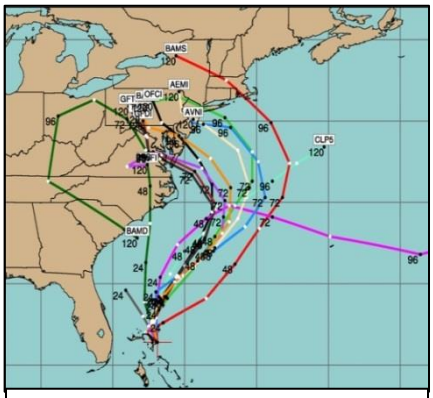
STAC Factsheet Multiple Models for Chesapeake Bay Management

This fact sheet summarizes a recent STAC workshop on multiple modeling. It presents the advantages of multiple modeling, defuses some common concerns, and offers STAC's recommendations for using multiple modeling to improve understanding and management of the Chesapeake Bay and its watershed.

What is multiple modeling?

Multiple modeling involves the analysis of a set of models that estimate some of the same processes or quantities. Scientists have documented many advantages-multi-model analysis can compare different conceptual models of systems, contrast the skills of different models, improve basic understanding of systems, and quantify the level of confidence in model predictions. Multiple models are already widely applied and accepted for some issues, such as hurricane forecasting (right). However, many managers and environmental advocates are wary of using multiple models. They worry that multi-model approaches cost more, and that results from more than one model may confuse the public and decision makers, provoke legal challenges, and slow the regulatory process. As discussed below, the recent STAC workshops on multiple modeling have demonstrated that these concerns are unfounded.



In October 2012, television weather broadcasts informed millions of anxious coastal residents with multiple-model projections ("spaghetti plots") of tropical storm Sandy. The same forecasts guided critical decisions by government and emergency managers.

Background

In recent years, the Chesapeake Bay Program's (CBP) Scientific and Technical Advisory Committee (STAC) has repeatedly recommended that the CBP apply multiple models to enhance modeling and decision-making supporting Chesapeake Bay restoration. In response, the Director of the CBP asked STAC to convene a workshop to explore how to incorporate multiple management models into CBP's modeling suite. Over 50 regional and national experts gathered in February 2013 to:

- Explore the scientific benefits of model comparison and multiple modeling.
- Consider case studies to examine how multiple modeling has helped or hindered environmental regulation.
- Seek legal insight on whether multiple modeling enhances the credibility and defensibility of regulatory decisions.
- Gain insight from social science on how the multiple modeling could affect public perceptions of model results.

The following findings and recommendations synthesize the sense of the workshop on how multiple modeling should be used by the CBP.

Findings about multiple modeling

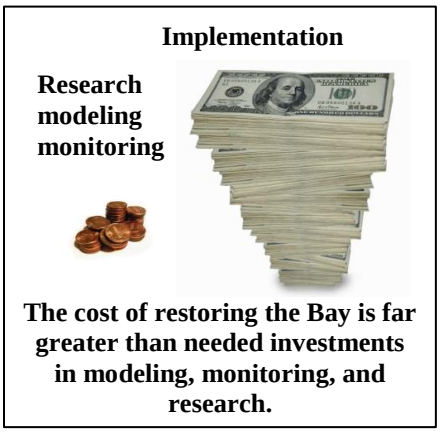
Scientific advantages of multiple modeling

Multiple models can offer more support for decisions than a single model.

- Using multiple models offers many documented advantages over analyzing one model of an environmental system.
- There are varying ways to implement multiple models (multi-model ensembles, using other models to assess the skill of a decision model, modular community modeling, and model comparisons in pilot studies or testbed areas). The common principle is that findings are stronger when multiple lines of evidence, multiple data sets, or multiple algorithms agree.
- Analyzing multiple models increases knowledge and understanding of underlying processes.
- Average predictions from a set of models typically perform better than those from any single model.
- Information from multiple models can help quantify model uncertainty, which is critical to sound science and rational decision-making.

Responses to concerns about multiple modeling

- Modeling is inexpensive compared to the costs of monitoring, implementation, and poor decisions.
- Properly framed multiple models can be a legal asset rather than a liability.
- Multiple modeling can expand opportunities for additional technical experts and non-technical stakeholders to participate in modeling, fostering greater understanding and acceptance of models and the decisions based upon them.
- Multiple models of the Chesapeake Bay and its watershed already exist and they could be integrated into CBP modeling to improve knowledge and decision-making.



The cost of restoring the Bay is far greater than needed investments in modeling, monitoring, and research.

Recommendations

1. The CBP should implement a multiple modeling strategy for each major decision-making model of the Bay (airshed, land use, watershed, and estuary) and analyze the output to quantify skill, advance knowledge, and inform adaptive management.
2. The CBP should exercise the multiple model systems developed under Recommendation 1 to quantify model uncertainty and confidence in key predictions used in decision-making.
3. The CBP should estimate and better communicate the appropriate levels of spending on monitoring, modeling, and research relative to the costs of implementation and the cost of sub-optimal decision-making.
4. The CBP should implement ways to better communicate modeling, uncertainty, and multiple model results to partners, decision makers, and the public.

These recommendations complement those of a 2012 STAC workshop which recommended that a pilot model comparison project would provide a foundation for future modeling in the productive shallow areas of the Bay and would demonstrate the potential for routine use of multiple modeling. The CBP accepted that recommendation, solicited proposals from interested modelers, and funded four teams to implement the comparison. STAC anticipates that the project will improve shallow water simulations of dissolved oxygen, chlorophyll *a*, suspended solids, and water clarity and yield better understanding of how alternative management strategies would improve water quality and living resources in the Bay.

Conclusion

Implementing the recommendation to incorporate multiple modeling in every decision model will begin the CBP path to realizing the many benefits of multiple modeling and would satisfy repeated recommendations from STAC. Once multiple modeling is the standard operating procedure for the CBP, the routine comparison of output from several other models with the EPA regulatory models will help document the skill of the regulatory models; enable effective adaptive management and accountability; and build scientist, management, and stakeholder confidence in the models and the decisions based upon them. Multiple modeling is essential to support the claim that CBP is exploiting the best possible science.

STAC emphasizes that recommending greater use of multiple models in the CBP does not undermine the current application of the existing CBP models or provide a rationale for delaying or halting TMDL implementation. The current Chesapeake Bay modeling suite was built on rigorous scientific foundation, but its future credibility and confidence require consideration of output from other quality models.

For additional information, please see:

Friedrichs, M., K.G. Sellner, and M.A. Johnston. 2012. Using Multiple Models for Management in the Chesapeake Bay: A shallow water pilot project. Chesapeake Bay Program Scientific and Technical Advisory Committee Report. No. 12-003, Edgewater, MD. 2012 09. http://www.chesapeake.org/pubs/291_Pyke2012.pdf

Weller, D., B. Benham, M. Friedrichs, R. Najjar, M. Paolisso, P. Pascual, K. Sellner, and G. Shenk. 2013. Multiple Models for Management in the Chesapeake Bay. STAC Publication Number 14-004, Edgewater, MD. 36 pages. http://www.chesapeake.org/pubs/324_Weller2014.pdf