

# Proposed Dissolved Oxygen Criteria for the Lower St. Johns River Marine Reach

*Presentation to the LSJR WQ TAC*

*February 8, 2006*

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# LSJR TMDL Recap -

SE U.S. coastal plain streams,  
rivers and estuaries accepted as  
net-heterotrophic environments



LSJR TMDL based on [DO] of 5/4 not a realistic  
response variable for eutrophication reduction  
scenarios; EPA Saltwater Criteria used instead



April 2004 – EPA Approves LSJR TMDL; challenge filed



November 2005 – EPA rescinds LSJR TMDL  
for failing to adhere to FL State Standards

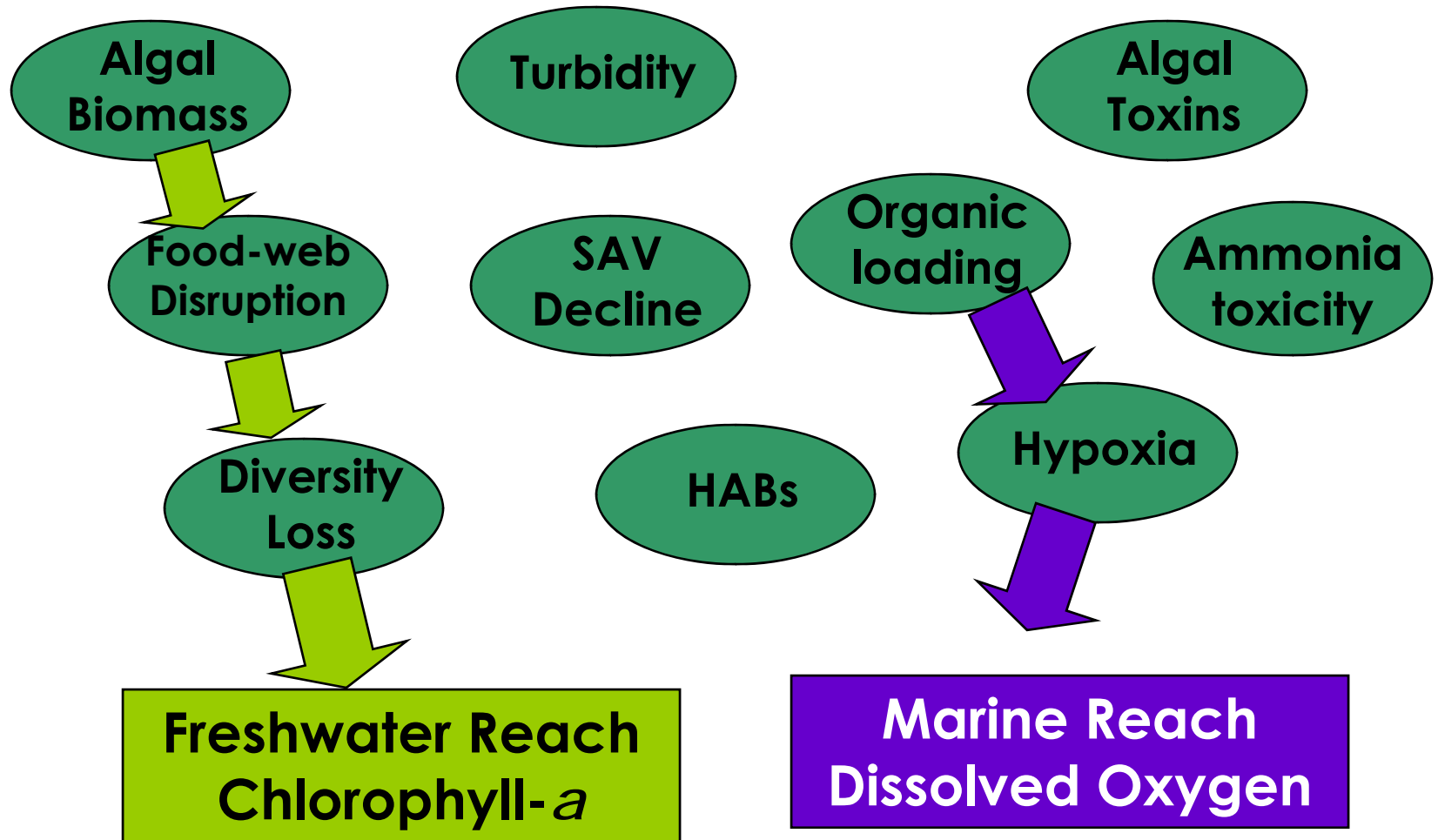


Corrective action: Adopt EPA Saltwater  
[DO] guidance as State Standard



*Back to the lab again!*

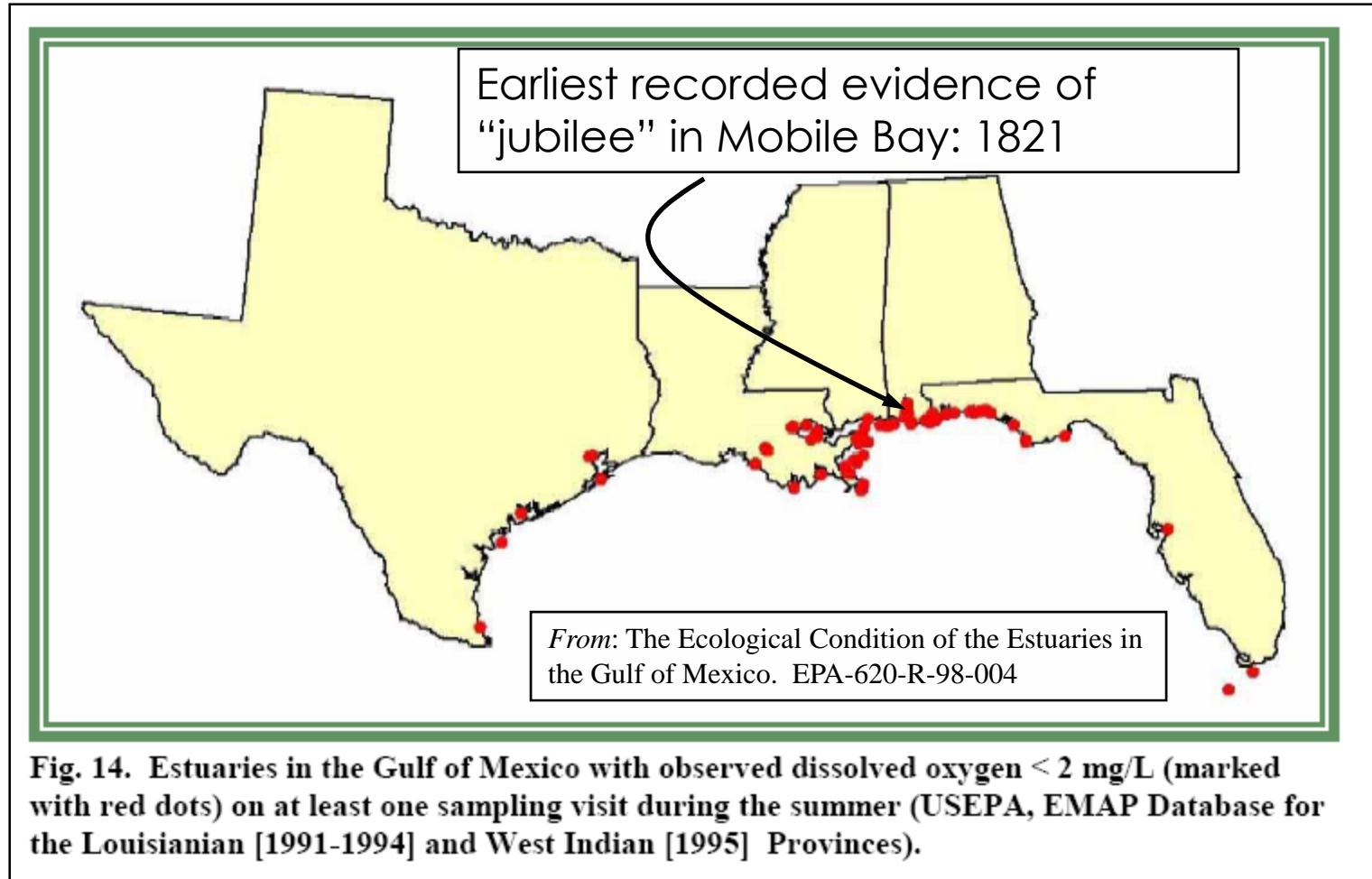
# LSJR Nutrient TMDL: Eutrophication Response Variables



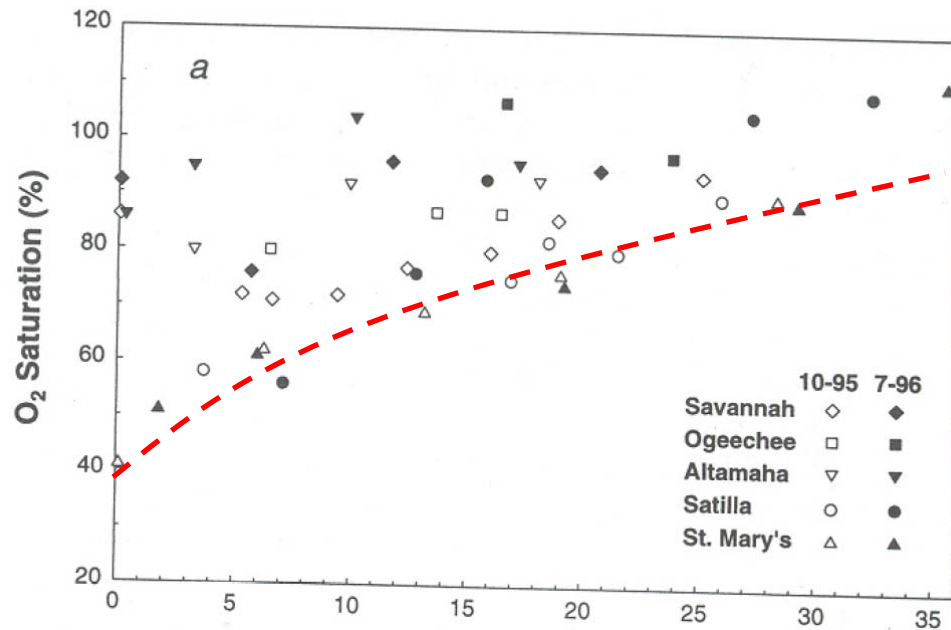
# Dissolved Oxygen Summary Statistics for Blackwater Streams Draining Undeveloped Watersheds – Northeast FL

<b>Location</b>	<b>Min</b>	<b>5th %ile</b>	<b>25th %ile</b>	<b>Mean</b>	<b>Mean % Saturation<sup>n</sup></b>
