CREATING A BENCHMARK FOR HYPOXIA RESTORATION USING A NEURAL NETWORK MODEL FOR CHESAPEAKE BAY

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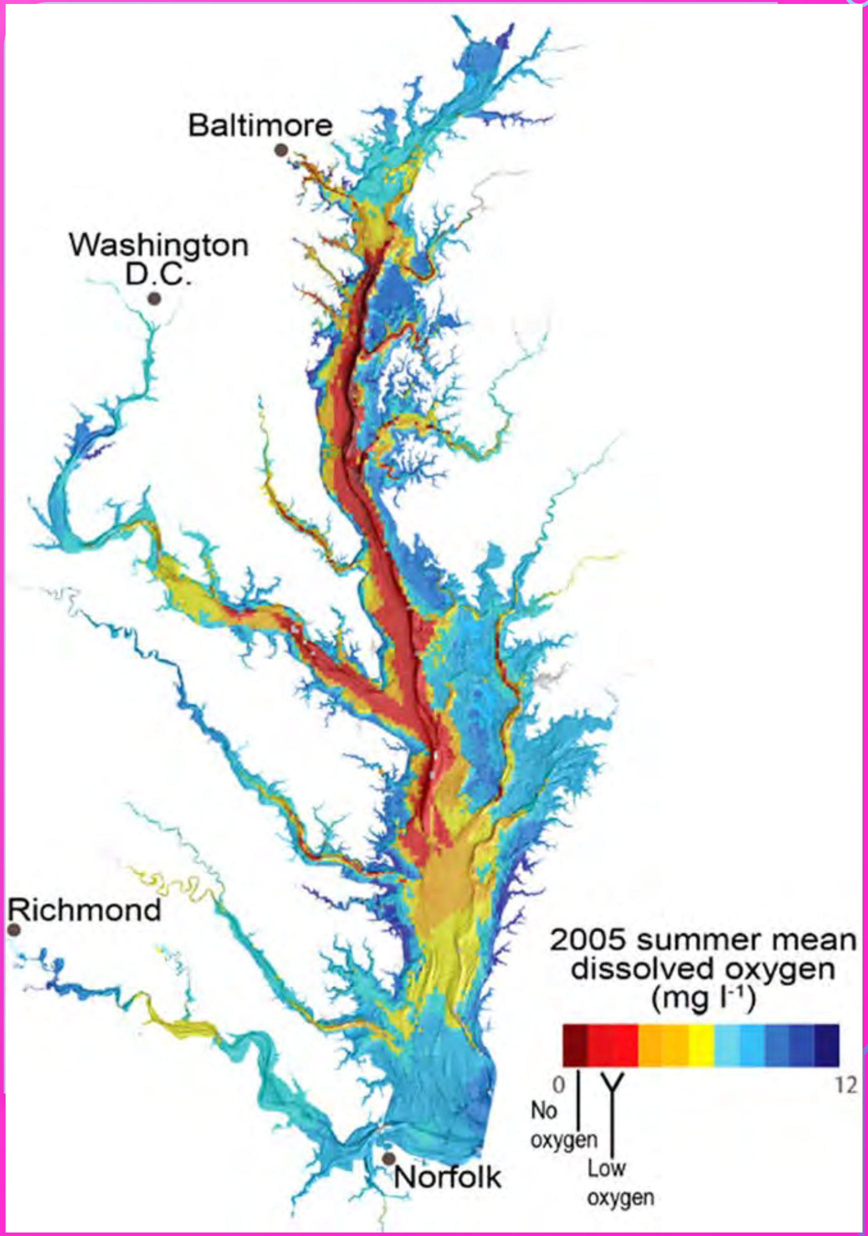
INTRODUCTION

. Numerous reports and studies have documented both spatial and temporal expansions of hypoxic conditions within coastal habitats worldwide over the last several decades (Bricker et al, 1999; Diaz and Rosenberg 1995; 2008).

Much of the recent ecosystem based management has focused on the use of models as a decision and policy making tools, including predictions of hypoxia.

