Evaluation Strategy and Reporting Tool for CHNEP Water Clarity Targets

Janicki Environmental, Inc.

Supplemental to Task 3 interim report

4/6/2011

FORWARD:

This report is a supplemental document to the Charlotte Harbor National Estuary Program (CHNEP) Task 3 interim report (March 2010) on developing water clarity targets for the estuarine waters of the CHNEP. This supplemental document is intended to summarize the evaluation and reporting strategy for annual reporting of water clarity conditions in CHNEP estuarine waters. The Task 3 report provides a more comprehensive overview and background on efforts to refine the existing optical model of CHNEP (2006) as well as the development of the scoring methodology and grading system used for annual reporting of segment water clarity. This document supplements the Task 3 report by providing a concise explanation of the methods of establishing the water clarity targets, scoring annual data and reporting annual water clarity grades in a convenient format that is easily understood by the general public. The final reporting tool format with data updated through 2009 is provided.

1.0 Background and Rationale:

The Charlotte Harbor National Estuary Program (CHNEP) is establishing a foundation of objective, science-based, decision making tools for use as indicators of estuarine health and is furthering its goals under its Comprehensive Conservation and Management Plan to protect and restore water quality through rigorous analysis of its management tools. The Task 3 study (March 2010) has furthered those objectives by assessing the optical model performance relative to empirical estimates of light attenuation which is an important component of seagrass success in the estuary. The extent of seagrass in the CHNEP study area is an exceptionally valuable natural resource and a primary focus of the CHNEP Comprehensive Conservation and Management Plan. The continued focus on science based management tools for seagrass will help to ensure the protection of these vital resources as anthropogenic pressures increase. The Task 3 analysis suggests that more efforts are needed to understand the interactions between attenuators of light in these waters before the current optical model can be confidently used to set management level criteria for individual water quality constituents in the Charlotte Harbor study area.

In light of the uncertainty in linking water quality and light attenuation in Charlotte Harbor estuarine waters, water clarity targets were identified that were relevant to the observed conditions affecting seagrass within each Harbor segment without explicitly identifying the light requirements of seagrass. The following reasoning was used to derive the proposed water clarity targets:

- Mechanistic relationships between ambient/antecedent water quality conditions and the living resource requirements of seagrass are not fully understood.

- Stability in measures of seagrass areal extent over recent history suggests that either:
    1. Ambient water quality conditions from recent history are sufficient for success of seagrasses (as expressed as areal extent) within the segment,

    2. seagrasses are stressed by ambient/antecedent water quality conditions but the seagrasses have not expressed the stressor - response relationship as a change in areal extent, or

    3. Ambient/antecedent water quality conditions are not relevant to the success of seagrasses (as expressed as areal extent), or

The preponderance of evidence suggests that water quality, explicitly water clarity, is a limiting factor in determining the depth distribution of seagrass. Therefore, the third argument is dismissed. The second alternative is plausible but the targets identified by this study are intended to make inferences regarding the **extent** of seagrass within a segment and not on:

- Speciation of seagrass within a bed

- Density of seagrass within a bed

- The quality of seagrasses within a bed

These measures of seagrass condition are better estimated through other monitoring efforts.

2.0 Establishing Water Clarity Targets

Based on the above, water clarity targets were proposed based on the assumptions that;

- changes in the areal extent of seagrasses are related to changes in water quality even if the mechanistic relationships are not fully understood, and

- improving water clarity will result in an increase in the areal extent of seagrasses given other factors are not limiting.

The 2003-2007 time period was chosen as a reference period from which a cumulative frequency distribution was generated for each Harbor segment. As discussed in the Task 3 report, the 30^{th} and 70^{th} percentile values from the reference distribution were chosen as benchmark points from which to evaluate future years data. These benchmark points bracket water clarity conditions thought to be most representative of the light requirements of seagrass in each segment at the target depths established by CHNEP 2006. The values for each Harbor segment are provided in Table 1 and the cumulative distribution curves are provided in Figure 1.

Table 1. Benchmark values for segment specific water clarity targets.

