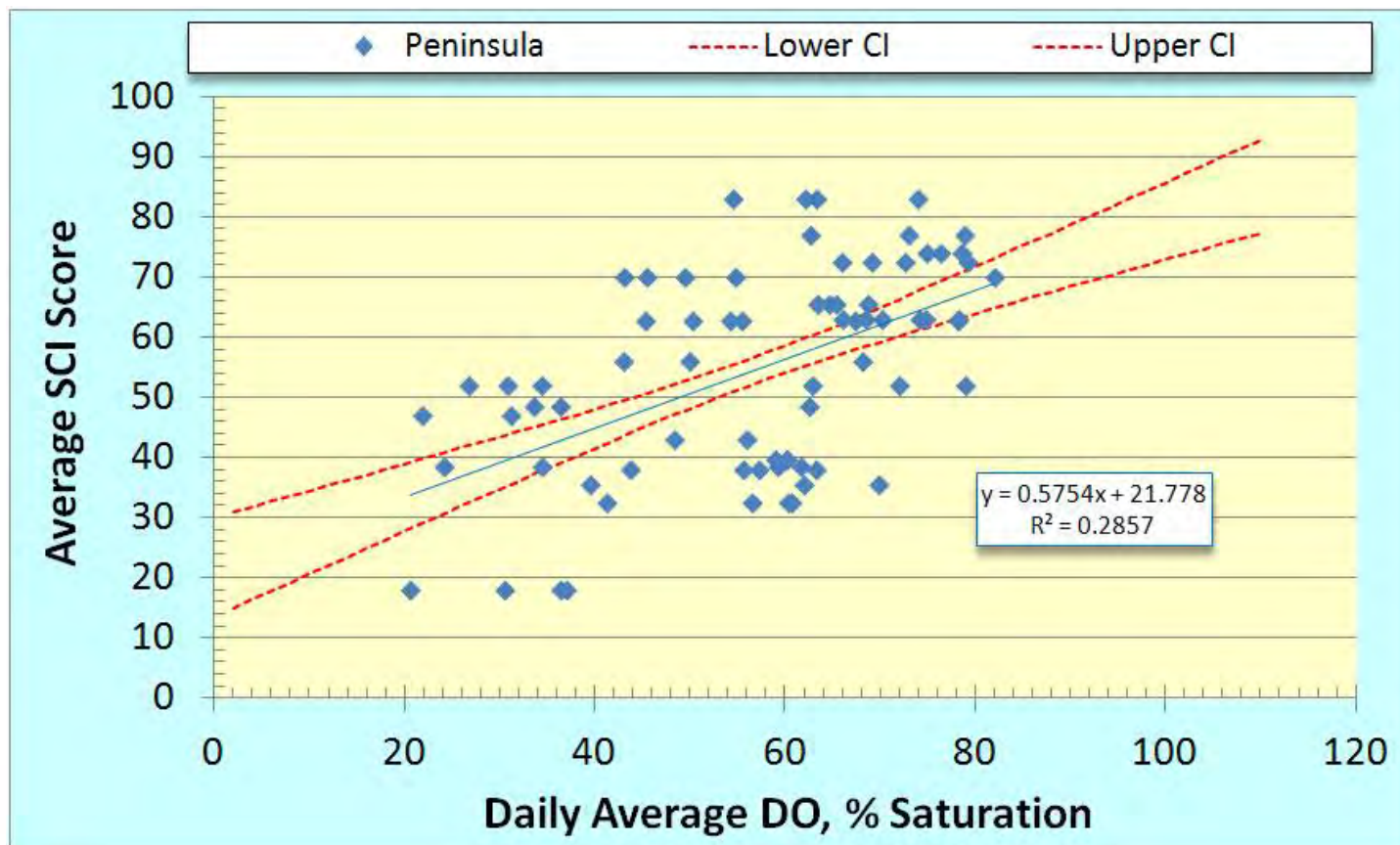
- Regression line = 26 % Saturation
- Lower Confidence Limit = 34 % Saturation





Peninsula SCI = 40 Thresholds (Daily Average DO)

- Regression line = 32 % Saturation
- Lower Confidence Limit = 38 % Saturation





Comparison of Regression Results with Reference Distribution

Parameter	Panhandle West	Northeast + Big Bend	Peninsula
SCI-2012 versus Daily Average DO Saturation Results			
Regression SCI=40	62	26	32
Lower CI SCI=40	67	34	38
Reference Site ($LDI \leq 2$, $SCI \geq 40$) DO Distribution			
Count	50	89	91
Avg	83.5	60.2	58.7
Median	85.9	62.3	62.9
5th percentile	63.8	27.4	25.9
10th percentile	68.3	38.7	33.6
25th percentile	79.9	48.0	77.6

