

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

Presentation to the LSJR WQ TAC

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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

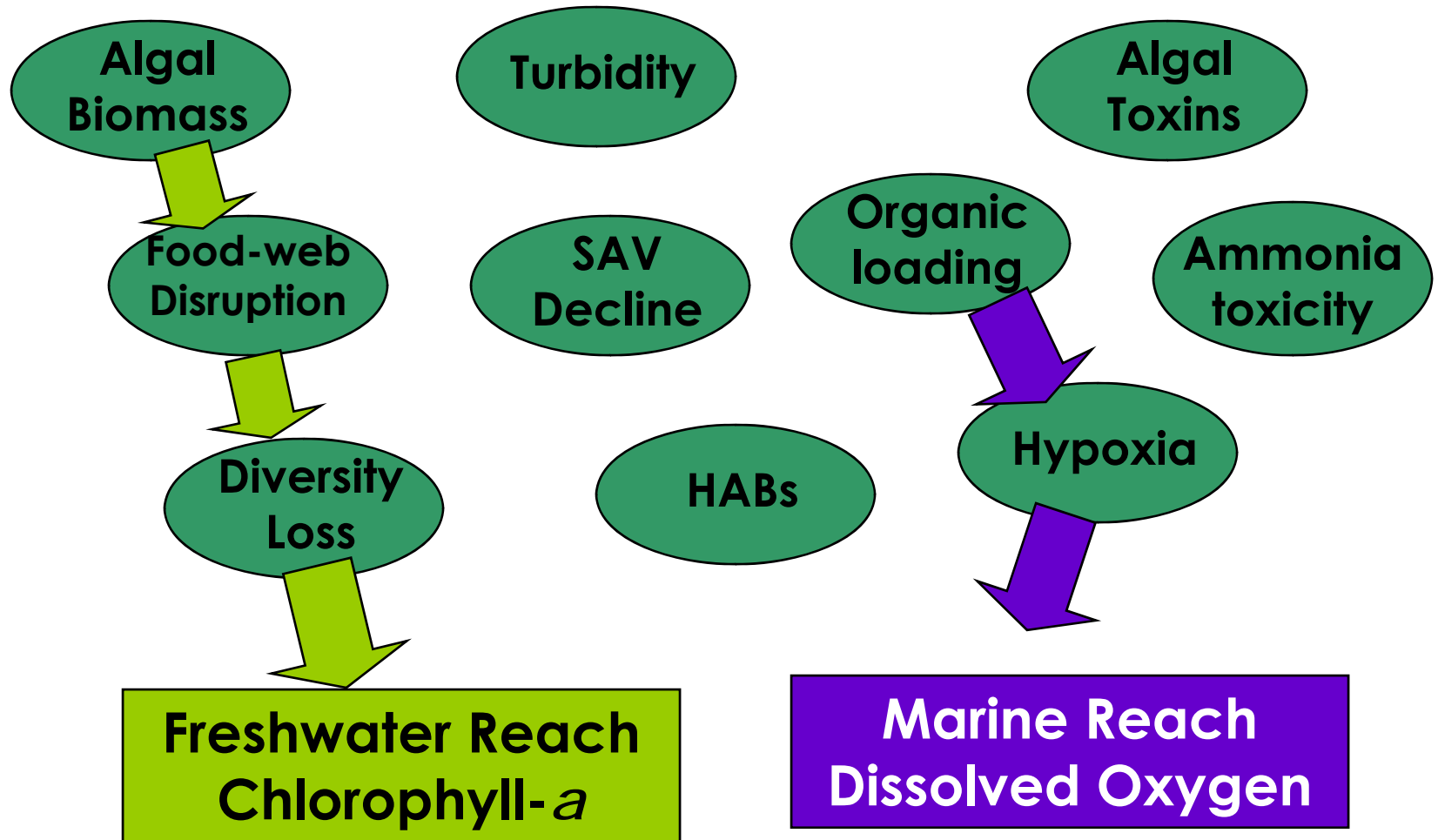


Corrective action: Adopt EPA Saltwater
[DO] guidance as State Standard



Back to the lab again!

