Water Quality Targets for Seagrass Recovery in Pensacola and Perdido Bays

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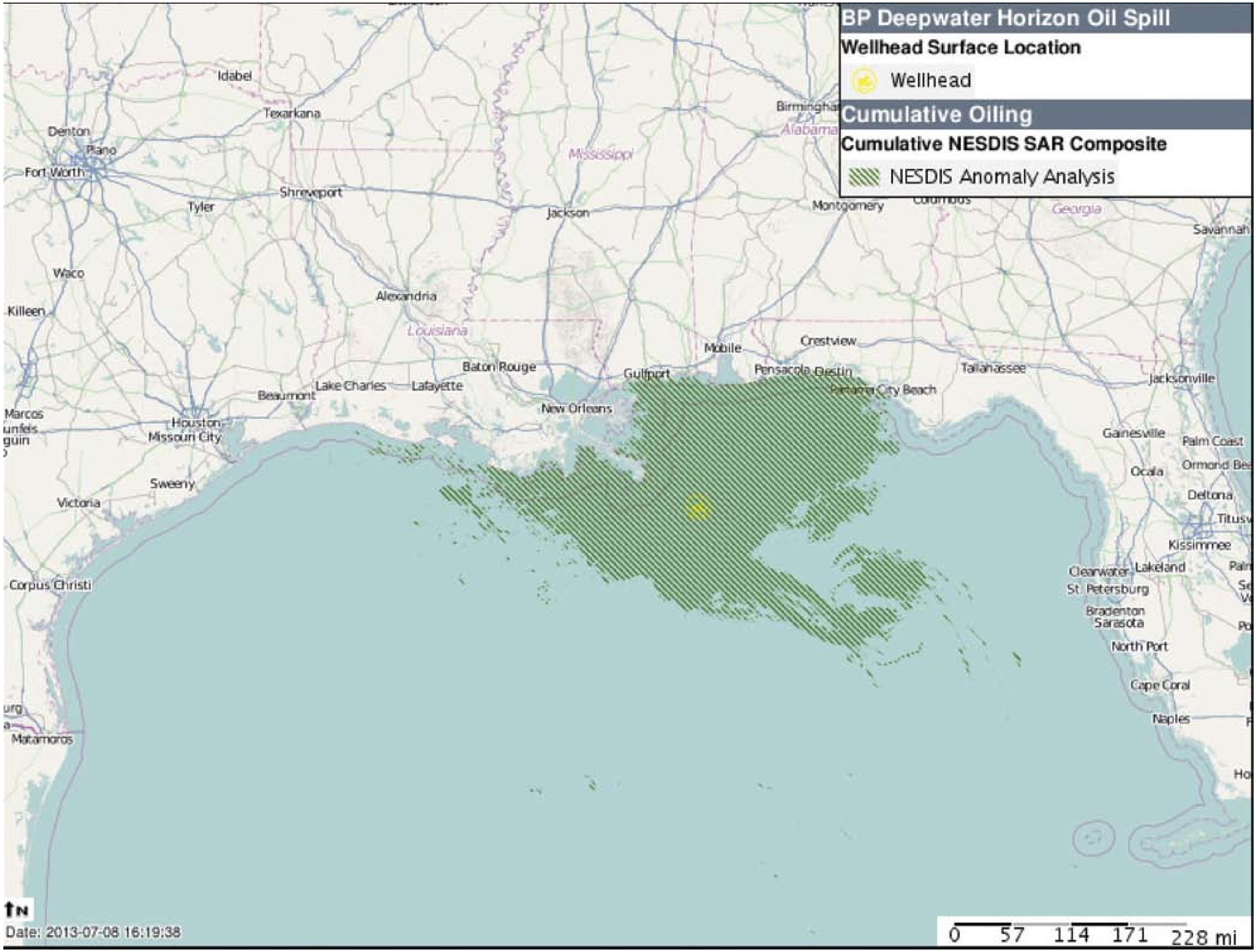
2010 Deepwater Horizon catastrophe

Spatial extent of spill (NAS 2013)



