Tampa Bay Estuary Program
Technical Publication #

Technical Memorandum

Tracking Chlorophyll-*a* and Light Attenuation in Tampa Bay: Application to 2006 Data

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Water quality targets have been adopted by the Tampa Bay Estuary Program Management and Policy Committees for the four mainstem segments of Tampa Bay. The Tampa Bay Estuary Program has developed a tracking process to determine if water quality targets are being achieved (Janicki et al., 2000). The process to track the status of chlorophyll-*a* concentration and light attenuation involves two steps. The first step utilizes a decision framework to evaluate differences in mean annual ambient conditions from the established targets. The second step incorporates the results of the decision framework into a decision matrix leading to possible outcomes dependent upon the magnitude and duration of the events in excess of the target (Janicki et al., 2000). The objective of this technical memorandum is to compare the annual mean ambient chlorophyll-*a* concentration and light attenuation for 2006 to the segment-specific targets using the tracking process.

The tracking process is used a) to determine if there are differences between ambient conditions and targets, and b) to determine the size of the differences and how long the conditions exist. The first step of the tracking process is presented in Figure 1. When mean ambient chlorophyll-*a* concentrations are less than the target, there is no cause for concern, as represented by Outcome 0 in Figure 1. When mean ambient chlorophyll-*a* concentrations are greater than target values, however, the size of the difference and the duration of the difference are considered. Small differences for short time periods result in Outcome 1, while large differences for short time periods and small differences for long time periods result in Outcome 2. In the most severe condition, when large differences exist for long periods, the framework results in Outcome 3.

The second step of the tracking process involves combining the outputs from the decision frameworks for chlorophyll-*a* concentration and light attenuation in a decision matrix to provide direction for management responses when targets are exceeded. The decision framework shown in Figure 1 for chlorophyll-*a* concentration is the same as that for light attenuation.

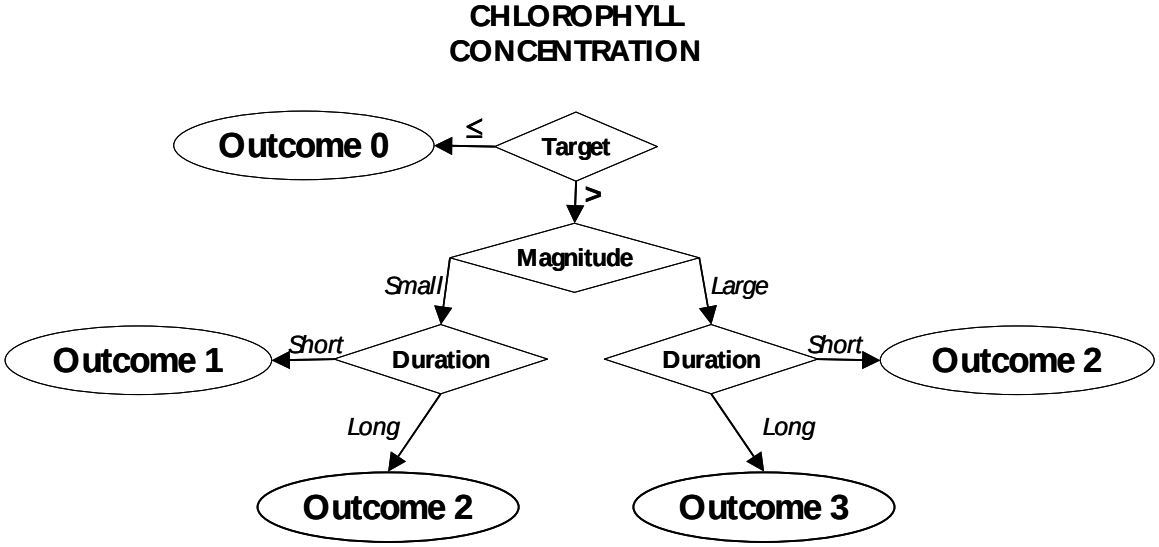

Figure 1. Monitoring and assessment decision framework for chlorophyll-a (from Janicki et al. 2000).

The decision matrix incorporating the outcomes for chlorophyll-*a* concentration and light attenuation is shown in Table 1. When outcomes for both chlorophyll-*a* concentration and light attenuation are good, as represented by Outcome 0 for both, a condition exists in which targets are being met, and so no management response is required. This condition is signified by the green cell in Table 1.

When conditions are intermediate, as signified by the yellow cells in Table 1, differences from the targets exist for either or both chlorophyll-*a* concentration and light attenuation. These conditions may result in some type of management response.

When conditions are problematic, such that the outcomes for the parameters fall within the red cells of Table 1, stronger management responses may be warranted. The types of management actions resulting from the decision matrix are classified by color into three categories, shown following Table 1.

Table 1. Decision matrix identifying appropriate categories of management actions in response to various outcomes of the monitoring and assessment of chlorophyll-*a* and light attenuation data.				
CHLOROPHYLL	LIGHT ATTENUATION			
↓	Outcome 0	Outcome 1	Outcome 2	Outcome 3
Outcome 0	*GREEN*	*YELLOW*	*YELLOW*	*YELLOW*
Outcome 1	*YELLOW*	*YELLOW*	*YELLOW*	*RED*
Outcome 2	*YELLOW*	*YELLOW*	*RED*	*RED*
Outcome 3	*YELLOW*	*RED*	*RED*	*RED*

- **GREEN** "Stay the course"; partners continue with planned projects to implement the CCMP. Data summary and reporting via the Baywide Environmental Monitoring Report and annual assessment and progress reports.

- **YELLOW** TAC and Management Board on caution alert; review monitoring data and loading estimates; attempt to identify causes of target exceedences; TAC report to Management Board on findings and recommended responses if needed.