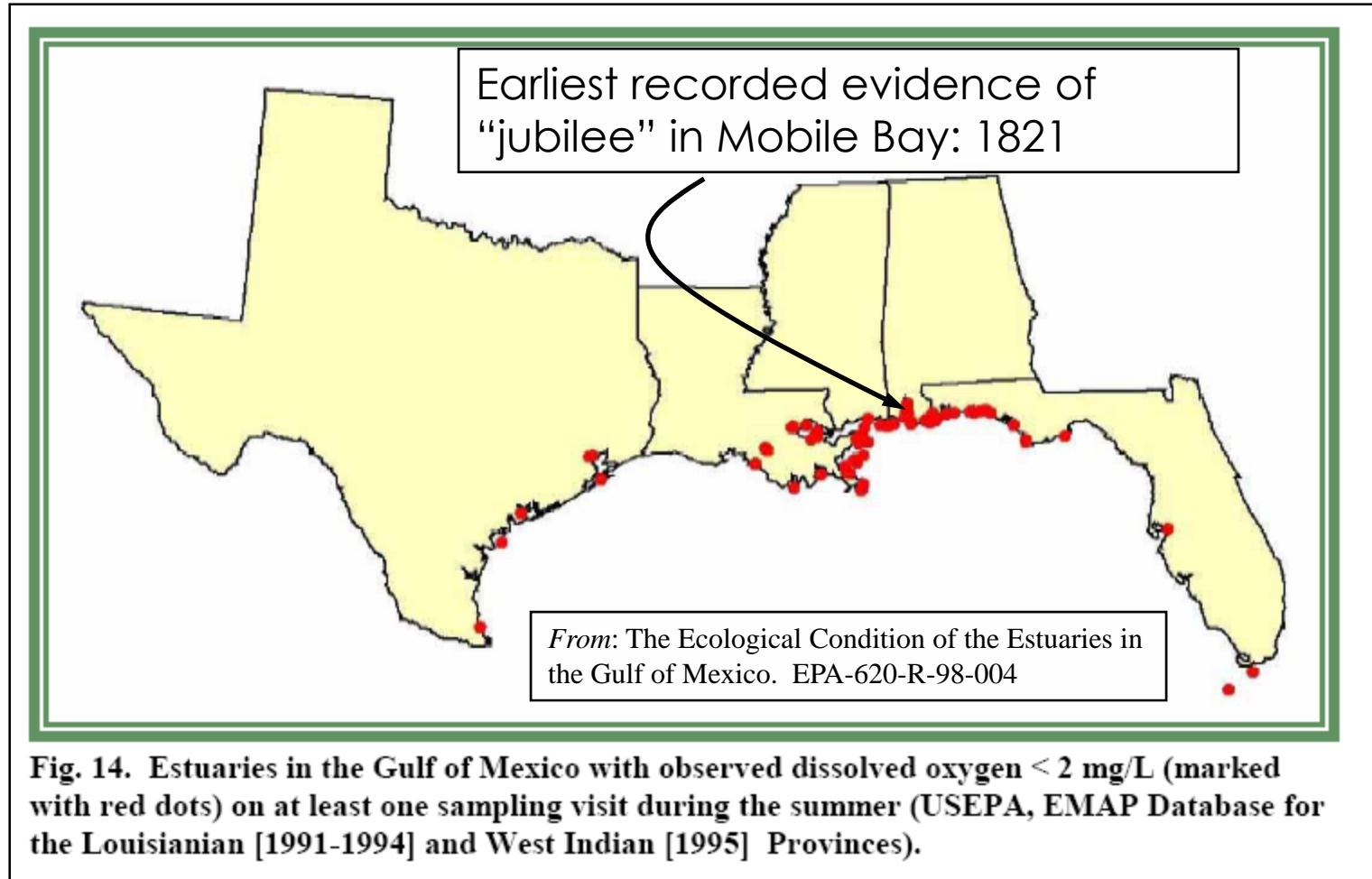
LSJR Nutrient TMDL: Eutrophication Response Variables



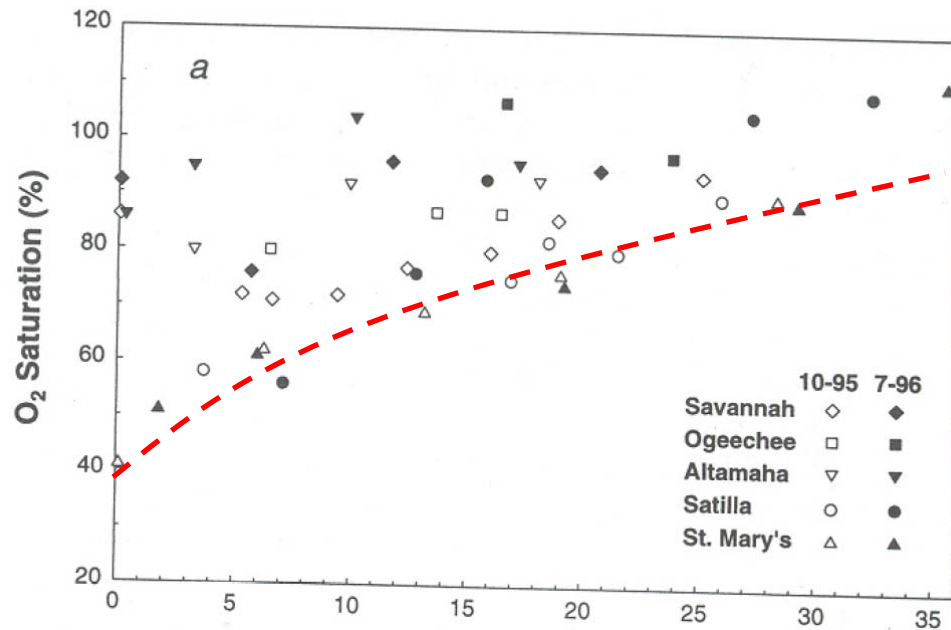
Dissolved Oxygen Summary Statistics for Blackwater Streams Draining Undeveloped Watersheds – Northeast FL