<b>Rice Cr. At Springside</b>	<b>5.21</b>	<b>5.48</b>	<b>6.09</b>	<b>6.74</b>	<b>72.7</b>
<b>Durbin Cr.</b>	<b>0.40</b>	<b>1.10</b>	<b>3.14</b>	<b>4.28</b>	<b>45.0</b>
<b>Big Davis Cr.</b>	<b>3.51</b>	<b>4.06</b>	<b>5.06</b>	<b>5.98</b>	<b>64.3</b>
<b>Simms Cr. Nr. Bardin</b>	<b>3.84</b>	<b>4.97</b>	<b>5.93</b>	<b>6.64</b>	<b>72.1</b>
<b>Bradley Cr. CR 218</b>	<b>0.77</b>	<b>1.29</b>	<b>2.20</b>	<b>3.51</b>	<b>37.1</b>
<b>So. Fork Black Creek at C</b>	<b>3.68</b>	<b>4.38</b>	<b>5.65</b>	<b>6.84</b>	<b>73.7</b>
<b>Peters Cr. Rosemary Hill</b>	<b>4.12</b>	<b>5.48</b>	<b>7.00</b>	<b>7.81</b>	<b>83.4</b>
<b>Average</b>	<b>3.08</b>	<b>3.82</b>	<b>5.01</b>	<b>5.97</b>	<b>64.04</b>

# Classic Salinity-Density Stratification for Low Tidal Energy Estuaries



# Coastal Marsh “Exhalation” Low [DO] of Georgia Bight High Tide Range Estuaries



From: Cai et al. 1999. Oxygen and carbon dioxide mass balance for the estuarine-intertidal marsh complex of five rivers in the southeast U.S. L&O 44(3).