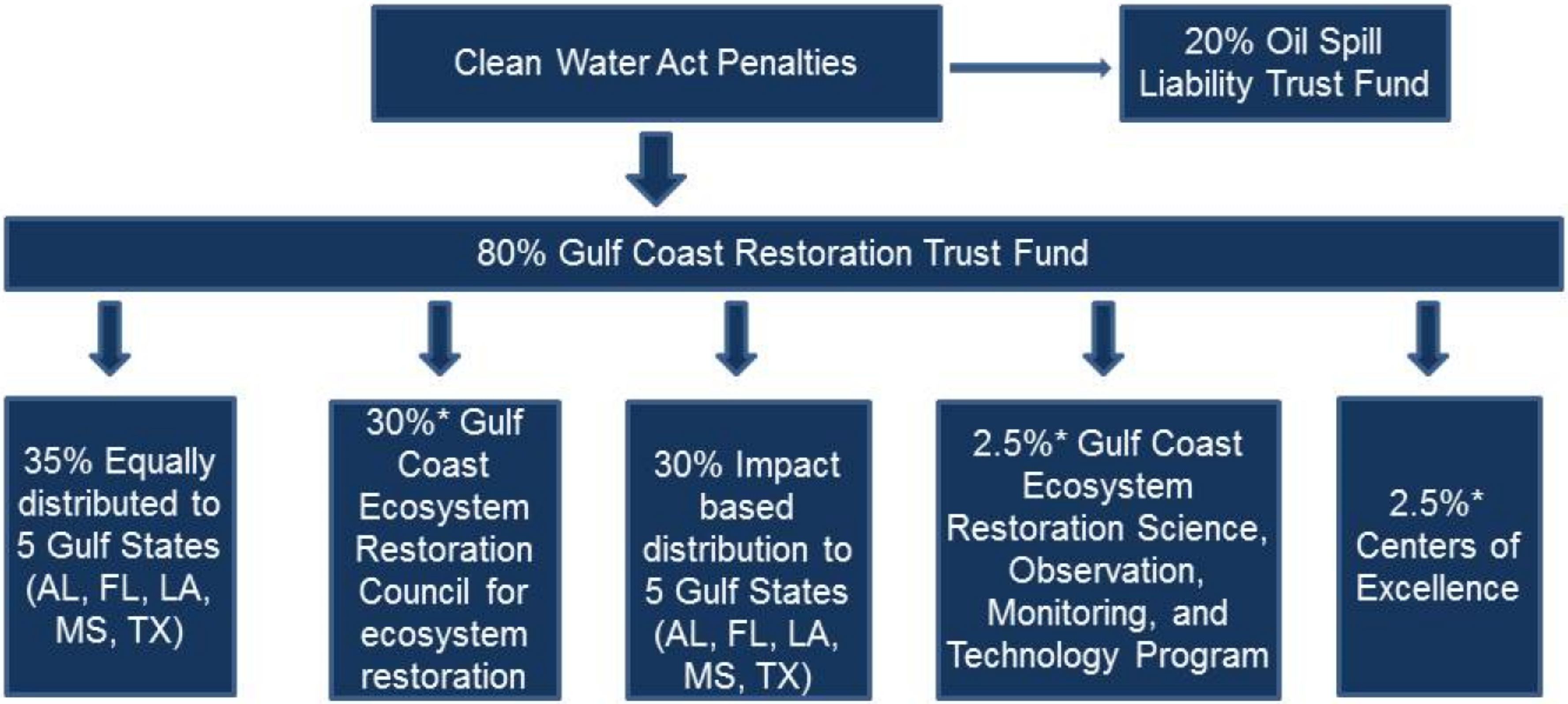
Environmental impacts

- At least 200 million gallons of oil
  - Significant amounts of dispersants
- > 1,000 miles of shoreline affected
- Direct impacts to fish, crabs, birds, marine mammals
  - At least 700 “additional” deaths of dolphins
  - Endangered species
  - Recreationally and commercially important species
  - Corals, deep sea communities, etc.
- Indirect impacts
  - Increased erosion in marshes
- Undetermined long-term impacts

Economic impacts and fines

- At least 20% reduction in fisheries revenue in affected region
- Tourists to coastal counties spent >$30 billion in 2008
  - Supporting > 400,000 jobs
  - Double digit decreases in travel plans in 2010
- Estimated impact of > $20 billion over 3 years
- **Total fines in excess of $20 billion**

Allocation of Gulf Coast Restoration Trust Fund



***Supplemented by interest generated by the Trust Fund (50% to Gulf Coast Ecosystem Restoration Council, 25% to Science Program, 25% to Centers of Excellence)**

State of Florida’s suggested priorities

- Stormwater and/or wastewater
- Community resilience / living shorelines
- Preservation of land
- Implementation of agricultural best management practices
- Fish and wildlife habitat management

What kind of projects should Escambia County consider?

- Habitat restoration?
  - Living shorelines
  - Artificial reefs
  - Oyster reefs
  - Reestablishing emergent and submerged vegetation
- Water quality?
  - Upgrades to public wastewater treatment facilities
    - Biological nitrogen removal?
    - Enhanced reuse and deep well injection?
  - Consolidation of private WWTP facilities
  - Septic tank replacement program
  - Stormwater retrofits

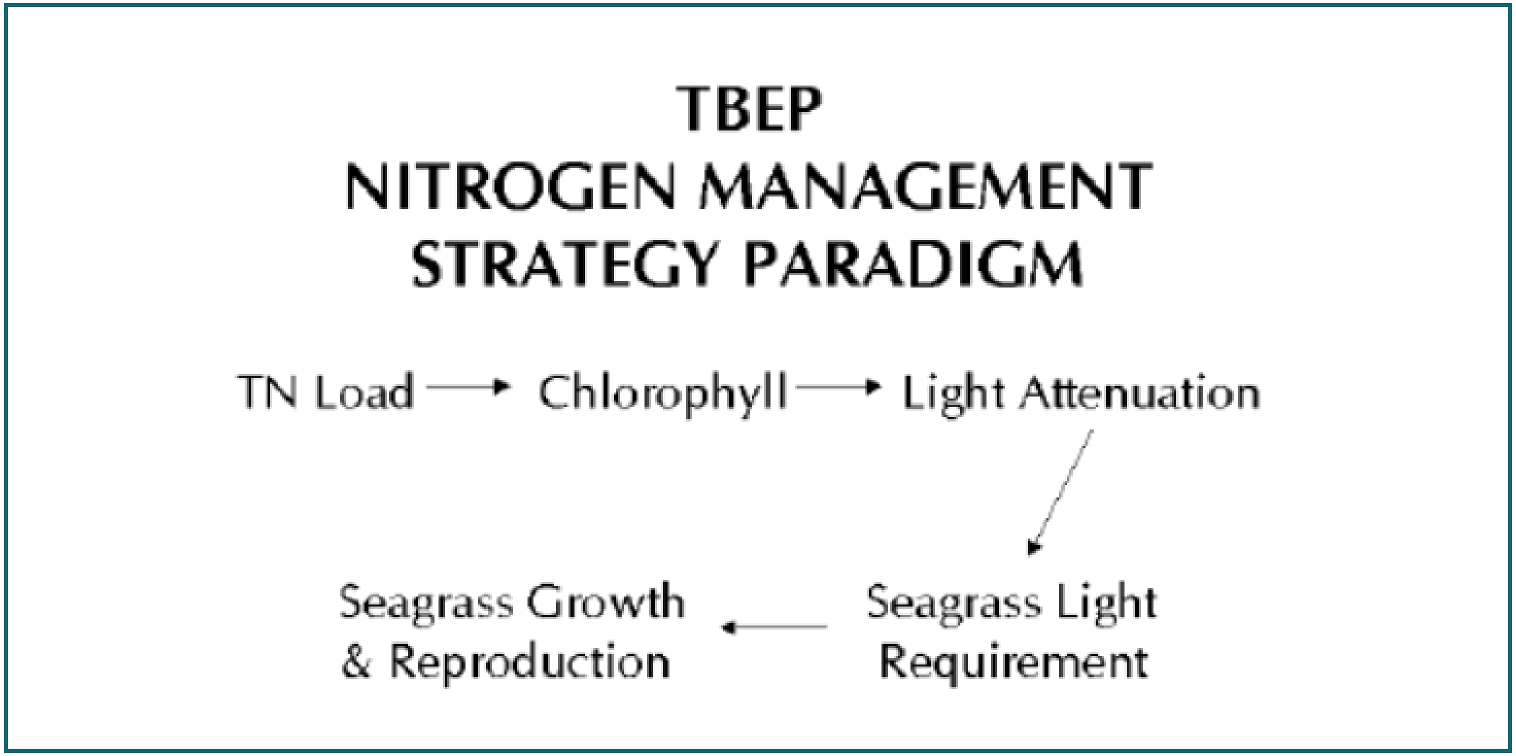
Focus on water quality

- What kind of guidance exists from various federal and state agencies
- What kind of problems have been identified
  - No problems = no need to address water quality?
  - Some problems = need for some action?
- What can be learned, if anything, from other systems in Florida
  - Are those lessons transferrable?