Several models ranging from simple linear regression to complex three-dimensional process based have been applied to the Chesapeake Bay in order to predict near-future summertime hypoxic/anoxic volume or future conditions based on nutrient load reductions. Although progress has been made in modeling oxygen dynamics and short-term predictions, there is still a lack of long-term forecasts that incorporate multiple inputs including climatological effects such as El Niño-Southern Oscillation (ENSO) events.



METHODS

Long-term monitoring Chesapeake Bay Stations for DO, from 1985-2010. Map annual Hypoxic volume (< 2 mg/L)

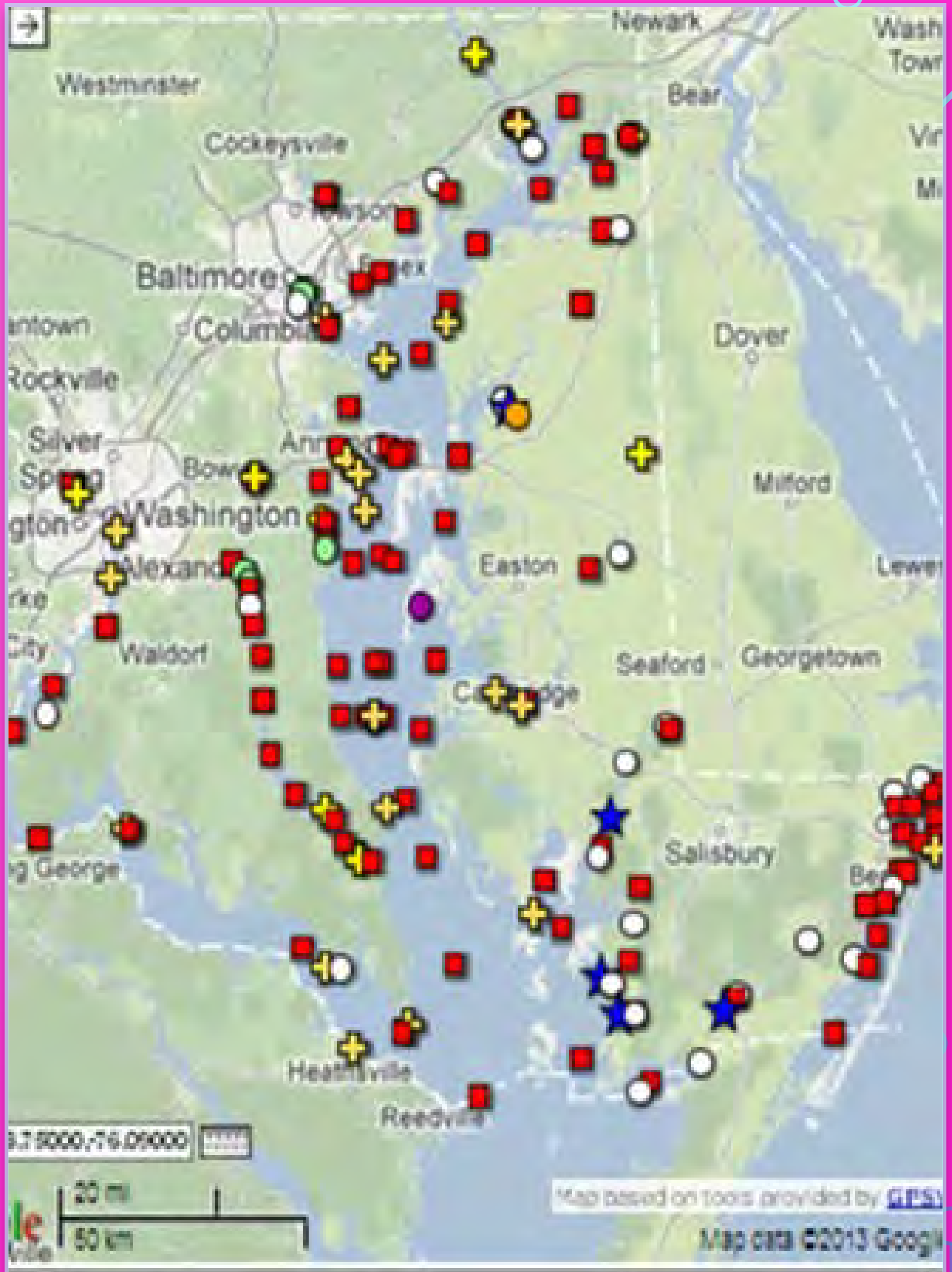
Create annual hypoxic volume index and annual (Jan-May) Susquehanna River Index (deviations from 26 year mean).