- **RED** TAC, Management and Policy Boards on alert; review and report by TAC to Management Board on recommended types of responses. Management and Policy Boards take appropriate actions to get the program back on track.

2006 Data

The time series of annual chlorophyll-*a* concentrations and light attenuation for 1974-2006 in Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay are shown in Figures 2 through 9. The mean ambient chlorophyll-*a* concentration and light attenuation for 2006 for each segment are shown in Table 2, along with the segment-specific targets.

Table 2. Mean ambient chlorophyll-*a* concentrations and light attenuation for 2006.				
Bay Segment	Chlorophyll-*a* (µg/L)		Light Attenuation (m^{-1})	
	2006	Target	2006	Target
Old Tampa Bay	6.3	8.5	0.62	0.83
Hillsborough Bay	10.9	13.2	0.83	1.58
Middle Tampa Bay	5.1	7.4	0.47	0.83
Lower Tampa Bay	3.6	4.6	0.49	0.63

Mean annual chlorophyll-*a* concentrations from the Environmental Protection Commission Surface Water Monitoring Program for 2006 are shown in Figure 10. During 2006, chlorophyll-*a* concentrations in Old Tampa Bay were much closer to the target concentration of 8.5 µg/L, with the highest concentration of 11 µg/L just south of the Bayside Bridge. Concentrations near the Bayside Bridge in 2005 were 17.9 µg/L. In Hillsborough Bay chlorophyll *a* concentrations were slightly higher on the eastern side and slight lower on the western side as compared to 2005 values. In Middle Tampa Bay there were overall decreases in chlorophyll *a* concentrations at most stations. In Lower Tampa Bay the biggest changes from 2005 data were lower concentrations in Lower Tampa Bay, with concentrations at or above 8 µg/L in 2005 and 2006 concentrations at or below 4 µg/L.

Applying the decision frameworks for chlorophyll-*a* concentration and light attenuation as shown in Figure 1, the outcomes for the 2006 data were:

Bay Segment	Chlorophyll-a Concentration	Light Attenuation
Old Tampa Bay	0	0
Hillsborough Bay	0	0
Middle Tampa Bay	0	0
Lower Tampa Bay	0	0

Placing these outcomes in the decision matrix shown in Table 1 leads to the following results:

Old Tampa Bay:	**Green**
Hillsborough Bay:	**Green**
Middle Tampa Bay:	**Green**
Lower Tampa Bay:	**Green**

For the second year Old Tampa Bay had an outcome of "Green" as shown in Figures 2 and 6. Light attenuation in Hillsborough Bay stayed below target levels (Figure 7) and chlorophyll-*a* concentration remained below target levels (Figure 3) resulting in an outcome of "Green." Changes from 2005 were found in Middle and Lower Tampa Bay with both chlorophyll-a concentration below the target (Figure 4 and Figure 5) and light attenuation below target (Figure 8 and Figure 9), resulting in an outcome of "Green."

To place the 2006 decision matrix results in perspective with results from previous years, the decision matrix results for 1975-2006 are shown below in Table 3.

Table 3. Decision matrix results.

Year	Old Tampa Bay	Hillsborough Bay	Middle Tampa Bay	Lower Tampa Bay
1975	Red	Red	Red	Green
1976	Red	Red	Red	Yellow
1977	Red	Red	Red	Red
1978	Red	Red	Red	Yellow
1979	Red	Red	Red	Red
1980	Red	Red	Red	Red
1981	Red	Red	Red	Red
1982	Red	Red	Red	Red
1983	Red	Yellow	Red	Red
1984	Red	Green	Red	Yellow
1985	Red	Red	Red	Yellow

1986	Red	Yellow	Red	Green
1987	Red	Yellow	Red	Green
1988	Yellow	Green	Yellow	Green
1989	Red	Yellow	Red	Yellow
1990	Red	Green	Red	Yellow
1991	Green	Yellow	Yellow	Yellow
1992	Yellow	Green	Yellow	Yellow
1993	Yellow	Green	Yellow	Yellow
1994	Yellow	Yellow	Red	Red
1995	Red	Yellow	Red	Yellow
1996	Yellow	Green	Yellow	Green
1997	Yellow	Green	Red	Yellow
1998	Red	Red	Red	Red
1999	Yellow	Green	Yellow	Yellow
2000	Green	Green	Yellow	Yellow
2001	Yellow	Green	Yellow	Yellow
2002	Yellow	Green	Green	Green
2003	Red	Yellow	Green	Yellow
2004	Red	Green	Green	Yellow
2005	Green	Green	Yellow	Yellow
2006	Green	Green	Green	Green

In conclusion, 2006 water quality in Tampa Bay based on the decision matrix showed an improvement from the 2005 outcome. Old Tampa Bay maintained "Green" status for the second year. Hillsborough Bay had a status of "Green" for the third consecutive year. Middle and Lower Tampa Bay both moved from "Yellow" to "Green" status.

