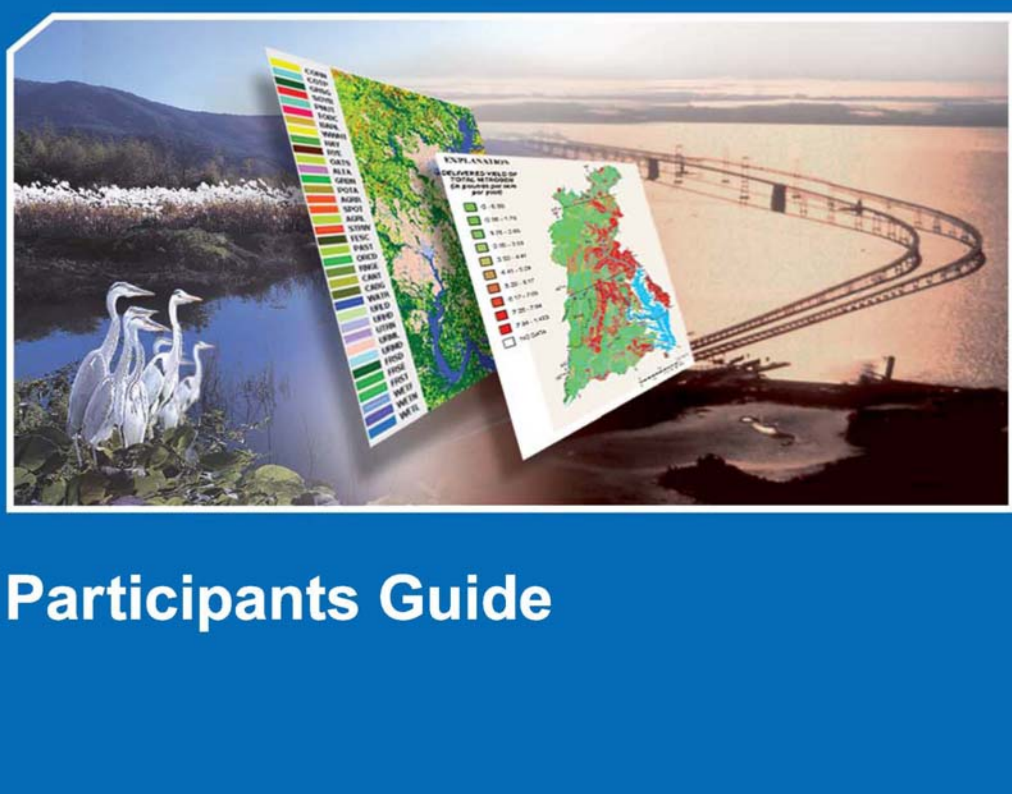
EPA
United States
Environmental Protection
Agency

Integrated Modeling and Analysis To Support the Management and Restoration of Large Aquatic Ecosystems

January 20 - January 21, 2010
Marriott at Metro Center
Washington, DC



Participants Guide

EPA Council for Regulatory Environmental Modeling
EPA Council for Large Aquatic Ecosystems

Table of Contents

About EPA's Council for Regulatory Environmental Modeling (CREM):

Given the crucial role that models play in informing regulatory decision making, the EPA established the Council for Regulatory Environmental Modeling (CREM) in 2000 in an effort to improve the quality, consistency and transparency of the models for environmental decision making. The CREM is a cross-Agency council of senior managers charged with developing practices to ensure that EPA's use of environmental models is consistent and defensible.

About the CREM's Integrated Modeling Program:

The CREM Integrated Modeling Program includes a set of activities that support CREM Strategic Goal 4 (*Enhancing Integrated Modeling for Environmental Decision Making: to bridge disciplines and foster a more integrated and joined up thinking approach to modeling in environmental management and advance integrated modeling science and technology*). These activities will help to facilitate the development of a strong integrated modeling capacity that supports environmental decision making at EPA.

The symposium on **Integrated Modeling and Analysis to Support the Management and Restoration of Large Aquatic Ecosystems** is the first of a series of symposia in the CREM Integrated Modeling Forum. The Integrated Modeling Forum seeks to create a cross-Agency forum for coordination and exchange of information on modeling activities related to high priority science and technology issues which would benefit from a systems analysis and integrated modeling approach.

U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

> ***"We have a stewardship responsibility to maintain healthy, resilient, and sustainable oceans, coasts, and Great Lakes resources for the benefit of this and future generations""***
>
> ***President Barack Obama, June 12, 2009***

Dear Symposium Participants:

Welcome and thank you for your interest in and enthusiasm for the upcoming symposium on **Integrated Modeling and Analysis to Support the Management and Restoration of Large Aquatic Ecosystems**! The symposium in which you are about to participate is intended to do several things:

- facilitate a discussion of the common multi-media, multi-scale and multi-disciplinary challenges facing the development and application of integrated models for large aquatic ecosystems;
- provide a forum for coordination, discussion, and exchange of information across disciplines, including ecologists and other natural scientists, environmental engineers, and economists and other social scientists;
- help ensure that model development is aligned with the policy design, management and decision-making needs of the large aquatic ecosystems;
- identify successful model development practices that may be widely shared and applied; and
- identify areas requiring further research and analysis, especially those with cross-media implications.

We have developed the symposium agenda to include a mix of keynote presentations, case-study and technical presentations, and break-out workshops that demonstrate integration in modeling and in modeling-based decision making. Ultimately we view this symposium as an opportunity to bring together many great minds to collectively understand the issues related to holistically analyzing and managing large aquatic ecosystems and to collaboratively chart out a roadmap to develop integrated modeling systems that are responsive to the management needs of protecting and restoring large aquatic ecosystems.

We invite you to look ahead in this Participants Guide which includes a symposium agenda and detailed information about the break-out sessions. Please take the time to examine the Participants Guide and the break-out sessions questions in preparation for the discussions.

Once again, we thank you for your enthusiasm and willingness to engage with us in addressing these difficult but critical issues. We are looking forward to your active involvement to make this symposium a resounding success.

Sincerely,
The Symposium Organizing Committee

Putting the Best Available Science and Information Technology to Use: Integrated Modeling and Analysis to Support the Management and Restoration of Large Aquatic Ecosystems

January 20-21, 2010

Overview

The visible signs of a major water-body under stress are profound. Harmful algal blooms, hypoxia, habitat loss, nuisance species invasions, declining fish and shellfish populations, waters unsafe for drinking or swimming and other environmental problems are impacting waters throughout the United States and across the globe.

Large aquatic ecosystems such as the Chesapeake Bay, Great Lakes and Puget Sound are facing some of the Nation's most complex water resources and ecosystem management challenges. These systems are very complicated networks of correlated hydraulic, hydrological, ecological, geochemical, biological, and atmospheric components, supporting a variety of processes. In addition to housing an amazingly diverse array of plants and wildlife, these large aquatic ecosystems support many important economic activities. The stress on these ecosystems from urban sprawl, air and water pollution, invasive species, and climate change has wide ranging impacts on the quality of life in their vicinity. Consequently, restoration of these large aquatic ecosystems is increasingly viewed as a national priority.

Developing strategies for the management and restoration of large aquatic ecosystems relies on scientific analyses that connect the multiple pressures on these systems to multiple ecological responses of concern. Over the past 4 decades, there has been considerable investment in understanding the science related to the processes at play in large aquatic ecosystems in order to inform actions that may reduce the stress. In addition to monitoring, computer models have been used for a variety of purposes, including identifying the sources of pollution, predicting episodes of hypoxia, and evaluating different management strategies and activities. Given the multi-scale and multi-media challenges associated with understanding and restoring large aquatic ecosystems, integrated modeling and analysis is an especially useful approach.

The US EPA is convening this symposium to develop a roadmap for the design and application of multi-media, multi-scale, and multi-disciplinary models to support the protection and restoration of large aquatic ecosystems.

Symposium Purpose

The symposium will:

- facilitate a discussion of the common multi-media, multi-scale and multi-disciplinary challenges facing the development and application of integrated models for large aquatic ecosystems;
- provide a forum for coordination, discussion, and exchange of information across disciplines, including ecologists and other natural scientists, environmental engineers, and economists and other social scientists;
- help ensure that model development is aligned with the policy design, management and decision-making needs of the large aquatic ecosystems;
- identify successful model development practices that may be widely shared and applied; and
- identify areas requiring further research and analysis, especially those with cross-media implications.

Participation:

This is a public meeting and participation is open to individuals from within and outside EPA.

The symposium should be of particular interest to individuals seeking to understand how science-based modeling systems can be used to inform the design of innovative policies, including those that combine traditional regulatory approaches with market-mechanisms.

We are expecting participation from a diverse audience representing a wide range of sectors (Federal, State and Local government, NGOs, academia, private sector), including policy analysts, ecologists, environmental engineers, economists, IT specialists, and program managers.

Symposium Organizing Committee

- Richard Allen, Office of Environmental Information, EPA
- Alan Dixon, Office of Prevention, Pesticides and Toxic Substances, EPA
- Noha Gaber, Office of the Science Advisor, EPA
- Michael Hiscock, Office of the Science Advisor, EPA
- Russell Kreis, Office of Research and Development, NHEERL, EPA
- John Lehrter, Office of Research and Development, NHEERL, EPA
- Lewis Linker, Chesapeake Bay Program Office, EPA
- Mahri Monson, Pacific Islands Office, EPA
- Gabriel Olchin, Office of the Science Advisor, EPA
- John Powers, Office of Water, EPA
- Gary Shenk, Chesapeake Bay Program Office, EPA

Symposium Agenda

Day 1: Wednesday January 20, 2010

8:00-9:00	**Registration**
9:00-9:15	**Symposium Introduction** Gabriel Olchin, Office of the Science Advisor, EPA **Welcome** Pai-Yei Whung, Chief Scientist, Office of the Science Advisor, EPA
9:15-10:00	**Defining Integrated Modeling: The What, Why and How?** <u>Introduction/ Session Moderators:</u> Noha Gaber, Office of the Science Advisor, EPA John Powers, Office of Water, EPA <u>Keynote Speaker:</u> ▪ Robert Costanza, Director, Gund Institute for Ecological Economics, University of Vermont
10:00-10:45	**Large Aquatic Ecosystems from a Senior Decision Making Perspective** <u>Introduction/ Session Moderator:</u> Pai-Yei Whung, Chief Scientist, Office of the Science Advisor, EPA <u>Keynote Speakers:</u> ▪ Chuck Fox, Senior Advisor to the EPA Administrator on the Chesapeake Bay ▪ Paul Horvatin, Branch Chief, EPA Great Lakes National Program Office
10:45-11:00	**Break**
11:00-12:30	**Case study 1: Chesapeake Bay** <u>Session Moderator:</u> Jeff Lape, Chesapeake Bay Program Office, EPA ▪ Chesapeake Bay Management and Policy: Michael Haire, Office of Water, EPA ▪ Chesapeake Bay Program Modeling: Lewis Linker and Gary Shenk, Chesapeake Bay Program Office, EPA ▪ Community/ State Level Modeling: Lee Currey, Maryland Department of the Environment
12:30-1:30	**Lunch (on your own)**
1:30-2:50	**Case study 2: Great Lakes** <u>Session Moderator:</u> Paul Horvatin, EPA Great Lakes National Program Office ▪ Great Lakes Management and Policy: Glenn Warren, EPA Great Lakes National Program Office