Annual Oni and NAO indexes

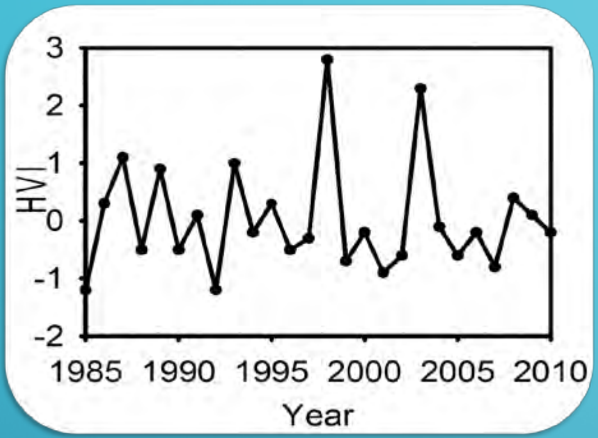
Cross Bay winds (Feb-April) from Pax. River Station

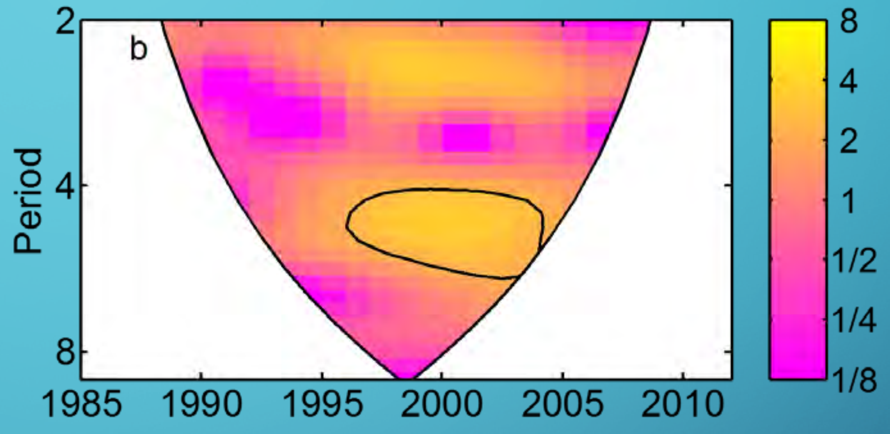
Wavelet and cross-wavelet coherence

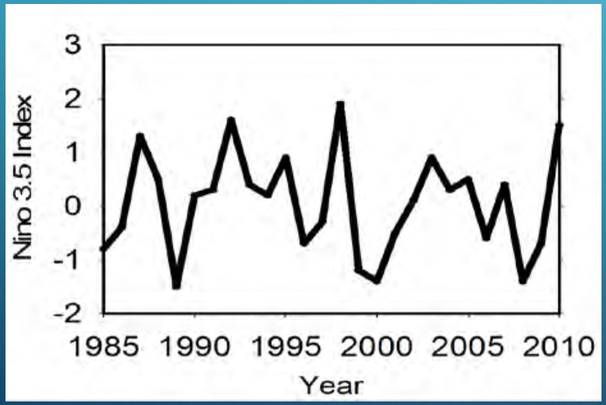
Feed forward dynamic (NARX) Neural Network model