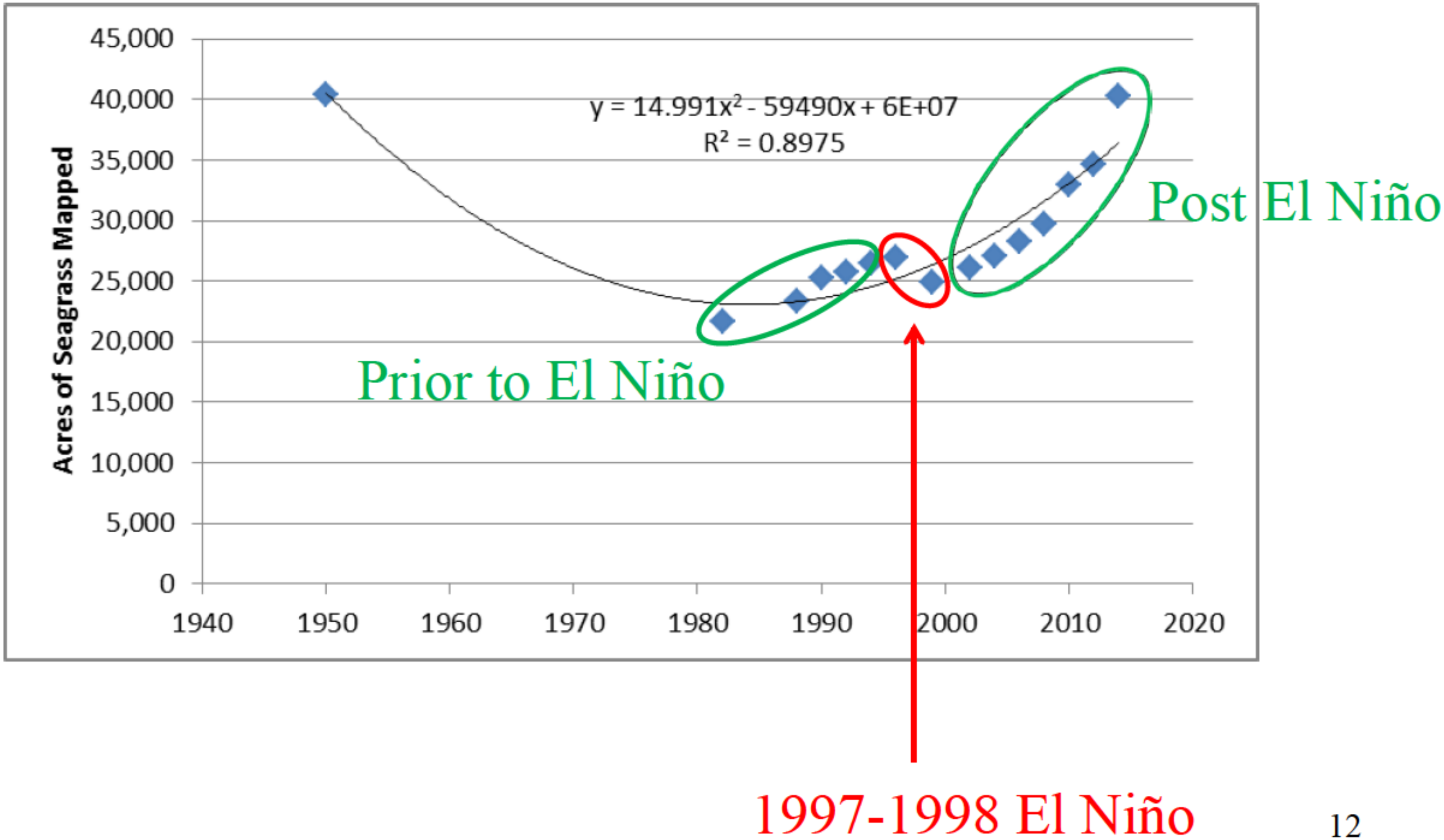
Prior efforts in Florida estuarine waters

- Locations with mixed to no good news
  - Florida Bay
  - Indian River Lagoon
- Locations with little evidence of adverse impacts
  - Big Bend region
- Locations where hydrologic alteration primary stressor, and restoration plans under consideration
  - Dona Bay
  - Naples Bay / Rookery Bay
- Locations with positive system responses to pollution abatement
  - Tampa Bay
  - Sarasota Bay

Tampa Bay nitrogen management paradigm. The basis for > $1 billion in management actions