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

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 exaserbates 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

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

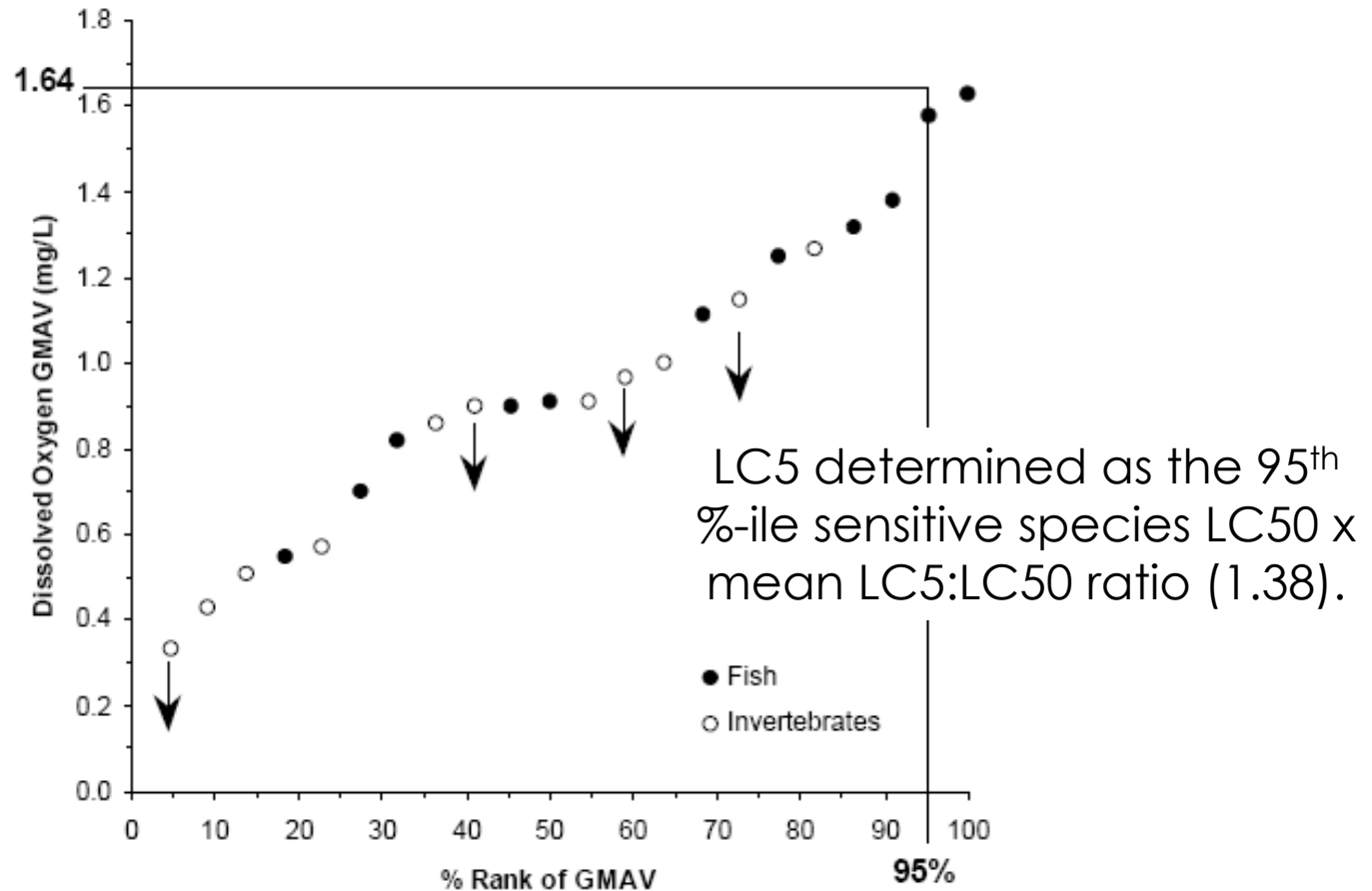
- Product of 10-year research effort
- Applies approach established in 1985 EPA Guidelines for Deriving Numerical WQ Standards