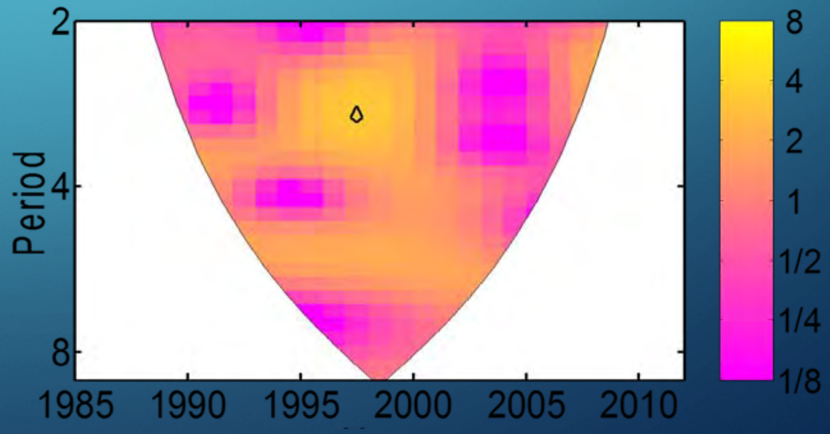


WAVELET ANALYSIS

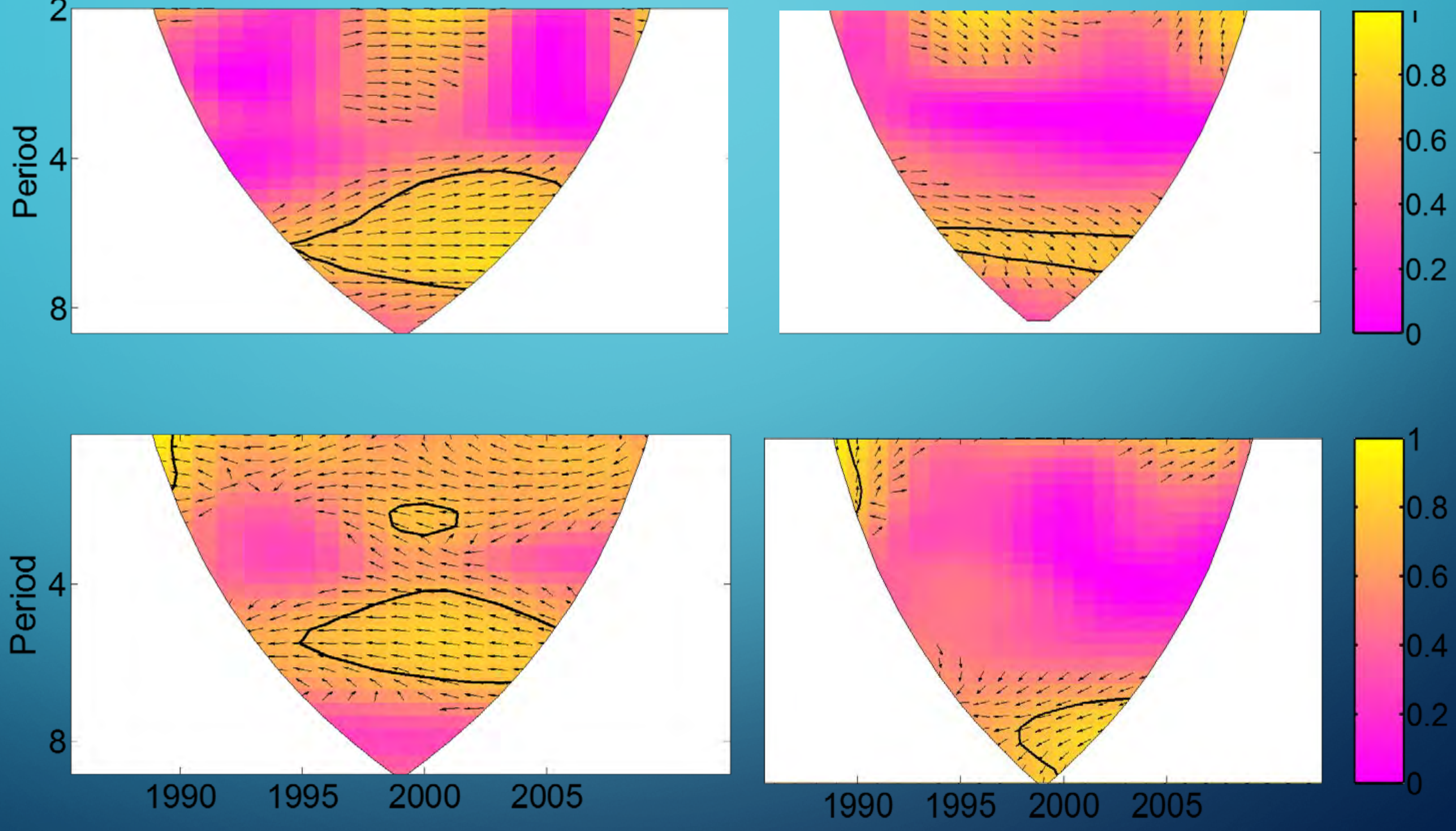






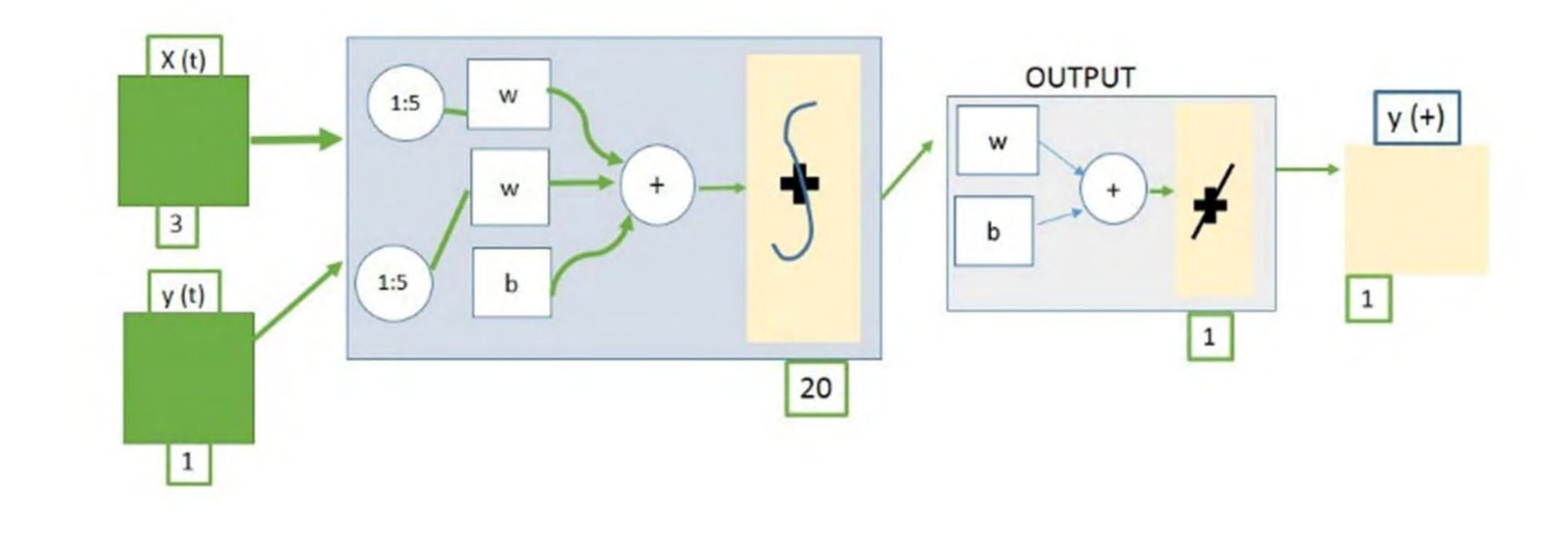