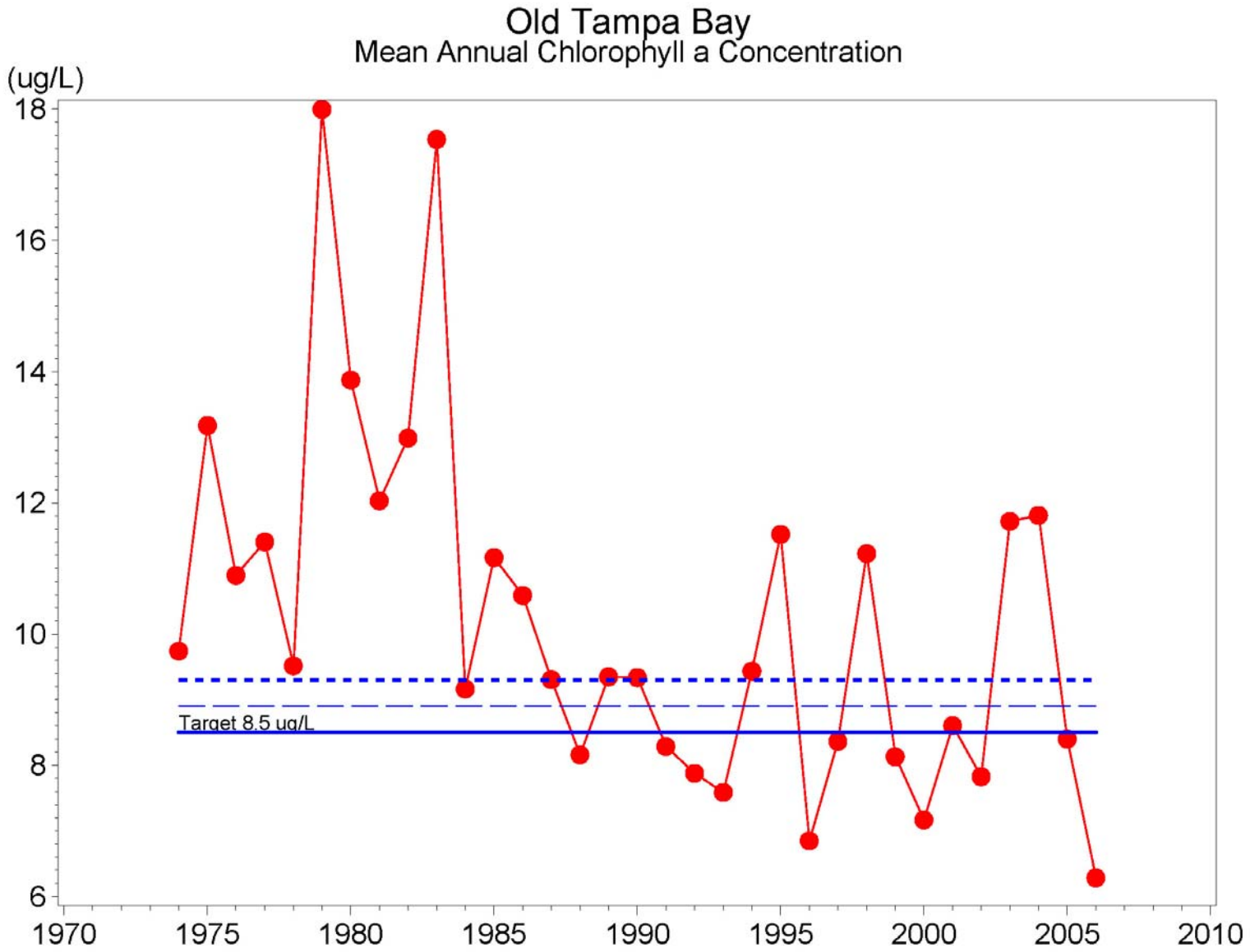

Figure 2. Old Tampa Bay mean annual chlorophyll-*a* concentrations, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

