PART 2

LM3-EUTRO

Chapter 6. Model Confirmation

The most common approach to model confirmation is the comparison of the model output to an independent field data set. Ideally, this independent field data set describes a different year or years than the calibration field data. We did not have the luxury of access to a second field data set as thorough as the 1994-1995 Lake Michigan Mass Balance Project (LMMBP) data used in model calibration. However, limited total phosphorus field data were available. In addition, we were able to compare LM3-Eutro to the historical MICH1 model, which was calibrated and applied in the 1970s and 1980s (Rodgers and Salisbury, 1981a,b) and recently extended to predict more recent chlorophyll and phosphorus concentrations in Lake Michigan (Pauer *et al.*, Submitted).

2.6.1 Additional Field Data

Limited Great Lakes National Program Office (GLNPO) monitoring data were available for comparison to model predictions. GLNPO data were collected on an annual basis for the purpose of monitoring long-term trends in the Great Lakes (Barbiero *et al.*, 2002). Samples were collected from a set of stations that formed a north-south transect through Lake Michigan (Barbiero *et al.*, 2002). Green Bay was not sampled as part of this lake monitoring effort. Samples were taken from discrete depths throughout the water column (Barbiero *et al.*, 2002). Data from the entire water column were averaged to produce 1998 spring total phosphorus and 1998 summer total phosphorus lake-wide values. The 1998 spring and summer chlorophyll *a* data were averaged to provide seasonal epilimnion (0-20 m in depth) chlorophyll *a* values.

2.6.2 MICH1 Model

The Lake Michigan eutrophication model (MICH1) was developed as part of the International Joint Commission's (IJC) Great Lakes International Surveillance Plan. The framework was constructed by Rodgers and Salisbury (1981a, b) based on the Great Lakes model LAKE1 which was originally developed and tested for Lake Ontario (Thomann *et al.*, 1975). It is a four-segment model, simulating two zooplankton classes, a single phytoplankton class (as chlorophyll), and several nutrient species. However, it does not have a sediment component and the segmentation excludes Green Bay. MICH1 was calibrated using field data from the Lake Michigan intensive survey of 1976-1977 (Rockwell *et al.*, 1980). This model was recently resurrected and extended to run from 1976 through 1995 and compared to the LMMBP field data. Changes were also made to the MICH1 model by reducing the detrital settling rate by 20%, which results in a better model fit with the LMMBP field data (Pauer *et al.*, Submitted).

2.6.3 Comparison of LM3-Eutro to the MICH1 Model and Field Data

In order to compare LM3-Eutro to the historical MICH1 model, some modifications and qualifications were necessary. The 1994 and 1995 loads were repeated for the period 1996-2000 in both models. However, the total phosphorus loads were averaged for MICH1, while the loads were alternated in LM3-

Eutro. Although the two approaches did not result in any significant long-term differences, we observed short-term differences. Because the two models used very different segmentation schemes, all comparisons were made on a lake-wide basis, excluding Green Bay. LM3-Eutro algal carbon was converted to chlorophyll *a* using a 40:1 carbon-to-chlorophyll *a* ratio. All MICH1 simulations started in 1976 and ran through 2000, while LM3-Eutro was only simulated from 1994 to 2000.

The results are shown in Figure 2.6.1. In general, the two models compared reasonably well, which was remarkable because the models are very different in structure. MICH1 total phosphorus output was lower than that of LM3-Eutro and the 1994-1995, 1998, and 2000 field data. The revised MICH1 (20% reduced settling rate) compared more favorably with the field data and LM3-Eutro.

The epilimnetic chlorophyll *a* concentration also compared reasonably well between the models, although LM3-Eutro predictions were higher than both MICH1 predictions. The lower MICH1 output values (as compared to LM3-Eutro) were probably due to the absence of a sediment phosphorus recycle mechanism. It was difficult to compare the model versus field data for the chlorophyll due to the steep peaks and large seasonal variation in the chlorophyll *a* data.

The overall strength of the comparison between the models and the model fit with limited 1998 and 2000 field data built confidence in the LM3-Eutro framework and confirmed that the model was able to represent the eutrophication state variables in Lake Michigan.