	▪ Great Lakes Modeling: Russell Kreis, Office of Research and Development, EPA ▪ Community Modeling: Challenges in the Future: Joseph DePinto, Limno Tech Inc.
2:50-3:00	**Charge for Break-out Session 1** Noha Gaber, Office of the Science Advisor, EPA
3:00-3:15	**Break**
3:15-5:00	**Break-out Session 1: Conceptual Models for Large Aquatic Ecosystems**
5:00-6:00	**Poster and Demonstration Session**

Day 2: Thursday January 21, 2010

9:00-10:30	**Break-out Session 1 Reporting and Discussion** **Moderator:** Noha Gaber, Office of the Science Advisor, EPA
10:30-10:45	**Break**
10:45-12:20	**Presentations: Modeling activities in other LAEs** **Introduction/ Moderator:** John Lehrter, Office of Research and Development, EPA **Puget Sound** Ben Cope, Region 10, EPA Mindy Roberts, Washington State Department of Ecology **Long Island Sound** Mark Tedesco, Long Island Sound Office, EPA Robin Miller, HydroQual, Inc. James O'Donnell, University of Connecticut **The Florida Everglades** Chris Madden, South Florida Water Management District
12:20-12:30	**Charge for Break-out Session 2** Noha Gaber, Office of the Science Advisor, EPA
12:30-1:30	**Lunch (on your own)**
1:30-3:00	**Break-out Session 2: Developing an Integrated Modeling and Analysis Tool-Box for Large Aquatic Ecosystems**
3:00-3:15	**Break**
3:15-4:30	**Break-out Session 2 Reporting and Discussion** **Moderator:** Noha Gaber, Office of the Science Advisor, EPA
4:30-5:00	**Synthesis and Next Steps** Noha Gaber, Office of the Science Advisor, EPA

Basic Discussion Group Principles

- **Stay on topic**: Start from the "big picture" before moving into details. Jumping to details prematurely can consume a lot of time on a topic that the group may later decide is unnecessary. A "Parking Lot" of ideas will be available to post ideas/comments to ensure that they are addressed at the appropriate time.

- **Everyone shares the responsibility for making the meeting a success**: This meeting is a true collaboration between all attendees, including the facilitators. If you have a suggestion that will enable the participants to be more effective, please suggest it either orally or through a posted note.

- **Listen and understand**: All participants bring to this meeting a diversity of experiences, ideas, knowledge, and perspectives. Seek to understand other's comments before advocating your own.

- **Be transparent**: Our assumption is that all participants are coming to this meeting with the intent of working collaboratively with other participants to achieve the workshop goals.

- **First brainstorm, then critique**: The most creative ideas emerge through an uninterrupted accumulation of participant comments built upon the suggestions of others in the group. Often the seemingly wildest ideas stretch thinking to tangible innovations. Avoid premature critiquing that can unintentionally shut down the creative process.

- **Provide everyone an equal opportunity to speak**: Part of our diversity includes variations in how we prefer to express ourselves. Freely offer your perspectives and allow others the space to express theirs. Self-managing our air time benefits the discussion by allowing a variety of perspectives and insights to be heard including some that have not occurred to others.

- **Commit to being fully present**: Please turn off all cell phones; put away the laptop computers/Palm Pilots/Blackberrys. You can always check them during breaks.

Break-out Session 1: Conceptual Models for Large Aquatic Ecosystems

Purpose: With their multitude of interacting systems, processes and activities, large aquatic ecosystems exemplify the need to treat environmental systems as an integrated whole (Figure 1). In this session, symposium participants will draw upon their multi-disciplinary expertise to discuss and refine the policy-relevant conceptual models for large aquatic ecosystems.

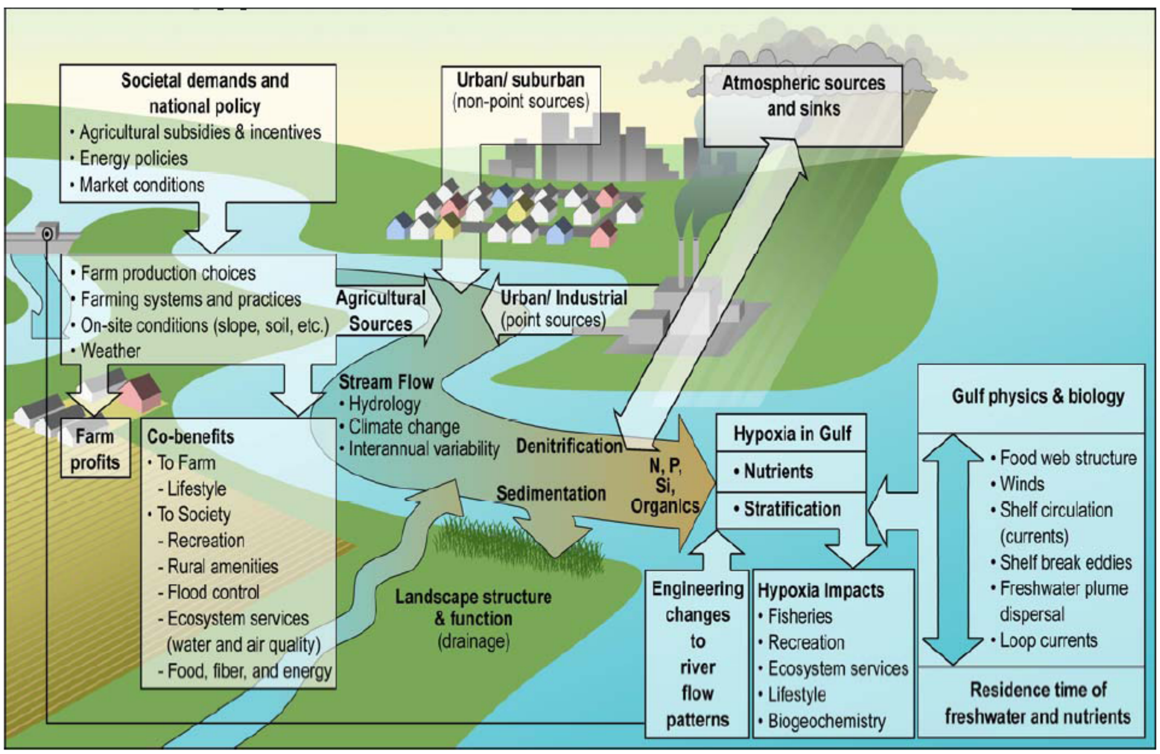


Figure 1: A Conceptual Framework for Hypoxia in the Northern Gulf of Mexico (USEPA 2007)[1]

[1] USEPA, 2007. Hypoxia in the Northern Gulf of Mexico: an update by the EPA Science Advisory Board. USEPA, Office of Water, Washington DC EPA-SAB-09-004

Break-Out Session Activities:

- Participants will break-out into 4 groups, each focusing on a different large aquatic ecosystem (LAE).
- Sign-up for the group you would like to participate in during registration.

Break-out Groups:

Group	**Co-Facilitators**
1. Chesapeake Bay	Lewis Linker and Alan Dixon
2. Great Lakes	Russell Kries and Gabriel Olchin
3. General LAE-Freshwater (e.g. Columbia River Basin, Lake Champlain, South Florida)	Gary Shenk and John Powers
4. General LAE-Coastal (e.g. Long Island Sound, Puget Sound, Gulf of Mexico, San Francisco Bay)	John Lehrter and Mahri Monson

- Each break-out group should include participants from different disciplines and sectors.
- **Key Task:** Group members are asked to consider the policy scenarios outlined in Box 1 and develop a conceptual model that captures the processes and interactions that take place in this system and identify and map key decision making questions and information requirements→ *this will play an integral role in tomorrow's break-out session!*
- A number of tools are provided to assist with thinking about this task: **(1) steps for developing a conceptual model, (2) a logic framework model and (3) an example of the DPSIR (Driver, Pressure, State, Impact, Response) framework applied to an LAE.**

Box 1: Policy Scenarios

For the purposes of this session please consider any or all of these policy scenarios in your conceptual model:

- A technology-based requirement for sources emitting a single pollutant (e.g., N, P, Hg);
- A TMDL (total maximum daily load) for one pollutant (e.g., N, P, Hg) in (i) an individual stream reach, (ii) for an individual river, lake or estuary, or (iii) for the entire watershed;
- A watershed-wide point-source to point source trading program (cap-and-trade) for N and P to eliminate a dead zone in the estuary;
- A point source to non-point source offset credit market that allows point sources to buy offset credits from unregulated (or underregulated) non-point sources;
- Credit markets that allow buyers (e.g., USDA subsidy programs, The Nature Conservancy, States) to competitively purchase credits for N, P, sediment, carbon, habitat, and flood mitigation through a reverse auction. Assume that buyers purchase credits to maximize the benefits generated by the credits they purchase with their pool of resources.

Tool 1: Developing a Conceptual Model in a few Simple Steps

In environmental systems analysis, a conceptual model is a qualitative or descriptive narrative or graphical representation of the multiple complex processes and interactions in an ecosystem. A properly developed conceptual model is useful for organizing, communicating, and facilitating analysis of natural systems. [2] It can effectively capture the scientific understanding of and the ecosystem's response to natural and anthropogenic stressors. A conceptual model is an effective tool for simply, clearly and transparently communicating this information to scientists and non-scientists alike. It can also be useful for providing an adaptive management framework for evaluating and selecting management actions.