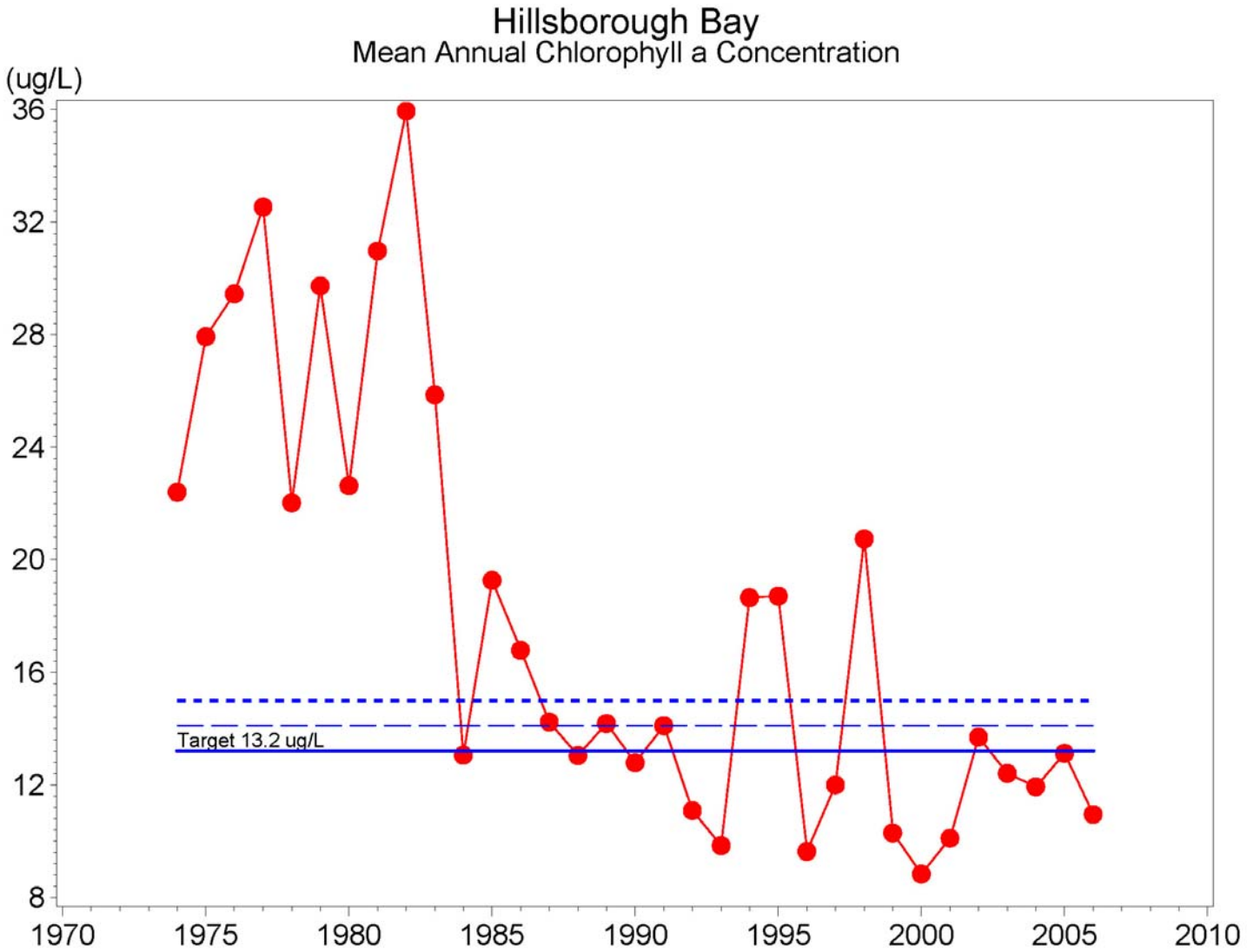

Figure 3. Hillsborough Bay mean annual chlorophyll-*a* concentrations, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line). Data from EPCHC Station 8 for September 2002 are included.

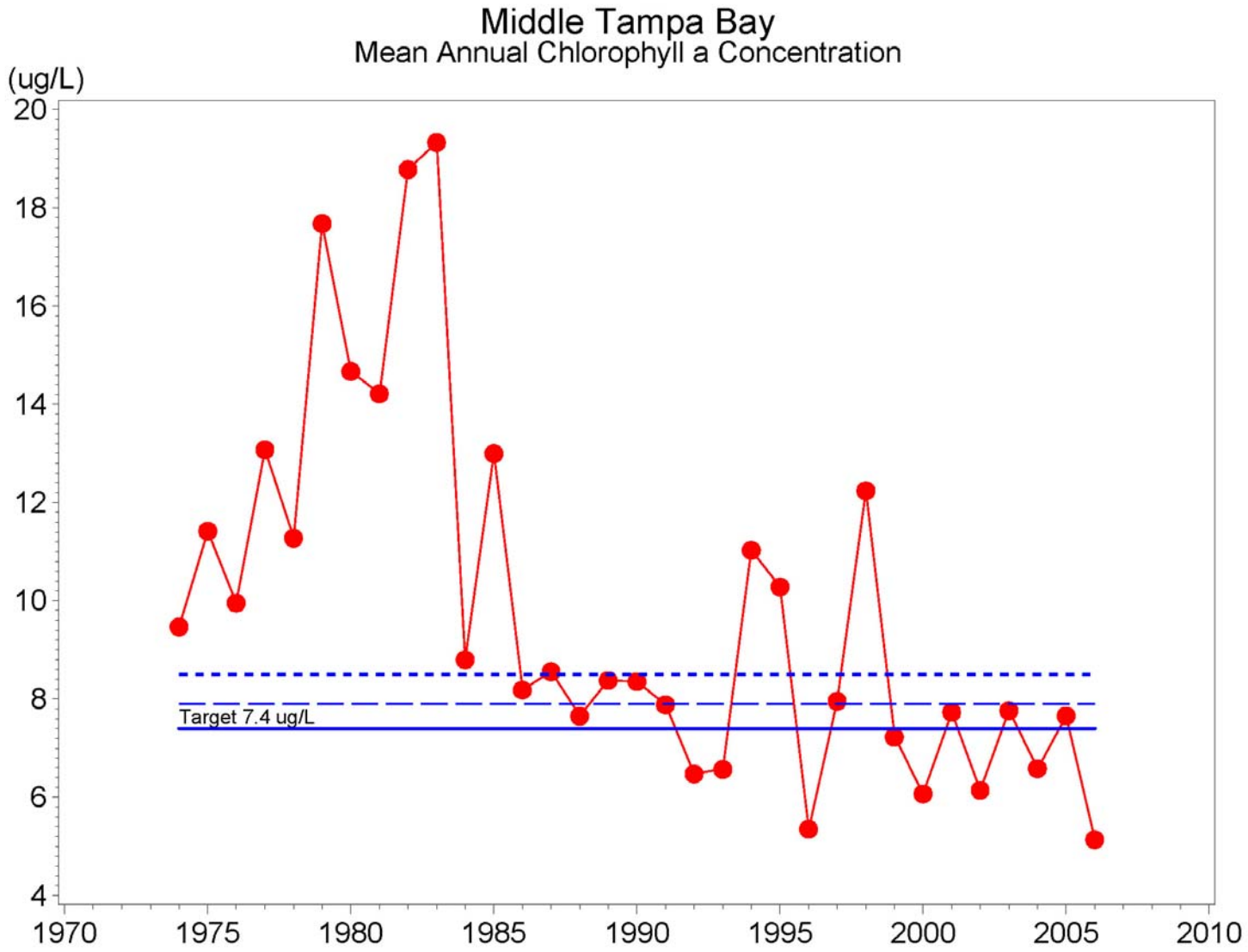

Figure 4. Middle Tampa Bay mean annual chlorophyll-*a* concentrations, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