*Conclusion:* Natural physio-chemical characteristics of SE U.S. coastal plain estuaries, coupled with high organic matter supply, leads to intermittent episodes of low dissolved oxygen. Eutrophication exasperates this condition, but does not cause it.

# Recommended DO Criteria for Savannah Harbor

(From the Savannah River TMDL documentation)

One-day water column average DO = 2.3 mg/l

Seven-day water column average DO = 3.0 mg/l

Thirty-day water column average DO = 3.55 mg/l

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Water quality modeling for the Savannah River determined the following with regard to natural background D.O. regimes:

- 1-day average = 3.5 mg/L
- 7-day average = 3.6 mg/L
- 30-day average = 3.95 mg/L



# Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras

- Product of 10-year research effort
- Applies approach established in 1985 EPA Guidelines for Deriving Numerical WQ Standards

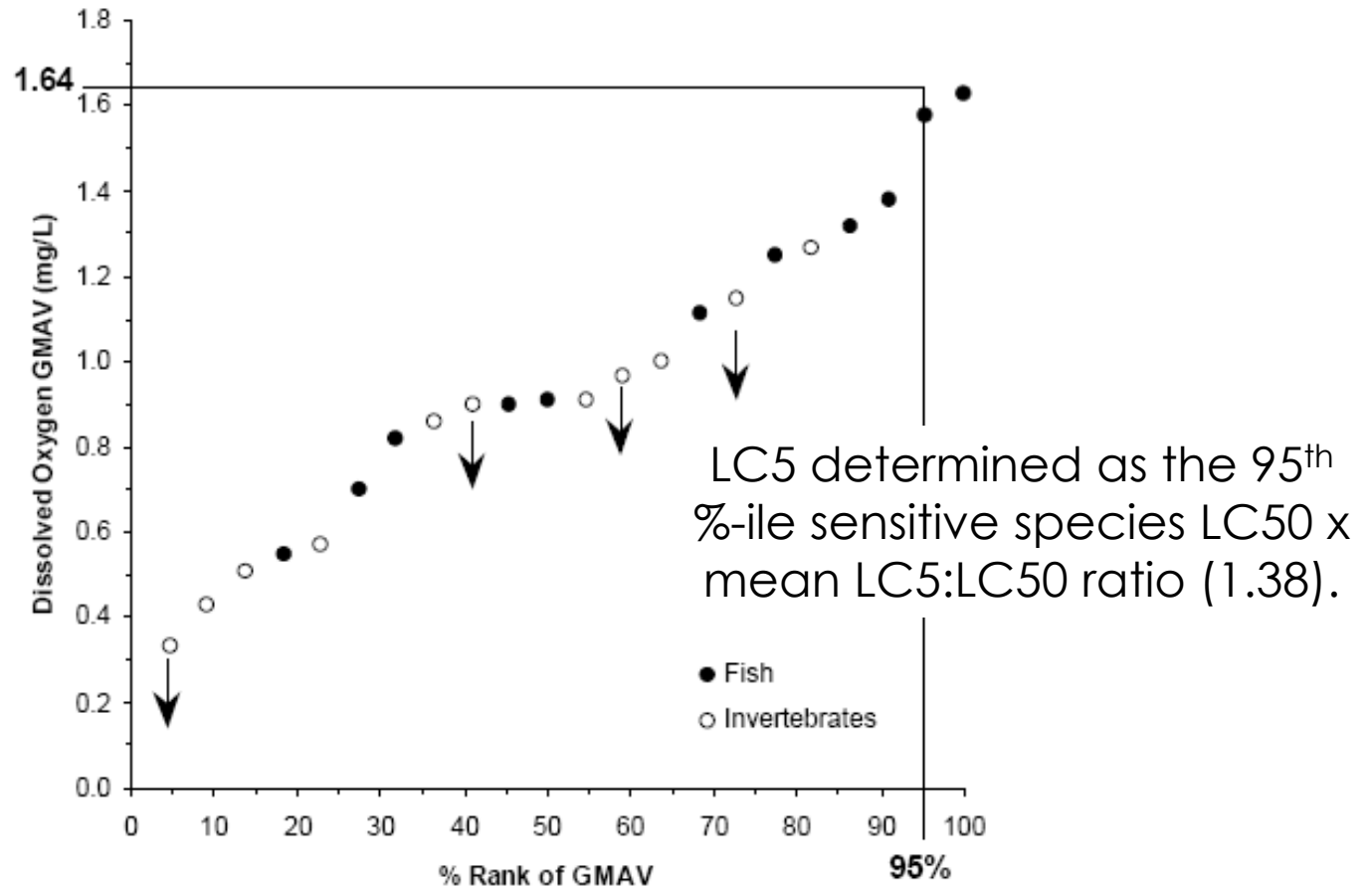
Persistent  
Exposure Criteria



- Juvenile and Adult Survival
- Growth Effects Threshold
- Larval Recruitment Model