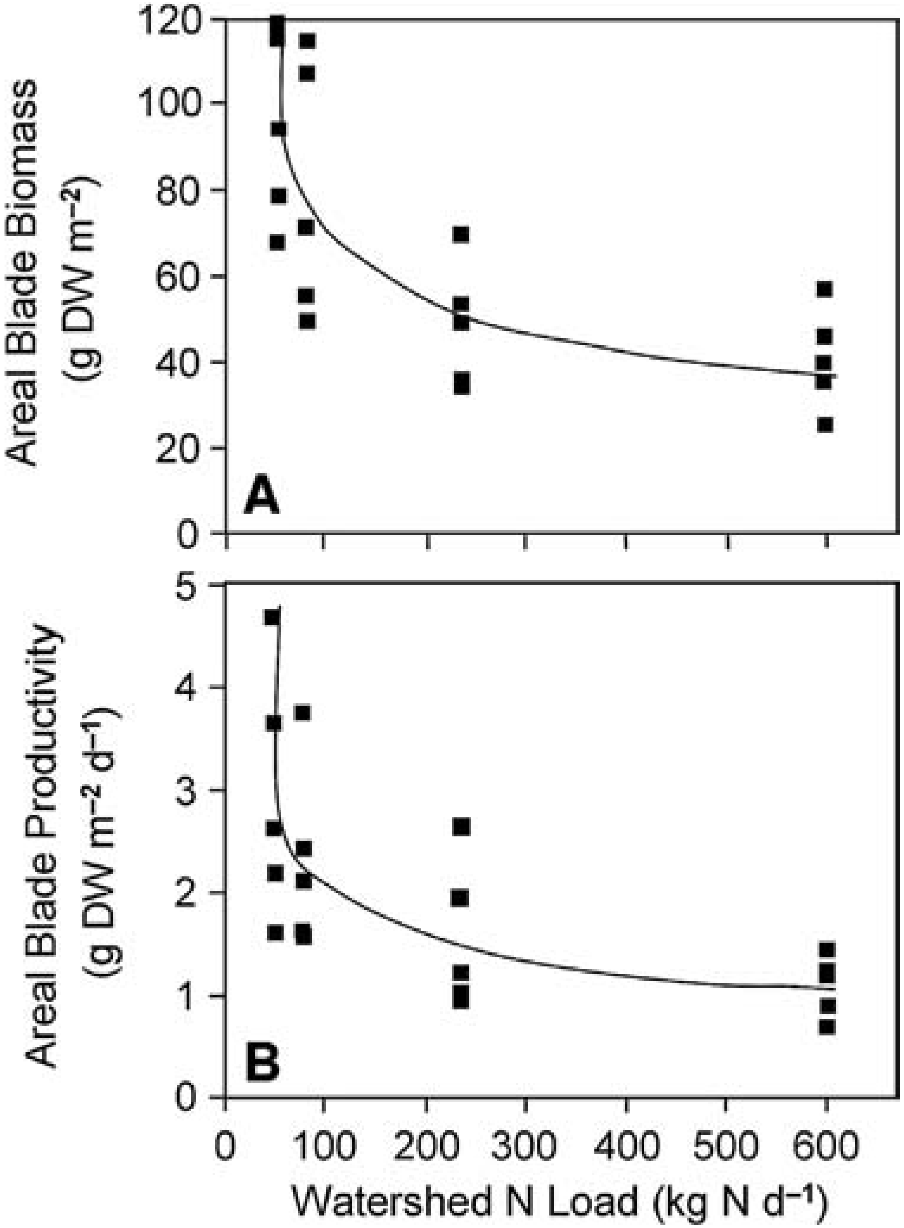


How has it worked out?



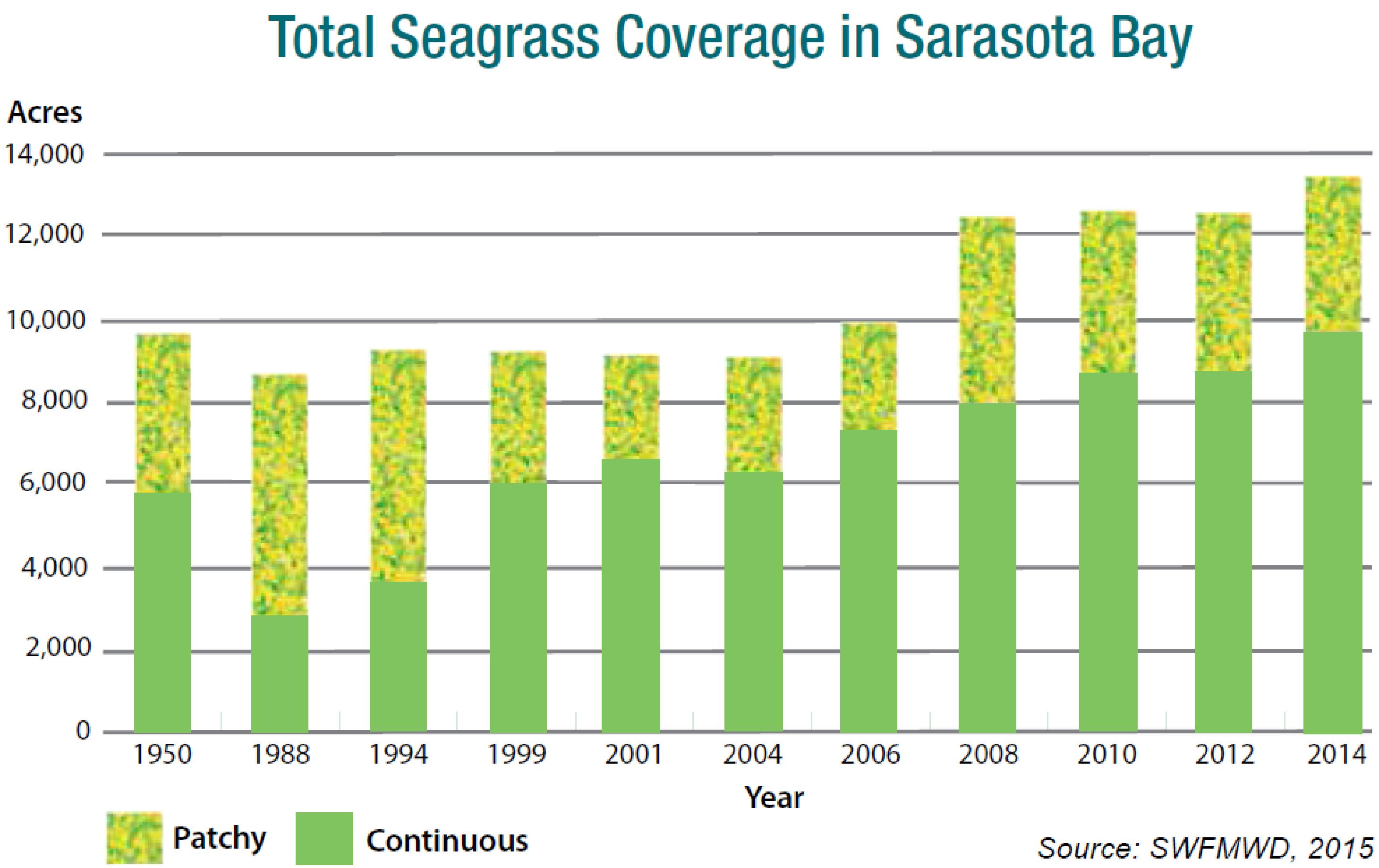
Whatever the mechanisms (phytoplankton, epiphytes, macroalgae, etc.) health of seagrass meadows in Sarasota Bay is inversely related to nitrogen loads.

More seagrass expected with N-load reductions.



