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ENVS 691 Laboratory Exercise No. 3

End-Member Mixing Analysis

End-member mixing analysis was performed on chemical constituents obtained from samples taken from Virginia Department of Environmental Quality monitoring stations in the tidal portion of the James River. The station at the mouth of the James River (Mile 0) was selected as the marine end member and the station near the Fall Line at the Route 360 bridge in Richmond (Mile 110) was selected as the river end member. A range of years and constituents were available for analysis. This exercise focused on chlorophyll *a*, total dissolved nitrogen, and total dissolved phosphorus in 12 monthly samples obtained in 2002.

Some of the data are incomplete: the Feb. 19 sample is missing a chlorophyll *a* observation from Buoy 166 (Mile 104), the Apr. 16 sample is missing chlorophyll a observations from buoys 91 through 166 (miles 69 through 104), and the Dec. 12 sample is missing all observations from the mouth of the James River (Mile 0). Most of the samples did not affect the computations of the analysis, but the Dec. 12 analysis required the use of data from Buoy 9 (Mile 6) as the marine end member. The only sample seriously affected by the missing data was the Apr. 16 sample.

This exercise assumes that chlorophyll *a* is a proxy measure for phytoplankton populations. Given the role that phytoplankton demand for nitrogen and phosphorus may be driven by biological demand, chlorophyll *a* concentrations are plotted along with both nitrogen and phosphorus concentrations. Total dissolved nitrogen results are plotted in Figure 1. Total dissolved phosphorus results are plotted in Figure 2.

Despite the busyness of both figures, the results show that none of the constituents are conservatively mixed. There appears to be a strong seasonal effect in chlorophyll *a* concentrations, with highest values in the period from June to September. Bukaveckas et al.,

(2011) reported a similar seasonal pattern. Geographically, the peak in chlorophyll *a* is near buoys 91 and 107 (miles 69 and 75), where the basin morphology of the James begins to change from a relatively narrow, deep channel to one where the channel, while still relatively deep, is flanked by extensive shallow areas toward either bank. This facilitates greater average penetration of sunlight into the water column and fuels extensive phytoplankton production (Bukaveckas, et al., 2011).

Bukaveckas et al., (2011) report that nitrogen and phosphorus concentrations tend to be lower in the vicinity of the chlorophyll *a* maximum. The 2002 data presented here seem to better support the notion that the concentrations of both nutrients show a rapid decrease in the vicinity of the chlorophyll *a* maximum, but that seasonal—and arguably annual—variability affects the pattern.

REFERENCES

Bukaveckas, P., Barry, L., Beckwith, M., David, V., & Lederer, B. (2011). Factors Determining the Location of the Chlorophyll Maximum and the Fate of Algal Production within the Tidal Freshwater James River. *Estuaries and Coasts, 34*(3), 569-582. doi: 10.1007/s12237-010-9372-4