1. Define the environmental restoration goals for your LAE.
2. Delineate the spatial, temporal, and ecological scales and boundaries that you will focus on.
3. Identify the major sources/ drivers of anthropogenic stressors (e.g. agricultural activities, urban development, modification of habitats and hydrology, recreation, industrial activities, and climate change) and natural stressors (e.g. hurricanes, droughts, freezes, fires, sea-level rise, and seasonal and inter-annual variability in precipitation) that lead to physical, chemical, and/or biological changes that could affect an ecosystem.
4. Identify the primary and secondary stressors of concern (e.g. toxic chemicals, elevated nutrients, altered salinity, increased sedimentation, over-harvesting and over-fishing, and physical damage).
5. Identify the ecological receptors, ecosystem services and other ecologically important end-points. Criteria for selecting endpoints typically include:

   (a) identification of their ecological importance (e.g. important structures, processes) or societal importance (e.g. economic or aesthetic species, water supply, flood protection);

   (b) consideration of organizational hierarchy, including species, ecosystem, and landscape scales;

   (c) susceptibility to the stressors of concern;

   (d) selection of those critical structural and functional attributes that can be used to characterize the state (health) or change of health of the regional environment; and

   (e) signal-to-noise ratio, that is, the ability to discriminate changes in endpoints from natural variability.[3]
6. Identify the stressor-effects causal pathways.
7. Identify management options that address the drivers-stressors-endpoints continuum.
8. Identify decision making information requirements.
9. Develop an ecosystem and adaptive management framework that provides the context and linkages between science and decision-making under each policy scenario.

---

[2] J. H. Gentile, M. A. Harwell, W. Cropper Jr., C. C. Harwell, D. DeAngelis, S. Davis, J. C. Ogden, D. Lirman, Ecological conceptual models: a framework and case study on ecosystem management for South Florida sustainability, The Science of The Total Environment, Volume 274, Issues 1-3, 2 July 2001, Pages 231-253, ISSN 0048-9697, DOI: 10.1016/S0048-9697(01)00746-X.

[3] Ibid.

Tool 2: Logic Framework Model

Logic framework models (such as in Figure 2) depict key relationships along the continuum of administrative actions, pollutant emissions and ecosystem condition. They are useful for gaining a better understanding of the linkages between stressors and ecological and human health, or for developing, evaluating or determining ways to improve programs.

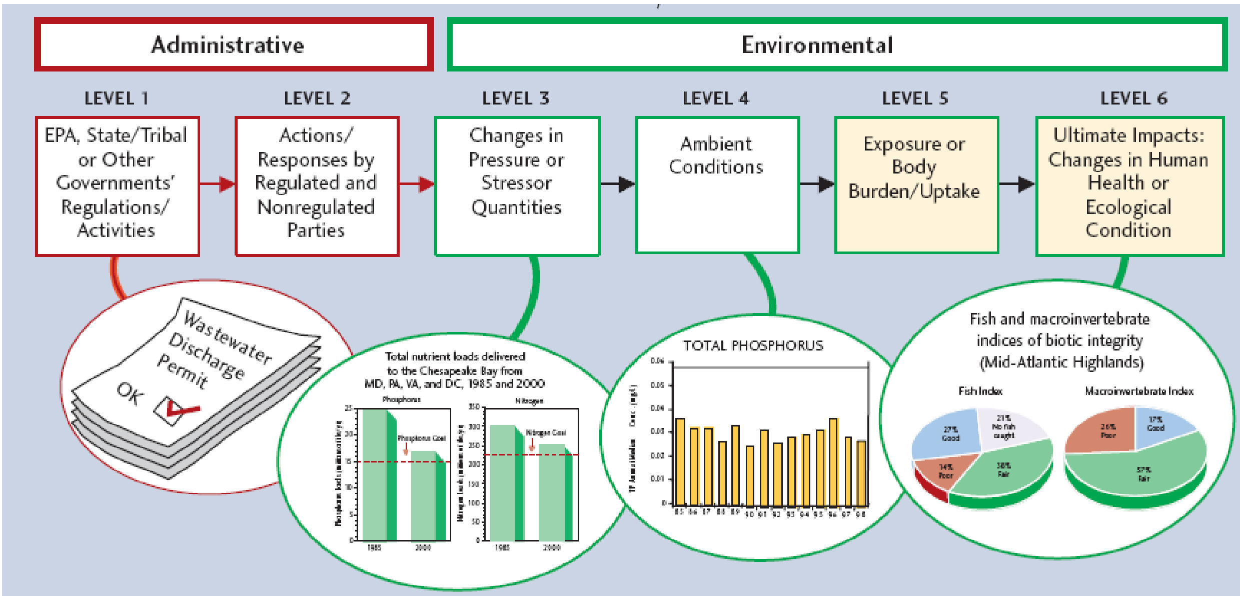


Figure 2: Hierarchy of Indicators (EPA Draft Report on the Environment, 2003[4])

[4] http://www.epa.gov/Indicators/roe/

Tool 3: DPSIR Framework

A number of frameworks may be used to develop an environmental conceptual model, including the DPSIR (Drivers-Pressures-State-Impacts-Responses) framework (Figure 3).

- **Drivers:** are the economic sectors that provide the goods and services of the economy; e.g. Agriculture, Industry/Manufacturing, Housing, Transportation, Retail etc.
- **Pressures:** are the human activities that manifest from the economic drivers; e.g. Land-use/land-cover changes such as clearing land and fertilizing fields for agriculture or clearing land and paving surfaces for retail, housing, and transportation. Another example would be the generation of air and water pollutants and wastes from industry or households.
- **State** (of the ecosystem): **State** (of the ecosystem): occurs as a result of pressures; e.g. fertilization of fields or clearing of riparian vegetation results in increased nutrient concentrations in streams, rivers, lakes, and estuaries.
- **Impacts** (on human and ecosystem health): occur as a result of changes in ecosystem state, e.g. loss of clean drinking water supplies or loss of benthic habitat due to hypoxia.
- **Responses:** are implemented to address the impacts. These responses also alter either the Drivers or the Pressures.

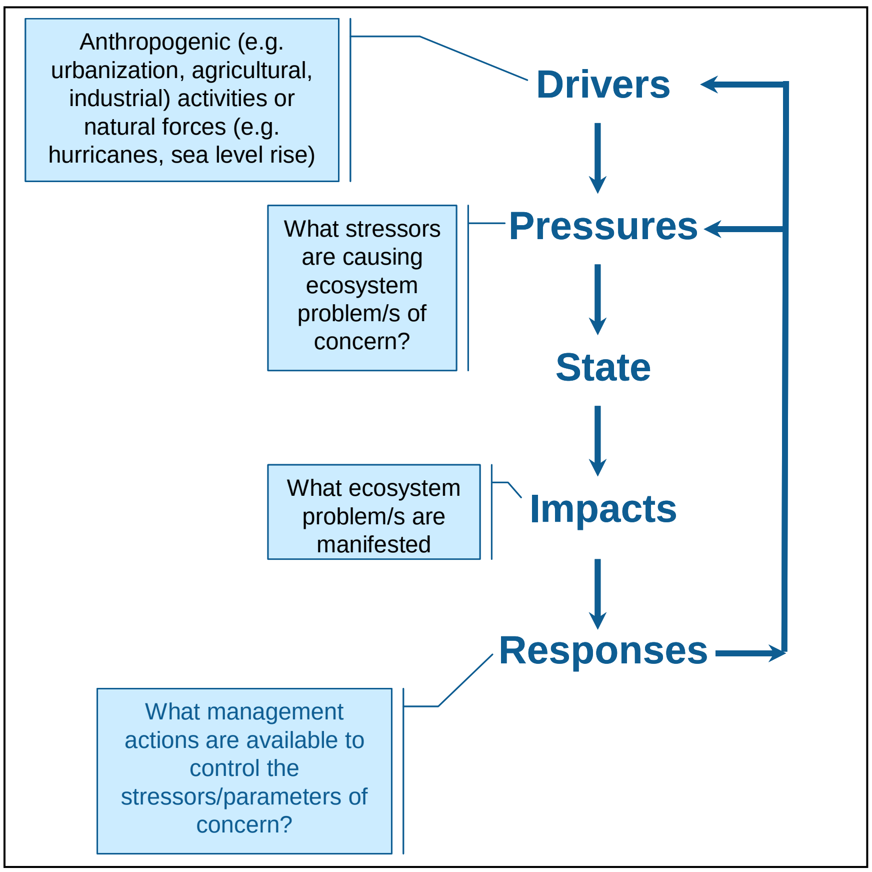


Figure 3: The DPSIR framework

Break-out Session 2: Developing an Integrated Modeling and Analysis Tool-Box for Large Aquatic Ecosystems

Purpose:

Over the course of the past day and a half we have gained more insight into the environmental challenges facing large aquatic ecosystems and the diverse modeling activities and analyses that provide valuable information in the development and assessment of management and policy actions. This afternoon we turn our attention to developing an integrated modeling and analysis tool-box for large aquatic ecosystems.

An integrated modeling system for an LAE may include the components shown in Figure 4 (climate change, airshed, watershed, and coastal or lake system, ecosystem and economic analyses models). Workshop participants will discuss developing an integrated modeling and analysis system for their LAE as well as identify the components that may be developed for LAEs in general.

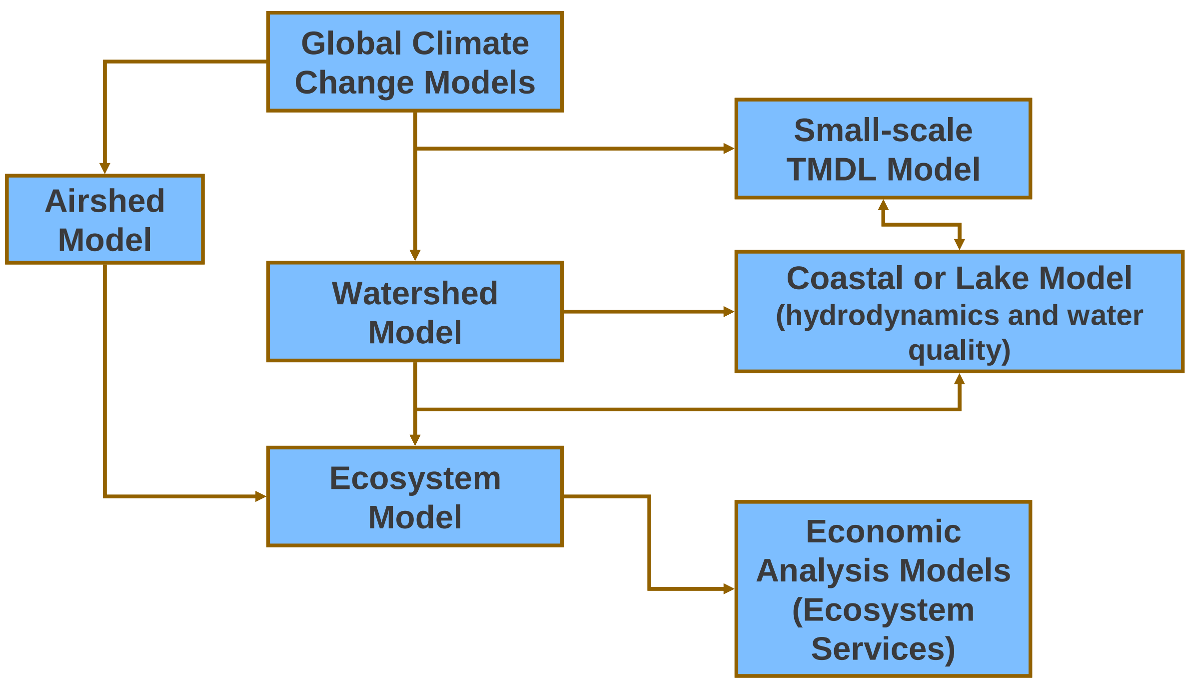


Figure 4: Draft LAE Integrated Modeling System

Break-out Session Activities:

- Participants will break-out into 4 groups, each focusing on a different large aquatic ecosystem (LAE).