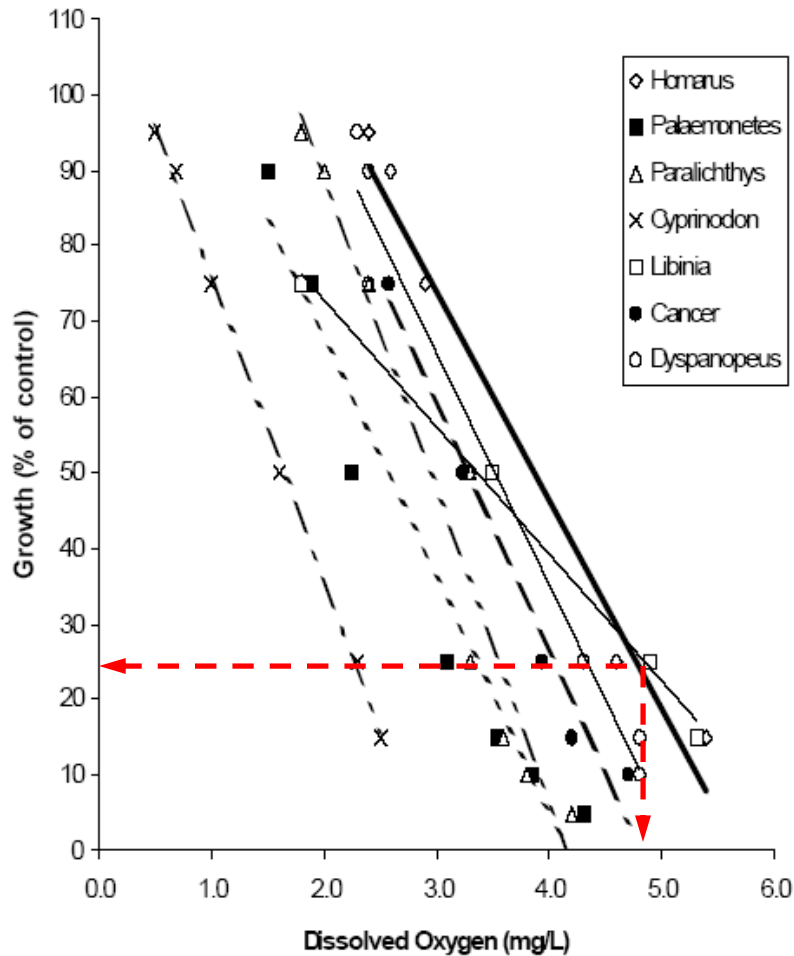
# Juvenile and Adult Survival



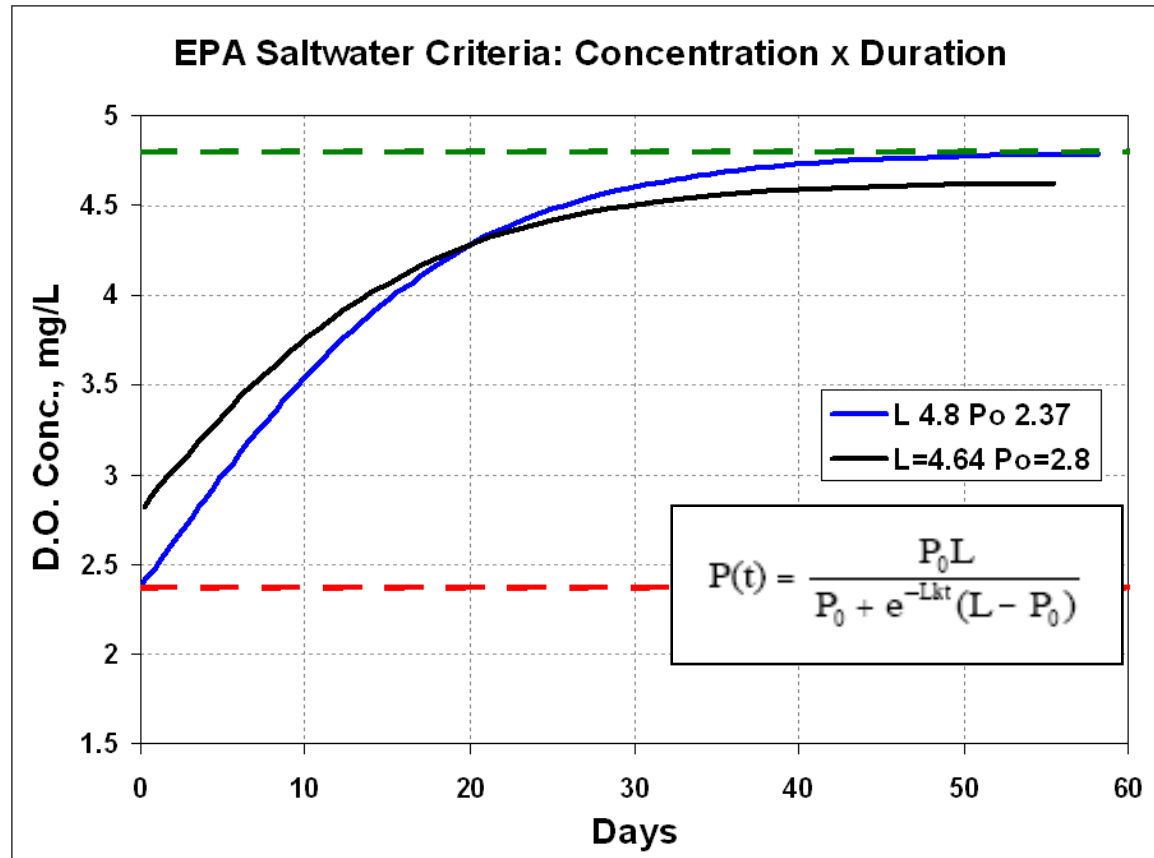
Plot of Genus Mean Acute Value – LC50s versus [DO].

Final Acute Value of 2.37 mg/L [DO] based on projected LC5 for 95<sup>th</sup> %ile most sensitive species.

# Growth Effects Threshold



Growth effects threshold of 4.8 mg/L [DO] based on 25% reduction in growth of most sensitive species (American lobster)



## Larval Recruitment Low [DO] Exposure:

Determined as the sum for continuous exposure of the fractional dose for a given duration ÷ the maximum allowable; Exceedence when > 1.