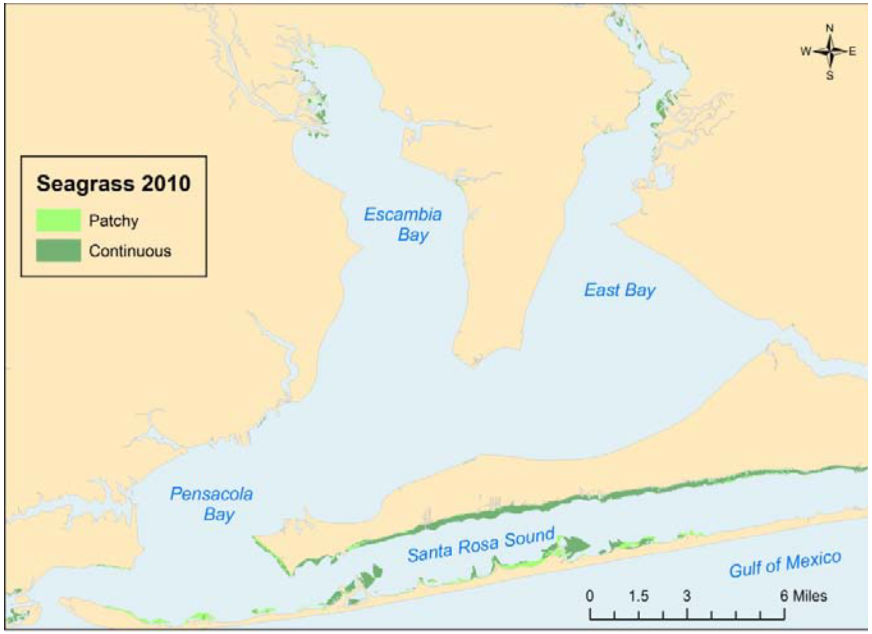
data from Tomasko et al. (1996)

Similar good news in Sarasota Bay – after expenditure of > $300 million



Source: SWFMWD, 2015

Local seagrass coverage



Figures from Harvey et al. (2015)

Trends in seagrass resources in local waters – data sources

Table 1. Seagrass area for the Pensacola Bay system.

[Values are given in hectares (acres)]

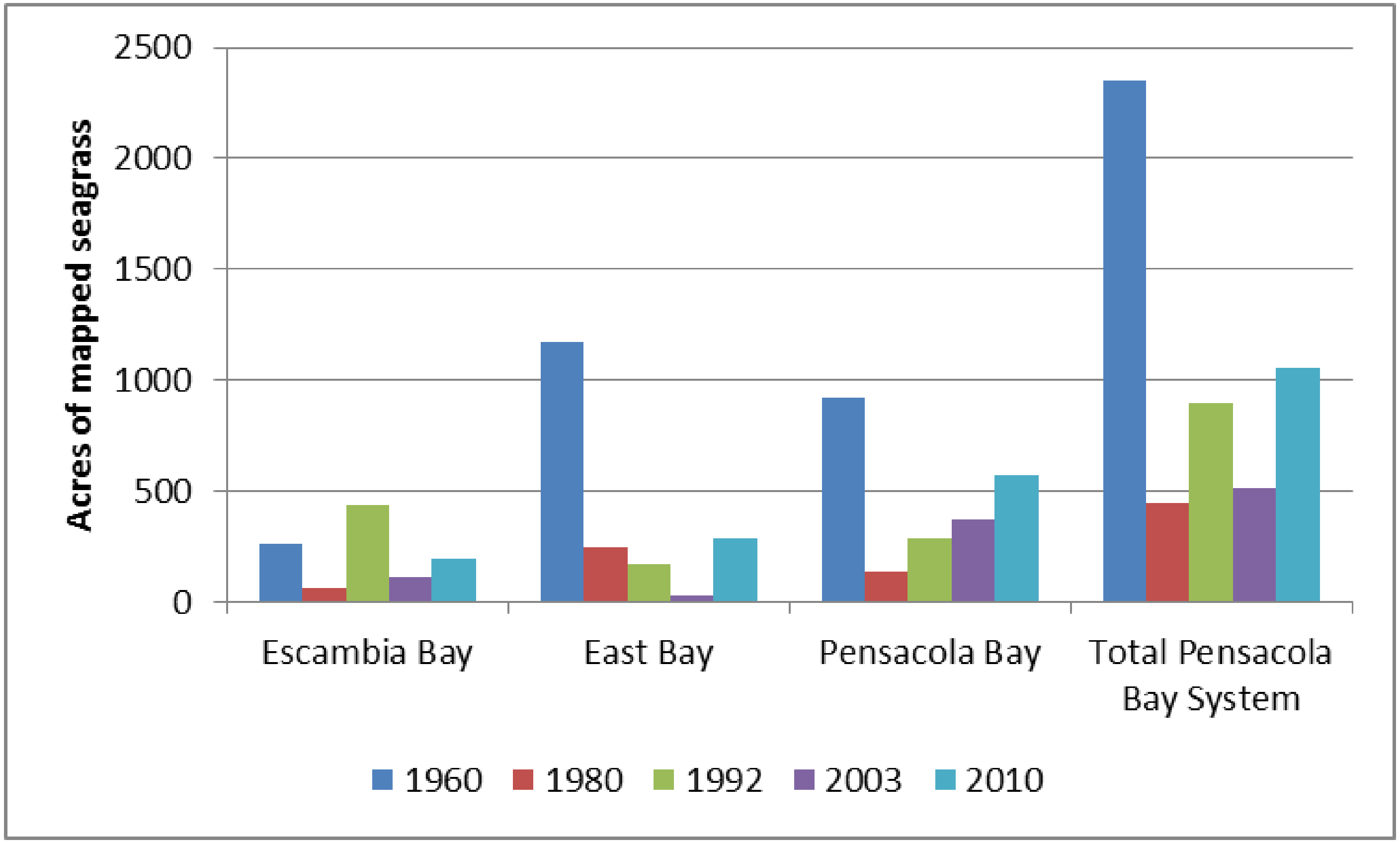
	Escambia Bay	East Bay	Pensacola Bay	Big Lagoon	Santa Rosa Sound
1960	105 (259)	476 (1,175)	372 (918)	271 (670)	2,634 (6,508)
1980	24 (60)	99 (245)	55 (137)	236 (582)	1,489 (3,680)
1992	178 (441)	165 (408)	114 (282)	218 (538)	1,140 (2,816)

Table 1 from Schwenning et al. (2007)