Break-out Groups:

Group	Co-Facilitators
1. Chesapeake Bay	Lewis Linker and Alan Dixon
2. Great Lakes	Russell Kries and Gabriel Olchin
3. General LAE-Freshwater (e.g. Columbia River Basin, Lake Champlain, South Florida)	Gary Shenk and John Powers
4. General LAE-Coastal (e.g. Long Island Sound, Puget Sound, Gulf of Mexico, San Francisco Bay)	John Lehrter and Michael Hiscock

- Each break-out group should include participants from different disciplines and sectors.
- For the LAE under consideration, each group will identify the modeling and information management capabilities that:
  - exist;
  - exist but will need to be refined or replaced; and
  - do not currently exist and need to be developed.
- Evaluate the integrated modeling and analysis system and determine which components may be unique to your LAE and which may be a general need of all LAEs.
- Estimate the level of resources and time required to develop the new models and capabilities and determine the priorities among these activities.

Poster and Demonstration Session Abstracts
Wednesday January 20, 2010, 5:00pm

01 Transient Tidal Eddy Motions in the Great South Channel East of Cape Cod, MA

The authors will be presenting a poster and a demonstration.

Authors: Wendell Brown, Gustavo Marques, and Shawna King

Affiliation: School for Marine Science & Technology; University of Massachusetts

Abstract: This research focuses on the Great South Channel (GSC) region of the western Gulf of Maine that lies east of Cape Cod, MA. The seafloor in the study region is densely populated with sea scallops. This study is our first step in addressing the question as to whether not this sea scallop population is sustained in any way by these tidal current-related processes. A permanent pair of high-frequency Coastal Ocean Dynamics Applications Radar (CODAR) stations on Cape Cod and Nantucket has been used to map surface currents in a region that extends about 100 km eastward offshore from Cape Cod. The CODAR-derived surface current maps reveal clockwise (CW; or anticlockwise ACW) eddy-like surface flow features that tend to appear at maximum semidiurnal tidal ebb (flood) flow near to the coast of outer Cape Cod. During the next quarter tidal cycle, the lateral scale of the eddy motion grows as it translates away from the coast towards the center of the Great South Channel (GSC), finally disappearing near the time of the change from ebb to flood (flood to ebb) tidal flow in the GSC. A series of model simulations of the well-mixed winter water column conditions in the GSC were conducted using the 3-D high-resolution, finite-element ocean circulation model called QUODDY in its barotropic mode with only tidal forcing. The model simulations show alternating CW and ACW eddy motion similar to those suggested by the observations. An analysis reveals (1) the detailed structures of the model eddy motion generation and evolution and (2) its impact on the upwellings and downwellings associated with the secondary flow field.

---

02 Title: A Regional Earth System Prediction Model for Pathogens, HABs, Swine flu: Large Aquatic Ecosystem Modeling

The author will be presenting a poster and a demonstration.

Authors: Raghu Murtugudde

Affiliation: Earth System Science Interdisciplinary Center, University of Maryland

Poster Abstract: Seasonal predictions from global climate models have been used with some success for various applications for resource management and human health. Even as the resolutions of the global climate models gets finer they are expected to remain at order kilometers if not coarser for many years to decades to come. It is evident that the day-to-day management of

resources and human health and planning the adaptation and mitigation strategies for future management will require information at meter scales with a keen understanding of regional specificities. A combination of dynamic and statistical downscaling is clearly the path forward and a prototype will be discussed not only for downscaling of the climate predictions but forecasting of linked Earth System parameters like pathogens, harmful algal blooms, and early attempts to drive towards respiratory disease morbidities. Computational social science is being used to project scenarios of rapid spreading of communicable diseases like swine flu and the same approach is being explored for optimizing the web of sensors to monitor the Earth System to validate, improve, and assess the skill of forecasts. How can large aquatic ecosystem modeling goals be dovetailed with the goals for regional Earth System prediction and make the two way communication seamless to cover both global governance issues and regional sustainable management issues at days to decades? The discussion will use a regional Earth System prediction prototype to raise the relevant issues.

Demonstration Abstract: A what-if scenario builder for interactive decision-making, learning by doing, and adaptive management will be needed to drive restoration and ecosystem-based management. A prototype of such a tool is developed for land use change impacts on the Chesapeake Bay.

---

03 Title: The eScience Revolution: Creating Semantic Web Platforms for Massive Scientific Collaboration

Authors: Deborah McGuinness and Peter Fox
Affiliation: RPI

Abstract: Funded by the American Recovery and Reinvestment Act via NSF, a new project seeks to create virtual collaboratories designed to break science data and information out of the laboratory and place it in the hands of the people (http://bit.ly/7HMC8C, http://bit.ly/1Gombr). The goal is to hasten scientific discovery and innovation by enabling rapid and easy collaboration between scientists, educators, students, policy makers, and "citizen scientists" around the world via the Web. The project uses real life use cases (e.g. restoration and management of large aquatic ecosystems) to advance innovation and application of semantic web, web science and web technologies to enable the compilation and sharing of scientific data on an unprecedented scale. Semantic technologies are used to lower the barrier of entry to do science and accelerate the growth of community knowledge, bridging gaps between questions that someone wants to ask in their limited scientific vocabulary and the extreme complexity of the underlying data. The effort provides a toolkit for scientists, policy professionals, and educators allowing them access to data from a variety of sources and, importantly, outside of their direct area of expertise but customized with vocabularies suitable for their use. Hidden behind the interfaces, the toolkit uses semantic ontologies to customize Web sites, services and programming interfaces. Web sites will be familiar, understandable, and navigable to end users depending on the level and type of expertise. The user

needs only to type a question, and it may be answered using data input by other users around world. Web services, will share a common exchange vocabularies, as will plug-in applications for commonly used data software such as Excel, again adding access to data in a format that is familiar to the end user.

---

04 Title: HAWQS: Multi-Spatial-Temporal Hydrologic and Water Quality Decision Support System for Policy Analysis

Authors: Debjani Deb[1], Jeyakanthan Veluppillai[1], Raghavan Srinivasan[1], and Jeff Arnold[2]
Affiliation: [1]Spatial Sciences Laboratory, Texas A&M University; [2]Grassland Soil and Water Research Laboratory, USDA-ARS

Abstract: The Hydrologic and Water Quality System (HAWQS) is an advanced, state-of-the-art water quality modeling system being developed for EPA's Office of Water to evaluate the impacts of management alternatives, pollution control scenarios, and climate change scenarios on the quantity and quality of water in large and complex river systems. HAWQS will be capable of supporting a wide variety of national- and regional-scale economic and policy analyses by simulating baseline and alternative water quality conditions with respect to the following seven broad categories of water quality constituents - sediments, pathogens, nutrients, metals, dissolved oxygen, PBTs and emerging toxic substances. HAWQS is an extension of the Hydrologic Unit Model of the United States (HUMUS), which was recently updated to support USDA's Conservation Effects Assessment Project (CEAP). Specifically, HAWQS updates input data, upgrades SWAT (Soil and Water Assessment Tool) modeling capabilities, replaces the existing stream network with the National Hydrography Dataset (NHD Plus), and creates interfaces and data management utilities beyond those included in the SWAT-HUMUS system. As an information management tool, HAWQS is a continental-scale system capable of handling large data files and intensive computations. It is designed as a distributed modeling system that allows multiple users at different locations to simultaneously access the system, perform simulations, and store results. It has a multi-tier (or n-tier) architecture that includes the HAWQS server database and several middle tier servers that perform various operations, including the transfer of data between servers, the creation of SWAT input files, SWAT model runs, and client-side output analysis.

---

05 Title: Gulf of Mexico Hypoxia Research, Analysis, and Modeling: Improving the Science to Support Decision-Making

Authors: J. Lehrter[1], J. Aukamp[1], D. Beddick[1], R. Devereux[1], R. Greene[1], J. Hagy[1], J. Kurtz[1], M. Murrell[1], B. Schaeffer[1], R. Stanley[1], D. Yates[1], R. Arnone[2], R. Gould[2], D. Ko[2], B. Penta[2], B. Herchenroder[3], R. Kreiss[4], K. Rygwelski[4], T. Feist[5], W. Melendez[5], J. Pauer[5]
Affiliation: [1]EPA Gulf Ecology Division, Gulf Breeze; [2]FL Naval Research Laboratory, Stennis Space Center, MS; [3]Lockheed Martin, contractor for EPA Environmental Modeling and Visualization Laboratory, Research Triangle Park, NC; [4]EPA Large Lakes Research Station, Grosse Ile, MI; [5]Z-Tech, contractors for EPA Large Lakes Research Station, Grosse Ile, MI

Abstract: Every summer large areas of oxygen-depleted or hypoxic bottom waters develop in the northern Gulf of Mexico along coastal Louisiana. The development, extent and persistence of hypoxia are partially attributable to anthropogenic nutrient loading from the Mississippi-Atchafalaya River Basin. The Gulf Hypoxia Action Plan 2008 (Mississippi River/Gulf of Mexico Watershed Nutrients Task Force, 2008) established goals to reduce the areal extent of hypoxia to 5,000 km^2 (1,800 sq mi) by 2015 and improve water quality in the Mississippi River Basin http://www.epa.gov/msbasin/index.htm. The areal extent of the hypoxic zone has a long term (1985 to present) average of 13,000 km^2. However, in five of the last ten years the hypoxic area has been >20,000 km^2 (7,200 sq mi, roughly the size of New Jersey). The USEPA's Office of Research and Development, in partnership with the Office of Water, Gulf of Mexico Program Office, Region 6, and the Naval Research Laboratory have developed and initiated a strategic framework that will help guide the science needed to address Gulf hypoxia and support nutrient management decisions. The goal is to develop a suite of model applications, data products and other tools to assess and predict the relationships between nutrient loads and Gulf hypoxia, quantify sources of error and uncertainty associated with nutrient load reduction targets, forecast the effects of nutrient management actions in the Basin on Gulf hypoxia, and provide defensible options to guide restoration and decision-making. Analysis and modeling integrate field data, remote sensing data, oceanographic buoy data, nutrient loading models, global and regional hydrodynamic models, and eutrophication/biogeochemical models for the northern Gulf of Mexico continental shelf.