Harbor Segment	P30 Exceedance criteria Kd values	P70 Exceedance criteria Kd values
Charlotte Harbor Proper	0.62	1.17
Dona And Roberts Bays	0.62	1.03
Estero Bay	0.91	1.6
Lemon Bay	0.73	1.13
Matlacha Pass	0.79	1.52
Pine Island Sound	0.64	1.17
San Carlos Bay	0.71	1.18
Tidal Caloosahatchee River	1.65	3.04
Tidal Myakka River	1.59	2.72
Tidal Peace River	1.08	2.57

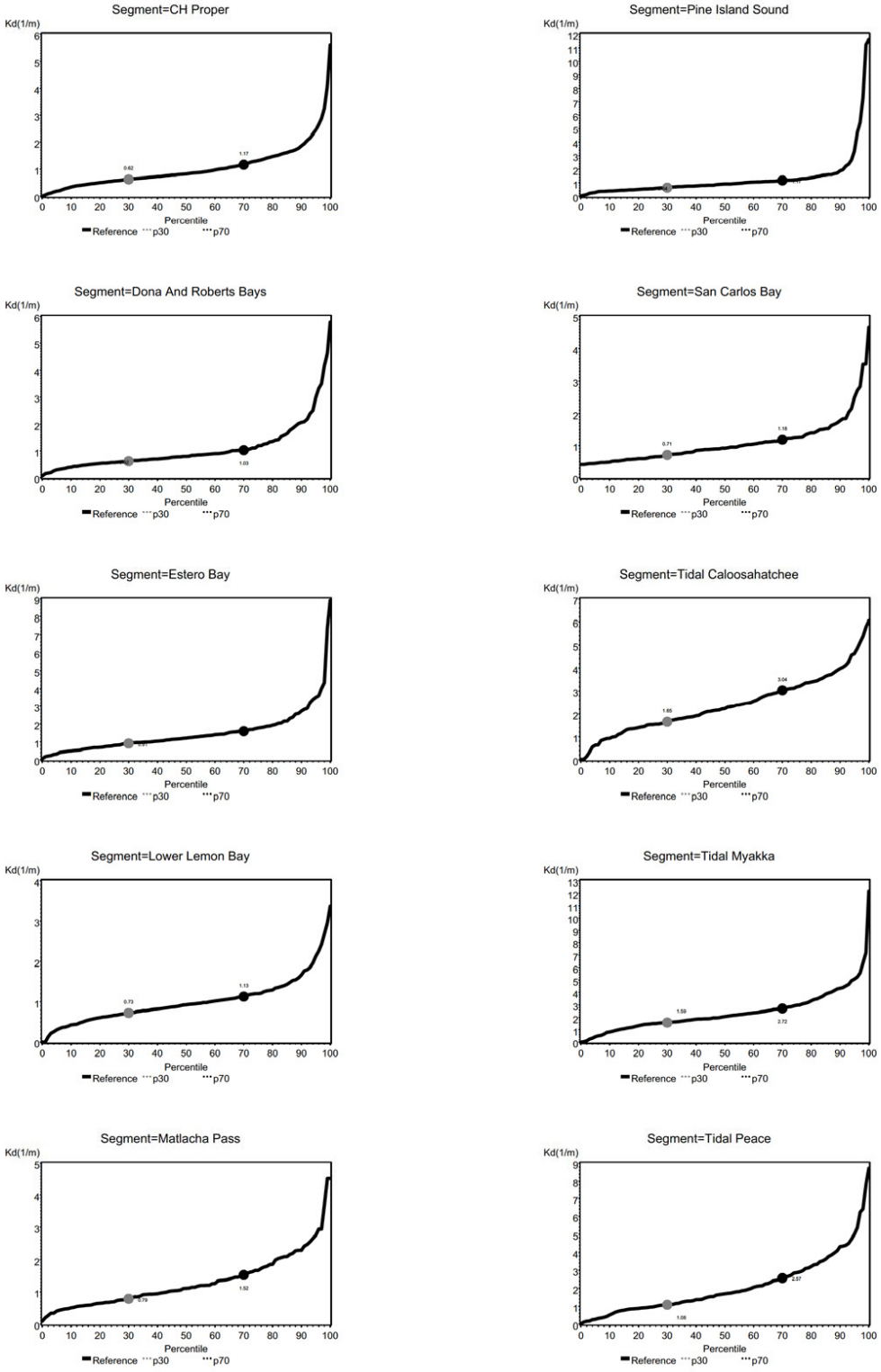

Figure 1. Reference distribution CDF's for each Harbor segment with benchmark points highlighted as circles on the curve.