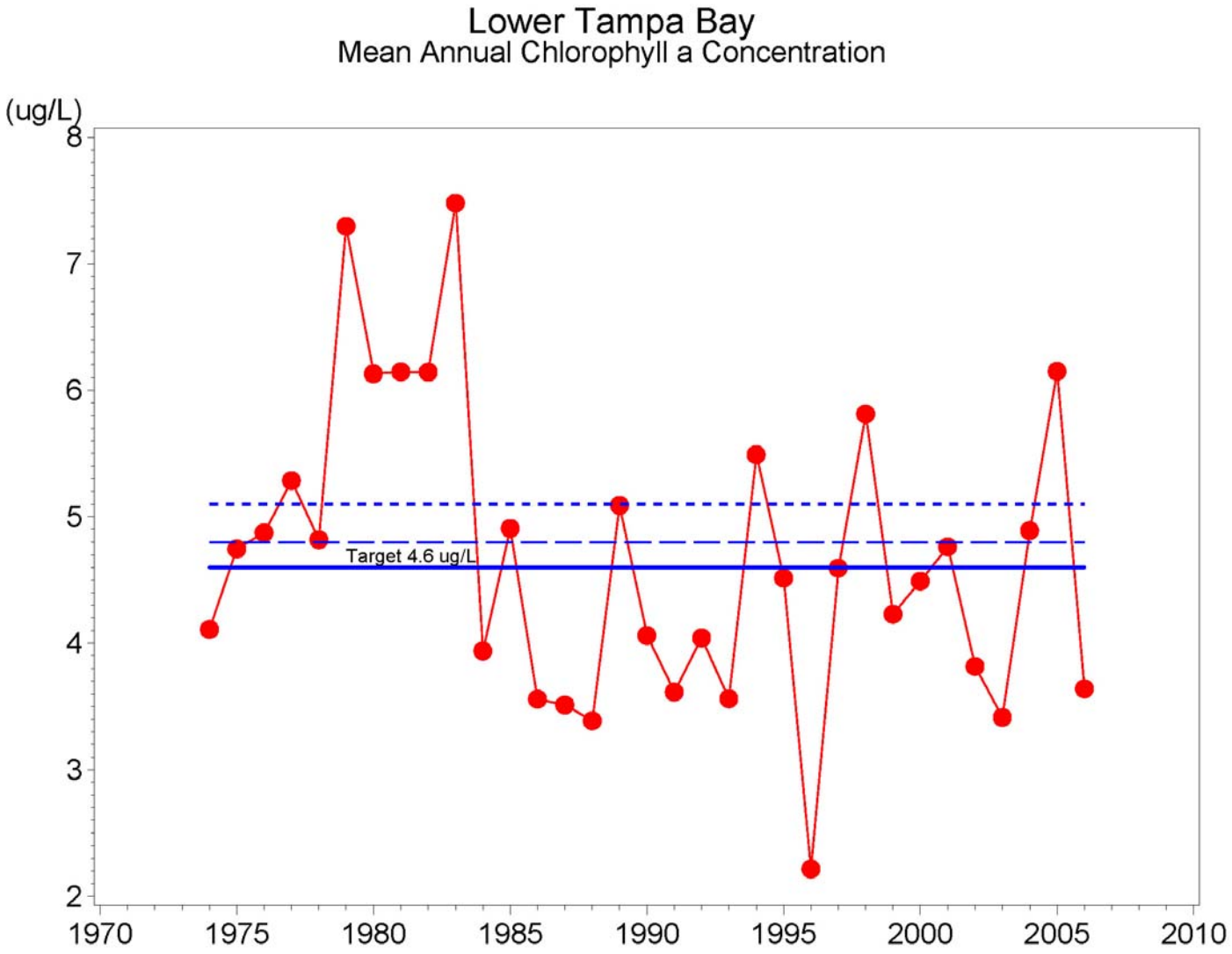

Figure 5. Lower Tampa Bay mean annual chlorophyll-*a* concentrations, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