---

06 Title: Habitat Forecasting of HABs and Pathogens in the Chesapeake Bay

Authors: Wen Long[1], Raleigh R. Hood[1], Robert Wood[2], John Jacobs[2], Doug Wilson[3], Christopher W. Brown[4], Guillaume Constantin de Magny[5]

Affiliation: [1]Univ of Maryland Center for Environmental Science [2]NOAA Coop. Oxford Lab [3]NOAA Chesapeake Bay Office [4]NOAA/NESDIS, CICS [5]Univ of Maryland Institutes for Advanced Computer Studies

Abstract: A poster presentation will be provided to summarize the ongoing research on using ChesROMS (Chesapeake Bay Regional Ocean Modeling System), an operational implementation of the ROMS model for the Chesapeake Bay estuary, to drive habitat suitability based nowcast and short-time forecast of harmful algal bloom species and pathogens. The system makes operational simulation of Chesapeake Bay circulation forced by tides, river discharge, surface wind stresses and heat fluxes. The forecast results of hydrodynamic parameters are employed in several habitat models for predicting the likelihood or probability of the occurrence of HABs including K. veneficum and pathogen species V. cholerae and V. vulnificus. A lower trophic level nitrogen based ecological model coupled with the hydrodynamical model is also built within ChesROMS and is under extensive tests. This study demonstrates early success in ecosystem forecasting combining mechanistic physical models and statistically based habitat models.

07 Title: Chesapeake Bay Program Phase 5 Watershed Model

Authors: Michael Barnes[1], Gary W. Shenk[2], Jing Wu[3], Lewis C. Linker[2]

Affiliation: [1]Chesapeake Bay Program Staff, Chesapeake Research Consortium, 410 Severn Ave, Suite 109, Annapolis, MD 21403. USA; [2]U.S. EPA Chesapeake Bay Program Office, 410 Severn Avenue, Suite109, Annapolis, MD 21403. USA; [3]Associate Research Scientist, University of Maryland Center for Environmental Science, 410 Severn Ave., Suite 109, Annapolis, MD 21403, USA. Email: jwu@chesapeakebay.net

Abstract: An HSPF-based watershed model has been used to simulate nutrient and sediment loads delivery to the Chesapeake Bay for more than two decades. Over time, the Watershed Model has increased in complexity commensurate with the management challenges in Chesapeake Bay restoration. In response, the Chesapeake Bay Program developed a software solution that enhances the existing HSPF model structure. The software system, consisting of preprocessors, an External Transfer Module, and postprocessors, was devised to conveniently generate and update parameter files essential to operations of a complex watershed modeling system and to implementing land use and nonpoint source management changes on any time scale. The Phase 5 software provides a means to represent the key forcing functions in more detail and to address issues of flexibility that are difficult to manage in traditional HSPF applications.

---

08 Title: Modeling the Impacts of Climate Change on the Structure and Function Aquatic Ecosystems

Authors: Mehmet Umit Taner[1], James Carleton[2], Marjorie Wellman[2]

Affiliation: [1]ORISE fellow, US EPA, Office of Water; [2]US EPA, Office of Water

Abstract: Aquatic ecosystems are generally viewed as resilient systems that can maintain their healthy status in a wide range of environmental conditions. However, results of recent scientific studies suggest that climate change may impose new environmental conditions that can alter the structure and function of aquatic ecosystems, particularly by altering hydrological regimes and water temperatures. In this study, we aimed to evaluate ecological impacts of water temperature increase by analyzing the sensitivity of a calibrated AQUATOX model of Onondaga Lake, NY. The previously calibrated food-web model incorporates four algae types, diatoms, greens, blue-greens and other algae; invertebrates, tubifex, daphnia, rotifer, predatory zooplankton; and four fish species. To examine sensitivity, six different temperature change scenarios were run, in which temperature was adjusted upwards in increments ranging from %5 to %50 above calibrated conditions. Results included changes in nitrogen and phosphorus cycling. For aquatic biota, certain species were predicted to benefit from temperature increase, at least up to a point, while other species only declined in response to rising temperatures. Animal species at higher trophic levels exhibited lower tolerance to temperature increases than animals at lower trophic levels. As a preliminary analysis, this study demonstrates the utility of ecosystem models for projecting the impacts of climate change-related temperature increases on chemical and biotic conditions in aquatic ecosystems.

09 Title: Relative Impacts of Loads from Basins and Their Reduction Allocations

Authors: Ping Wang[1], Gary Shenk[2], Lewis Linker[2], Jing Wu[1]

Affiliation: [1]UMCES / CBPO, [2]USEPA Chesapeake Bay Program

Abstract: The Chesapeake Bay Water Quality and Sediment Transport Model (WQSTM) has been used by the Chesapeake managers to asses the responses of water quality in the Bay's designated-uses to nutrient and sediment loads from the airshed and watershed. In the efforts of TMDL development and allocations of load reduction among different sub-watersheds, we need to know relative impacts of key designated-uses by the sub-watersheds. We used tracer simulation and a set of geographic isolation runs to analyze the relative effects and estimate transport factors. This poster will display WQSTM and the method to analyzing relative impacts from sub-watersheds. A load allocation strategy will also be discussed.

---

10 Title: Modeling Watershed Effects on Aquatic Ecosystem Services with AQUATOX Release 3

Authors: Marjorie Coombs Wellman[1], Brenda Rashleigh[2], Richard A. Park[3], James N. Carleton[1], Jonathan S. Clough[4]

Affiliation: [1]US EPA Office of Science and Technology; [2]US EPA Office of Research and Development; [3]Eco Modeling; [4]Warren Pinnacle Consulting, Inc.

Abstract: AQUATOX is a mechanistic aquatic ecosystem simulation model that predicts the fate and effects of nutrients, sediments, organic toxicants, temperature, and flow on multiple species of periphyton, phytoplankton, macrophytes, invertebrates, and fish in diverse waterbody types. AQUATOX is useful for modeling watershed effects because it integrates the effects of multiple stressors, thus helping managers develop a holistic assessment, to evaluate relative contributions of stressors and thus prioritize scarce resources for restoration. AQUATOX can simulate the delivery of ecosystem services such as nutrient cycling, fisheries, and aesthetic considerations such as algal blooms. Modeling strengths include data libraries for species and chemicals, a flexible design that allows input in many formats, and graphing and statistical functions. AQUATOX is an integral part of BASINS and can be linked to the watershed models HSPF and SWAT, which permits assessment of tradeoffs between upland and in-stream services. The open-source software (new to Release 3) facilitates customization to specific applications, and linkages to other models. Additional advantages of Release 3 include the linked-segment version for spatially explicit modeling, and options for modeling estuaries, which are important providers of ecosystem services.

---

11 Title: From Airshed to Fish: An Interactive Modeling Approach to Understanding Chesapeake Bay

Authors: Carl F. Cerco and P. Soupy Dalyander

Affiliation: U.S. Army Corps of Engineers, Environmental Lab

Abstract: Management of nutrient and solids sources in a watershed is often aimed at protecting and restoring living resources in receiving waters which may be far-removed from the pollution origins.

Recently, interest has developed in managing receiving-water living resources, such as filter feeders which consume phytoplankton, as a supplement to management in the watershed. Development of a single, comprehensive model to address these issues is a formidable task. An alternative is a combination of interactive models, as employed here to examine the effects of the Atlantic menhaden, a filter-feeding fish, on water quality and nutrient budgets in Chesapeake Bay. A continental-scale airshed model, CMAQ, provides atmospheric nutrient loads to the watershed, the surface waters of the bay, and to the coastal ocean. The Watershed Model incorporates atmospheric loads and provides runoff, nutrient and solids loads to the receiving water model. This model combines a hydrodynamic model, which computes surface level, currents, and mixing, and a eutrophication model which computes nutrients, solids, dissolved oxygen, and phytoplankton. The eutrophication model provides the environment for the bioenergetics model of menhaden. The bioenergetics model allows for fish growth to be quantified based on food intake and energy losses to life processes such as respiration. Fish biomass and nutrient accumulation/recycling are explicitly accounted for, allowing for a realistic estimate of the impact of fish on the water column. Schools of fish are tracked individually, allowing for spatial resolution of their effects on phytoplankton and nutrient loading. Initial model runs have qualitatively replicated observed effects on water quality, including significant algal consumption, oxygen depletion, and ammonium excretion. Application of the model on a more detailed mesh grid for Chesapeake Bay is recommended before a definitive assessment is made of the potential impact a population increase might have on managing eutrophication.

---

12 Title: Numerical Simulation of Aquatic Ecology

Authors: Gaurav Savant, Charlie Berger, Steve Bartell, and Steve Ashby

Affiliation: U.S. Army Corps of Engineers

Abstract: The ecological effects of an island restoration effort were simulated within the combined numerical framework of the US Army Corps of Engineers (USACE) estuarine and riverine Adaptive Hydraulics (ADH) hydrodynamic-transport model and the ecological model "Comprehensive Aquatic System Model (CASM)". ADH is the USACE next generation unstructured and spatially adaptive finite element hydrodynamic model. CASM has been coupled to ADH using a Runge-Kutta 4th level time stepping scheme. This coupling has several advantages for ecological modeling such as fine resolution, faster run times, simultaneous hydrodynamic-ecological computations as well as the ability to simulate varied aquatic ecologies such as coastal, estuarine, riverine and others. Simulations results from several species show that the restoration of this island does not adversely affect the established ecology and the restoration of this island is beneficial to macrophytes as well as benthic invertebrates. The authors will present the coupling process between ADH and CASM as well as simulation results from the restoration efforts for an island. Current work using ADH-CASM on the hydrodynamic and ecological effects of Caernarvon diversion (Louisiana) will also be presented.

13 Title: The Development of Ecological Forecasts for Marine and Coastal Decision-making

Authors: Elizabeth Turner[1], Nathalie Valette-Silver[1], David Scheurer[1], Rob Magnien[1], Gary Matlock[2], and Marie Colton[3]

Affiliation: [1]NOAA National Ocean Service, National Centers for Coastal Ocean Science; [2]NOAA Office of Program Planning and Integration; [3]NOAA Great Lakes Environmental Research Lab

Abstract: The National Oceanic and Atmospheric Administration (NOAA) has a long history of forecasting weather, water levels, currents, and fish stocks through its various line offices. Ecosystem-based management demands the integration of marine and coastal ecosystem models with existing climate, water, and weather models, but this presents unique development challenges. These include: understanding complex physical, biological, chemical and behavioral interactions sufficiently to inform decision making over broad time and spatial scales; acquiring and assimilating adequate and representative observational and process data; testing and validating standard models; characterizing uncertainty in probabilistic forecasts; and providing adequate support to sustain operations. This poster will present examples of marine and coastal ecosystem model development at NOAA, including the forecasting of harmful algal blooms in the coastal ocean, beach water quality in the Great Lakes, sea nettle occurrence in Chesapeake Bay, and hypoxia in the northern Gulf of Mexico. It will also present an overview of efforts to evaluate the creation of a NOAA-wide Ecological Forecasting System to provide these types of forecasts in a more operational manner.