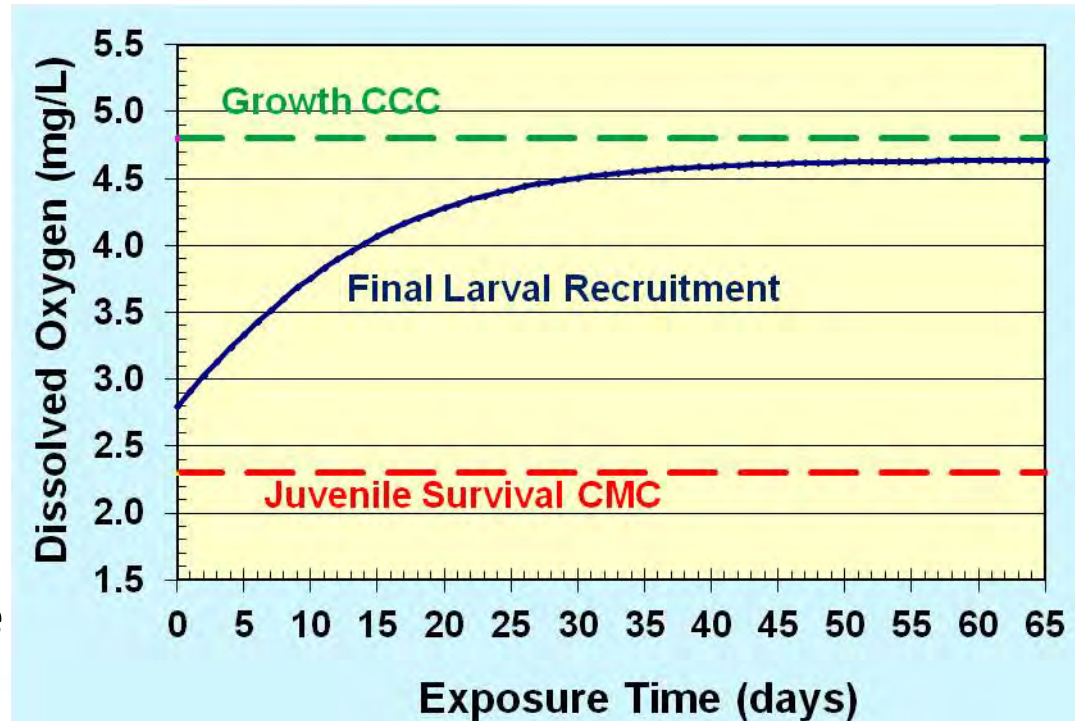
- Thresholds based on lower 90% Confidence limit for SCI-2012 versus daily average DO saturation agree well with the 10th percentile of the reference distribution



Methods to Revise Florida's Marine DO Criteria

- Based on EPA's Virginian Province Approach (EPA 2000), which uses measured response of sensitive organisms to low DO levels to establish allowable exposure durations

- **Three components to criteria:**
 - Criteria Minimum Concentration (CMC)
 - Criteria Continuous Concentration (CCC)
 - Final larval recruitment/survival Curve