Persistent
Exposure Criteria



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

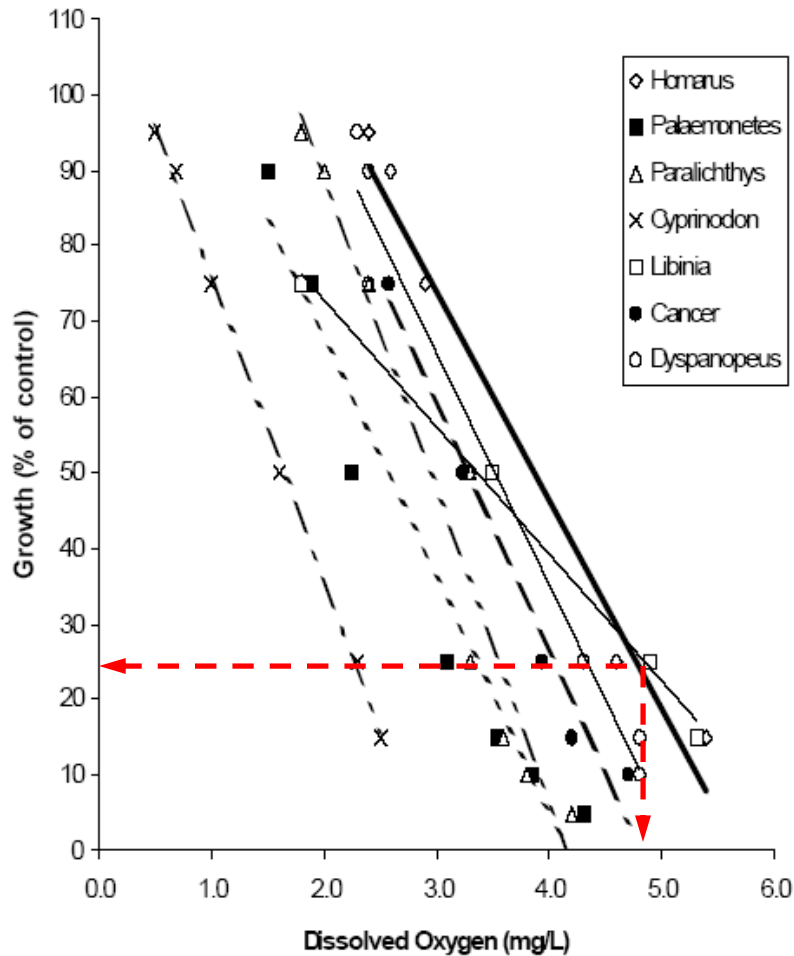
Juvenile and Adult Survival



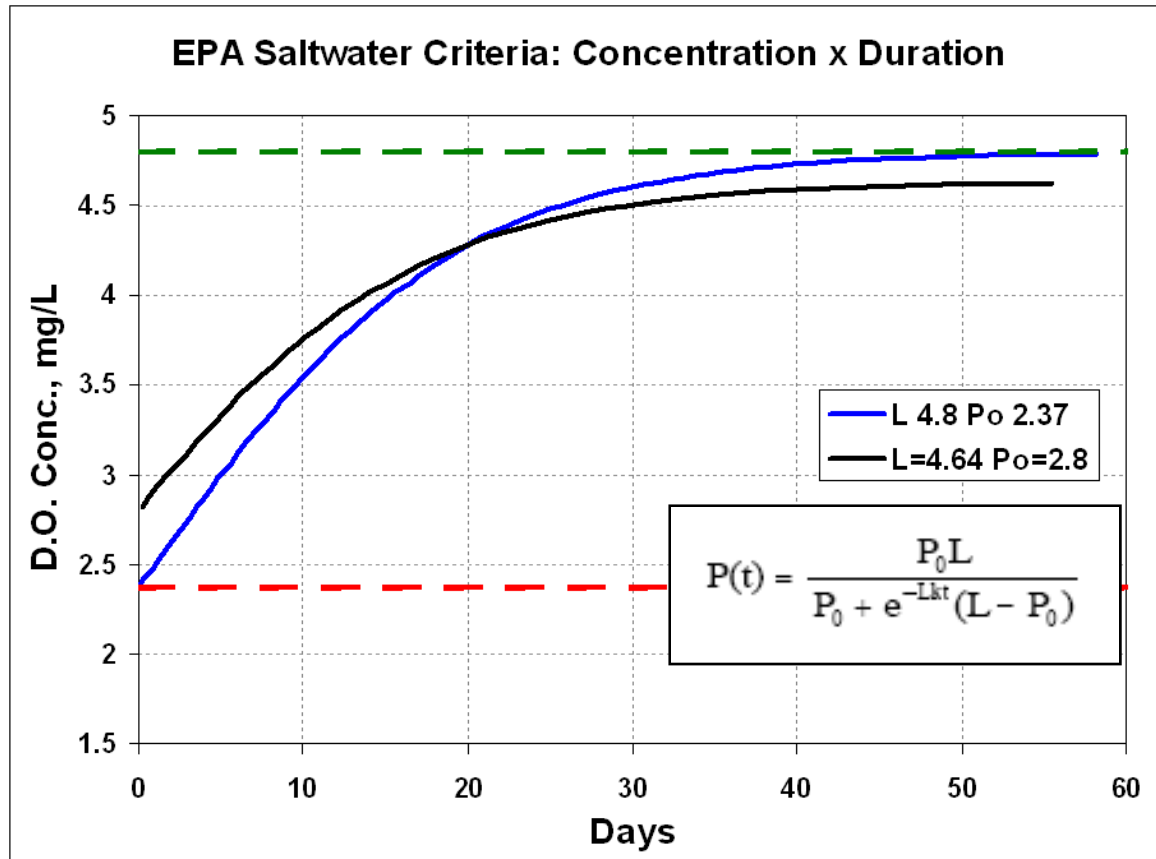
Plot of Genus Mean Acute Value – LC50s versus [DO].

