SEEING THE LIGHT: A WATER CLARITY INDEX FOR INTEGRATED WATER QUALITY ASSESSMENTS

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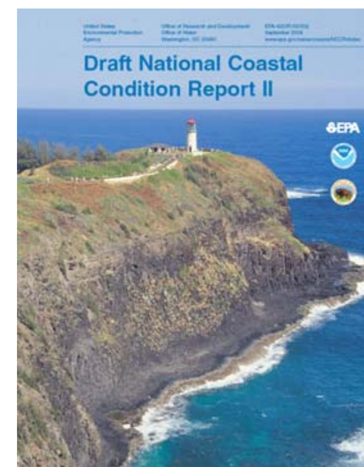
National Coastal Condition

- 1991 – 1997 EMAP survey data
- Assessed condition including water quality
- Raised some issues (Water Clarity)

- 1997 – 2000 National Coastal Assessment survey data
- Evaluated changes over time
- Addressed some earlier criticisms



Why Make Water Clarity a Component of Water Quality?

- Clear waters have both social and economic value.

- Water clarity is often used as a "yard stick" for certain biological and physical processes.

Water Clarity – One Size Doesn't Fit All

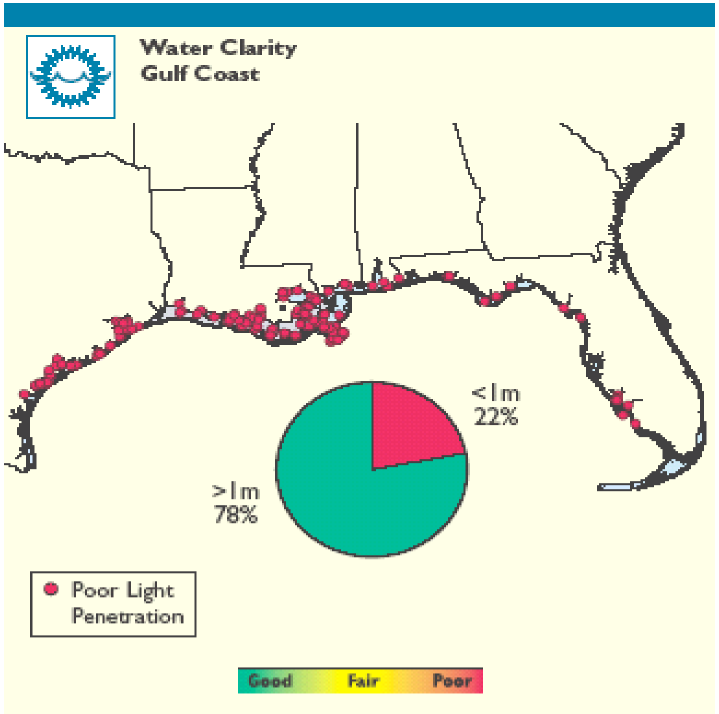
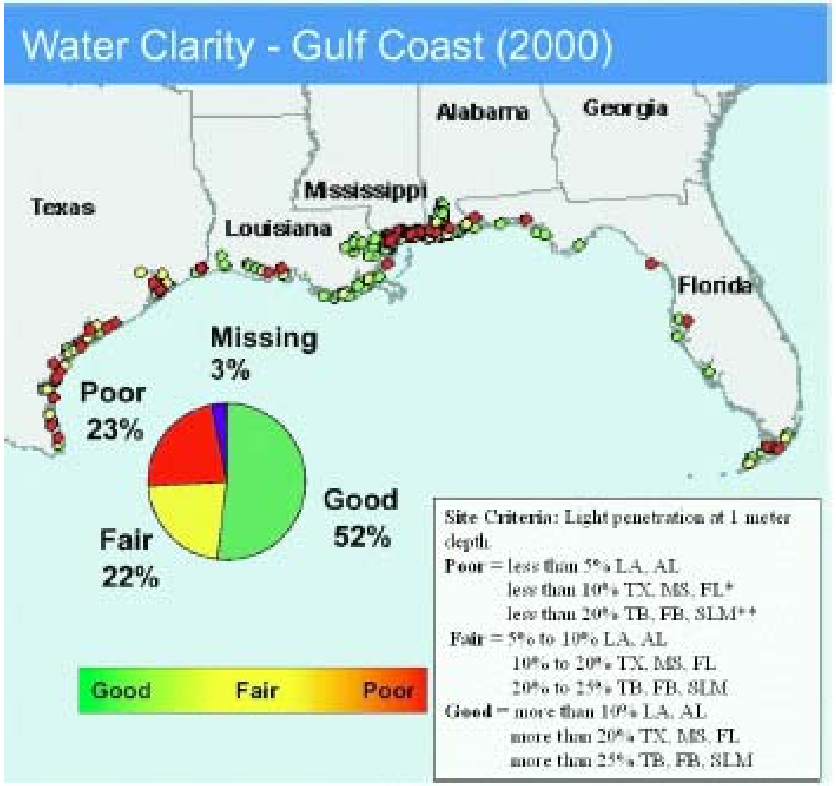