# Exceedence Events Based On EPA Saltwater Criteria for the LSJR Marine Reach

(Data source: USGS continuous gauge at Dames Point)

<u>MAX CHRONIC IMPAIRMENT</u>		
YEAR	ACOSTA	DAMES
1996	0.03	0.25*
1997	0.37	1.74
1998	0.73	0.56
1999	0.10	3.57
2000	0.26	0.20
2001	0.19	1.07

## Site-Specific Alternative Criteria (*F.A.C.* 62-302)

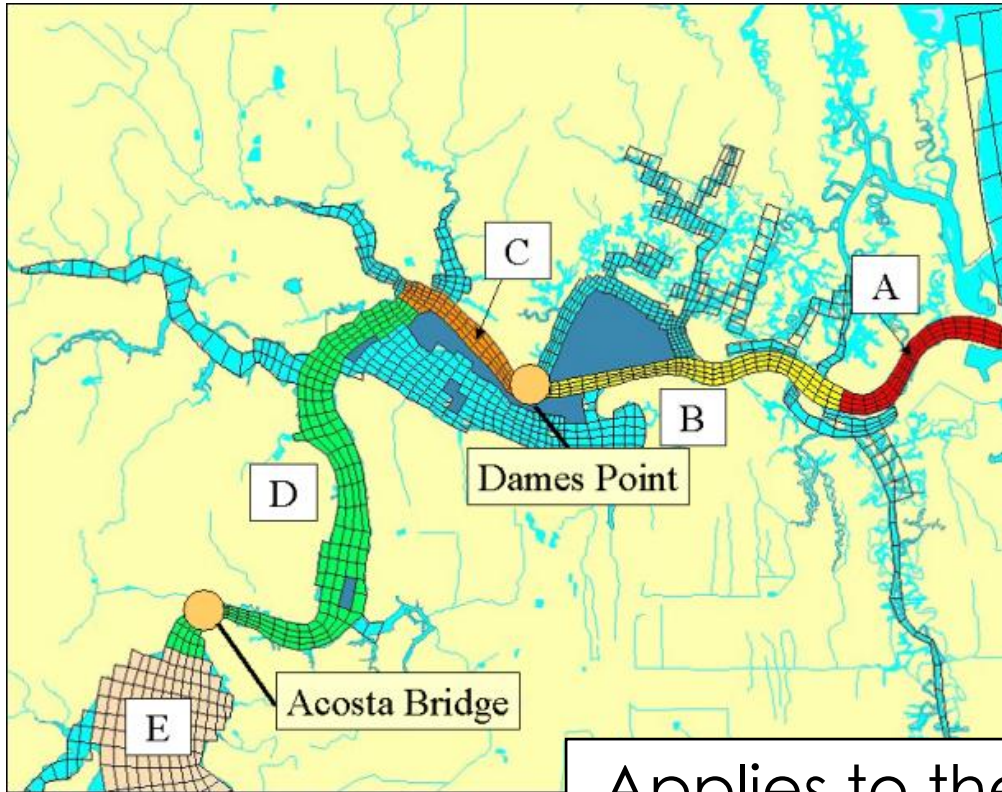
*Applies when . . .*

Natural conditions  
preclude attainment

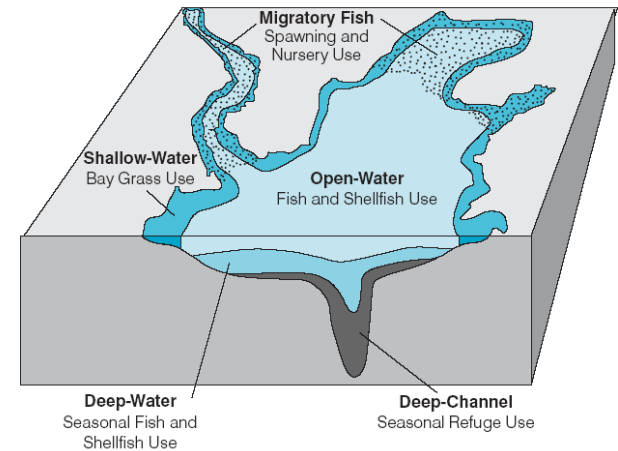
Human-induced  
non-abatable  
(dredged channel?)

Less restrictive  
standard sufficient  
for native organism  
survival, growth

Area of intended applicability: The predominantly marine reach of the LSJR



B. Oblique View of the Chesapeake Bay and its Tidal Tributaries

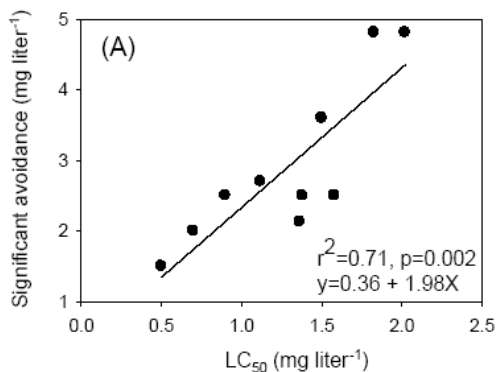
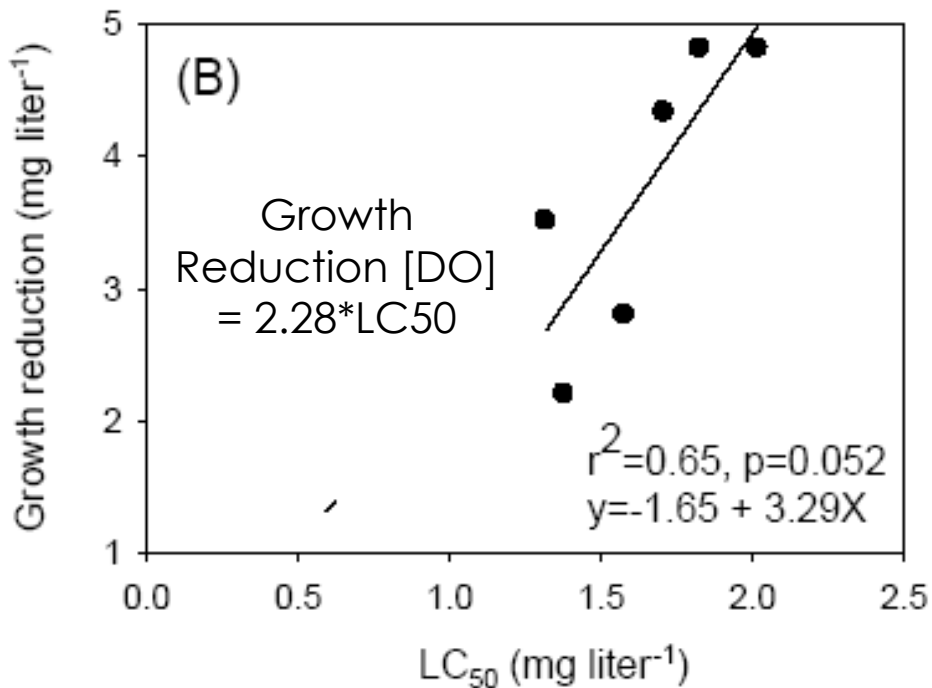