Final Acute Value of 2.37 mg/L [DO] based on projected LC5 for 95th %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)

MAX CHRONIC IMPAIRMENT

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)

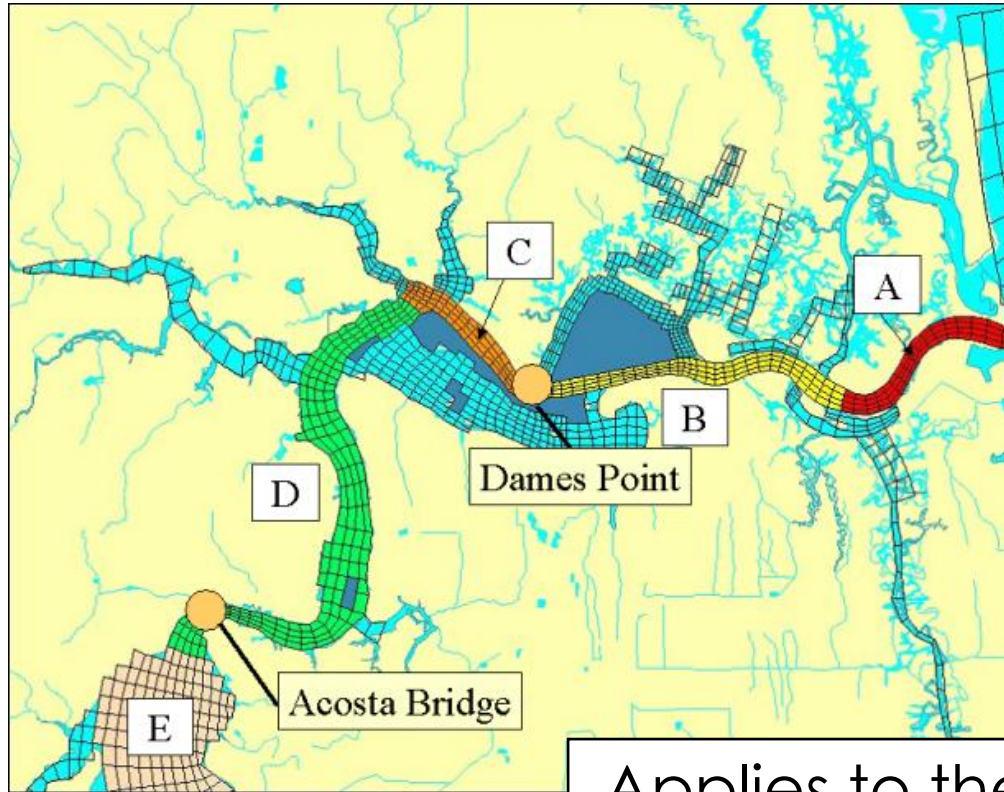
Applies when . . .

Natural conditions
preclude attainment

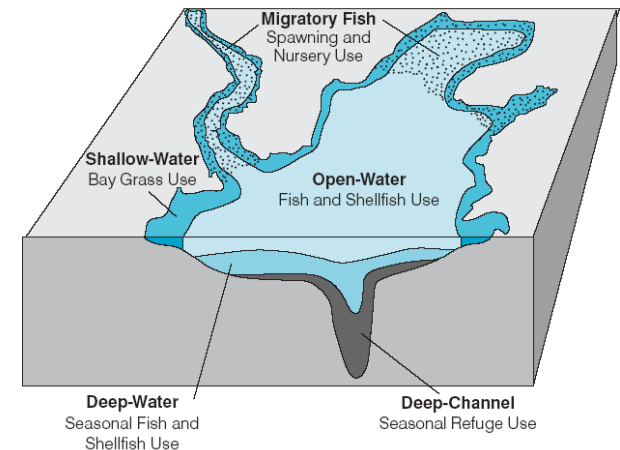
Human-induced
non-abatable
(dredged channel?)