Figure 5-4. Light penetration data and locations for sites with <10% light penetration along the Gulf Coast (U.S. EPA/EMAP).

- A single reference value was used to assess all estuarine waters without considering regional difference.
- Evaluated Water Clarity as "Poor" or "Good"

Water Clarity – One Size Doesn't Fit All

- **Water clarity was evaluated using reference values reflecting "expected" clarity of specific coastal regions.**
- **Created a new category for waterbodies with "moderately" impacted clarity.**



Regional Differences in Water Clarity

Florida Bay-Clear Water, Supports SAV

Pensacola Bay-Moderately Turbid, Partially Supports SAV

Mobile Bay-Naturally Turbid

A Water Quality Index

•Dissolved oxygen

•Chlorophyll *a*

•Dissolved Inorganic Nutrients (Nitrogen and Phosphorus)

•Water Clarity

Evaluating Water Quality for the Gulf of Mexico Region*

REGION	N(mg/L)			P(mg/L)			Chl a(ug/L)			%Transmissivity@ 1m		
	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
Majority of the Gulf	<.10	.10-.50	>.50	<.01	.01-.05	>.05	<5.0	5-20	>20	>25	10-25	<10
Tampa south to Florida Bay and Laguna Madre	<.05	.05-0.1	>0.1	<.005	.005-.01	>.01	<0.5	0.5-1	>1.0	>40	20-40	<20
Mobile Bay and Louisiana estuaries Lake Pontchartrain, Breton Sound excluded	<.10	.10-.50	>.50	<.01	.01-.05	>.05	<5.0	5-20	>20	>20	5-20	<5

*Dissolved Oxygen Guidelines <2.0 mg/L= poor, 2.0-5.0 mg/L=fair, >5.0 mg/L=good

All Water Clarity Data Are Not Created Equal

Water Body Name	Raw Water Clarity
ANNA MARIA SOUND	1.0
ARANSAS BAY	0.8
BACK BAY BILOXI/BERN	14.052
BAFFIN BAY	0.7
BANGS LAKE	12.881
BARATARIA BAY	29.732
BAY BATISTE	0.7
BAY BOUDREAUX	0.5
BAYOU CASOTTE	18.795
BILOXI BAY	2.875
BOCA CIEGA BAY	0.5
BON SECOUR RIVER	13.004
BRETON SOUND	0.5

41% of sampling sites did not have expected transmissivity data

Using Different Types of Data to Evaluate Water Clarity

When light meter data were available, the data were evaluated using the regional guidelines:

REGION	%Transmissivity@ 1m		
	Good	Fair	Poor
Majority of the Gulf	>25	10-25	<10
Tampa south to Florida Bay and Laguna Madre	>40	20-40	<20
Mobile Bay and Louisiana estuaries Lake Pontchartrain, Breton Sound excluded	>20	5-20	<5

If Secchi was used as a substitute for light meter data ...

- The regional reference values for the three types of expected water clarity were used to calculate reference light attenuation coefficients (k).
- Secchi depth was used to calculate k values for evaluating water clarity.