---

14 Title: Modeling Land Change in the Chesapeake Bay Watershed

Authors: David I. Donato and Peter R. Claggett

Affiliation: U.S. Geological Survey (Eastern Geographic Science Center)

Abstract: Regional land-change models are essential tools for decision-making related to restoration of the Chesapeake Bay because: (i) land cover and land use (now and in the future) influence water quality, water availability, and other environmental assets and outcomes; (ii) land use and land cover are dynamic, especially in coastal areas; (iii) many important drivers of land change can be managed; and (iv) managing the drivers of land change and planning for change will increase the effectiveness of policies and interventions required to restore the Bay. To achieve their full utility as tools for adaptive management, regional land-change models must be integrated with socio-economic models and physical environmental models because land change both influences, and is influenced by, a complex set of interactions and feedbacks among various natural and human-induced processes. The ongoing development of land-change models to support the adaptive formation, evaluation, and modification of Chesapeake Bay restoration policies will produce integrated datasets and new modeling tools essential for managing and planning for land change at the regional scale.

15 Title: Estimates of County-level Nitrogen and Phosphorous Data for use in Modeling Pollutant Reduction

Authors: Guido Yactayo
Affiliation: Universtiy of Maryland

Abstract: The Chesapeake Bay Program is facilitating increased nutrient and sediment control strategies by creating a framework and toolkit for adaptive management. The Chesapeake Bay Program recognizes that integrating regional water quality needs into local land use decisions is key to restoring the Bay. The Chesapeake Bay Program has worked for 25 years to track progress toward abating nitrogen, phosphorus, and sediment pollution in the Bay. The Chesapeake Bay Program is developing a free and on-line decision-support tool known as the Nutrient and Sediment Scenario Builder. This tool is designed to assist planners in meeting cap-loads associated with the TMDL. Since the Bay Program staff will also use this tool, the methods used for tracking progress will become more transparent. The tool is designed for rapid scenario development so users may understand the impacts of management practices and land use change, as well as develop more effective nitrogen and phosphorus management strategies. In essence, Scenario Builder allows local governments and watershed organizations to translate land use decisions such as zoning, permit approvals and BMP implementation into changes in pounds of nitrogen, phosphorus and sediment originating from a particular county or watershed. The underlying model to the Nutrient and Sediment Scenario Builder is process-based. The sources of nutrients include farm animals, chemical fertilizer, sewage sludge, septic and sewer systems. Users can estimate the impact of land use changes on nutrient and sediment loads by comparing scenarios. The implication of where and which best management practices are applied may also be determined. This information can help users target limited resources to the locations where they will have the most impact. Exploring these scenarios, coupled with monitoring and explanatory information, provides a powerful adaptive management tool to decrease nutrient and sediment loads to the Chesapeake Bay. The Scenario Builder is also used to provide the inputs to the Chesapeake Bay Program's Watershed Model – HSPF, which is newly updated to Phase 5.3. The intent is to have the inputs fully developed in Scenario Builder. The data used to calculate the inputs to the Watershed Model – HSPF Phase 5 are finer scale and takes additional factors into consideration, such as mineralization from organic fertilizer, crop types, and double-cropping.

---

16 Title: Transitioning a Chesapeake bay Ecological Prediction System to Operations

Authors: [1]Frank Aikman, [2]Christopher Brown, [1]Mary Erickson, [3]David Green, [4]Raleigh Hood, [5]Anthony Siebers, [6]Hendrik Tolman, [7]Doug Wilson* *(*Names of authors are arranged alphabetically)*
Affiliation: [1]NOAA National Ocean Service, Silver Spring, MD; [2]NOAA National Environmental Satellite, Data, and Information Service, College Park, MD; [3]NOAA, National Weather Service, Silver Spring, MD; [4]University of Maryland Center for Environmental Science - Horn Point Laboratory, Cambridge, MD; [5]NOAA, National Weather Service Forecast Office, Wakefield, MD; [6]NOAA, National Weather Service, National Centers for Environmental Prediction, Camp Springs, MD;

[7]NOAA Chesapeake Bay Office, Annapolis, MD

Abstract: NOAA is transitioning a prototype ecological system that predicts the probability of encountering sea nettles (*Chrysaora quinquecirrha*), a stinging jellyfish, in the Chesapeake Bay and its tidal tributaries, to operations. These jellyfish can negatively impact activities in the bay, and knowing where and when this biotic nuisance occurs may help to alleviate its effects. The bay-wide nowcasts and three-day forecasts of sea nettle likelihood are generated daily by forcing an empirical habitat model (that predicts the probability of sea nettles) with real-time and 3-day forecasts of sea-surface temperature (SST) and salinity (SSS). Importantly, this prediction system can be easily modified to predict the probability of other important target organisms, such as harmful algal blooms and water-borne pathogens, in the Chesapeake Bay. In the operational system, the SST and SSS fields will be generated by the Chesapeake Bay Operational Forecast System (CBOFS2), a 3-dimensional hydrodynamic model developed and operated by NOAA's Ocean Service and run at the NWS's National Centers for Environmental Prediction. It is anticipated that the operational forecasts will be disseminated and delivered through existing methods and portals, e.g. as digital images available via the World Wide Web and text-based messages included within NWS marine weather forecast products. This activity represents the first effort to leverage and strengthen NOAA-wide capabilities in order to transition a prototype ecological forecast product to NWS operations. The steps involved are consistent with NOAA Research to Operations Policy and adhere to the NWS Operations and Services Improvement Process (OSIP), the accepted requirements management process for bringing research results into the NWS operational environment. Consequently, in addition to operationalizing the sea nettle forecasts, the exercise will develop a framework for transitioning other ecological forecasts, promote an enterprise architecture and earth system management infrastructure, and improve delivery of knowledge-based products for integrated environmental decision support services.

---

17 Title: Assessing optimal complexity in aquatic ecosystem modeling

Authors: Corey McDonald and N.R. Urban
Affiliation: Michigan Technological University

Abstract: Aquatic ecosystem models have grown in complexity order to address increasingly intricate scientific and management issues. While the danger posed by overly complex models (overfitting resulting in reduced reliability) is widely recognized by modelers, quantitative evaluation of appropriate model complexity is not common in practice. We have applied information-theoretic model selection techniques to a set of 1-D aquatic ecosystem models; results suggest a simplified model structure is preferable even when a relatively large amount of calibration data is available. This approach highlights the need to develop parsimonious models, even when modeling large and/or data rich ecosystems, as well as the importance of fully assimilating available data. Current efforts are focused on synthesizing Bayesian calibration with model selection techniques to specify an optimal biogeochemical model for Lake Superior.

18 Title: Importance of Spatially Defined Sediment Chemistry on Modeling Accuracy

Authors: Keith Pilgrim and Brian Huser
Affiliation: Barr Engineering

Abstract: Large aquatic ecosystems are non-uniform, spatially diverse systems. Most three dimensional models adequately simulate the physical properties (e.g., temperature and density) and hydrodynamics of water in these ecosystems. However, the spatially distinct chemical properties and processes of bottom sediments are not included in the functionality of most three dimensional models despite the central role of bottom sediments in aquatic ecosystems. This poster demonstrates the importance of including spatially defined sediment chemistry in models for accurate calibration, prediction, and ecosystem understanding. The focus of this poster will be the spatial distribution of mobile phosphorus in lake sediments, depth-dependent phosphorus release, and other spatially dependent processes such as dissolved inorganic chemical flux (e.g., sulfate) and accumulation patterns of elements such as iron. This poster will be presented in conjunction with a poster by Deltares and the Delft 3D model.

---

19 Title: Modeling Towards a Healthy Ecosystem

Authors: Tineke Troost
Affiliation: Deltares

Abstract: The ecology in large aquatic ecosystems is deteriorating quickly. Deltares studies the ecological functioning of these ecosystems in relation to human use and spatial development, and provides high-end solutions on the most effective ways to restore ecosystem balance. This requires a sound understanding of the complex and dynamic characteristics of these ecosystems, and the various temporal and spatial scales involved. Deltares has developed a unique, fully integrated modeling framework for a multi-disciplinary approach and 3D computations of coastal, river, lake and estuarine areas. It can carry out simulations of flows, sediment transports, waves, water quality, morphological developments and ecology. The Delft3D framework is versatile by providing an open, user programmable, process-library. It is composed of several interactive modules, grouped around a mutual interface. Furthermore, Deltares participates actively in the development and application of the Open Modeling Interface (OpenMI), which allows interactive communication between various models (software) at an operational level. This poster will be presented in conjunction with a poster by Barr Engineering on the importance of spatially defined sediments on modeling accuracy.

---

20 Title: Coupling Conceptual Models with GIS to Develop a Community-based Index Model for the Missouri River Cottonwood Management Plan

Authors: Kelly A. Burks-Copes[1], Lisa A. Rabbe[2], Suzanne Boltz[3], Kristine Nemec[4], Antisa C. Webb[1], and Greg Kiker[5]
Affiliation: [1]Environmental Laboratory, US Army Engineer Research and Development Center, Vicksburg, MS; [2]US Army Corps of Engineers, Alaska District; [3]EA Engineering, Science and

Technology; [4]US Army Corps of Engineers, Omaha District; [5]Agricultural and Biological Engineering Department, University of Florida

Abstract: In compliance with the USFWS Biological Opinion regarding the Missouri River Operation activities, the Omaha and Kansas City Districts are actively pursuing restoration and preservation initiatives to offset past losses of cottonwood forests due in part to damming and channelizing the Missouri River in the early 1950s. Because the study area encompasses an enormous geographic range (1,500+ river miles flowing through 7 states), a decision was made to divide the system into 13 (6 of which were designated as priorities by USFWS) segments and address the restoration/preservation of each segment in an incremental (segment-by-segment) fashion. However, the functioning of the system's cottonwood riparian ecosystem can be affected by the current and future conditions at the local, regional and basin-wide scales. As such, the emphasis placed on a "systems" approach to the Missouri River Bi-Op's planning process has given rise to the need for methods to characterize habitat conditions now and in the future in a portable, adaptive manner with landscape-level sensitivity. As part of the cottonwood management planning effort, an extensive multidisciplinary ecosystem evaluation team has developed (and is currently applying) a community-based cottonwood index model to characterize the current state of the ecosystem today, and evaluate/compare the outputs of proposed preservation and restoration plans in the first of the 6 segments in the study (Segment 10 – a 59-mile stretch of "Wild and Scenic" Missouri River flowing from Gavins Point Dam to Ponca State Park in South Dakota and Nebraska). Here we provide a detailed look at the cottonwood model – its variables, formulas, and overall composition. A discussion of the modeling and application process will include our reference-based approach to calibration (including historical pre-damming characterizations); the expert elicitation strategies used to forecast landuse conversion, forest succession, and potential global climate change factors; the risk and uncertainty analysis incorporated into the plan formulation and evaluation efforts; and ultimately the development of a standardized, integrated planning procedure that will now be used to systematically evaluate the segments (both upstream and downstream) highlighted in the Missouri River Bi-Op's cottonwood management plan.