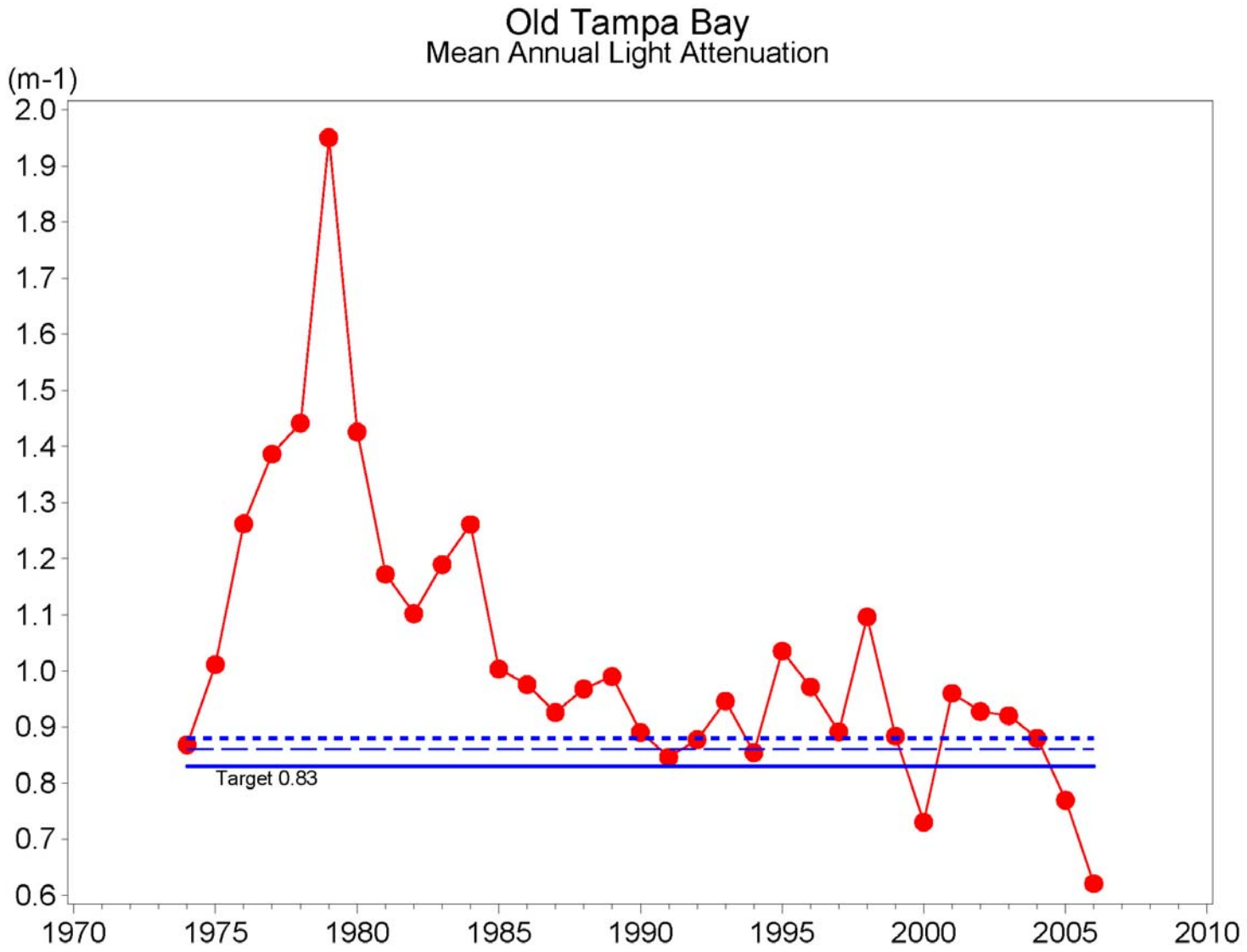

Figure 6. Old Tampa Bay mean annual light attenuation, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

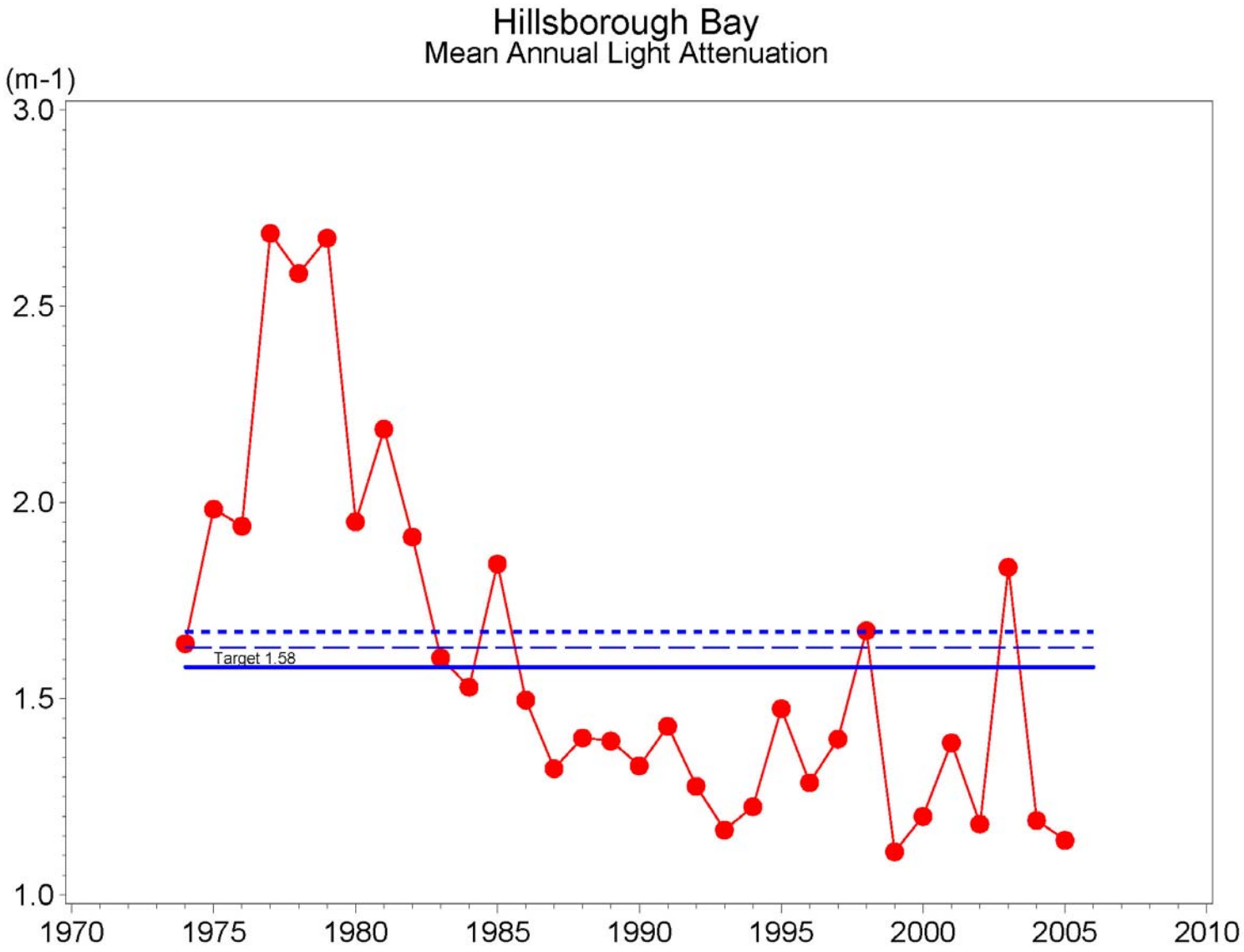

Figure 7. Hillsborough Bay mean annual light attenuation, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