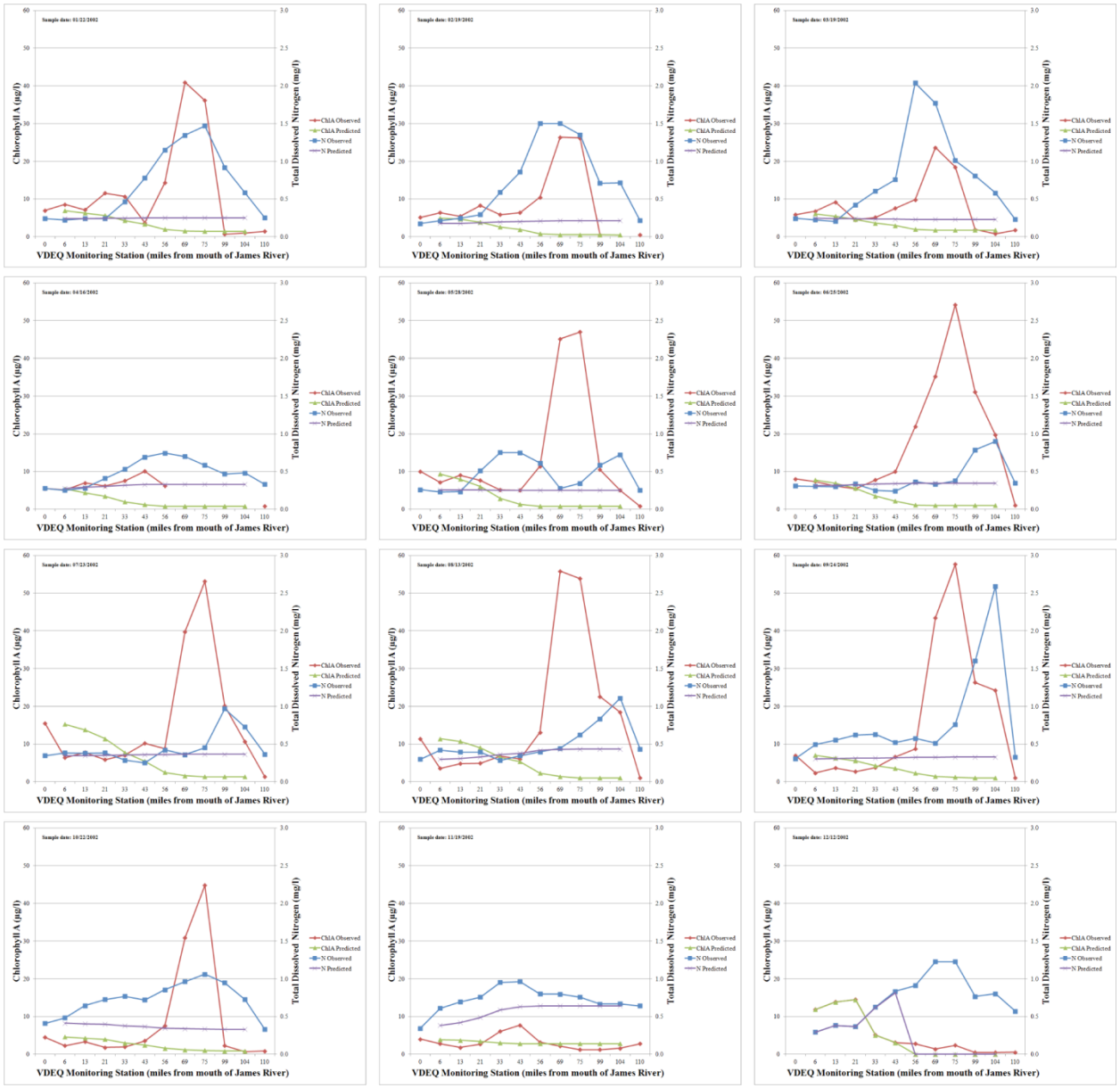

Figure 1. Results of end-member mixing analyses of chlorophyll a (µg l^{-1}) and total dissolved nitrogen (mg l^{-1}) in 12 monthly water samples from a transect along the James River in 2002.

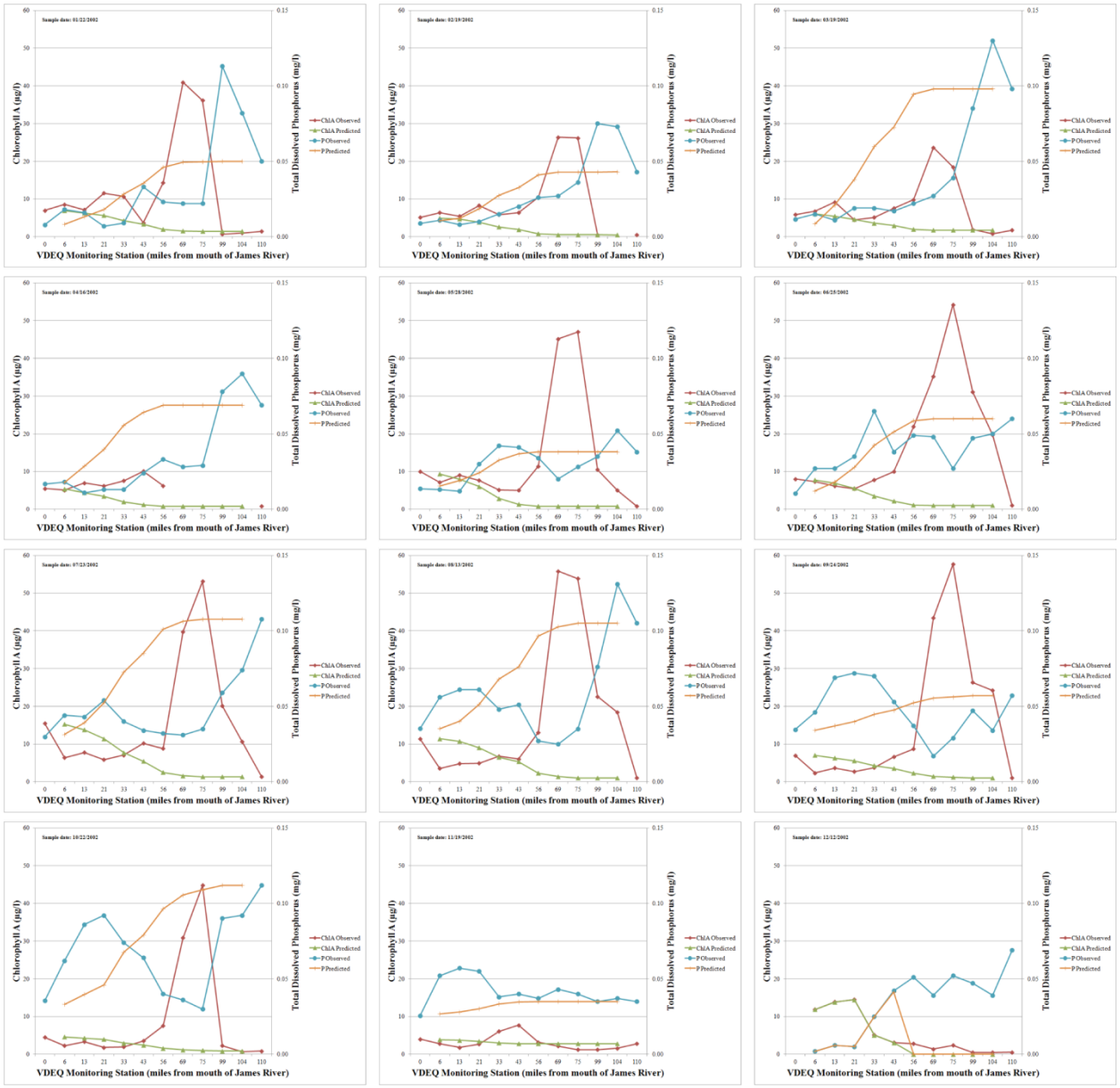

Figure 2. Results of end-member mixing analyses of chlorophyll a (µg l^{-1}) and total dissolved phosphorus (mg l^{-1}) in 12 monthly water samples from a transect along the James River in 2002.