---

21 Demonstration Title: Application of the "Advanced Aquatic Ecosystem Model" (A2EM-3D) to Inform Management of Great Lakes Ecosystems

Authors: Todd M. Redder, Joseph V. DePinto, Edward M. Verhamme
Affiliation: LimnoTech

Abstract: The aquatic ecosystems that comprise the Great Lakes are faced with many stressors that affect water and sediment quality, including excessive localized loadings of sediment and nutrients, harmful algal blooms, invasive species, and toxic chemicals. An integrated modeling framework that we call the Advanced Aquatic Ecosystem Model (A2EM-3D) has been specifically designed to serve as a dynamic modeling framework to address these issues and related management questions in several Great Lakes systems, including Saginaw Bay and the Maumee River/Bay system. The

model framework simulates hydrodynamics and sediment transport within the Environmental Fluid Dynamics Code (EFDC) model, which is linked to an enhanced version of the Row-Column AESOP (RCA) model to simulate water quality dynamics. Water quality dynamics are represented by a suite of water quality and lower food web state variables, including multiple inorganic and organic forms of carbon, nitrogen, phosphorus, and silica; 5 classes of phytoplankton; and 3 classes of zooplankton. A2EM-3D has recently been enhanced to include a benthic algae component and two classes of benthic filter feeders intended to represent invasive Dreissenid mussel species. The development and application of A2EM-3D for these systems has been greatly facilitated by the pre-/post-processing and visualization tools provided by WinModel, a software application developed by LimnoTech. WinModel supports rapid development of water quality simulations and highly efficient visualization and calibration of model results, including spatial and temporal animations and map-based animations based on the open-source MapWindow GIS software.

Speakers Biographies

Ben Cope

Ben Cope is an environmental engineer (BS, Stanford University) with the Office of Environmental Assessment in EPA Region 10. He worked for several years in the Region's water programs (NPDES permits and TMDLs) prior to focusing on water quality modeling and assessment in the 2000. His current projects include assessments of the Snake River (temperature), Spokane River (dissolved oxygen, nutrients), and Klamath River (temperature, nutrients, dissolved oxygen). He is also providing support for the state of Washington as they develop models for analysis of water quality impacts in Puget Sound. Ben brings state and EPA modelers together for an annual meeting on water quality modeling practice, and he co-authored the recent guidance document on modeling by EPA's Council on Regulatory Environmental Modeling (CREM).

Robert Costanza

Dr. Costanza is the Gordon and Lulie Gund Professor of Ecological Economics and director of the Gund Institute for Ecological Economics at the University of Vermont. He is also a Distinguished Research Fellow at the New Zealand Center for Ecological Economics, Massey University, Palmerston North, New Zealand, a Senior Fellow at the Stockholm Resilience Center, Stockholm, Sweden.

Dr. Costanza received BA and MA degrees in Architecture and a Ph.D. in Environmental Engineering Sciences (Systems Ecology with Economics minor) all from the University of Florida. Before Vermont, he was on the faculty at LSU and Maryland.

Dr. Costanza's transdisciplinary research integrates the study of humans and the rest of nature to address research, policy and management issues at multiple time and space scales, from small watersheds to the global system. Dr. Costanza is co-founder and past-president of the International Society for Ecological Economics, and was chief editor of the society's journal, Ecological Economics from its inception in 1989 until 2002. He currently serves on the editorial board of eight other international academic journals. He is founding editor in chief of Solutions, a new hybrid academic/popular journal. His awards include a Kellogg National Fellowship, the Society for Conservation Biology Distinguished Achievement Award, a Pew Scholarship in Conservation and the Environment, the Kenneth Boulding Memorial Award for Outstanding Contributions in Ecological Economics, and an honorary doctorate in natural sciences from Stockholm University.

Dr. Costanza is the author or co-author of over 400 scientific papers and 20 books. His work has been cited in more than 5000 scientific articles and he has been named as one of ISI's Highly Cited Researchers. More than 200 interviews and reports on his work have appeared in various popular media. His article on "The value of the world's ecosystem services and natural capital", published in Nature 387:253-260 (1997) is the second most highly cited article in ecology/environment in the last decade. More information on Costanza and the Gund Institute is online at www.uvm.edu/giee/

Lee Currey

Lee Currey is a division chief in the TMDL Technical Development Program where he currently oversees both TMDL development and biological stressor identification for the Department of the Environment (MDE). While at MDE Lee has led the development bacteria and sediment TMDL methods, developed TMDL monitoring strategies, served as co-chair of the Chesapeake Bay Program sediment workgroup and participates in several Chesapeake Bay Program workgroups. Lee is currently providing technical and policy oversight on in both the Coastal Bays and Chesapeake Bay TMDLs. In addition Lee is leading the efforts and developing strategies for MD*s Chesapeake Bay TMDL sub-allocation process.

Lee is as registered professional engineer, has a Bachelors Degree in Civil Engineering with an environmental engineering concentration from University of Delaware, and a Master of Science Degree in Civil Engineering with a water resources engineering concentration from Old Dominion University.

Joseph DePinto

Dr. DePinto is a Senior Scientist at LimnoTech, a water science and engineering consulting firm in Ann Arbor MI. In this position, he directs both applied research and resource management and restoration projects on a wide range of aquatic system topics, including nutrient cycling-eutrophication, hydrophobic organic chemical and heavy metal (including mercury) exposure and bioaccumulation, contaminated sediment assessment and remediation, aquatic ecosystem structure and functioning, and water sustainability and stewardship. He has 37 years experience in the field, the first 27 of which were as a Professor of Environmental Engineering at Clarkson University and the University at Buffalo. His studies have led to over 150 publications and the direction of more than 50 Master's theses and 12 Ph.D. dissertations. Much of Dr. DePinto's career has been focused on research and management of the Great Lakes, with important contributions to the development and application of mathematical models aimed at providing a quantitative understanding and predictive capability for the full range of issues within the basin. Most recently his work has been directed on modeling the impacts of multiple stressors acting in concert on aquatic systems to produce multiple response endpoints. This new paradigm of modeling allows simultaneous consideration of several management areas, such as nutrient load control, toxic chemical exposure, fish harvesting/stocking practices, aquatic nuisance species invasions, and water use and resource management.

Chuck Fox

Chuck Fox is a Senior Advisor to the Administrator, focused on Chesapeake Bay and the Anacostia River. Before joining the Environmental Protection Agency in March 2009, he served as a Senior Officer with The Pew Charitable Trusts, managing its international marine conservation programs. Fox also served as the Secretary of the Maryland Department of Natural Resources and the Assistant Administrator for Water at EPA. He worked for a number of nonprofit environmental organizations including the Chesapeake Bay Foundation, Friends of the Earth, American Rivers and the Environmental Policy Institute. He is the former Chairman of the Board of the Maryland League of Conservation Voters and a graduate of the University of Wisconsin.

Noha Gaber

Noha Gaber is the Executive Director for EPA’s Council for Regulatory Environmental Modeling (CREM). She has served as an environmental engineer on the CREM staff since joining the Agency in 2005. The primary focus of her position is to provide leadership in developing and implementing activities to help ensure that the Agency's model-based decisions are founded on the best available science and are legally defensible. Noha has initiated a new initiative at EPA on “Integrated Modeling for Integrated Environmental Decision Making”. Under this initiative, she organized and facilitated two international workshops on integrated modeling, lead the development of an Agency white paper on “Integrated Modeling for Integrated Environmental Decision Making” and is leading the development of an international Community of Practice on Integrated Environmental Modeling. She is also the co-author of the EPA Guidance on the Development, Evaluation and Application of Environmental Models and 3 book chapters in a book on Environmental Modeling. The book chapters were entitled “Good Modelling Practice”, “Bridging the gaps between design and use: developing tools to support environmental management and policy”, and “Complexity and Uncertainty: Rethinking the Modelling Activity”. Noha received her Bachelors and Doctoral degrees in Environmental Engineering from the University of Southampton in the UK. Her doctoral thesis focused on developing a model to determine the fate of heavy metals in municipal wastewater treatment plants.

Michael Haire

Michael Haire has been with EPA’s, Office of Wetlands, Oceans and Watersheds, since 1999. He has worked closely with the states and Regions to address technical and policy issues associated with the identification of impaired waters. He has led agency efforts in issuing guidance on developing Integrated Reports. Additionally, he has been involved in developing and reviewing complex TMDLs, especially on the watershed scale.

Prior to his employment with EPA, Mr. Haire worked for the Maryland Department of the Environment (MDE) as the Director of the Technical and Regulatory Services Administration. In this position, Mr. Haire was responsible for the State=s water quality standards program, the water quality monitoring program, the shellfish certification program, the TMDL program, the environmental health program and the emergency response program.

Mr. Haire holds undergraduate degrees in civil engineering and biology and graduate degrees in marine biology and business administration.

Paul Horvatin

Paul Horvatin is the Monitoring, Indicators, and Reporting Branch Chief for the U.S. EPA Great Lakes National Program Office. Paul has been with the EPA for over 30 years. He received his MS from the University of Illinois-Urbana in Environmental Engineering and his BS from University of Illinois-Urbana in Biology. Paul is responsible for indicator development and monitoring programs for USEPA in the Great Lakes including: open lakes monitoring, Integrated Atmospheric Deposition Network (IADN), contaminated fish monitoring, biological monitoring (phytoplankton, zooplankton and benthic), Research Vessel Lake Guardian management, and health and safety management for GLNPO. He is also the U.S. Co-Chair for State of the Lakes Ecosystem Conference (SOLEC). Paul has served as project manager and project officer for numerous EPA programs and has received numerous Agency Honor Awards.