Beer-Lambert's Law

$$k = \mathit{ln}(L_z/L_o)/-z$$

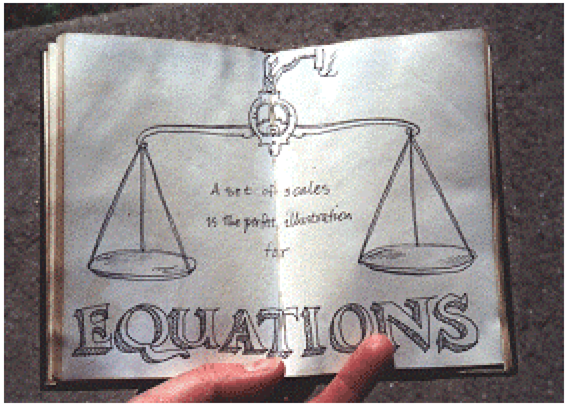
where,

k=light attenuation coefficient

L_z=light at depth

L_o=light at surface

z=depth



Beer-Lambert's Law continued

- Since Lz/Lo = transmissivity, and z= 1 meter, the reference k values were calculated from the regional guidelines for transmissivity at 1 meter.

- The k reference values were calculated using:

  ref k= -ln(ref transmissivity)

Resulting in …

Lower reference value (lo ref)	Light attenuation coefficient for lo ref (klo)	Upper reference value (hi ref)	Light attenuation coefficient for hi ref (khi)
5%	2.99	20%	1.61
10%	2.30	25%	1.39
20%	1.61	40%	0.916