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

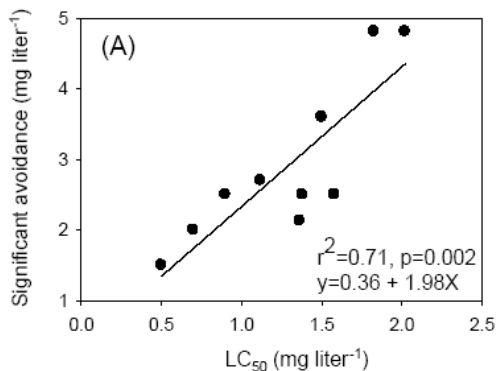
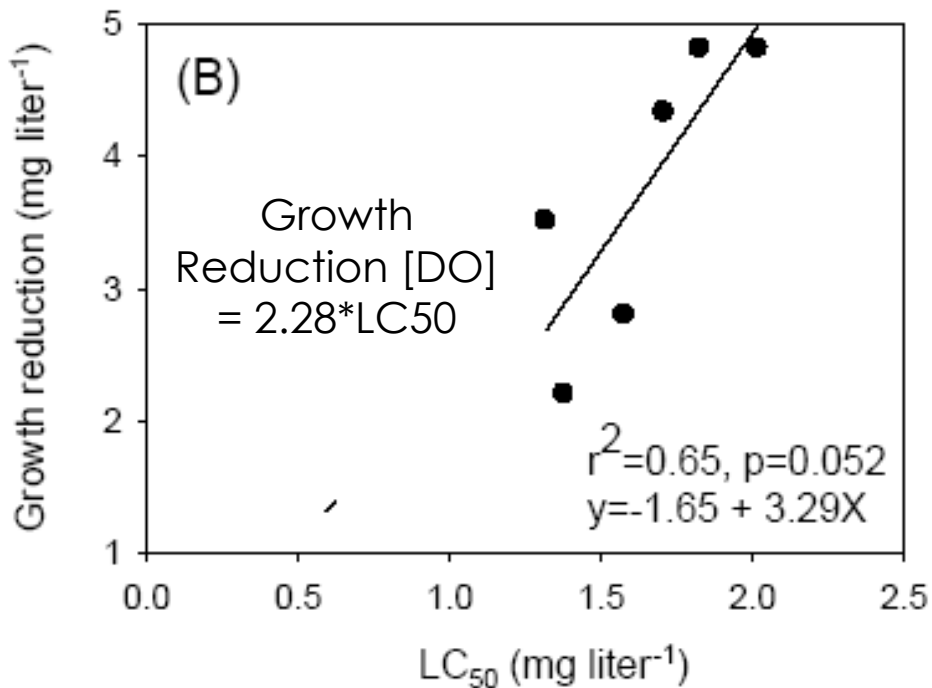


Applies to the evaluation of ambient waters of the LSJR; Effluents will still be required to meet 5 mg/L.

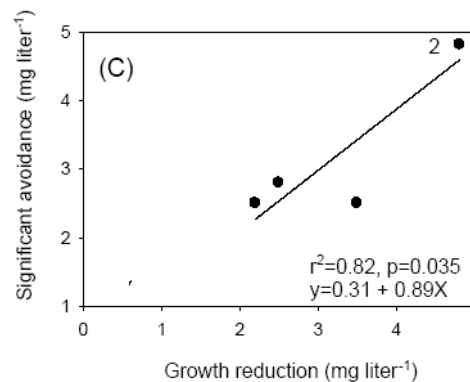
Adjustments to EPA Saltwater [DO] Guidance for LSJR

Accounting for growth reduction effects below 5 mg/L

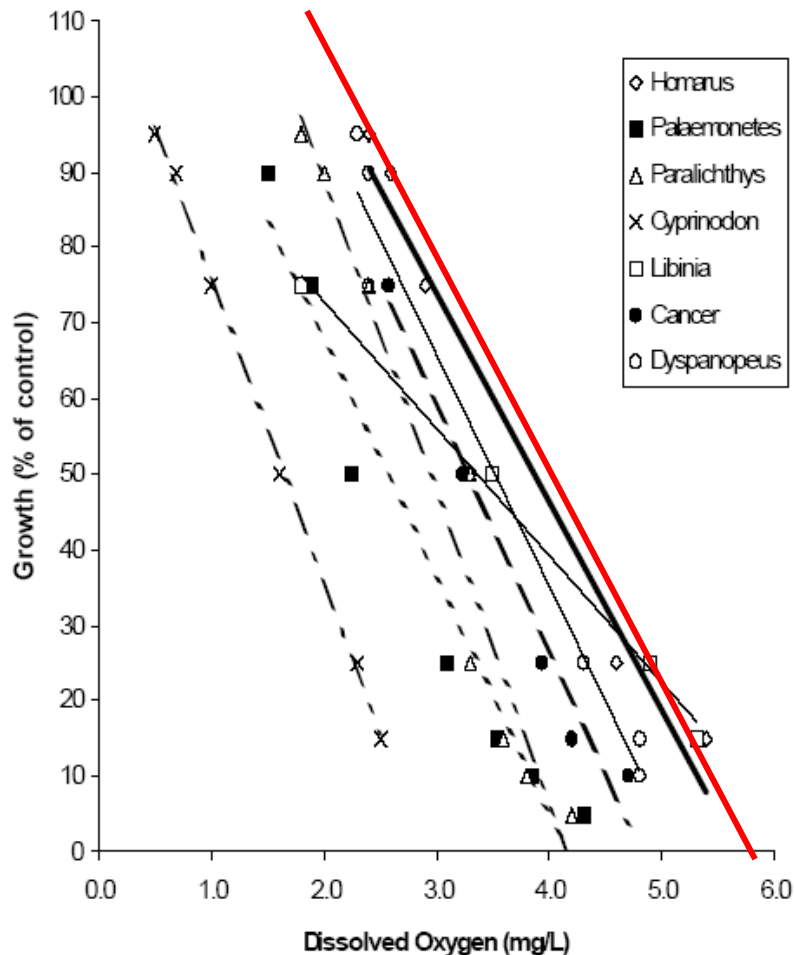
Data from Breitburg, 2002.