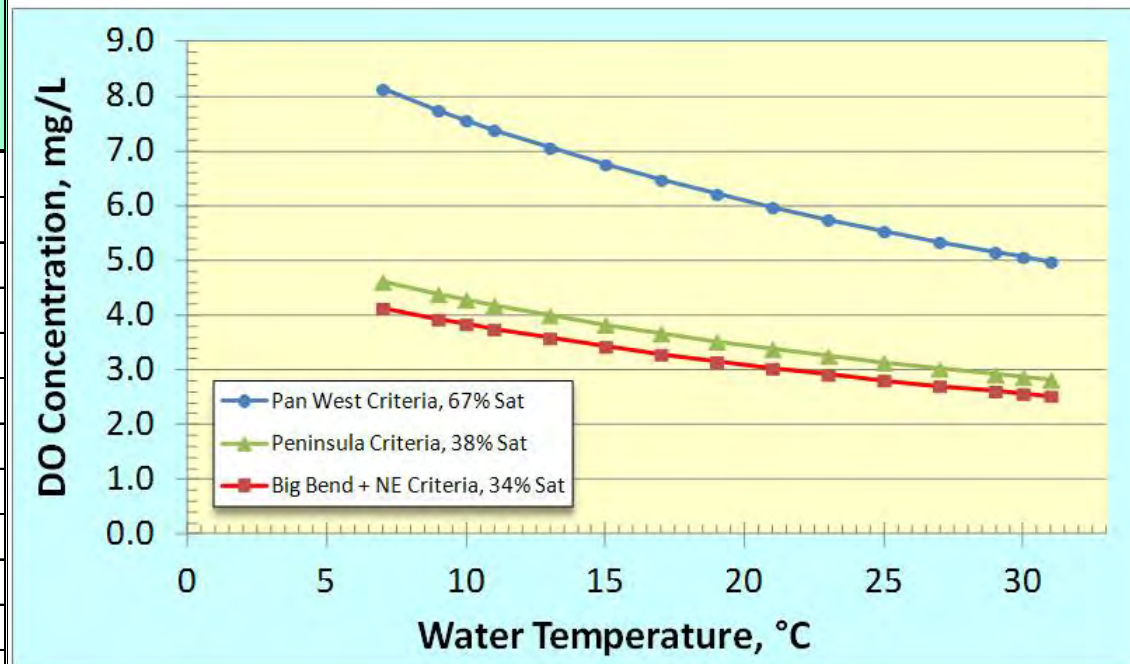




DO Concentration - Water Temperature Relationships

DO Concentrations Required to Achieve Proposed Criteria Based on Water Temperature

Temp, °C	NE + Pan East Criteria, 34% Sat	Peninsula Criteria, 38% Sat	Pan West Criteria, 67% Sat
8	4.0	4.5	7.9
10	3.8	4.3	7.6
12	3.7	4.1	7.2
14	3.5	3.9	6.9
16	3.4	3.8	6.6
18	3.2	3.6	6.3
20	3.1	3.5	6.1
22	3.0	3.3	5.9
24	2.9	3.2	5.6
26	2.8	3.1	5.4
28	2.7	3.0	5.2
30	2.6	2.9	5.1





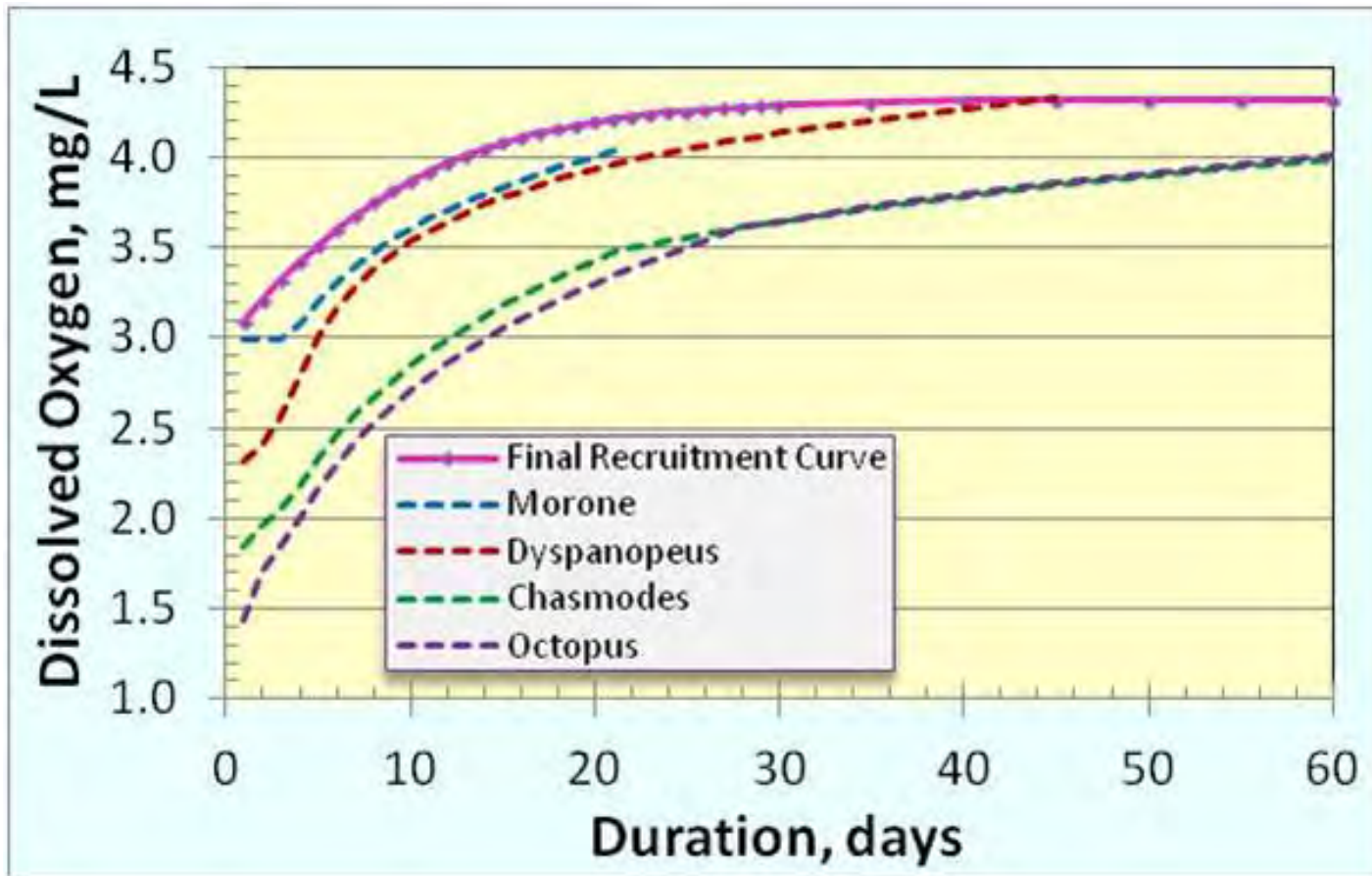
Florida Species Used to Derive Marine DO Criteria CMC