References

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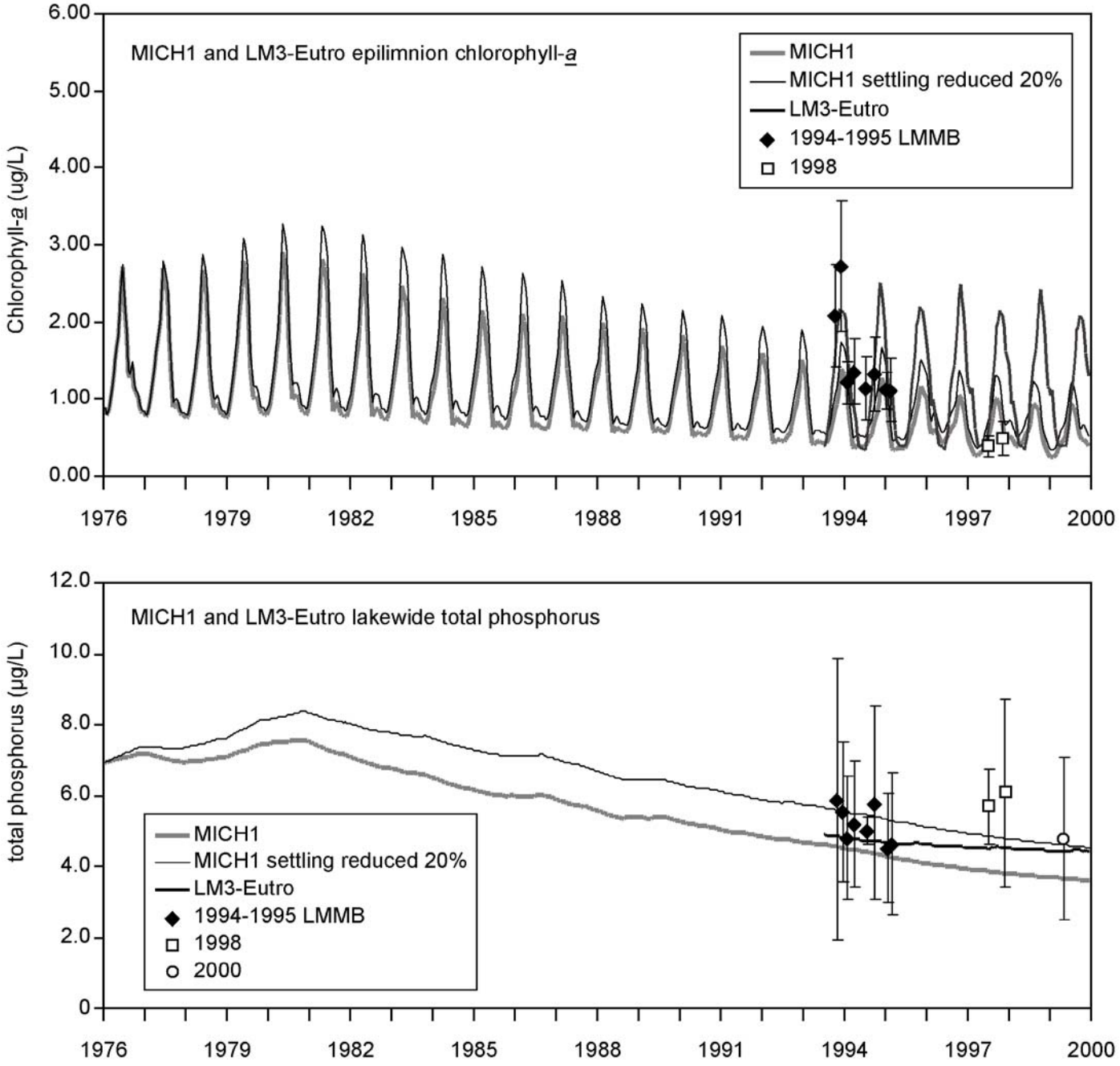

Figure 2.6.1. MICH1 versus LM3-Eutro model predictions and available field data.