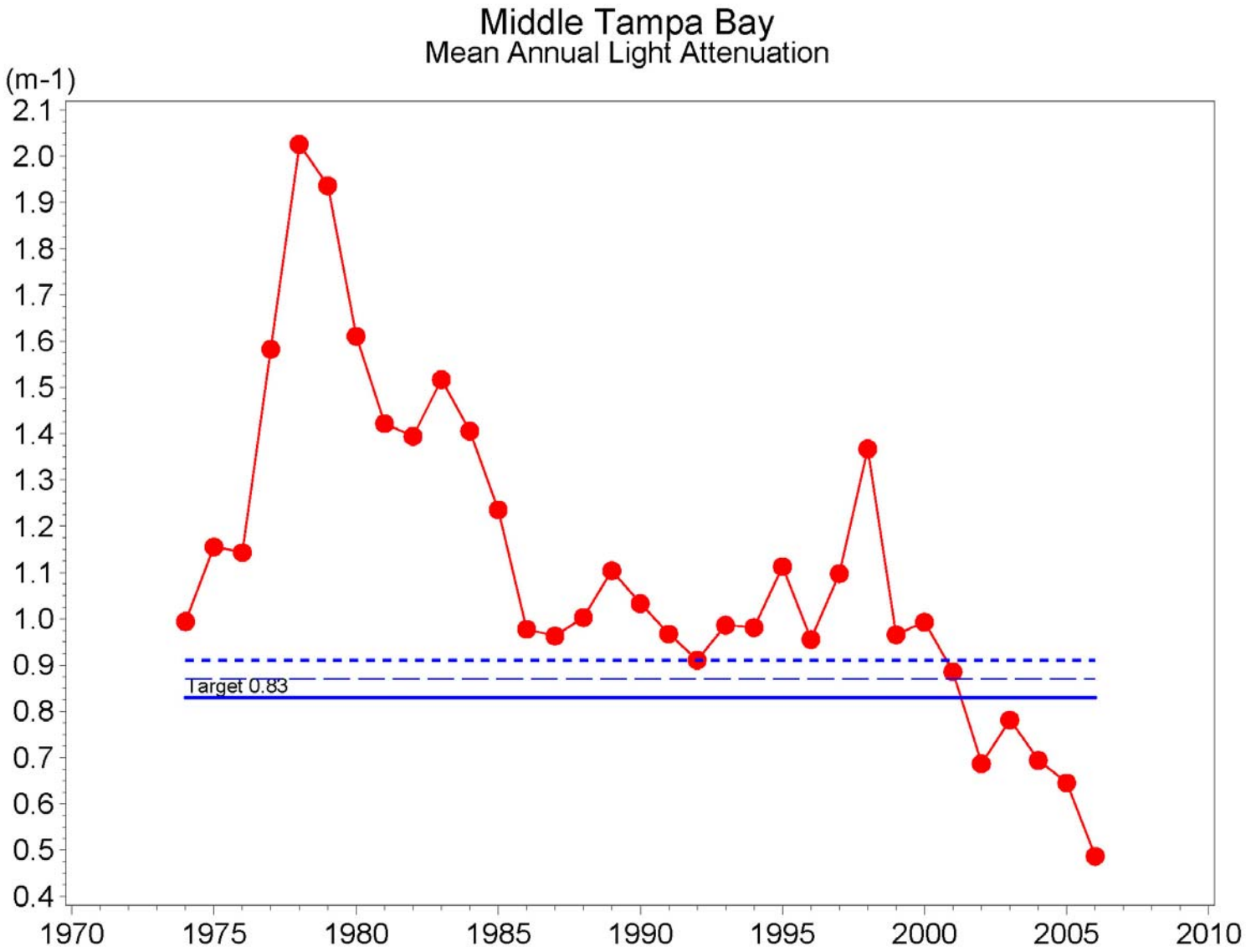

Figure 8. Middle Tampa Bay mean annual light attenuation, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