Rank	Genus	Species	Common Name	SMAV (Sat) (LC ₅₀)	GMAV (Sat) (LC ₅₀)	LC ₅ /LC ₅₀
1	Spisula	Spisula solidissima	Atlantic surfclam	5.99	5.99	1.63
2	Rithropanopeus	Rithropanopeus harrisi	Harris mud crab	7.13	7.13	
3	Prionotus	Prionotus carolinus	northern sea robin	7.22	7.22	1.45
4	Eurypanopeus	Eurypanopeus depressus	flat mud crab	7.97	7.97	
5	Leiostomus	Leiostomus xanthurus	spot	10.10	10.10	1.16
6	Scophthalmus	Scophthalmus aquosus	windowpane flounder	10.54	10.54	1.48
7	Palaemonetes	Palaemonetes pugio	daggerblade grass shrimp	9.48	11.76	1.53
7b	Palaemonetes	Palaemonetes vulgaris	marsh grass shrimp	14.60	11.76	1.37
8	Ampelisca	Ampelisca abdita	amphipod	12.03	12.03	
9	Brevoortia	Brevoortia tyrannus	Atlantic menhaden	13.97	13.97	1.53
10	Crassostrea	Crassostrea virginica	eastern oyster	16.76	16.76	
11	Stenotomus	Stenotomus chrysops	scup	16.72	16.72	
12	Mugil	Mugil cephalus	striped mullet	20.79	20.79	
13	Americamysis	Americamysis bahia	mysid shrimp	19.64	19.64	1.16
14	Callinectes	Callinectes sapidus	blue crab	20.21	20.21	
15	Paralichthys	Paralichthys dentatus	summer flounder	19.56	19.56	1.19
16	Farfantepenaeus	Farfantepenaeus duorarum	pink shrimp	20.05	20.05	
17	Sciaenops	Sciaenops ocellatus	red drum	20.71	20.71	
18	Litopenaeus	Litopenaeus setiferus	northern white shrimp	22.48	22.48	
19	Morone	Morone saxatilis	striped bass	20.96	20.96	1.24
20	Lagodon	Lagodon rhomboides	pinfish	23.52	23.52	
21	Syngnathus	Syngnathus fuscus	pipe fish	21.13	21.13	1.17
22	Menidia	Menidia beryllina	inland silversides	24.77	24.77	
23	Trachinotus	Trachinotus carolinus	pompano	25.57	25.57	
24	Cynoscion	Cynoscion nebulosus	spotted seatrout	28.14	28.14	
25	Harengula	Harengula jaguana	scaled sardines	32.53	32.53	

- The CMC was calculated based on the acute effects data for 25 genera
- Genera mean acute values (LC₅₀) of the test organisms ranged from 6 to 33% Saturation
- CMC was calculated as the FAV (95th percentile genus GMAV) multiplied by the mean LC₅ to LC₅₀ ratio (1.35)
- Resulting CMC is 42% Saturation



Recruitment Model Output for Florida Species





Marine Water DO Criteria

Rule Language

- (2) Class II, Class III, and Class III-Limited predominantly marine waters.
- (a) Minimum DO saturation levels shall be as follows:
1. The daily average percent DO saturation shall not be below 42 percent saturation in more than 10 percent of the values, and
 2. The weekly average DO percent saturation shall not be below 51 percent more than once in any twelve week period, and
 3. The monthly average DO percent saturation shall not be below 56 percent more than once per year.



Addressing Natural Background

- Proposed criteria will allow DO levels to be below the numeric criteria due to natural background conditions
 - Reductions of 0.1 mg/L or less in freshwaters would be presumed to not cause adversely impact
 - Reductions up to 10% below background could be allowed in marine waters if demonstrated to not cause adverse impact
- Would not need a SSAC to implement



DO Schedule

- Have had 4 public workshops
- Bring to Environmental Regulation Commission in December for potential adoption
- May require legislative ratification

DEP's Nutrient Rule



EPA's Nutrient Rule