Applies to the evaluation of ambient waters of the LSJR; Effluents will still be required to meet 5 mg/L.

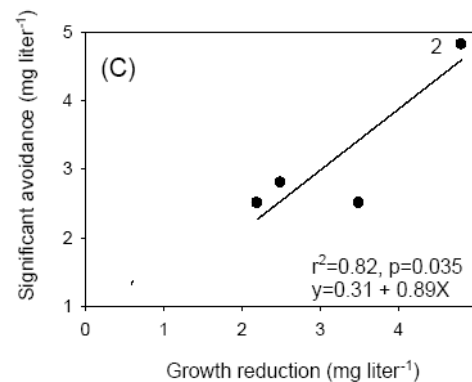
# Adjustments to EPA Saltwater [DO] Guidance for LSJR

## Accounting for growth reduction effects below 5 mg/L

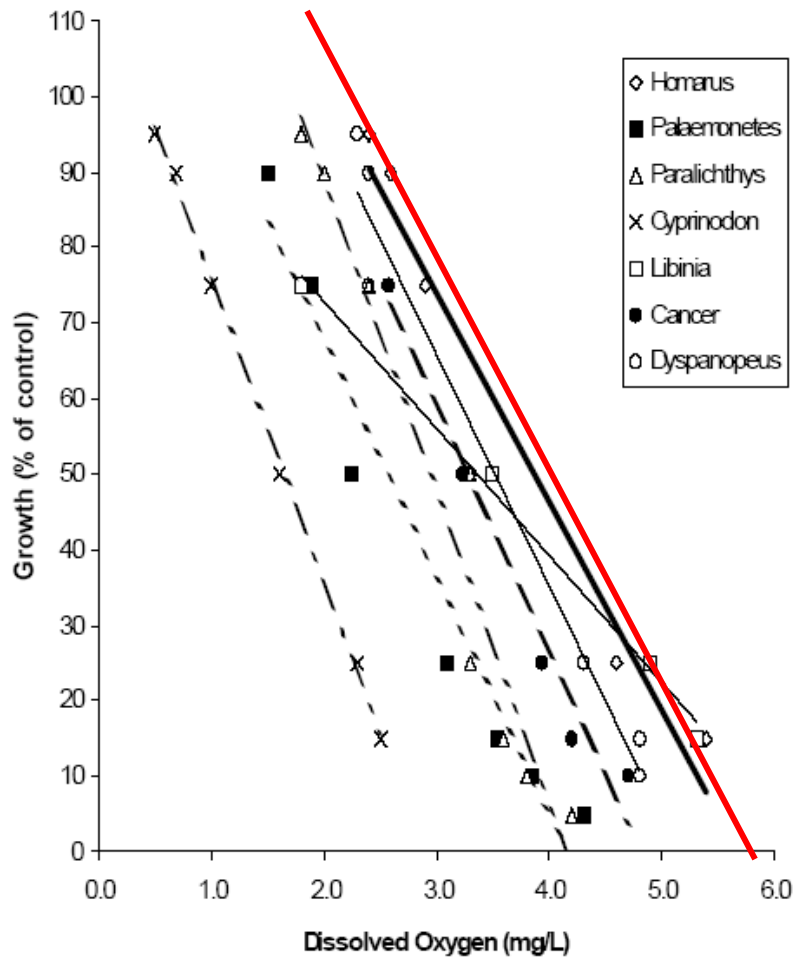
*Data from Breitburg, 2002.*



Dissolved oxygen concentrations  $\square$   
 causing avoidance = 2.25\*LC50  $\square$   
 $\square$



Dissolved oxygen concentrations  $\square$   
 causing avoidance = 0.98 \* dissolved oxygen  $\square$   
 causing growth reduction



Growth Reduction Function  
 **$Gfr = -0.28 [DO] + 1.58,$**   
 Gfr = fractional growth reduction

**$Rygp = \sum(Gfr/Tg)$**   
 Rygp = fractional reduction of the  
 year's growth potential  
 Tg = # of days in growth season