Using Secchi Depth to calculate k

$$k = \text{constant}/z_{secchi}$$

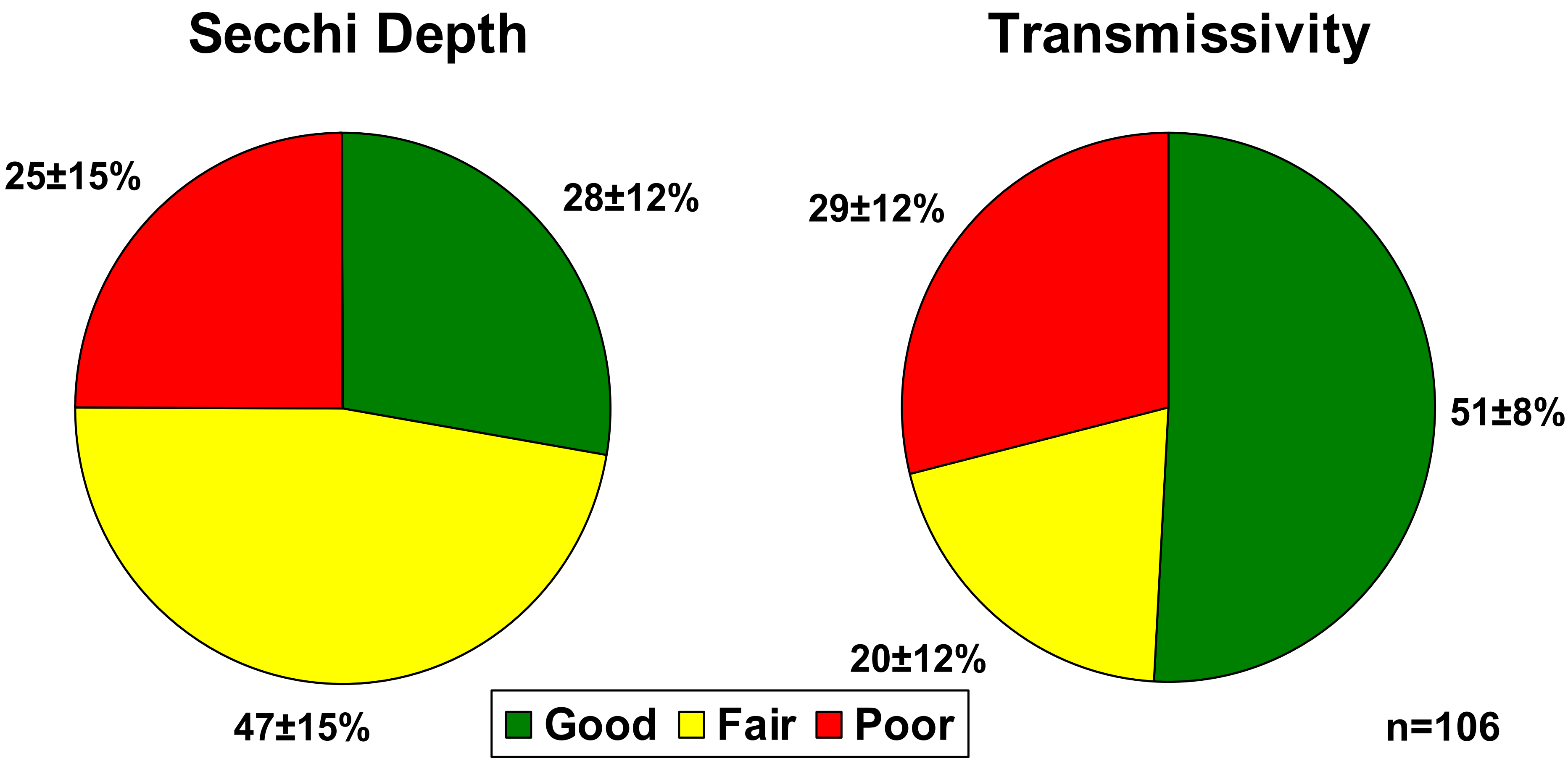
Constants for estuarine types

- 1.7 for clear water estuaries