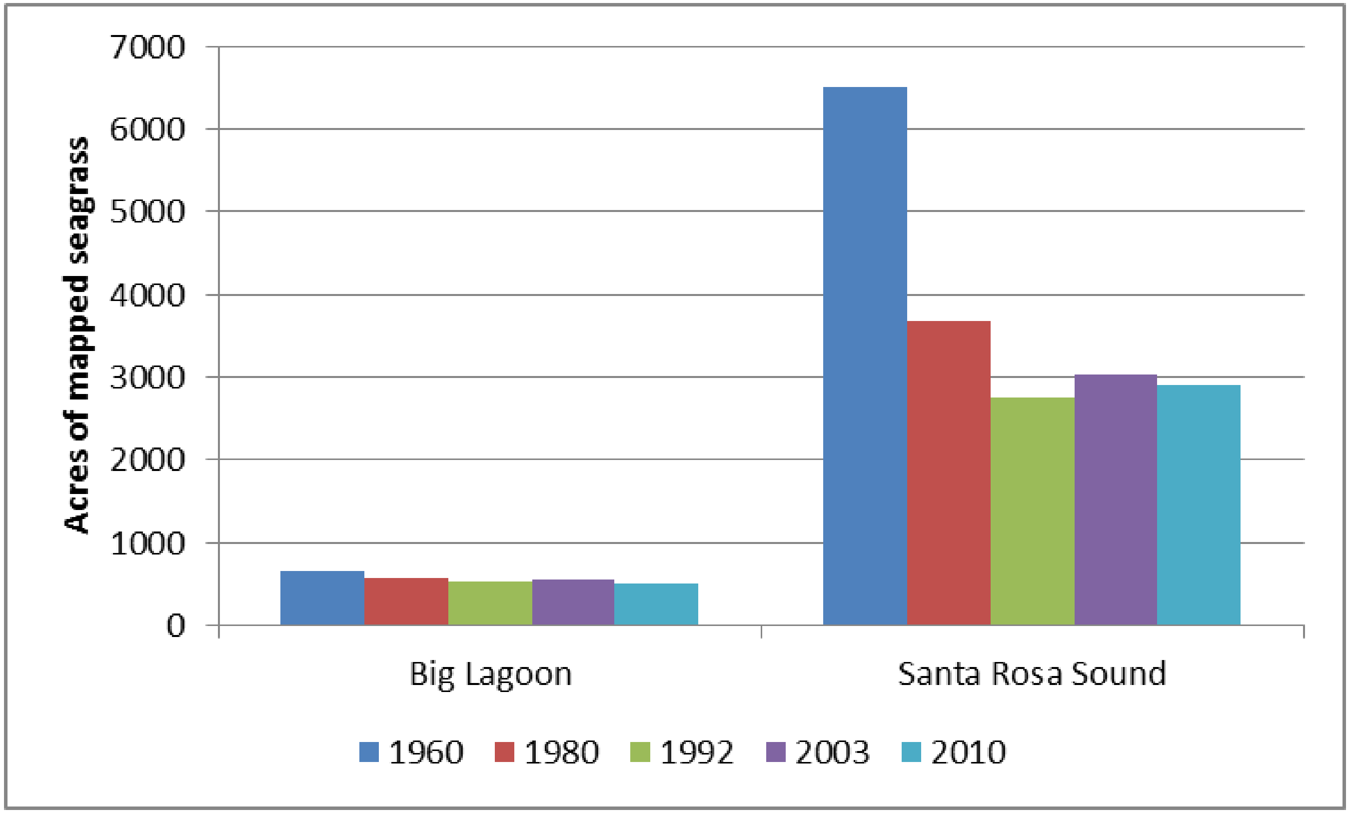
	Acres of seagrass					
Segment	1992	2003	Change 1992–2003	2010	Change 2003–2010	% Change 2003–2010
Pensacola Bay	282	373	91	574	201	35%
Escambia Bay	440	111	-329	196	85	43%
East Bay	170	27.2	-143	283	256	90%
Total Pensacola Bay	892	511	-381	1,053	542	51%
Santa Rosa Sound	2,760	3,032	272	2,894	-138	-4.8%
Big Lagoon	538	544	6	515	-29	-5.6%
Total Pensacola Region	**4,190**	**4,087**	**-103**	**4,462**	**375**	**8.4%**

Table 1 from Harvey et al. (2015)

Trend over the past decades – down 55% from 1960. Recent good news in Pensacola Bay proper



Trend over the past decades – down 56% from 1960. No evidence of recent improvements



Interpretation from state and federal agencies

- Degraded water quality responsible for some loss in historical seagrass coverage
  - As opposed to disease
- Water quality impacts mostly acted upon in past few years to decades
  - Recent improvement in Pensacola Bay proper
  - No clear evidence of recovery in East and Escambia Bays
  - No evidence of recovery Santa Rosa Sound
- > 50 percent reduction vs. 1960
  - While both Tampa and Sarasota Bays have MORE seagrass coverage than 65 years ago

NNC guidance document for Pensacola Bay (FDEP 2012)

Response Variable	Observed Historically?	Observed Currently?	Explanation
Low dissolved oxygen (DO) (hypoxia/anoxia)	Yes	Yes	Low DO concentrations have been observed historically, and current episodic low DOs are associated with natural salinity stratification and natural organic material delivered by river systems, not nutrient enrichment (Caffery 2009, Hagy and Murrell 2007, Hagy *et al.* 2008).
Reduced clarity	No	No	Turbidity is a temporary phenomenon associated with storm events (Heck 1996).
Increased chlorophyll *a* concentrations	No	No (one exception)	Although chlorophyll a levels fluctuate with hydrologic cycles, the absolute values remain at low levels that do not interfere with SAV photosynthesis (Hagy *et al.* 2008, Hydroqual 2010), except in upper Escambia Bay. Upper Escambia Bay was placed on the Verified List due to chlorophyll > 11 ug/L.
Phytoplankton blooms (nuisance or toxic)	No	No	Problematic algae blooms have not been observed (Livingston 2010).
Problematic epiphyte growth	No	No	Epiphyte growth is not an issue in Santa Rosa Sound, where SAV remains constant.
Problematic macroalgal growth	No	No	Problematic macroalgal growth has not been observed (FDEP 2007).
SAV community changes or loss	Yes	Yes	SAV was largely eliminated from Pensacola Bay during toxic discharge events of the 1970s and has not yet recovered, even though chlorophyll does not limit photosynthesis (EPA 1971; Livingston 2005, Hagy et al. 2008).
Emergent or shoreline vegetation community changes or loss	Yes	No	Some shoreline vegetation was affected in urbanized bayous prior to the 1970s (FDEP 1998).
Coral/hardbottom community changes or loss	No	No	Hard bottom not present except for small patch near Pensacola Pass.
Impacts to benthic community	Yes	No	Industrial discharges affected benthic communities in 1970s, but present communities stable (Livingston 2010).
Fish kills	Yes	No	Fish kills were common in the 1970s but have not occurred in recent years.