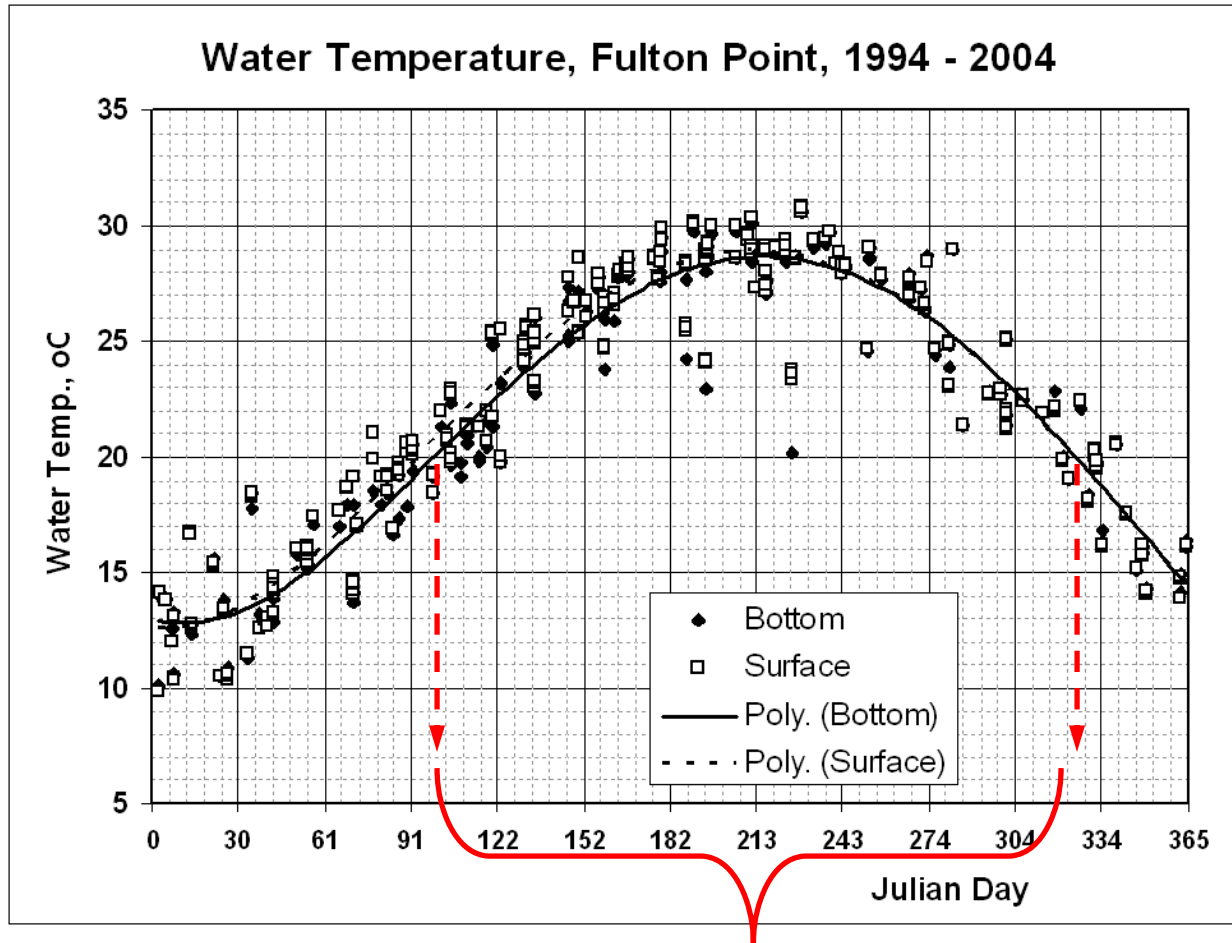
Maximum acceptable seasonal  
 growth reduction = 0.05

**Figure I-1.** Plot of growth (percentage impairment relative to control) for several species of saltwater animals. The American lobster (*Homarus americanus*—bold solid line) is the most sensitive tested. Experimental conditions are listed in Table I-1.