3.0 Scoring Method:

The binomial test (Wackerly et. al., 1996) was used as the tool to establish a scoring method to evaluate each year's water quality data at the benchmark points on the distribution. For example:

- If more than 30% of the K_d measurements were below the benchmark with statistical significance (alpha=0.05), then the water clarity was considered to be improving and was assigned a value of positive 1.

- If less than 30% of the values were below the benchmark with statistical significance (alpha=0.05), then the water clarity was considered to be degrading and was assigned a value of negative 1.

- Otherwise the value was 0.

This scoring is performed on both endpoints (i.e. the 30^{th} and 70^{th} percentile).

The sum of these scores was used as the basis for the assessment of water clarity for each Harbor segment. The distribution of potential scores ranges from -2 to 2.

A scoring algorithm was provided to the CHNEP as a Excel spreadsheet from which the scores for each Harbor segment could easily be derived. All that needs to be known is the number of samples and the number of samples less than or equal to the criterion values for 30^{th} and 70^{th} percentile benchmarks. A screenshot of the scoring algorithm is provided in Figure 2.

Binomial Test	P30 test	P70 test					
Inputs							
# <= target	40	80	In this example there are more values under the target than expected. Light conditions a better than expected;therefore scores are good. Change the number of values <= target and see how the scores change in the final score cell highlighted in yellow below				
# Samples	100	100					
Expected Proportion	0.3	0.7					
Returns							
P value better	0.012	0.009					
P value worse	0.988	0.991					
	1	1					
	0	0					
Individual scores	1	1					
Segment Score =	2						

Note: This procedure is sensitive to changes in sampling design.

Figure 2. Example of the scoring algorithm provided to CHNEP for scoring water clarity conditions.

4.0 Decision Rules:

Given the definitions above, the seagrass targets identified in Task 2 of this scope of work were used to establish an decision rules for water clarity. The following decision rule was applied:

- If the **protection target** was chosen as the segment specific seagrass target, then the water clarity target established will be a “hold the line” strategy to maintain ambient conditions experienced over the recent areal surveys.

- If the **restoration target** was chosen as the segment specific seagrass target, then the water clarity target will be an “Improvement” strategy measured as an “improving” trend in for light attenuation.

The tidal tributary seagrass targets including the Tidal Peace, Tidal Caloosahatchee, Tidal Myakka and Dona and Roberts Bay were not to be considered as management targets for seagrass based on the subcommittee opinion that the influence of tanic river waters reduced the ability to capture the bottom profile of these segments with aerial photography as well as the local observations of sparse but substantial coverage of seagrass in areas previously characterized by aerial photography as being devoid of

seagrass. However, the tidal tributary segments were assigned a restoration or protection water clarity target by CHNEP staff based on local expertise.

For the **protection targets** the following grading system will be used:

Green = scores greater than -1	Stable
Yellow = a score of -1 or less	Caution
Red = a score of less than -1 for consecutive years	Degrading

For the **restoration targets** the following grading system will be used:

Green = scores greater than 1	Improving towards target
Yellow = scores between -1 and 1	Caution
Red = a score of less than -1	Degrading

Based on this grading system, the restoration targets have more stringent water quality criteria than the protection targets. Stability in scores relative to the benchmark period is considered sufficient for the protection targets but not for the restoration targets. Therefore, scores between -1 and 1 are given a “caution” score. These scores can be related to changes in seagrass over time by either adding the scores between the biennial seagrass surveys, or evaluating each of the benchmark scores (i.e., the 30th and 70th percentile) separately. It should be noted that the binomial test used to score the water clarity data relies on the assumption that samples are independent and the design of the CCHMN network conforms to this assumption. The test is also sensitive to changes in temporal sampling frequency that may bias the seasonal weighting of samples. Currently the CCHMN sampling scheme is monthly.

5.0 Reporting Tool:

A reporting format was constructed such that water clarity annual grades would be easily conveyed to the public. The final reporting tool format is provided in Figure 3 with scores updated through 2009. The reporting tool allows the reader to easily assess trends in water clarity over time for each Harbor segment of interest.