NNC and TMDL guidance (FDEP 2012 and 2013)

- No evidence of nutrient problem in any location other than North Escambia Bay (WBID 548AA)
  - And only for phosphorous there

Average Load	Calibration (lbs/yr)	TMDL (LA) (lbs/yr)[1]	% Reduction
TN	16,669,238	16,669,238	0%
TP	906,914	589,494	35%

- In other locations…
  - No need for wastewater upgrades?
  - No need for stormwater retrofits?
  - No septic tank replacement programs needed (for nutrients)?

Table 5.14 in FDEP (2013)

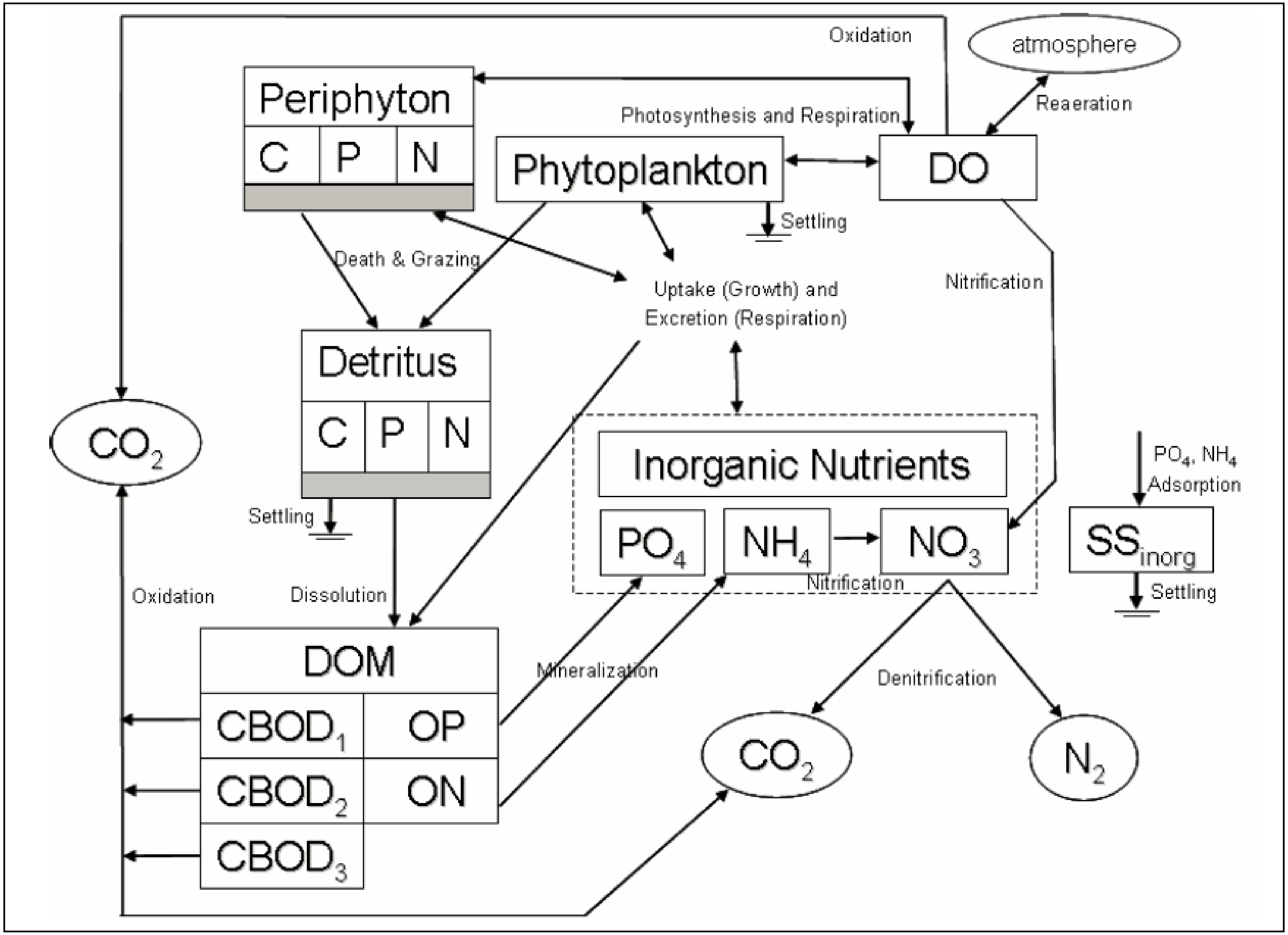
Mostly no problem with nutrients? That's great news! But…

- Other than Pensacola Bay proper, why not the widespread recovery seen in -
  - Tampa Bay
  - Sarasota Bay
  - Clearwater Harbor
  - Indian River Lagoon
    - Until 2009 "superbloom"
  - Gunston Cove, VA
  - Occoquan Bay, VA
  - Belmont Bay, VA
  - Other locations worldwide

Two different modeling approaches in NNC guidance (FDEP 2012)

- 1st group
  - LSPC for watershed nutrient loads
  - EFDC for hydrodynamics
  - WASP for estuarine water quality
- Local Stakeholder Group
  - Measured flows and loads from gaged sites
  - LSPC for non-gaged watershed loads
  - ECOMSED for hydrodynamics
  - Row Column AESOP (RCA) for water quality
    - "…traces its lineage to WASP family of computer codes…"

State variables and rate coefficients



Model assumptions for seagrass protection and recovery (FDEP 2012 and 2013)