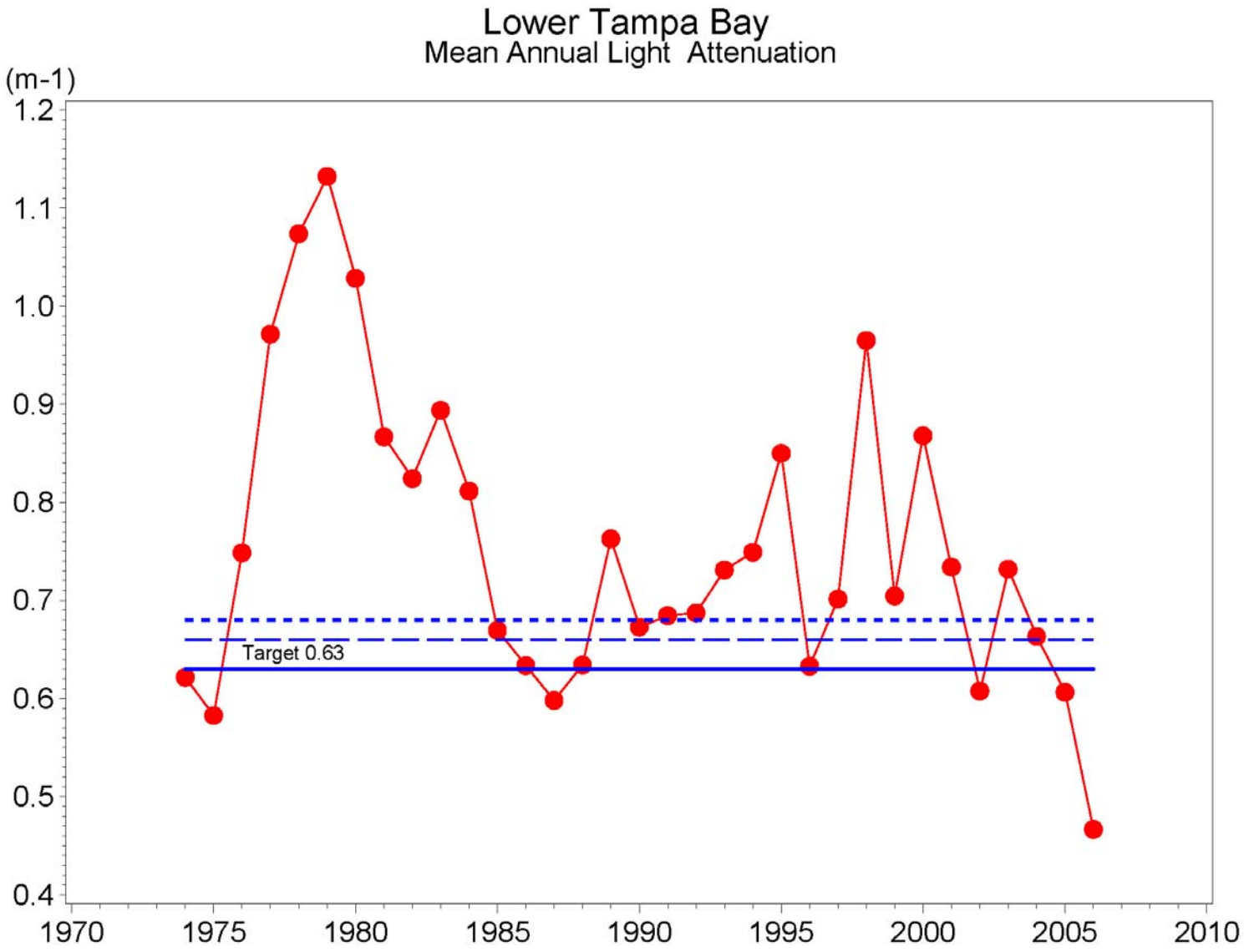

Figure 9. Lower Tampa Bay mean annual light attenuation, with target (solid line), small magnitude difference threshold (long dashed line), and large magnitude difference threshold (short dashed line).

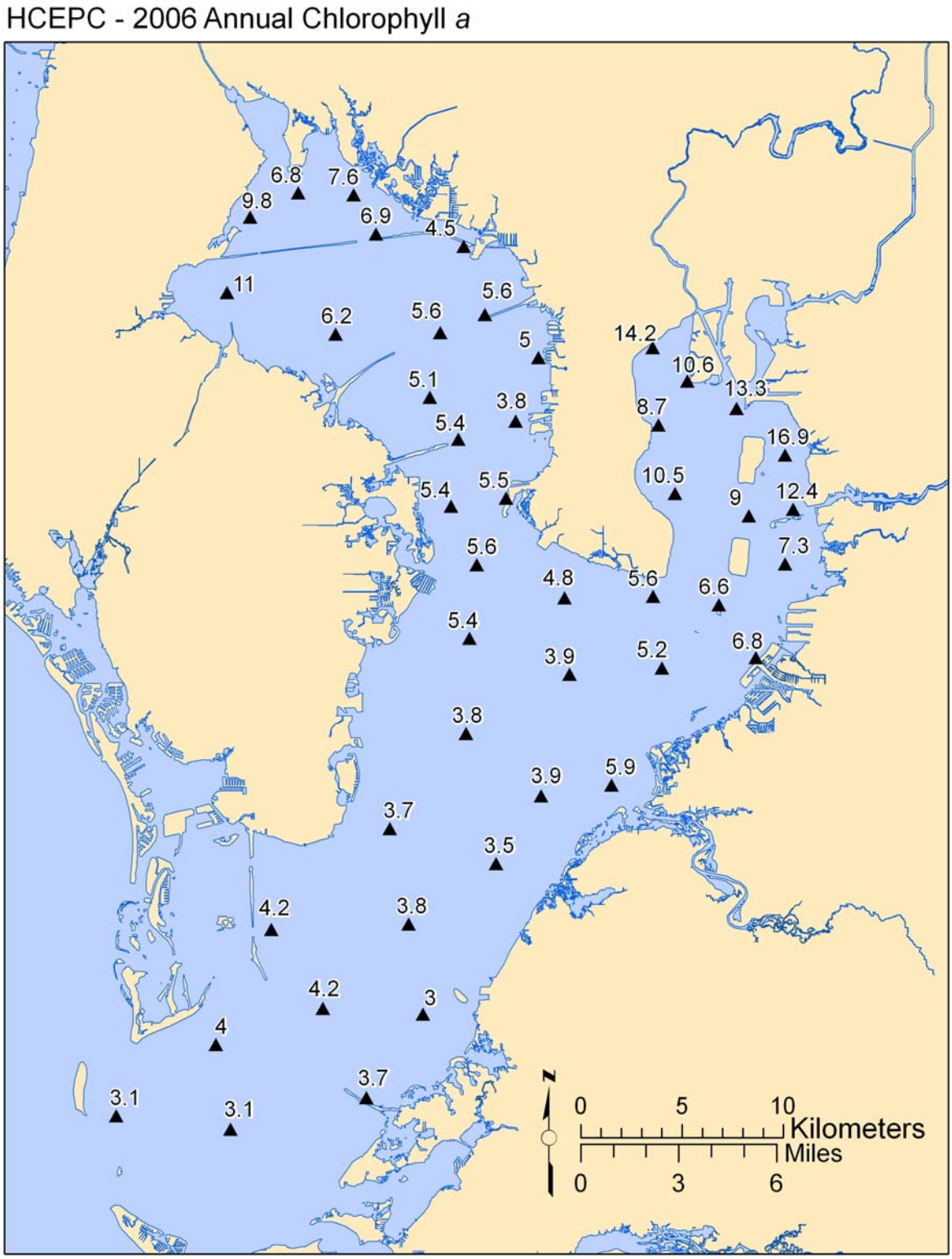

Figure10. Mean annual chlorophyll-a values for 2006 from the Environmental Protection Commission of Hillsborough County.

References

Janicki, A.J., D. Wade, and J.R. Pribble. 2000. Establishing a process for tracking chlorophyll-*a* concentrations and light attenuation in Tampa Bay. Prepared for: Tampa Bay Estuary Program. Prepared by: Janicki Environmental, Inc.

Acknowledgements

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