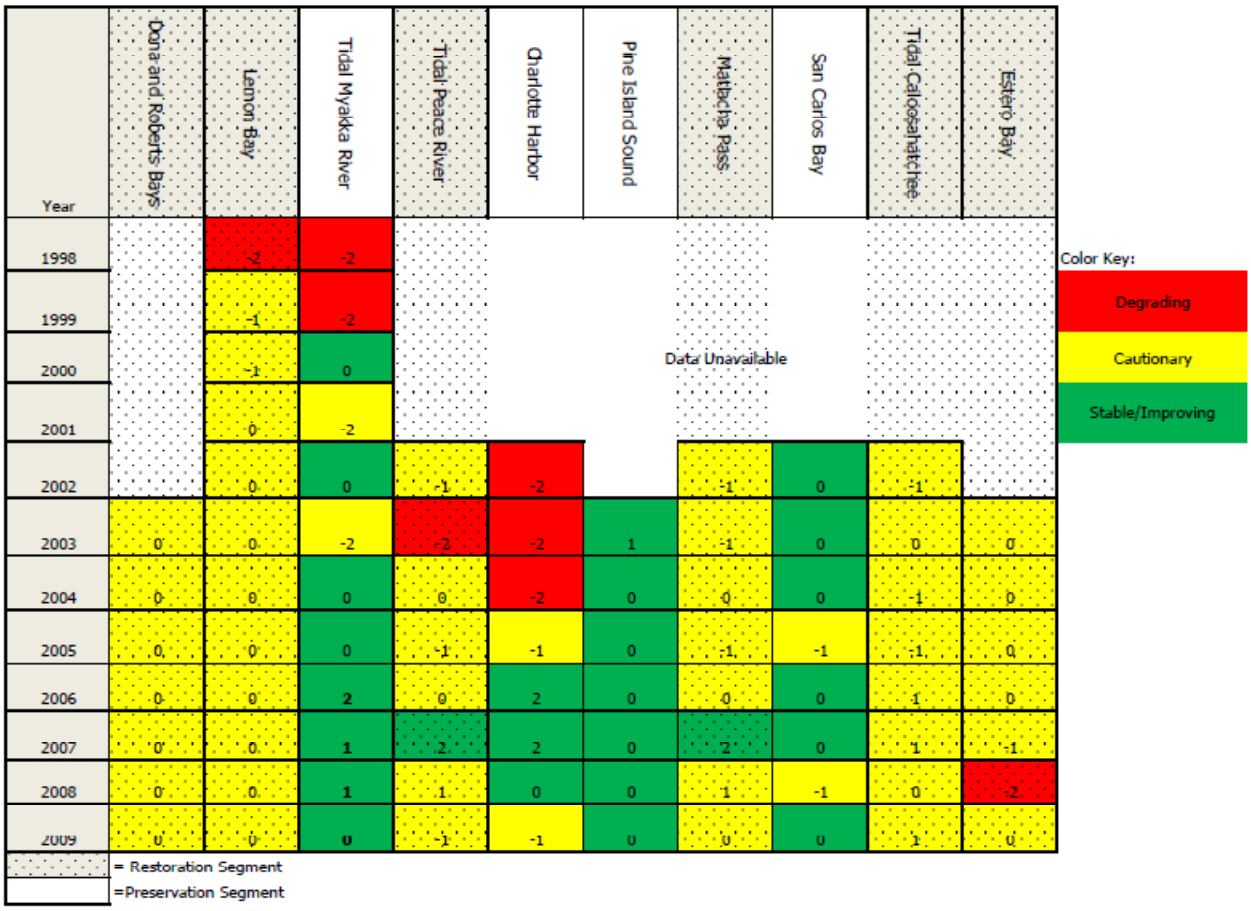

Figure 3. Final water clarity reporting tool format with updated scores through 2009.

As described in the Task 3 report, the measurement of light attenuation in the field is an area of ongoing research in the CHNEP estuarine waters. Therefore, it is recommended that in 2012, the scoring method be re-assessed to ensure that the benchmark period remains relevant to the expected ambient water quality conditions in each Harbor segment. The grading system should also be evaluated at this time to determine the sensitivity of the benchmark points relative to changes in water clarity and seagrass conditions.