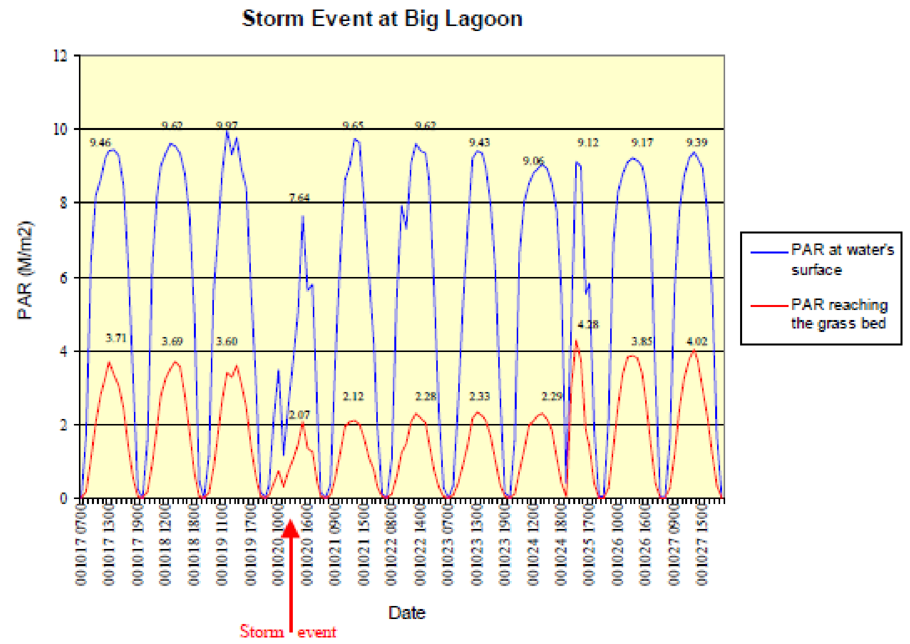
- *Healthy seagrass communities:*
  - Relate colonization depth targets to CChla limits.
  - Determine where the growing season average bottom light equals or exceeds 20% of the surface light for both current and natural conditions.
  - Compare the areas where the bottom light is 20% of surface light or greater with historical seagrass coverages (for both current and natural conditions).
  - Compare areas where the growing season average 20% light depth on the bottom is achieved against the zone depth targets developed by the EPA.

20 percent surface light for seagrass

- Tampa Bay (Dixon 2000)
  - 20.5% for T. testudinum from Lower Tampa Bay
- Tampa Bay (Johansson 2000)
  - 17 to 19% for T. testudinum
  - 16 to 17% for S. filiforme
  - 29 to 60% for H. wrightii in Hillsborough Bay
- Sarasota Bay
  - Avg. 38% (Tomasko et al. 1992)
- Lemon Bay
  - 15 to 45% (Tomasko et al. 2001)
- Indian River Lagoon
  - 33 $\pm$ 17 % (Steward et al. 2005)
- Duarte et al. (2007) summary from 424 studies
  - @ depth limit 1 m, avg. % PAR of 45
  - @ depth limit 5 m, avg. % PAR of 33
  - @ depth limit 30 m, avg. % PAR of 12

Local data?

Seagrass Management Plan for Big Lagoon and Santa Rosa Sound (FDEP 2001)



“Available PAR to the grass bed is about 38% of surface PAR” and…”Available PAR has decreased to ***insufficient levels*** of around 22%,….” (page 37).

Where does this leave Escambia County?

- Based on guidance received, no need for nutrient management efforts other than in North Escambia Bay
  - Despite > 50 reduction in historical seagrass coverage and “recovery” only apparent in Pensacola Bay proper
- Dependent upon output from mechanistic water quality models (WASP, RCA)
- Dependent upon assumption of 20% sub-surface light requirement for seagrass

Proposed project

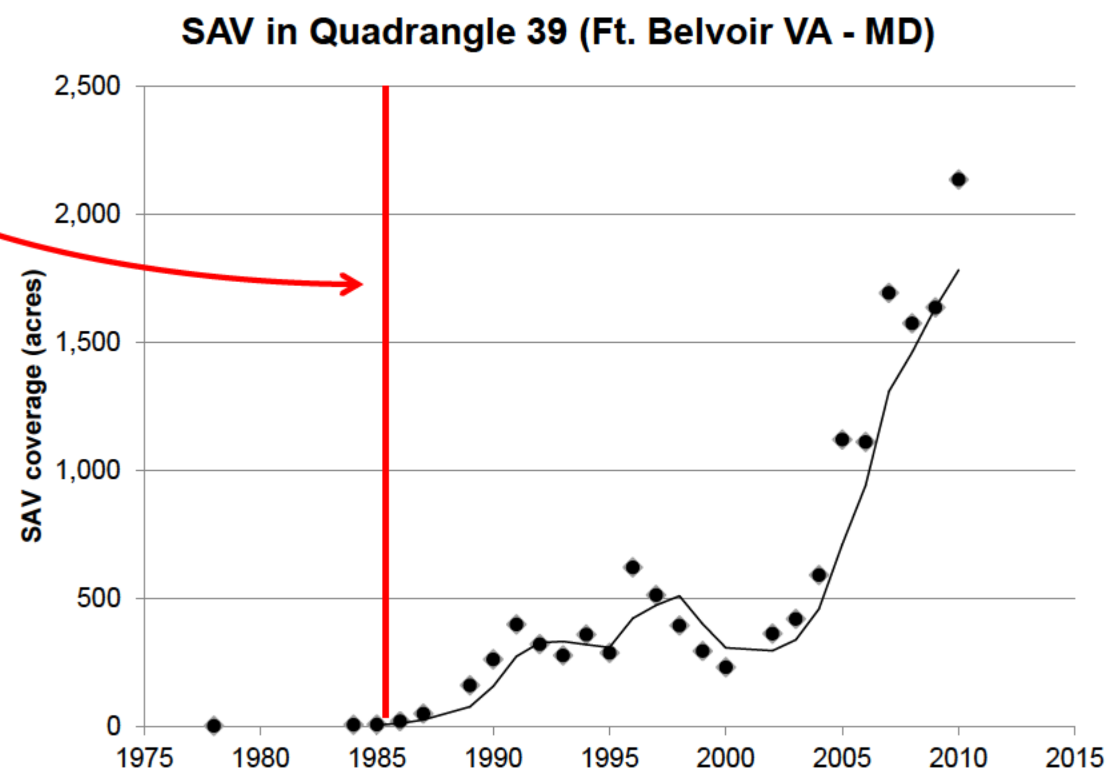
- Develop locally-derived light requirements for seagrass
  - Monthly sampling for 18 months at 21 locations at existing seagrass meadows
  - Monthly sampling for 18 months at 15 locations that historically supported seagrass meadows
- Develop empirically-derived optical model
  - Chlorophyll-a
  - CDOM
  - Turbidity
    - TSS and VSS
- Independently develop guidance on nutrient of concern for various bay segments

Value of proposed project

- Should Escambia County spend time and resources on water quality improvement?
  - Nutrient management
  - Sediment management
- Is the lack of seagrass recovery due to ongoing issues with water quality?
  - No – then transplanting might make sense to "jump start" recovery
  - Yes – then transplanting might be problematic
- Overall, site-specific, less complex assessment of water quality issues
  - Consistent with management approach used successfully in other areas

However, sometimes restoration can involve long lag periods

80 % point source load reduction



Acreage data from VIMS SAV coverage website.

Thank you