- 1.4 for moderately turbid estuaries
- 1.0 for highly turbid estuaries

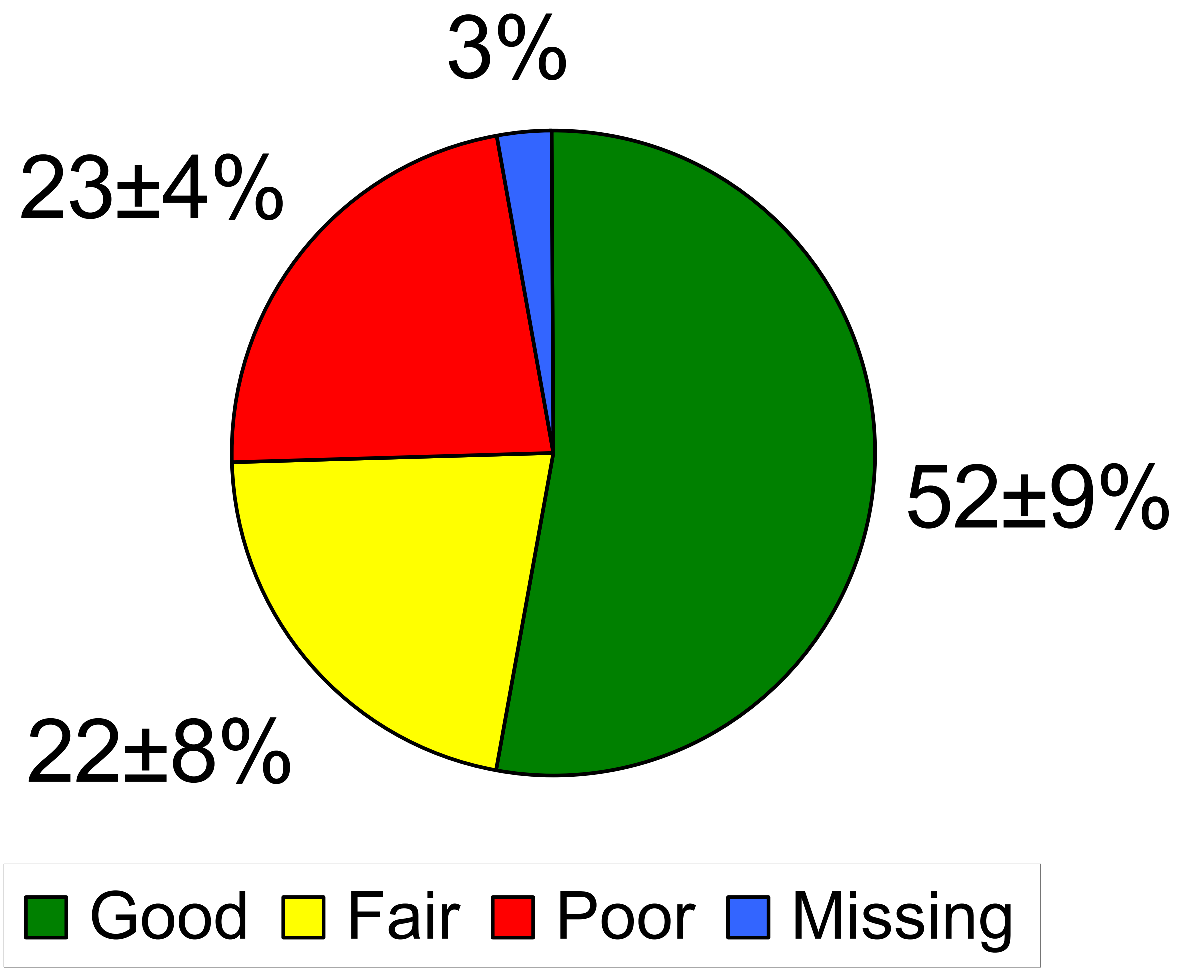
Guidelines for Evaluating Light Attenuation Coefficients (k)