Russell Kreis

Russ is the Station Director and Branch Chief at ORD’s Large Lakes Research Station at Grosse Ile, Michigan. Russ has been with the EPA for over 20 years and has worked on the Great Lakes for over 30 years. He received his Ph.D. from the University of Michigan in Natural Resources and his Bachelors and Masters degrees from Eastern Michigan University in Biology, Chemistry, and Geology. Russ has authored or co-authored over 60 publications and reports dealing with diatoms, contaminated sediment and bioassays, zebra mussels, paleolimnology, acid rain, and the mass balance modeling of contaminants in the Great Lakes. He has served as project manager and project officer for numerous EPA programs, has received 2 EPA Bronze Medals, and is a Past Secretary of the International Association for Great Lakes Research.

Jeff Lape

Director of Chesapeake Bay Program Office

John Lehrter

John Lehrter is a research ecologist at EPA's Office of Research and Development, Gulf Ecology Division. John received his PhD from the University of Alabama in 2003 and joined EPA in 2004. John is the team leader of the Nutrients team, who's research focuses on mechanistic understanding of the biogeochemical processes regulating ecosystem responses to nutrients and other stressors. Through research activities and technical support, our team assists EPA and the states in the development of nutrient-related water quality standards for estuarine and coastal ecosystems. John's current research topics include oceanographic studies and modeling of the Louisiana Continental Shelf relative to Mississippi River nutrient inputs and the formation of the 'Dead Zone', coupled watershed-estuarine studies of nutrient transport and fate, and uncertainty analysis and propagation in ecosystem studies.

Lewis Linker

Lewis Linker is the Chesapeake Bay Program Modeling Coordinator, and works with colleagues throughout the Chesapeake Bay Program to develop linked models of the airshed, watershed, estuary, and living resources of the Chesapeake. Active collaborators in Chesapeake model development include the U.S. Environmental Protection Agency, the Corps of Engineers, the U.S. Geological Survey, NOAA, the Maryland Department of the Environment, the Virginia Department of Conservation and Recreation, the University of Maryland, the Interstate Commission of the Potomac River Basin, and others. The collaborative Chesapeake Bay community model is one of the largest and most detailed regional simulations of water quality and living resources to date. The linked models of the Chesapeake have made key contributions to developing nutrient and sediment reductions in the Chesapeake, which will be fully protective of living resources. The nutrient and sediment allocations now under development for the Chesapeake TMDL will reduce Chesapeake nutrient and sediment loads by about a half and one third, respectively, from the high point of nutrient and sediment loading in the mid 1980's.

Lew Linker's professional interest is in the expansion and refinement of current watershed, airshed, and estuarine models of the Chesapeake, and in expanding the capabilities and analysis of linked water quality and living resource models generally. Lewis Linker has authored more than 110 reports, book chapters, papers, and invited presentations. He and his team have received sixteen major awards including an EPA Gold Medal and three Bronze Medals, two major EPA awards for scientific achievement, two Smithsonian Awards in information technology excellence, and the Horner Award from the American Society of Civil Engineers.

Christopher J. Madden

Dr. Madden is Lead Scientist with the Everglades Division at South Florida Water Management, the agency responsible for managing water resources in the Everglades, Florida Bay and the Florida Keys. His research in estuarine and coastal ecology focuses on ecosystem dynamics and ecological modeling, addressing watershed and coastal processes. Of interest is the influence of hydrologic and biogeochemical processes on water quality, primary production and ecosystem function in Florida and diverse other systems such as the Yucatan and Baja coasts in Mexico, the Mississippi Delta, Chesapeake Bay and Danish fjord ecosystems. Current projects include field studies on seagrass dynamics and phytoplankton bloom processes including development of a simulation model characterizing ecosystem response to restoration, management and climate change in Florida Bay. Madden is the developer of Dataflow© technology for high-speed, spatially extensive water quality mapping in real time. He has adjunct appointments at the University of Maryland, Florida Atlantic University and was a Fulbright Fellow at the National Polytechnic Institute of Mexico.

Robin Landeck Miller

Robin has more than twenty years of experience in water quality modeling, mostly in the NY/NJ Harbor Estuary, New York Bight, Long Island Sound system. Robin is HydroQual Inc.'s Environmental Fate and Transport Operation Leader. Robin has been involved with numerous water quality projects related to Long Island Sound including a re-assessment of the nutrient TMDL and investigating factors contributing to the decline of the lobster population. The re-assessment of the Long Island Sound Nutrient TMDL included an evaluation of shellfish and seaweed biomass extraction as an alternative dissolved oxygen and nutrient management strategy. Many of Robin's professional endeavors have been devoted to the application of the System-Wide Eutrophication Model (SWEM) to address the management of nitrogen inputs to the East River and Long Island Sound. She was directly responsible for the development of SWEM including its construction, calibration/validation, code refinement, peer review (i.e. through a Model Evaluation Group (MEG) process), and the management of the supercomputer resources necessary to implement SWEM. She holds a Master of Science Degree in Environmental Engineering and a Bachelor of Science Degree in Biology.

James O'Donnell

Professor O'Donnell is a coastal physical oceanographer. His research is aimed at understand the physical processes that determine the circulation and transport of materials in the coastal ocean. With students and research associates, he is currently involved in both the construction and testing of models and the development of observational techniques. He is also interested in fundamental geophysical and environmental fluid dynamics and the application of mathematical and statistical methods to the development of models of biogeochemical processes.

In the last decade Prof. O'Donnell has been involved in the development of a permanent ocean observing system in Long Island Sound and the adjacent shelf. This multi-use infrastructure informs environmental managers, the general public as well as providing new scientific insights. The availability of this type of data has provoked new applications and Prof. O'Donnell has collaborated with the U.S. Coast Guard to develop an improved drift prediction system for the search and rescue applications.

Prof. O'Donnell has contributed to the administration of the University of Connecticut as chair of the Committee on Courses and Curricula of the College of Liberal Arts and Sciences as Interim Head of the Department of Marine Sciences and Interim Director of the Marine Science and Technology Center. He is a Director of both the North East Regional Association of Coastal Ocean Observing Systems and the Middle Atlantic Coastal Ocean Observing Regional Association. He has been appointed to the Bi-State Commission on Long Island Sound.

John Powers

John Powers is a senior economist on the Water Policy Staff in EPA's Office of Water. John's responsibilities include developing multidisciplinary models for conducting economic analysis and designing forward-looking strategic policy. Prior to joining EPA a little more than 10 years ago, John taught economics at St. Lawrence University and worked as a consultant at ICF Consulting. John holds a Ph.D. in economics from Indiana University.

Mindy Roberts

Mindy Roberts is an environmental engineer with the Washington State Department of Ecology, Environmental Assessment Program, and a registered professional engineer in the State of Washington and Commonwealth of Massachusetts. Mindy received her BS in Civil Engineering from the University of California, Berkeley, in 1989; MS in Civil and Oceanographic Engineering from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution in 1992; and Ph.D. in Civil and Environmental Engineering from the University of Washington in 2007. She manages several projects evaluating human influences on Puget Sound and its watershed using modeling tools. Mindy also is affiliate faculty at the University of Washington, Tacoma, Environmental Sciences program, where she teaches stream ecology.

Gary Shenk

Gary Shenk has been with the Chesapeake Bay Program for 14 years and is primarily responsible for the development of the watershed model. He also is active in model integration and the analysis of monitoring data. He is currently the coordinator of the newly-formed Scientific and Technical Analysis and Reporting group at the Chesapeake Bay Program.

Mark Tedesco

Mark Tedesco is director of the United States Environmental Protection Agency's Long Island Sound Office. The office coordinates the Long Island Sound Study, administered by EPA as part of the National

Estuary Program under the Clean Water Act. Mr. Tedesco was responsible for completing the $16 million, multi-year program to identify and address remaining water quality impairments in the Sound. The study culminated in the 1994 approval of a Comprehensive Conservation and Management Plan for the Sound by the Governors of New York and Connecticut and the EPA Administrator. Mr. Tedesco is now responsible for continued oversight of the program with a focus on implementation of the management plan in cooperation with government and private agencies and organizations. Mr. Tedesco has worked for EPA for 23 years. He received his M.S. in marine environmental science in 1986 from Stony Brook University.

Glenn Warren

Dr. Glenn Warren began working on the Great Lakes in 1975. He received a B.S. in Zoology from the University of Wisconsin, M.S. and Ph.D. from the University of Wisconsin-Milwaukee (Limnology). His current responsibilities include chemical and biological monitoring of the Great Lakes as part of the long-term U.S. EPA-Great Lakes National Program Office monitoring effort, including sampling and other operations from the R/V Lake Guardian. He has managed the Lake Michigan Mass Balance Program and is currently involved with the Coordinated Science and Monitoring Initiative with U.S. and Canadian federal agencies.

Pai-Yei Whung

As Chief Scientist, Dr. Pai-Yei Whung shares fully with the EPA Science Advisor in planning and developing cross-Agency scientific efforts. Dr. Whung joined EPA in April 2008, and led the completion of the first cross-EPA Science Priorities initiative. In support of President's Green Jobs and Environment efforts, Dr. Whung is leading an integrated environmental technology portfolio to provide rapid solutions to emerging environmental challenges. In the area of climate change, as a trained climate change scientist, Dr. Whung chairs an intra-Agency and inter-Agency workgroup on climate and health science for decision and policy making. She is also spear heading a climate change and health initiative with the World Health Organization to focus on co-benefits of greenhouse gas and/or black carbon reduction.

Dr. Whung has a doctoral degree in climate change, marine and atmospheric chemistry, a masters degree in oceanography and marine chemistry, and a bachelors degree in oceanography and geology. She has fifteen years of field research experience and eight years of program management and leadership in air quality, water quality, weather, sustainable ecosystems, climate change, and agricultural research. Her research has been published in peer-reviewed journals and presented at many professional meetings.

Dr. Whung has worked successfully with states, private-sector stakeholders, cross-federal agencies, the Office of Management and Budget, the Office of Science and Technology, and Congress to develop science for policy and decision making initiatives, such as National Integrated Drought Information System, National Air Quality Forecasting Program and improved weather and climate information for advancing energy management.

Prior to joining EPA, Dr. Whung served as the senior executive director for international in the Agricultural Research Service at U.S. Department of Agriculture. One of her major accomplishments is to open the dialogue between U.S. and Brazil on science and technology exchanges in renewable energy, particularly in agricultural based biofuel. Dr. Whung also worked at the National Oceanic and Atmospheric Administration where she was seconded to the World Meteorological Organization. Dr. Whung successfully worked with the Weather Channel, Energy CEOs, and federal agencies to launch an U.S. led twelve-nation climate prediction program. Through these positions, Dr. Whung has cultivated a broad perspective on science and technology in the federal government and our partners.