From: EPA Saltwater [DO] Guidance Appendix I



# Growth Season ( $T_g$ ) = 200 Days

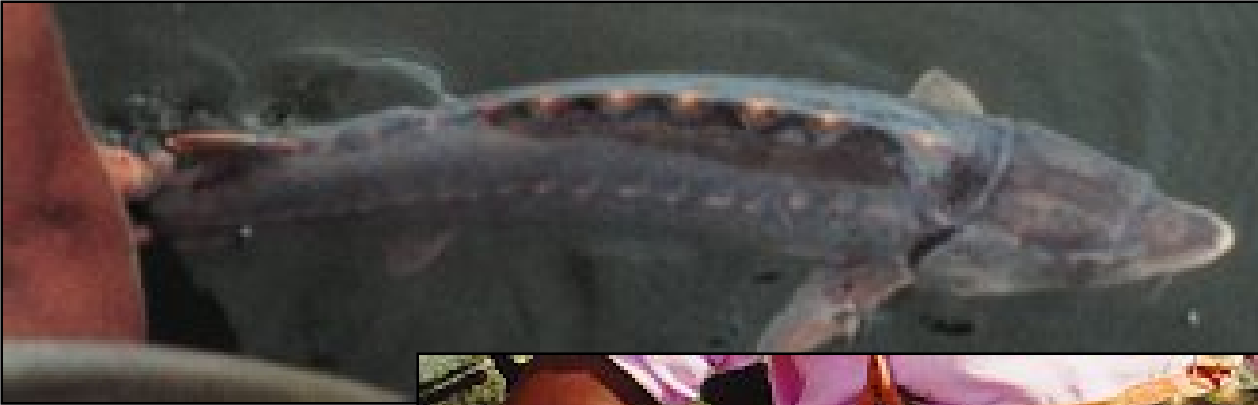


Estimated as the # days when water temperature is  $> 20^{\circ}\text{C}$

# Life History Critical Period Overlaps

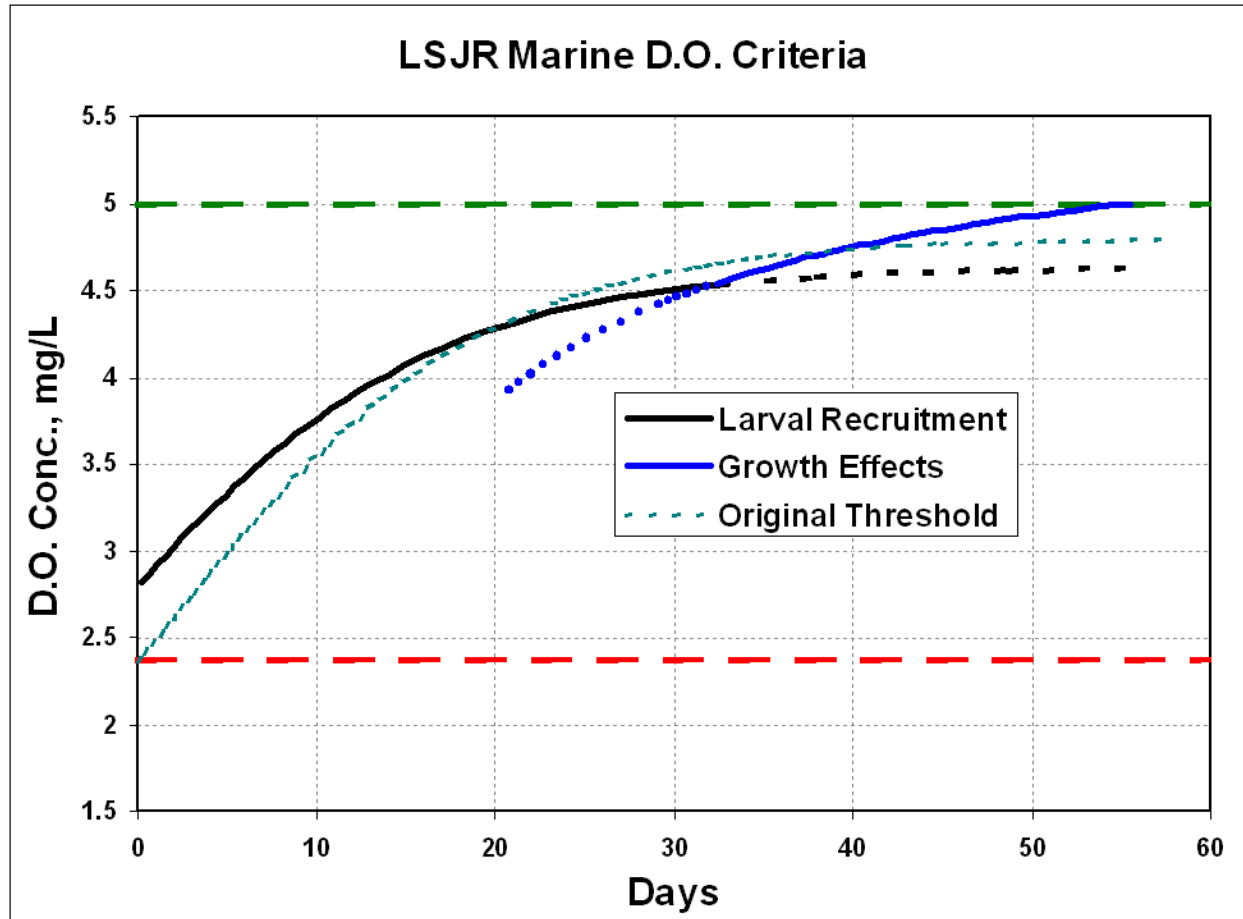
Species	Spawning Time	Spawning Area	Recruitment Time	Recruitment Areas
<b>Atlantic Croaker</b> ( <i>Micropogonias undulatus</i> )	October - April	Offshore	December - April	Estuary/Tidal creeks/Upriver areas
<b>Spot</b> ( <i>Leiostomous xanthurus</i> )	October - April	Offshore	December - April	Estuary/Tidal creeks/Upriver areas
<b>Weakfish</b> ( <i>Cynoscion regalis</i> )	April - August	Estuary/Nearshore/ Mouth/Inlets	May - September	Estuary/Tidal creeks
<b>Spotted Seatrout</b> ( <i>Cynoscion nebulosus</i> )	May - September	Estuary Nearshore/Mouth/Inlets	June - October	Estuary/Tidal creeks
<b>Red Drum</b> ( <i>Sciaenops ocellatus</i> )	July - December	ets	August - January	Estuary/Tidal creeks
<b>Sheepshead</b> ( <i>Archosargus probatocephalus</i> )	February - April	ets	April - July	Estuary/Tidal creeks
<b>Southern Flounder</b> ( <i>Paralichthys lethostigma</i> )	September - January	Offshore	October - February	Estuary/Tidal creeks/Upriver areas
<b>Florida Pompano</b> ( <i>Trachinotus carolinus</i> )	April - September	Offshore	April - October	Inlets/Sounds/Sandy areas
<b>Striped Mullet</b> ( <i>Mugil cephalus</i> )	November - January	Offshore	January - April	Estuary/Tidal creeks
<b>White Mullet</b> ( <i>Mugil curema</i> )	May - September	Offshore	June - October	Estuary/Tidal creeks
<b>Southern Kingfish</b> ( <i>Menticirrhus americanus</i> )	April - August	Offshore	May - September	Inlets/Sounds/Sandy areas Estuary/Tidal creeks/Upriver areas
<b>White Shrimp</b> ( <i>Litopenaeus setiferus</i> )	May - September	Offshore	June - October	Estuary/Tidal creeks/Upriver areas
<b>Pink Shrimp</b> ( <i>Farfantepenaeus duorarum</i> )	April - August	Offshore	May - November	Estuary/Tidal creeks/Upriver areas
<b>Bay anchovy</b> ( <i>Anchoa mitchilli</i> )			May - November	Estuary/Tidal creeks/Upriver areas
<b>Blue Crab</b> ( <i>Callinectes sapidus</i> )**	Year Round	Nearshore/Mouth/Inlets	Year Round	Estuary/Tidal creeks/Upriver areas

# Shortnose and Atlantic Sturgeon



Though intolerant of low D.O., life history data suggest that it is not present in the estuary during the most sensitive life stages.

# Final Proposed LSJR Marine Reach [DO] SSAC



# Increased Level of Protection over EPA Saltwater D.O. Guidance

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- Threshold for assessing impact raised from 4.64 to 5 mg/L
- Continuous sub-4.64 mg/L exposure revised to accumulated exposure
- Minimum acute concentration raised from 2.37 to 2.80 mg/L