Estuarine Type	k values		
	Good	Fair	Poor
Clear	<0.916	0.916-1.61	>1.61
Moderately Turbid	<1.39	1.39-2.30	>2.30
Highly Turbid	<1.61	1.61-2.99	>2.99

Water Clarity
Transmissivity and Secchi Depth

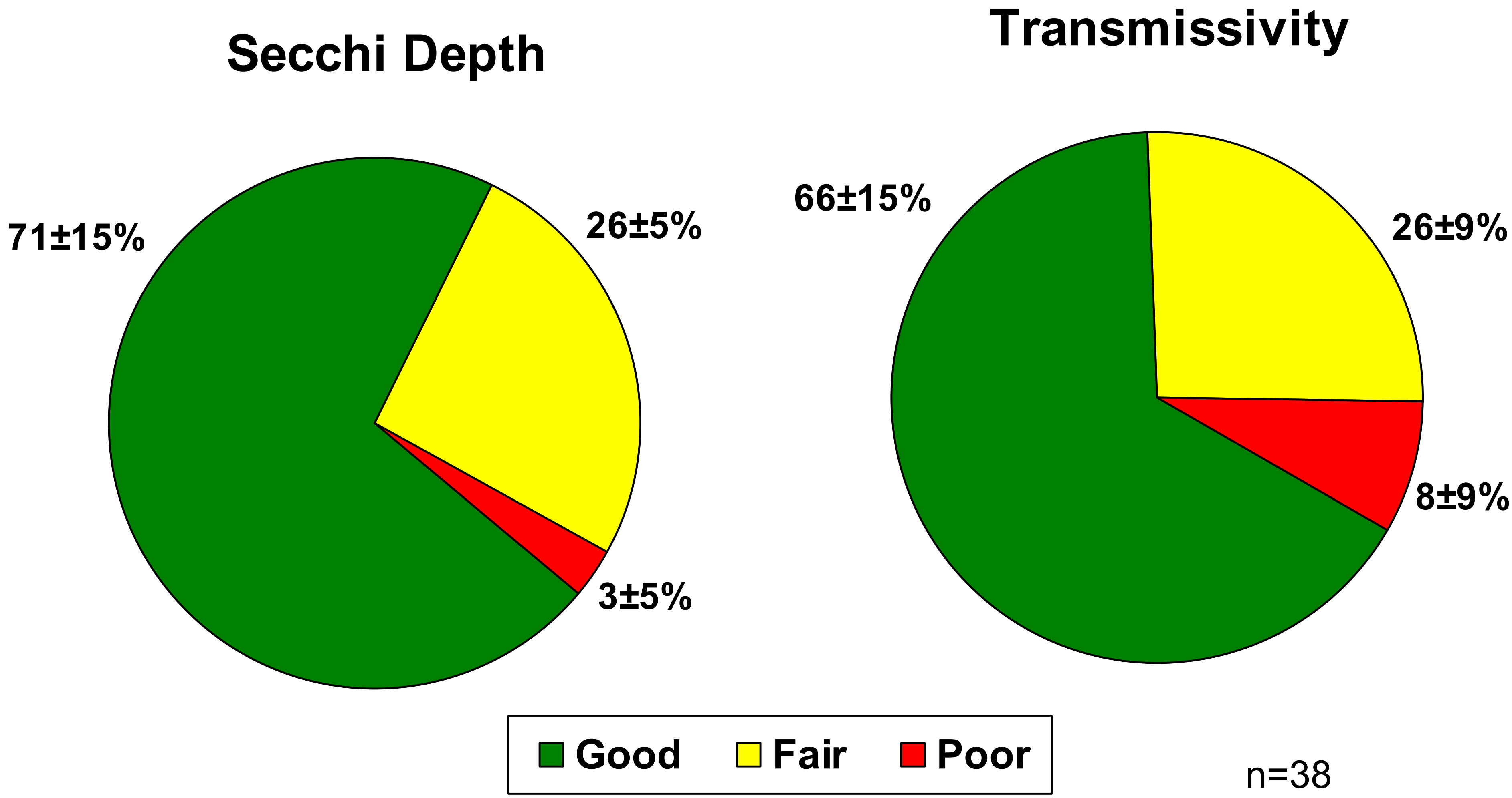


Gulf of Mexico Water Clarity: All Data

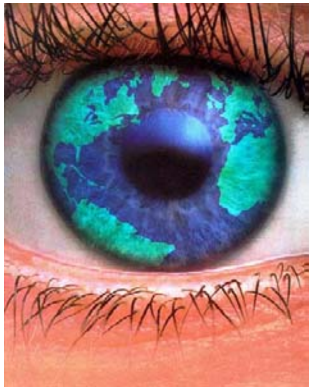


n=191

The Local Scale-Pensacola Bay



Concluding Remarks



- No statistical differences were observed in the ‘poor’ water clarity category when the two types of data were evaluated for the Gulf Region subset.

- This is an important issue since ‘poor’ is the only condition contributing to ‘poor’ overall water quality in the Eutrophication Index.

Concluding Remarks (continued)

- The use of combined data resulted in a gulf-wide assessment similar to the transmissivity data subset.

- This similarity may imply that the combined water clarity index can successfully be used to estimate water clarity when light meter data sets are incomplete.

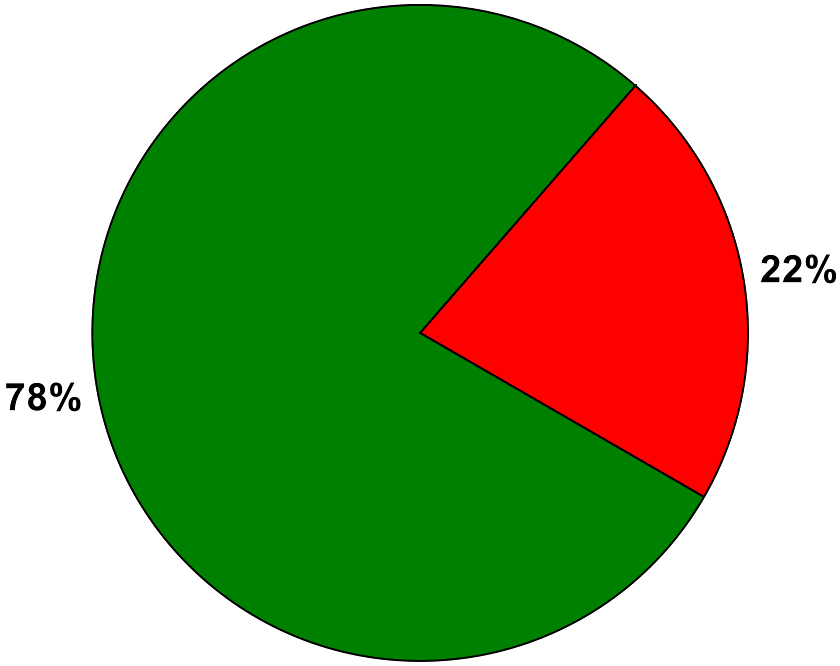
Concluding Remarks (continued)

- The overlapping conditions observed in the water clarity assessment for Pensacola Bay, using transmissivity and secchi depth, are evidence that the secchi depth can be used to estimate water clarity with confidence.

- The water clarity index can be adapted for natural turbidity differences and successfully applied at regional and local scales.

Gulf of Mexico Water Clarity… Then and Now

First National Coastal Condition Report



Second National Coastal Condition Report