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

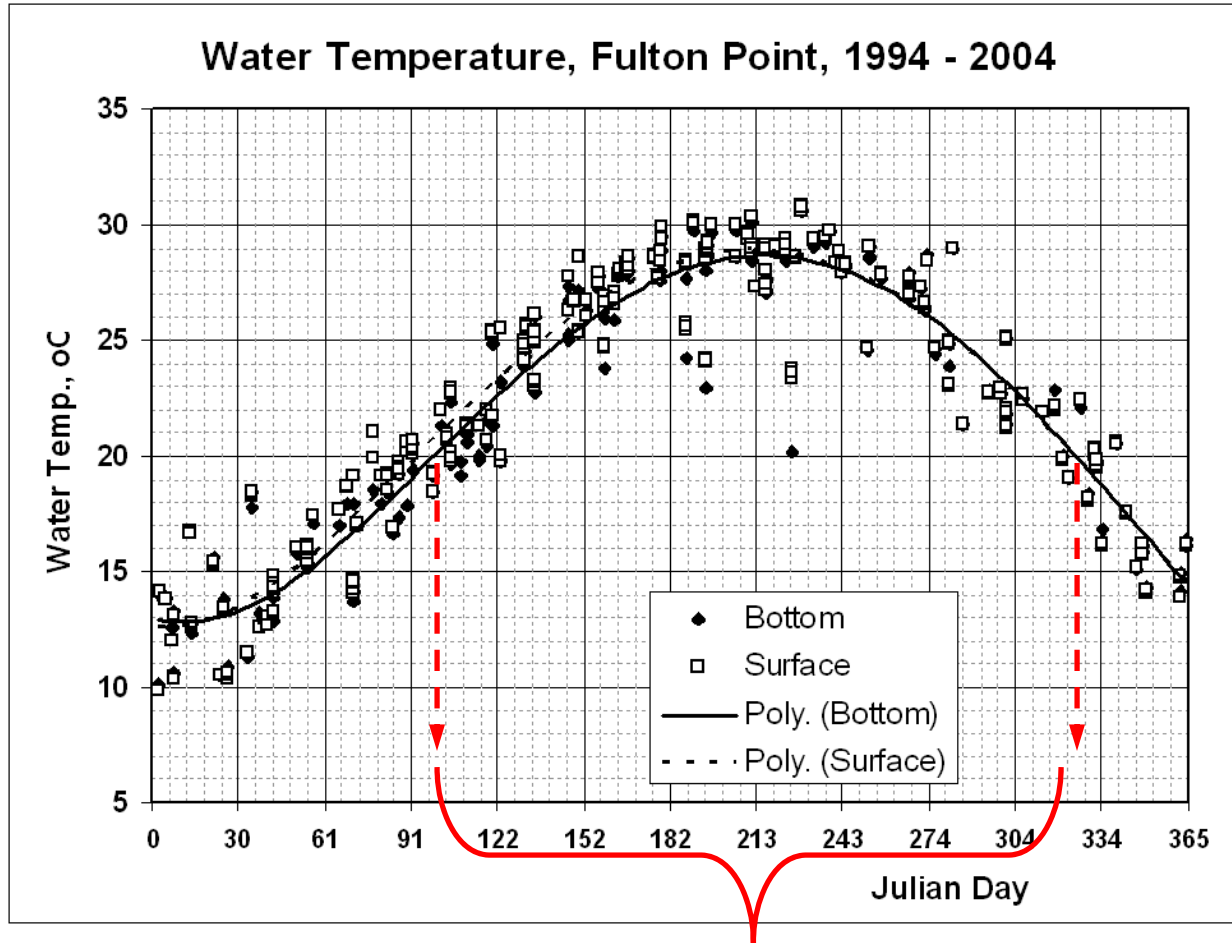
$Rygp = \sum(Gfr/Tg)$
 Rygp = fractional reduction of the
 year's growth potential
 Tg = # of days in growth season