CROSS-WAVELET COHERENCE

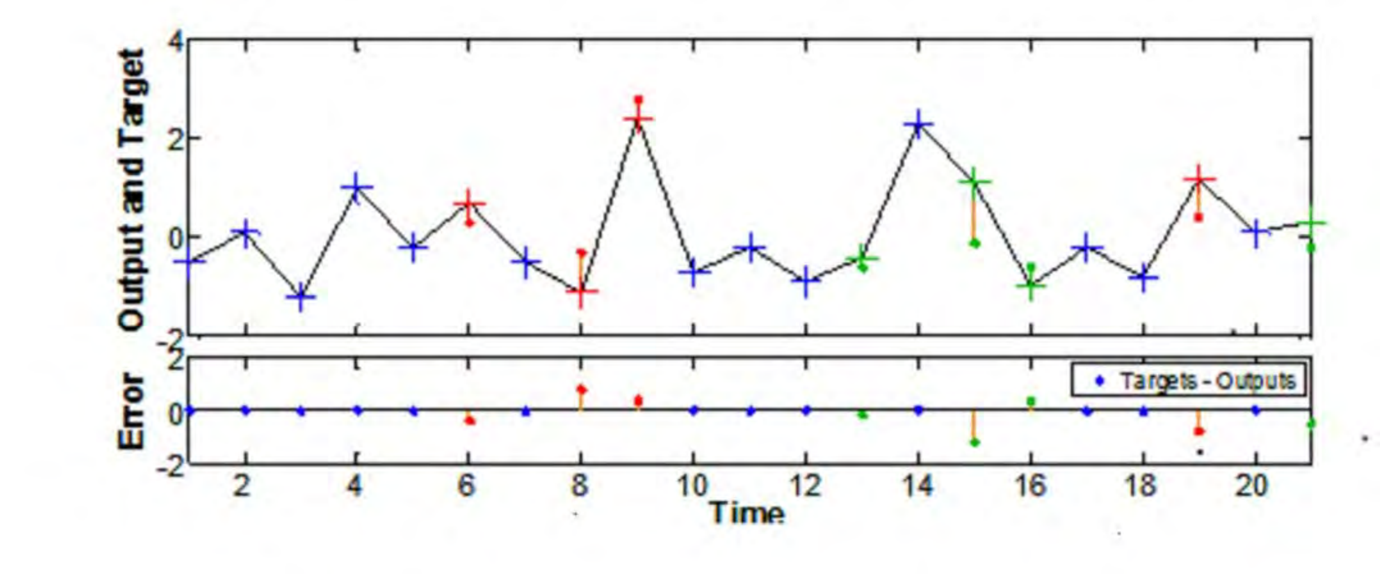


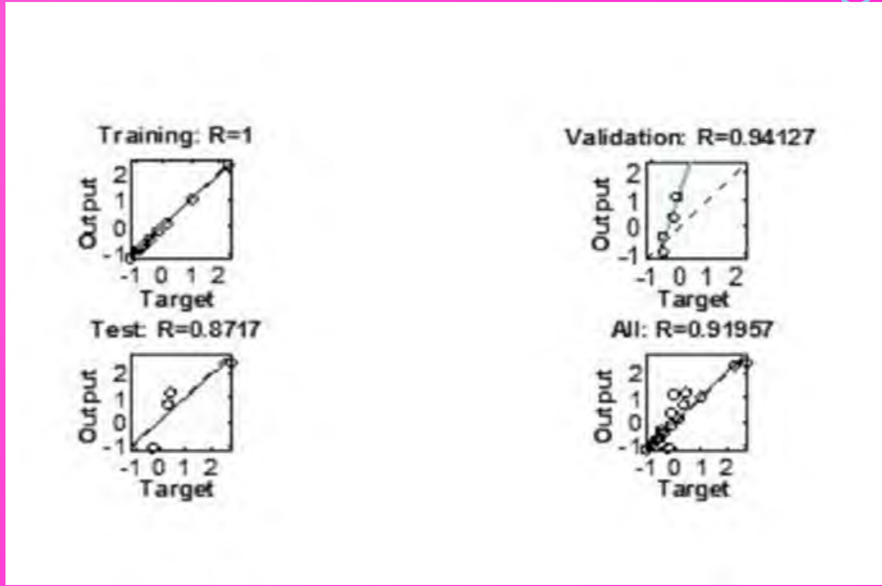
THE NARX MODEL= NON LINEAR AUTOREGRESSIVE WITH EXOGENOUS INPUTS

$$y(t) = f\,(y(t-1), y(t-2), y(t-3), \ldots y(t-n_y), u(t-1), u(t-2), u(t-3), \ldots u(t-n_u))$$