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

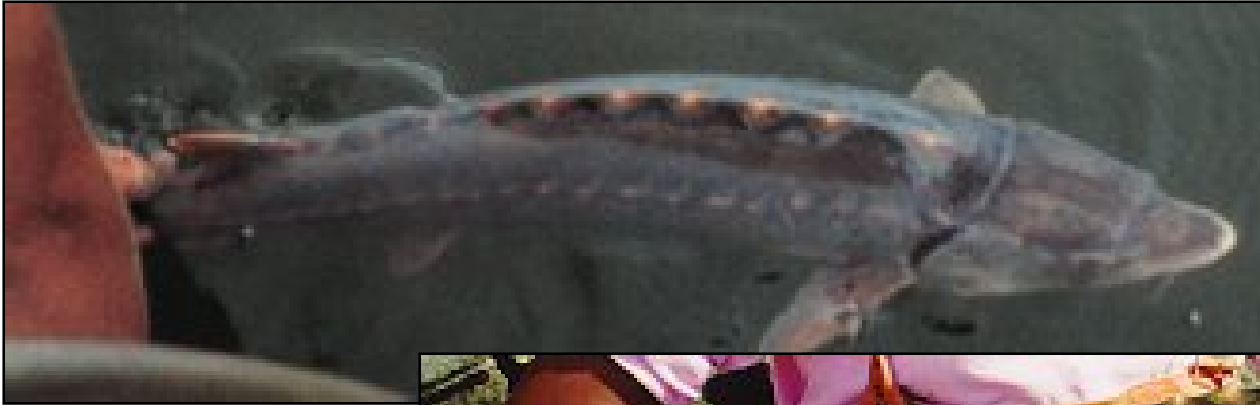


Estimated as the # days when water temperature is $> 20^{\circ}\text{C}$

Life History Critical Period Overlaps

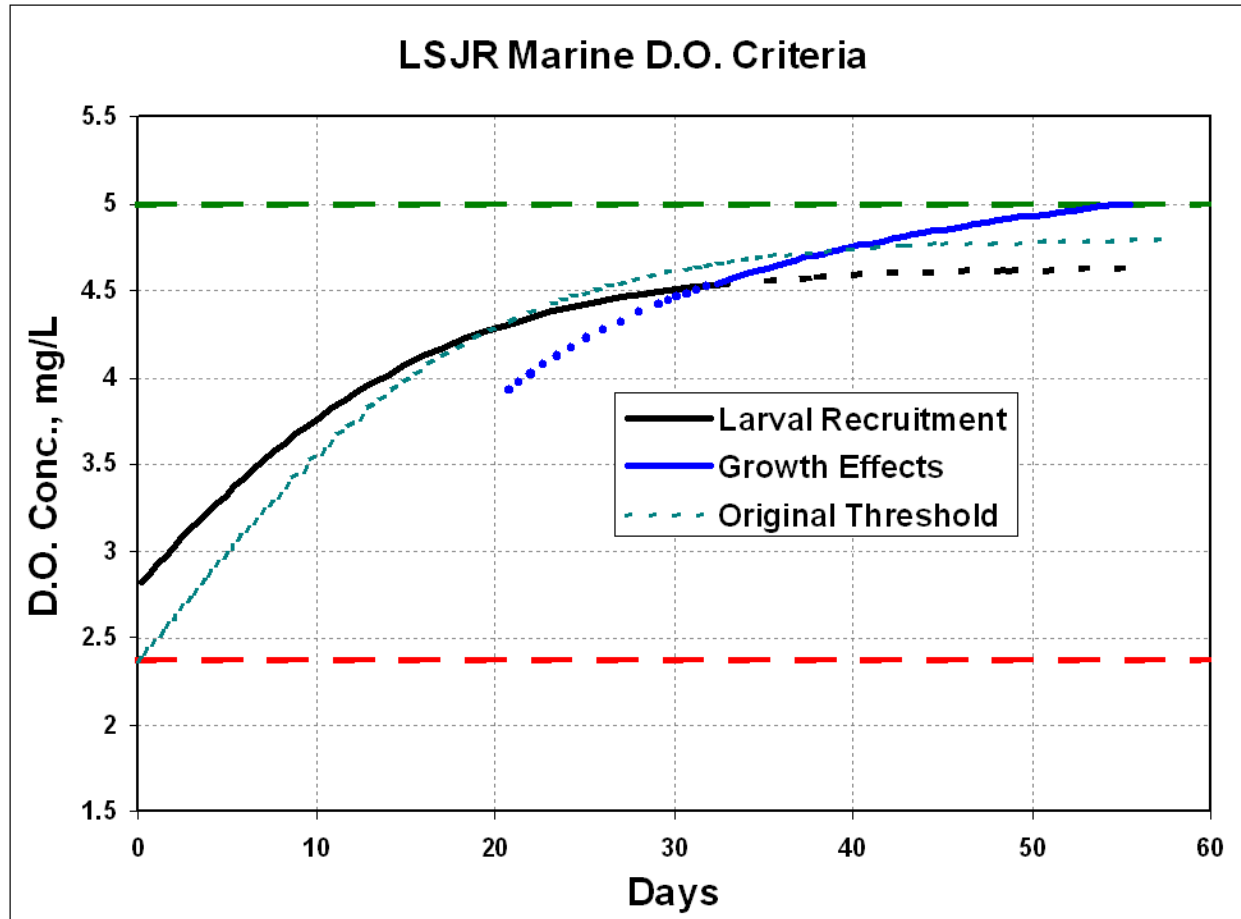
Species	Spawning Time	Spawning Area	Recruitment Time	Recruitment Areas
Atlantic Croaker (<i>Micropogonias undulatus</i>)	October - April	Offshore	December - April	Estuary/Tidal creeks/Upriver areas
Spot (<i>Leiostomous xanthurus</i>)	October - April	Offshore	December - April	Estuary/Tidal creeks/Upriver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

- 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