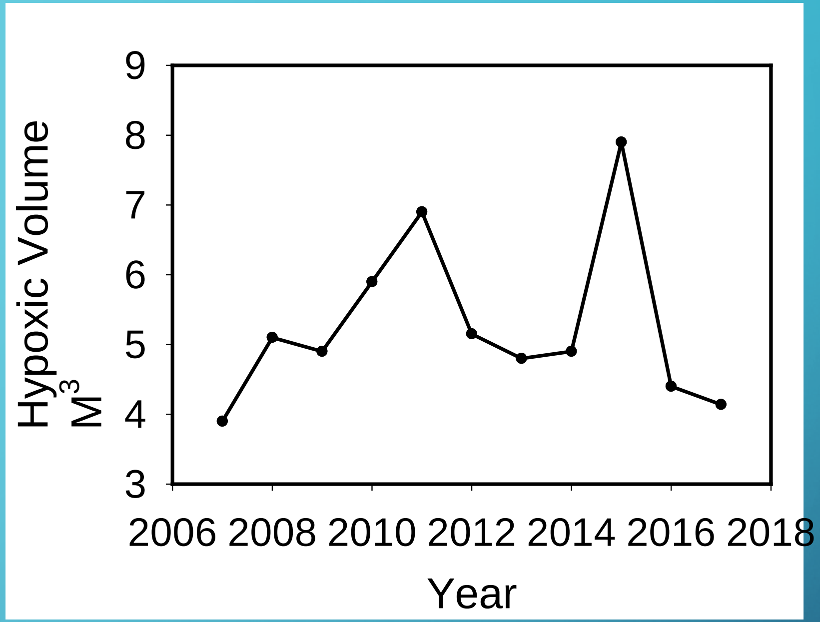
MODEL RESULTS

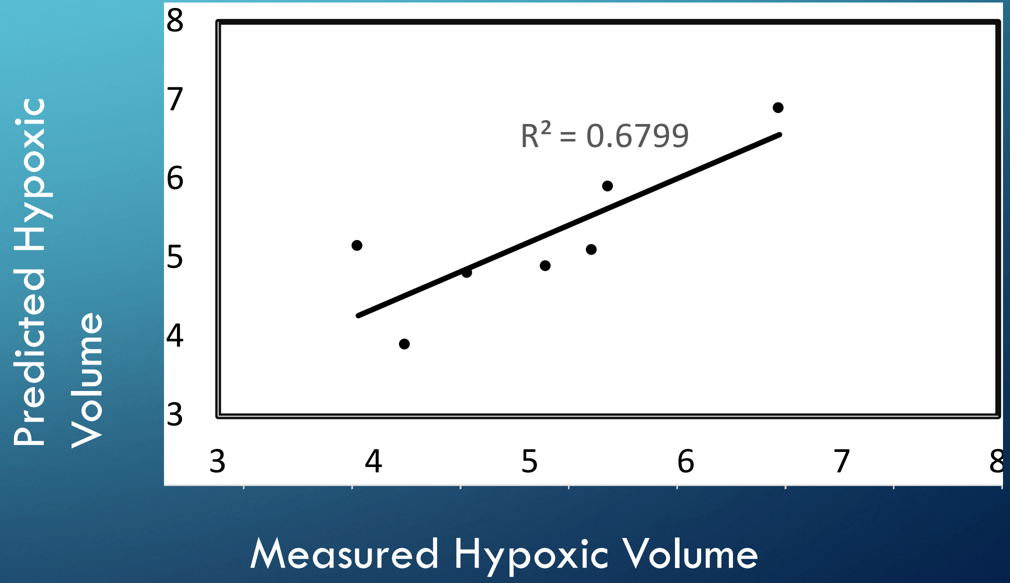




CREATING THE BENCHMARK

The NARX model is reasonably effective in predicting future Hypoxic volume. As a climatological based model, the predictions could be used as a benchmark for assessing TMDL success, as well as a guidance tool for ecosystem based management decisions.





SUMMARY

- Wavelet analysis can be useful in determining input parameters for models especially since most environmental variables behave as waves. The 18 month lag-time between the SQI and HVI suggest that previous condition can influence the next year's hypoxic volume/
- The NARX neural network model is as good or better than other models for hypoxia, and can actually predict hypoxic conditions in the Chesapeake Bay several years into the future.
- A climatological benchmark can be crested as an assessment tool to measure success of nutrient reduction activities.
- The benchmark can also be used for effective adaptive and ecosystem based management.
- We need to recognize and model environmental parameters as the waves they are, rather than forcing linear relationships
- Thank You